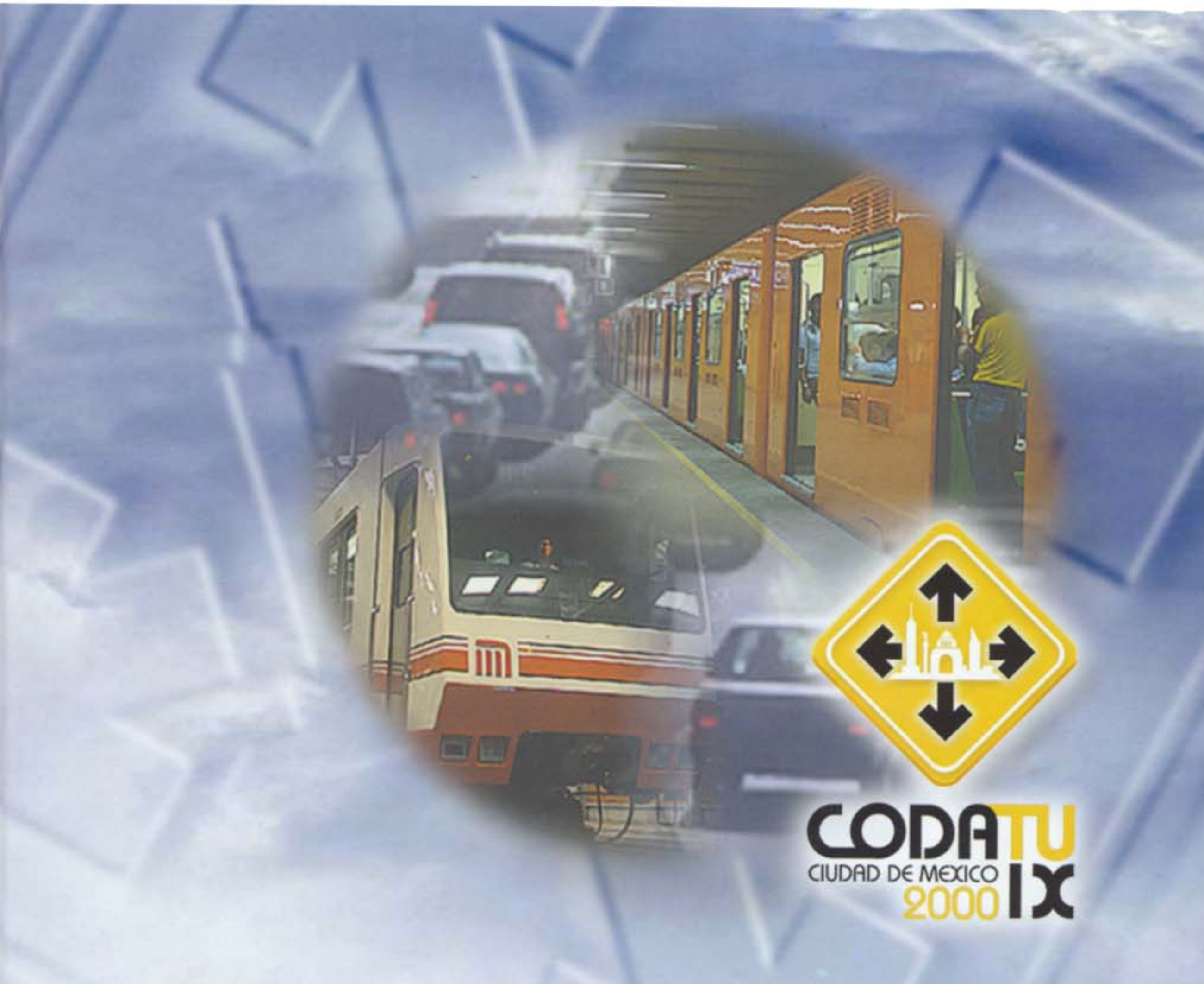
Urban Transportation and Environment

Transport Urbain et Environnement

Transporte Urbano y Medio Ambiente



INTERNATIONAL SCIENTIFIC COMMITTEE

EDITED BY

OSCAR DÍAZ, GONZÁLEZ PALOMAS & CHRISTIAN JAMET

CODATU

CIUDAD DE MÉXICO

URBAN TRANSPORTATION AND ENVIRONMENT
TRANSPORT URBAIN ET ENVIRONNEMENT
TRANSPORTE URBANO Y MEDIO AMBIENTE

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Urban Transportation and Environment
Transport Urbain et Environnement
Transporte Urbano y Medio Ambiente

Edited by

Oscar Díaz González Palomas & Christian Jamet

Co-presidents CODATU IX International Scientific Committee

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Table of contents
Table des matières
Índice

1.2 *Examples of transport policies*
Exemples des politiques de transport
Ejemplos de políticas de transporte

1.3 *Methods of choice of a transport policy*
Méthodes de choix d'une politique de transport
Métodos de eleccíon de políticas de transporte

1.6 *Pedestrians, two wheels*
Piétons, deux roues
Peatones, dos ruedas

2 *Transport planning and urban development*
Planification du transport et développement urbain
Planeación del transporte y desarrollo urbano

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Preface

The Association CODATU (Cooperation for the continuing development of urban and suburban transportation) is an association of international vocation, the aim of which is to promote scientific, technical, economic, and social exchanges and activities in the field of urban and suburban transportation; it is based on exchanges of experiences between developing, transition and older industrialized countries.

CODATU IX will be held in Mexico, one of the greatest metropolises of the world. The metropolitan zone of Mexico (ZMCM) gathers, on 4945 square kilometres, the 17 millions of inhabitants of the Federal District and of the State of Mexico; it provides the 30 millions of everyday transportation and represents 38% of the Mexican GDP; the average altitude of the ZMCM (2200 m) means that the concentration of oxygen is reduced by a third; as a consequence, the 3,2 million vehicle traffic of the urban centre produces twice as much carbon monoxyde as at the level of the sea; more than 80% of the pollution of Mexico comes from the traffic of vehicles.

The main topic selected for the Conference CODATU IX is 'Urban Transportation and Environment'.

As a matter of fact, which metropolitan zone could, better than Mexico's, symbolize the importance of taking into account the environment in the establishment of transportation policies? The notion of environment, understood in its wide meaning, includes the various technical, social, political, and economic factors which have an influence on the life conditions in town; efficient transport and mastered urban development constitute a vital link in the perspective to improve the air quality in urban centres. The main goal of CODATU IX is to enlighten the necessary structures between the transportation and the environmental policies.

This policy presents the papers received in time so as to be inserted in it. These are classified according to the topics presented in the final programme.

The topics are the following:

Transport policies related to environment:

- examples of the present situation;
- examples of transport policies;
- methods of choice of a transport policy;
- noise, pollution and other environmental issues;
- public transport issues;
- pedestrian, twowheels.

Transport planning and urban development;

Transport demand management measures;

Institutional strengthening;

Financial aspects – Externalities;

Mobility and accessibility – Socials aspects;
Technologies – Energy and alternative fuels;
Transport, safety and traffic engineering.

All the papers gathered in these records cover a very wide field; this basic matter, enriched with the discussions and exchanges that will be held during the sessions and round-table will constitute an important contribution to the topic of CODATU IX: urban transportation and environment.

Christian Jamet and Oscar Díaz González Palomas
Co-Presidents CODATU IX of the International Scientific Committee

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Préface

L'association CODATU (Coopération pour le Développement et l'Amélioration des Transports Urbains et périurbains) est une association à vocation internationale dont l'objectif est de promouvoir les actions d'animation et des échanges scientifiques, techniques, économiques et sociaux concernant les systèmes des déplacements urbains et périurbains; elle s'appuie sur l'échange des expériences entre les pays en développement et les pays les plus anciennement industrialisés.

CODATU IX se tient à Mexico, une des plus grandes métropoles du monde. La zone métropolitaine de Mexico (ZMCM) rassemble, sur 4945 km^2, les 17 millions d'habitants du District Fédéral et de l'Etat de Mexico; elle en assure les 30 millions de déplacements quotidiens et représente 38% du P.I.B. Mexicain; l'altitude moyenne de la ZMCM (2200 m) fait que la concentration d'oxygène est réduite d'un tiers; en conséquence, la circulation de 3,2 millions de véhicules de l'agglomération produit deux fois plus de monoxyde de carbone qu'au niveau de la mer; plus de 80% de la pollution de Mexico provient de la circulation automobile.

Le thème principal retenu pour la conférence CODATU IX est 'Les déplacements urbains et l'environnement'.

Quelle zone métropolitaine dans le monde pouvait, en effet, mieux que celle de Mexico symboliser l'importance de la prise en compte de l'environnement dans l'établissement des politiques des déplacements? La notion d'environnement, comprise dans un sens large, intégre les différents facteurs techniques, sociaux, politiques et économiques qui influent sur les conditions de vie en ville; transports efficaces et développement urbain maîtrisé constituent un lien essentiel dans la perspective d'améliorer la qualité de l'air dans les centres urbains. L'objectif principal de CODATU IX est de mettre en lumière les nécessaires articulations entre les politiques des déplacements et les politiques d'environnement.

Cette politique présente les contributions reçues à temps pour y être intégrées. Celles-ci sont classées selon les thèmes présentés dans le programme final.

Les thèmes sont les suivants:

Politiques de transport en rapport avec l'environnement:
- exemples de la situation présente;
- exemples des politiques de transport;
- méthodes de choix d'une politique de transport;
- bruit, pollution et autres questions liées à l'environnement;
- qualité du transport public;
- piétons, deux roues.

Planification du transport et développement urbain;

Demande du transport et mesures de la gestion;

Renforcement institutionnel;

Aspects financiers – Externalités;
Mobilité et accessibilité – Aspects sociaux;
Technologie – Energie et carburants alternatifs;
Transport, sécurité et techniques de circulation.

L'ensemble des contributions regroupées dans ces actes couvre un champ très large; cette matière de base enrichie des discussions et échanges qui auront lieu pendant les sessions et table ronde constituera une contribution importante au thème de CODATU IX: les déplacements urbains et l'environnement.

Christian Jamet et Oscar Díaz González Palomas
Co-Présidents CODATU IX du Comité Scientifique International

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Prefacio

La asociación CODATU (Cooperación para el Desarollo y Mejora de los Transportes Urbanos y Suburbanos) es un asociación con vocación internacional cuya finalidad es la promoción de las acciones de animación y de intercambios científicos, técnicos, económicos y sociales referentes a los sistemas de transportes urbanos y suburbanos: se apoya en el intercamio de experiencias entre los países en vias de desarrollo y los países ya industrializados.

CODATU IX se celebra en México, una de las mayores metrópolis del mundo. La zona metropolitana de México (ZMCM) reúne, en 4945 km^2, a los 17 millones del Distrito federal y del Estado de México; permite los 30 millones de transportes cotidianos y representa el 38% del P.I.B. mexicano. La altitud media de la ZMCM (2200 m) tiene como consecuencia que se reduce en un tercio la concentración de oxígeno; por tanto, el tránsito de 3,2 millones de vehículos por la zona poblada produce dos veces más monóxido de carbono que a nivel del mar; más del 80% de la contaminación tiene su origen en el tráfico automovilístico.

El tema principal seleccionado para la conferencia CODATU IX es "Los transportes urbanos y el medio ambiente".

De hecho, ¿qué zona metropolitana en el mundo podía, mejor que la de México, simbolizar la importancia de la toma en cuenta del medio ambiente en la previsión de las políticas de transportes? La noción de medio ambiente, concebida en un sentido amplio, integra diferentes factores técnicos, sociales, políticos y económicos que influyen en las condiciones de vida en la ciudad; transportes eficientes y desarrollo urbano dominado, constituyen un lazo esencial con vistas a la mejora en la calidad del aire en los centros urbanos. La meta principal de CODATU IX es evidenciar las necesarias articulaciones entre las políticas de transportes y las políticas del medioambientales.

Esta política presenta las contribuciones recibidas a tiempo para ser integradas. Se clasifican según los temas presentados en el programa final.

Los temas son los siguientes:

Políticas de transporte relacionadas con el medio ambiente:

- ejemplos de la situación actual;
- ejemplo de políticas de transporte;
- métodos de elección de políticas de transporte;
- ruido, contaminación y medio publico;
- calidad del transporte público;
- peatones, dos ruedas.

Planeación del transporte y desarrollo urbano;
Medidas para la administración de la demanda de transporte;
Fortalecimiento institucional;
Aspectos financieros – Externalidades;
Movilidad y accesibilidad – Aspectos sociales;
Tecnologías – Energía y combustibles alternos;
Transporte, seguridad y técnicas de ingeniería de tránsito.

Todas estas contribuciones agrupadas en estas actas abarcan un campo muy amplio; estas bases enriquecidas por las discusiones y los intercambios que tengan lugar durante las sesiones y las mesas redondas constituirán una importante contribución al tema de CODATU IX; los transportes urbanos y el medio ambiente.

Christian Jamet y Oscar Díaz González Palomas
Co-presidentes CODATU IX del Comité Científico Internacional

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Welcome address

On behalf of the Federal District Government, I have the pleasure to welcome all participants to the 9th World Urban and Suburban Transport Congress which will be held in Mexico City and whose main topic is: Transport and Environment.

It is with a great sense of responsibility that we have accepted the task of organising this wide ranging event, which will be the meeting place for key figures and world experts anxious to find optimal solutions which will bring a better quality of life to all cities, no matter what size or density.

Obtaining steady development is no easy task and it is to this that authorities and citizens throughout the world are committed. I therefore propose to make the most of our experience and the opportunities that meetings which unite us, such as this one, can offer, to generate technological development without detriment to either the culture or the characteristics of each country and each city.

The 9th World CODATU Conference is an occasion to discuss problems and solutions as much for Mexico City as for other world metropolises. It is in fact a wonderful forum in which the cities can confer frankly and constructively and can do this in the legitimate interests of their inhabitants.

We are totally aware of the fact that the governmental policies in terms of transport and environment must be in keeping with and complementaryto the programmes of urban development. What we need is a transport that will support the economic development of cities and countries, that will bring men together, but that will also avoid the degradation of the environment. It is thus necessary to define policies in line with one goal: To transform our planet into a more welcoming place to live for the human being, and it is together that we will achieve this.

During this event we may discover the experiences of legislators, technicians, faculty members, consultants, company heads and authorities. Each will offer their best solutions and among the propositions we will choose the best option to apply to our own city. CODATU IX is in perfect accord with Mexico City's Local Authorities and wishes to research long term policies and programmes and to envisage viable financial mechanisms for the city.

For these reasons, on behalf of Mr Rosario Robles Berlanga, the Federal District Government Head, once again I would like to wish acting spokespersons and participants an agreeable stay in this 'Open City' and I foresee great success for the works of CODATU IX.

Engineer A. Joel Ortega Cuevas
Secretary for Transport and Highways of the District Federal Government

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Message de bienvenue

Au nom du Gouvernement du District Fédéral, j'ai le plaisir de souhaiter la bienvenue à tous les participants au 9ème Congrès Mondial du Transport Urbain et Suburbain qui aura lieu dans la Ville de México et dont le thème central sera: Transport et Environnement.

C'est avec un grand sens de la responsabilité que nous avons accepté la mission d'organiser cet événement d'envergure, qui sera le rendez-vous de hautes personnalités et d'experts mondiaux, soucieux de trouver les solutions optimales qui apporteront une meilleure qualité de vie à toutes villes quelles que soient leur importance et leur densité.

Obtenir un développement soutenu n'est pas une tâche facile et c'est à cela que s'engagent les autorités et les citoyens du monde entier. Je propose donc de mettre à profit notre expérience et les occasions, que des rencontres comme celle qui nous réunit nous offrent, pour générer un développement technologique, sans porter préjudice à la culture ni aux caractéristiques de chaque région, de chaque pays et de chaque ville.

Le Neuvième Congrès Mondial de CODATU est une chance pour que soient débattus tant les problèmes et les solutions de la Ville de México que ceux des métropoles du monde. Il s'agit d'un magnifique forum pour que les villes discutent entre elles de manière franche et constructive et dans l'intérêt légitime de leurs habitants.

Nous sommes bien conscients du fait que les politiques gouvernementales en matière de transport et d'environnement doivent s'harmoniser et être complémentaires des programmes de développement urbain. Nous avons besoin d'un transport qui soutiendra le développement économique des villes et des pays, qui rapprochera les hommes, mais qui évitera aussi la dégradation de l'environnement. Il est donc nécessaire de définir des politiques en adéquation avec un objectif: transformer notre planète en habitat plus accueillant pour l'être humain et c'est ensemble que nous y parviendrons.

A l'occasion de cet événement nous pourrons découvrir les expériences des législateurs, techniciens, universitaires, consultants, chefs d'entreprises et autorités. Tous nous apporteront les meilleures solutions et parmi chaque proposition nous choisirons la meilleure option pour l'appliquer à notre ville. CODATU IX est en parfait accord avec le Gouvernement de la Ville de México, et a la volonté de rechercher des politiques et des programmes à long terme et d'envisager des mécanismes de financement viables pour la Ville.

C'est pourquoi, au nom de Maître Rosario Robles Berlanga, Chef du Gouvernement du District Fédéral, je renouvelle aux rapporteurs et congressistes mes voeux d'agréable séjour dans cette 'Ville ouverte à tous' et j'augure le plus grand succès pour les travaux de CODATU IX.

Ingénieur A. Joel Ortega Cuevas
Secrétaire aux Transports et à la Voirie du Gouvernement du District Fédéral

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Mensaje de bienvenida

En nombre del Gobierno del Distrito Federal me complace dar la bienvenida a todos los participantes al Noveno Congreso Mundial de Transporte Urbano y Suburbano que habrá de realizarse en esta Ciudad de México, cuyo tema central es Transporte y Medio Ambiente.

Con enorme responsabilidad hemos recibido la encomienda de organizar este evento de gran envergadura, ya que da cita a grandes personalidades y expertos a nivel mundial, preocupados por encontrar las mejores soluciones que permitan forjar una mejor calidad de vida en las ciudades, sin importar su tamaña o densidad.

Lograr un desarrollo sustenable no es tarea fácil y en ello estamos comprometidos autoridades y ciudadanos del mundo entero. Propongo que utilicemos la experiencia y las condiciones que encuentros como el que nos ocupa, nos proporcionan para generar desarrollo en donde no lo hay; para mantener el bienestar en donde existe, para universalizar el conocimiento y el desarrollo tecnológico, sin menoscabo por la cultura y las características de cada región, país y ciudad.

El Noveno Congreso Mundial de CODATU es una oportunidad para que sean discutidos tanto los problemas y soluciones de la Ciudad de México como los de las metrópolis del orbe; es un magnífico foro para que las ciudades se hablen entre sí de manera directa y constructiva, que coincida con el legitimo interés de sus ciudadanos.

Estamos conscientes de que las políticas gubernamentales en materia de transporte y medio ambiente, deben ser acordes entre sí y complementarias, en su caso, con las políticas de desarrollo urbano. Requerimos de un transporte que apoye el desarrollo económico de las ciudades y de los países, que acerque a los hombres, pero que también evite el deterioro al medio ambiente. Necesitamos establecer políticas públicas congruentes con un objetivo: lograr hacer de nuestro planeta un mejor hábitat para el ser humano, justos lo lograremos.

En este evento podrán conocerse las experiencias de legisladores, técnicos, académicos, consultores, empresarios y autoridades y de todos ellos aprenderemos lo mejor buscaremos en cada propuesta la mejor opción para aplicarla en nuestra ciudad. CODATU IX coincide con el Gobierno de la Ciudad de México en el ánimo de buscar políticas y programas de largo plazo y de identificar mecanismos viables de financiamiento para la Ciudad.

Por ello, a nombre de la Lic. Rosario Robles Berlanga, Jefa de Gobierno del Distrito Federal, reitero a los ponentes y congresistas que tengan una grata estancia en esta 'Ciudad para Todos' y auguro el mayor de los éxitos en los trabajos de CODATU IX.

Ing. A.Joel Ortega Cuevas
Secretario de Transportes y Vialidad del Gobierno del Distrito Federal

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1 Transport policies related to environment
Politiques de transport en rapport avec l'environnement
Políticas de transporte relacionadas con el medio ambiente

1.1 Examples of the present situation
Exemples de la situation actuelle
Ejemplos de la situación actual

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The automobile as a pollutant
L'Automobile en rôle de pollutant

A.M.Dayomi
University of the North, Sovenga, South Africa

ABSTRACT: The growth of transportation has brought many benefits and many problems too, which are now leading to an environmental crisis point - a crisis of energy, environmental pollution and congestion. This paper highlights these problems with particular reference to the role of the automobile in the urban environment. First, air is polluted due to automobile emissions and this comes mainly from fossil fuels used. There is carbon dioxide an inescapable waste product and the most important gas contributing to climate change and global warming. More than 70% of air pollution may be attributed to pollution emanating from the automobile in developing countries and that this continues to rise even where motorisation levels are much lower.
Policy changes are suggested in the areas of monitoring of emission and the maintenance of vehicles to reduce exhaust emissions. But the critical choice to be made is between moving people or moving vehicles to the detriment of the environment and a better cadre de vie.

RESUME: La croissance et le développement des transports a apporté de biens ainsi que des problèmes. Ces problèmes nous ont amené a des crises de l'énergie, de congestion et la pollution de l'environnement. Cette communication évalue le role que joue l'automobile dans l'environnement urbain tels la pollution, notamment les effets négatifs des émissions sur la santé, l'économie et le cadre de vie dans les pays en voie de développement ou il y a beaucoup de pollution automobile malgré un faible taux de motorisation.
Des propositions de politique et de stratégies ont été suggerés dans les domaines de controle/suivie des émissions et l'entrétien des vehicules, mais nous devons aussi choisir entre le mouvement des persons et merchandises ou le déplacement des vehicules au détriment de l'environnement et un meilleur cadre de vie.

Introduction

One of the most urgent issues we face in our large urban centres is air pollution from motor vehicle emissions. This is an environmental issue, an economic issue, and a major public health concern. Clean is needed to promote healthy ecosystems, abundant crops, good jobs, and long and healthy lives as individuals. Without clean air, the environment, public health and the economy are at risk. Unless prompt and vigorous action is taken, pollution trends will result in buildups to crisis levels of fine particulates, ground-level ozone and other pollutants. Inaction will also contribute to the worldwide buildup of greenhouse gases and the associated detrimental effects of climate change.

After shelter the automobile is usually the most important thing ordinary people own. It is most often charged with a good deal of emotion. Many people can recite the day they passed their driving test and remember the first car they owned. Cars deliver the freedom to go where one likes, whenever one wants; they are objects of utility. The automobile has become the carapace, the protective and aggressive shell of the metropolitan man that has strongly shaped our mobility, urban design and brought such wealth and pleasure is now seen as a threat to the environment.

The Challenge: Costs of Air Pollution

Air pollution is more than a nuisance: it's a threat to public health. This ranges from irritation of the eyes, nose and respiratory tract to impaired lung function. increased incidence and severity of asthmatic attacks. lung cancer, birth defects. and premature death mainly due to respiratory and heart conditions. In addition. air pollution reduces crop yields. damages vegetation. impairs visibility and spoils the natural beauty.

Put simply, air pollution increases the cost of living and hurts the economy and the environment. The largest single source of the problem. apart from emissions from the manufacturing industries. is transportation. Within urban areas. the proportion of air pollutants attributable to transportation is even higher. Greater Lagos studies (*Dayomi.1994*) show motor vehicles emit more than 70 percent of air pollutants in the region. Measurements have indicated transportation accounts for more than half of the very fine particulate matter. a major public health concern.

49 percent of carbon dioxide emissions:
50 percent of nitrogen oxide emissions:
34 percent of carbon monoxide emissions;
30 percent of hydrocarbon emissions; and
9 percent of particulate emissions (primary particulate emissions only).

There are two main reasons why the measured concentration of fine particulates from transportation in urban areas (more than half) is so much higher than the provincial emission inventory: transportation is a relatively large source of gases. which are responsible for these secondary particulates.

The Practical Use of the Automobile

The use of the automobile is to facilitate the movements of human beings from one place to another. The aspect of personal mobility is just one side of the coin. The same car has also contributed to the creation of new distances between dwelling and work places. The role of the automobile in urban sprawl is well stated by two Swedish geographers.

> *"Without any exaggeration. it is possible to say that the automobile has been built in into the physical structure of dwellings. places of work. service facilities and their mutual positions in space" (Listerusa & Nordströem. '79).*

Trips can be made by walking. cycling. driving a car, or as a passenger. using public transport bus, metro, rail. mini and midi buses (taxis) according to the situation in the country one is in. Some are production trips i.e. to and from work. others are associated with the life of reproduction: trips to markets. medical facilities. schools. etc. Most of these trips, where motorised in Nigeria. especially in our urban environment. are made by public transport (70%) and private automobile (30%). In the South African example where public transport is not a priority, higher motorisation level has engendered a heavier dependence on the private automobile resulting in a 70/30 ratio. But what does the car user gain from going by car and not travelling in other ways? He travels faster where the traffic and circulation allow him. The difference is however not dramatic especially in highly congested urban areas like Lagos where the average speed of the car is about 20 km per hour at the most (*Dayomi. 86*). The real gain of the private automobile in the presence of a rapid and efficient public transport service. is thus hardly increased speed. but rather superior comfort, greater flexibility. a better guarantee of the preservation of personal integrity and other possibilities. The same private automobile occupies 30 times more space per passenger bus. consumes more parking space. adds more to the pollution of others and is economically. environmentally. and spatially inefficient. The time gained is used for other activities. which is sometimes considered as contributing to the living standard/quality of life of people. They can now choose their dwelling places at longer distance from their work (the sprawl): travel longer distances to various leisure activities including vacations.

How much does the car user pay for his/her car use? The average person does not seem to know. It is thus difficult to ignore the impression that most automobile users do not perform any cost-benefit analysis related to their car use. Cost of purchase. petrol, repair. extra-equipments and taxes appear immaterial because the automobile is a status symbol. Owners are willing at least after a period of hesitation to pay higher cost of petrol and taxes. But if one costs the price of road traffic in terms of the negative effects of pollution. noise. vibration. losses and human suffering associated with traffic accidents and damages in aesthetically valuable environments. it is possible to state that car users do not bear the total responsibility of their use. The cost in turn can best be imagined when you are stuck in a traffic jam in the middle of the Midrand expressway during one of its notorious jams and you lose a multi-million rand contract because you arrived late for the negotiation and signing.

The above plus other negative externalities. particularly those affecting the environment. ought to be passed to the consumers. In other words the polluters-pays-principle should be applied in full to the above and others including services provided by the road safety and the traffic policemen.

The Automobile as a Pollutant

Like most other artifacts, the automobile has a certain impact not only on human life but also on the human and natural environment. In a largely less-motorised society such as ours (less than 15 cars for a thousand people generally according to *State of the World 1994* (Reinvesting in transport - *Lowe, 1994*) the impact of the total number may not be substantial. But the impact of the concentrations of the motorised transport modes in our urban areas is substantial. This impact is to a large extent of a negative character environmentally speaking.

The effects are possible to register in the local environment (the automobile contributes massively to the pollution of the air, heat island effect, etc); in the regional environment (the automobile contributes to the increased rigidity of the soil and the alteration of nature); and in the global environment (it contributes to the greenhouse effect). By traffic environment, we refer to road traffic, which is composed of roads, vehicles and human beings and their conflicts. The urban environment consists of buildings, streets, and open spaces together with human beings and the automobile which has significantly altered urban design. This alteration has led to urban sprawl and the abandon of the traditional core to the poor. Affected also is the ecological environment which includes climatic factors along with a number of ecosystems.

During its lifetime, an average car travels some 200,000km but in structurally adjusted Nigeria, three hundred thousand kilometres is not impossible even for an imported used vehicle.

Air Pollution Sources (see table)

The following table summarises the sources, effects, and prevention and control methods for some of the air pollutants with the automobile a very important and prominent role player.

How, Precisely, Does the Automobile Pollute.

From its exhaust pipe, it discharges tons of carbon, sulphur, and nitrogen in form of various gases and particles. In dense urban environments where temperature inversion sometimes occur such as in Istanbul, Athens, Aix en Provence and Paris. The effects can be devastating. The world's more than 500 million cars, of which less than twenty million are in Africa, produce ten million cubic metres of exhaust fumes each year (The Economist, *Survey on Living with the Car*, June 1996). The figure is likely to rise, but with all the less efficient and more polluting automobiles likely to be in Africa. This only means that with a relatively low percentage of the world automobile fleet we would be having a high percentage of the pollution. The scenario makes many environmentalists and ecologists fear that the car is about to become a curse. In the absence of unleaded fuel and catalytic converters in automobiles, individuals with weak hearts, sufferers from anaemia and young children are thought to be at risk from exhaust carbon monoxide (CO) in urban areas (*WHO, 1992*). So also are the traffic wardens/policemen who don't wear masks unlike their colleagues in Istanbul, Athens Mexico and Bangkok.

Automobile-generated waste is an under-recognized but a growing pollution (and environmental) problem. The problem of abandoned vehicles has increased and this has led to a disposal crisis since parts re-use can not take care of the whole vehicle. Used tyres and oils are other problems that have not really gained recognition simply because they are dumped, burned, or emptied into the drains. But the problem of educating people on these subsists.

Carbon monoxide (CO), nitrogen oxide (NO) and hydrocarbons (HC) comprise the category of principal pollutants under consideration. These are liberated primarily in the energy conversion process in the internal combustion (IC) engine in motor vehicles. The efficiency of the IC engine is directly related to the octane rating of the fuel and to the compression ratio. Several additives such as lead have been added to improve this rating.

Carbon monoxide is colourless, odourless and tasteless and a concentration of only 0.1% (by volume) produces unconsciousness in one hour and death in four.

Hydrocarbons from which our fuel (petrol, diesel gas, etc) comes from comprise a broad class of materials that it is impossible to make any general statement about its toxicity. It is the HC's synergy with other products that leads to petrochemical smog, which creates the problem. Nearly every major city with industrial concerns suffers from this. When you add the resultant of these two pollutants (industrial and automobile) the damage becomes economic damage, plant and animal impairment, and possible alteration of the weather. The effects are (1) damage to vegetation (2) eye irritation (3) respiratory distress and even death (4) reduction in visibility (5) objectionable odour (6) material damage (rubber, buildings). See table

Catalogue of Ills

The World Health Organisation (WHO), the American Environmental Protection Agency, The Nigerian Federal Environmental Protection agency

(FEPA), the Federal Roads Safety Corps (FRSC) and United Nations Environmental Programme (UNEP) have been saying that automobiles are responsible for at least 70% if not more of the pollution in our urban areas. CO hinders the transfer of oxygen from the blood into tissues, ultimately stopping the heart. Catalytic converters which reduce CO by more than 30%, which are compulsory in Europe and North America are absent in our vehicles.

The other pollutants, notably oxides of nitrogen and to a lesser extent sulphur, are not easily trapped. We don't have pollution control of these vehicles except the ones done in Europe for the sale of second-hand vehicles. Contrary to general view, newly imported used vehicles do not pollute as much as the poorly maintained vehicles on the ground. Since subsequent tests are not performed on them here in Nigeria, they become pollutants. In this, they are unfortunately aided by the various kinds of imported fuel from so many sources all in the name of combating fuel scarcity. To the above may be added the general level of poverty and ignorance which hamper regular maintenance and inspection of vehicles. As a result of the large number of poorly maintained vehicles, and in the absence of pollution control measures, most of our cities are already experiencing motor-vehicle-related air pollution problems. Unfortunately, there are no data on our health statistics with links CO, Lead (Pb), HC and NO_x, SO_2 emissions and particulate matter (PM) with our health problems.

Nitrogen oxides react with other pollutants in the atmosphere (helped by sunlight) to produce a form of ozone which is the basic component of smog. Short exposures to these oxides are linked to asthma attacks, sore throats and running noses. Although ozone in the stratosphere is a protection against harmful air radiation, excess amount in the lower atmosphere can harm plant growth and have been linked with respiratory problems.

A third group of pollutants known as volatile organic compounds (VOCs) is also toxic. It is linked to hydrocarbons whose particulates are thought to aggravate bronchial diseases. With newer and more fuel efficient and lower emission vehicles on the road in Europe, things will get slightly better over there even in the absence of emission controls. But it may not last, especially if the economy picks up except we are able to buy the new electric cars in the market (and provide charging stations OR revert back to the promotion of public transit.

With attention recently turned to global air quality, there is concern that increased levels of CO_2 and other green house gases resulting from increased fossil fuel use could lead to possible global warning. Rapidly increasing population and massive urbanization coupled with corresponding increase in auto-mobility and use have now made it imperative that we look at this question now because the problem of poor air quality is there in our cities and it is acute. The resources for tackling the problem are limited. This requires knowledge not only of the major sources of pollution but also of the technical options available and their effectiveness, practicality and cost. As part of the corrective process it may be necessary to take measurements of air quality on a regular basis, and to establish and maintain inventories of sources of pollution. Other priorities must be the reduction of driving or rather the promotion of public transport.

Priorities for Action

A. Assessment of Existing Vehicle Emission:

1). Through Inspection and Maintenance Strategies

A badly maintained car can emit 100 tons more pollutants than that of a properly maintained car. Schemes to improve the standard of maintenance of vehicles and to replace old vehicles can dramatically reduce vehicle emission. To be effective though, inspection and maintenance must be backed up by adequate policing policy, as a majority of vehicles on the road are old (more than ten (10) years old). A component of the law should also involve motorcycles. The use of lubricating oil mixed with fuel should be gradually reduced.

2). Fuel: The industrialized world has changed to unleaded fuel but we are still using leaded fuel. A gradual reduction in the amount of lead should be the objective (<0.015gramme per litre). Diesel is known to emit SO_2 from combustion with other particulates especially in our warm environment. A reduction of the sulphur content in the diesel would go a long way. Natural and liquified petroleum gases are known to pollute less (they actually burn cleanly without many residues). It may replace ordinary petrol and diesel but the cost of installation would be a burden for the auto users but cleaner air for everybody. Methanol has the same cleanliness even though it may be differently produced - from molasses. All the above would require a major policy shift which is necessary if we do not want to remain simple consumers of technology.

3. More Stringent Automobile Standards: Advances in automotive technologies have made it possible to lower emissions drastically. We may take advantage of this only if we are able to monitor strictly the type of vehicles (new and second-hand technology) that come into the country. It simply means that developing countries would stop being a dumping ground and that stricter controls would have

to be strengthened to cope technically.

4 The use of the electric car may be an option but it would require the installation of charging points in certain areas of the towns. The cost of acquisition is currently very high even in the developed countries and its use is still limited

B - Long Term and Sustainable Solutions

The above mentioned solutions are highly technical and may have implications for the local economy if we are unable to support the emission controls without excessively limiting economic growth. It will definitely require phasing if we are not to lose control of emission control and/or the growth of the economy especially at this moment of low purchasing power.

Our cities suffer from traffic congestion due to the poor use of road space, frequent break downs, absence of traffic and land use management (and lack of integration) etc. These tend to compound the problems of air quality since fuel consumption and emission of CO and HC are increased at low average speeds. If it's agreed that increased auto-mobility is a likely consequence of increasing development, then cities must be developed with public transportation in mind. Any strategy to reduce automobile emission must necessarily include schemes to improve traffic flows and minimize car usage. This imperatively means the promotion of mass transportation modes, priority to the integration of land use planning and traffic circulation (i.e. Curitiba) and limitation of vehicle use. The last line would be with the objective of minimizing congestion in certain dense areas as was done with Singapore Licensing Scheme (ALS) now modified to Electronic Road Pricing which allows more flexibility than was previously possible with the ALS.

Parking lots must be limited and made expensive to disallow inner city traffic but this must be accompanied by greater and more accessible public transportation as well as walking and cycling. The goal of such a policy should not be higher mobility but greater accessibility. Other objectives of such a programme should be greater efficiency in transportation, greater environmental awareness and enhanced equity (and choice) in transportation possibilities between different social groups and enlarged democratic influence in the execution of the policy.

Air Pollution Sources

The following table summarises the sources, effects, and prevention and control methods for some of the air pollutants with the automobile a very important and prominent role player.

POLLUTANT	SOURCES	EFFECTS	PREVENTION & CONTROL
Ozone (O3)	Formed when reactive organic gases and NOx react in the presence of sunlight. These include any source that burns (gas, wood, oil), solvents: petroleum and pesticides	*Breathing difficulties, lung tissue damage, vegetation damage, damage to rubber and some plastics fuel*	Reduce motor vehicle reactive organic gas (ROG) and nitrogen oxide (NOx) emission through emission standards, inspections & reduced vehicle use. Limit ROG & NOx emissions from commercial, industrial and consumer operations. Conserve energy
Particulate Matter (PM2.5)	Combustion in vehicles, domestic use agriculture & industries. Also formed from reaction of other pollutants (acid rain, Nox)	*Increases respiratory disease, lung damage and premature cancer and premature death, reduced visibility*	Reduce combustion emissions from vehicles, equipments, industries agriculture and residential burning. Precursor controls like those for ozone, reduce fine particle formation in the atmosphere
Carbon Monoxide	Fuel combustion in vehicles construction, farm equipments and residential heating	*Chest pain in heart patients, headaches reduced mental alertness*	Control motor vehicle and industrial emissions. Use oxygenated gasoline during winter months. Conserve energy.
Nitrogen Dioxide (NO2)	(See Carbon Monoxide)	*Lung irritation and damage. Reacts in the atmosphere to form ozone and acid rain.*	Control motor vehicle and industrial combustion emissions Conserve energy.
Lead	Metal smelters, resource recovery, Pb gasoline, deterioration of Pb paint.	*Learning disabilities brain and kidney damage.*	Control metal smelters. No lead in No lead in gasoline. Replace leaded paint with non-lead substitutes.
Sulphur Dioxide	Coal or oil burning power, industries, refineries and & diesel engines	*Increases lung disease and breathing problems for asthmatics. Reacts to form acid rain in atmosphere*	Reduce use of high sulfur fuels (e.g., use low sulfur reformulated diesel or natural gas).Conserve energy

Conclusion

Planning the City for Fewer Automobiles

Can it be really considered progress when mobility in its original meaning (defined as number of trips for everyday purposes) did not change significantly since the automobile came to the fore? Only the modes and distances have changed but the number of trips has remained stable. Can we continue to go greater distances simply because we have separated functionally related uses? The growth of the automobile and its use have led to a greater demand for road and parking spaces, which degrade the quality of the urban environment. Noise, exhaust emissions, accidents, lead to an even greater exodus of inhabitants towards the outskirts. The consequences of this sprawl are more traffic, longer trips, worsening air quality, destruction of the biosphere, poor cadre de vie, etc. And the question *to whom does the city belong?* comes up. To those who live in it evidently and not the automobilists who contribute to its destruction through turning the automobile into a pollutant.

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Urban transport challenges of developing countries: The case of Harare

Les défis du transport urbain dans les pays en voie de développement: le cas de Harare

Los desafíos del transporte urbano en los países en vías de desarrolo: El caso de Harare

T.C. Mbara
University of Zimbabwe, Harare, Zimbabwe

ABSTRACT: Countries of the developing world are experiencing rapid urbanisation and unprecedented high growth rates in traffic resulting in detrimental environmental effects such as congestion, noise and pollution. Urban Local Authorities cannot afford to build roads to keep pace with traffic growth. The solution to construct roads is environmentally and financially not feasible. Using Harare, the capital city of Zimbabwe as a case study, the paper argues that the problems arising from traffic growth in cities of the developing countries can be addressed by non engineering solutions that include travel demand management, strategic planning and the need for good governance.

RESUME : Les pays en voie de développement font face à une urbanisation accélérée et à des niveaux de croissance du transport routier sans précédents qui ont pour conséquence une dégradation de l'environnement, notamment en raison des embouteillages, du bruit et de la pollution. Les autorités locales en charge du développement urbain n'ont pas les moyens nécessaires à la construction de nouvelles routes pour répondre à cette augmentation du traffic routier. La solution qui consisterait à bâtir de nouvelles routes n'est pas viable du point de vue environnemental et financier. En se servanr d'Harare, la capitale du Zimbabwe, comme sujet d'étude, cette présentation soutient que les problèmes engendrés par l'augmentation du traffic routier dans les villes des pays en voie de développement pourraient être envisagés avec des réponses non matérielles tels que la gestion de la demande de transport, la planification réfléchie et la réussite d'une meilleure règlementation.

RESUMEN: Resumen: La urbanización acelerada y el alto crecimiento de los índices de tráfico en las ciudades de los países en vías de desarrollo están provocando una serie de efectos negativos para el medio ambiente como son los atascos, el ruido y la contaminación. Por otra parte, las autoridades urbanas locales no pueden hacer frente al costo que supone la construcción de nuevas carreteras para resolver los conflictos derivados del aumento sin precedentes de la circulación en las ciudades. Las soluciones que pasan por la puesta en marcha de grandes obras públicas son, tanto desde el punto de vista económico como ambiental, inviables en los países en desarrollo. Tomando como referencia Harare, la capital de Zimbabue, este artículo propone otro tipo de soluciones a los problemas descritos, tales como la gestión responsable de las demandas de transporte, la planificación de estrategias y la mejora de las ordenanzas urbanas.

1 INTRODUCTION

Many governments in the developing world recently liberalised their economies. Liberalisation has impacted on a wide economic spectrum including the transport sector. In Harare (capital city of Zimbabwe) for example, traffic has increased rapidly in the last 5 years following the Government's decision to liberalise the economy in 1993. The opening up of the economy resulted in an increase of both commercial and private vehicles. Commercial vehicles, including public service vehicles (PSV) were permitted to enter the country at very low duty rates. Private vehicle importers were allowed to import vehicles without the need to apply for an import licence. The net result has been a rapid increase in traffic on the city roads, which has resulted in congestion and other environmental problems such as accidents and pollution. Thus, the reputation of a "sunshine city" the capital was dubbed in the early eighties is increasingly being questioned.

The current traffic congestion in Harare, is a problem that is experienced in many other cities of the developing world. One of the biggest challenges of cities of the developing world in the coming millenium is to resolve the problems related to traffic growth. In as much as central and local governments want to address the problem by constructing new roads, the solution is not tenable as financial resources are limited and traffic would simple grow to congest the new road infrastructure.

This paper seeks to assess the present traffic problems in cities of the developing world using Harare as a case study. The paper is a result of extensive discussions conducted with a wide spectrum of stakeholders in Harare that include technocrats, politicians academics and lay people. It is a critique, and endeavors to assess the traffic problems and how the city of Harare has attempted to resolve them and the lessons to be learned by other cities. The paper will argue that the traffic problems in cities of the developing world can successfully be addressed by methods other than the construction of more roads.

2. City characteristics and traffic growth

With a population of approximately 1.7 million (current estimates), Harare like many other cities of the developing world is experiencing the stresses of rapid growth. The population has grown by an average of approximately 6.5 percent per annum since the early eighties.

Harare is the capital and principal industrial and administrative centre. The main road network is a radial system connecting the various residential areas with the Central Business district (CBD). Within the CBD, there is a grid road network. The principal industrial areas are located to the southwest of the city. Low density residential areas are found in the north while high density residential areas are located to the south.

Traffic, has grown at an unprecedented rate particularly in the last 5 years. Table 1 shows the growth in traffic in Harare and the country as a whole.

Table 1: Trends in Traffic Growth (1994-1998)

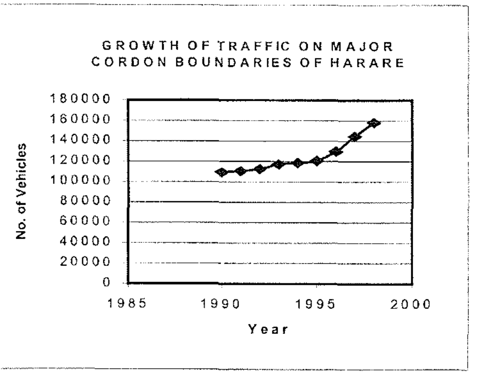
Year	Registered vehicles (national	Percentage increase	Registered vehicles in Harare	Percentage increase
1994	582 420	-	217 442	-
1995	640 662	10%	247 883	14%
1996	711 135	11%	287 544	16%
1997	789 360	11%	339 301	18%
1998	884 083	12%	399 312	18%

Source: Central Vehicle Registry

Although overall traffic has increased, the rate of increase has been higher in Harare compared to the country as a whole. Between 1994 and 1998 traffic has grown by an annual average of 11% and 16.5% in the country as a whole and Harare respectively. The increase of traffic in Harare from about 220 000 in 1994 to nearly 400 000 in 1998 represent an approximate 80% growth.

Focusing on public transport, the number of public vehicles increased from about 850 in 1993 to the current estimated figure of 6000. While the 850 public service vehicles operating before 1993 were mainly conventional buses and operated by a single company, the 6000 vehicles is a diversified fleet operated in competition by a multiplicity of operators.

The results of traffic counts on the cordon boundary close to the CBD in Harare between 1990 and1998 show that traffic crossing the cordon boundary has been increasing. Figure 1 illustrates the growth of traffic on the cordon boundary.



Traffic on the major cordon boundaries has increased by an annual average of about 5% since 1990. However, for the period 1995 to 1998, the annual average growth was approximately 10%.

3. Effects of traffic growth

From interviews conducted with a cross section of people in Harare, there was a general consensus on the negative impacts of traffic to the quality of the urban environment. The main detrimental effects cited were congestion, pollution, noise, accidents and the general city aesthetics. The effects of congestion are apparent as heavy congestion is experienced on most city roads within the Central Business District, particularly during the morning and evening peaks. Average travelling speeds have decreased from approximately 35 km/hour (late eighties) to about 18 km/hour (Department of Physical Planning and University of Zimbabwe unpublished surveys).

In view of the non-existence of statistical data on pollution and noise measurements, it becomes difficult to provide evidence on how traffic pollution and noise have impacted on the environment. However, most Harare residents perceive vehicle pollution as a serious problem. This is quite evident from observations on emissions from moving vehicles.

Noise is another negative environmental effect of traffic growth. Apart from the noise produced by a large number of highly diversified fleet, public transport termini within the CBD are known to be noisy places. The noise comes from hooting vehicles, vendors selling their goods and "rank marshals" touting for passengers.

Accidents in Harare have increased with the increase in traffic. Table 2 shows accident trends from 1996 to 1998.

As illustrated by the tables 1, approximately half the total accidents in Zimbabwe occur in the capital. The accidents rate (measured in number of accidents per 1000 vehicles) in Harare, increased from 67 in 1996 to 607 in 1998. During the same period, the death rate increased from 11 to 14.

Most of the accidents are caused by commuter omnibuses, which are privately operated public transport vehicles. Although accident statistics do not make a distinction between commuter omnibuses and conventional buses, there are a number of reasons that attribute commuter omnibuses to most of these accidents.

Table 2: Accident trends, 1996-1998

Year	1996	1997	1998
Total accidents (National)	38 777	43 357	58 101
Total accidents (Harare)	19 125	21 097	27 382
Harare as a percentage of National	49.3%	48.7%	46.3%
Accidents per 1000 vehicles (Harare)	67	487	607
Total fatalities (Harare)	200	226	391
Fatalities per 1000 vehicles (Harare)	11	11	14

Source: Zimbabwe Traffic Safety Board

The crew is normally remunerated on the basis of revenue earned. In order to maximise revenue, the crew try to make as many trips as possible. Consequently, the driving behaviour of commuter omnibus drivers leaves a lot to be desired. Drivers are known to drive very fast and sometimes involve themselves in some of the most complicated and dangerous manoeuvres on the road. Courtesy on the road and basic safety regulations are not adhered to. For instance overtaking on the wrong side, and passing through red traffic signals are common practices.

4. Addressing the problem: Council Response

The manner in which the City of Harare has attempted to resolve the traffic problem has been described by one expert as "piecemeal half backed solutions". Some solutions have been suggested and never got implemented. Among the solutions considered by the City of Harare were:

4.1 Banning deliveries in the CBD by heavy goods vehicles from 07.00 to 17.00

The proposal to ban heavy goods vehicles (HGVs) in making deliveries in the CBD during the normal working hours was conceived in the early nineties. The proposal was not properly marketed and hence the resistance by key stakeholders in commerce and industry. At any rate the proportion of HGVs making deliveries during the normal working hours is small. This solution could not have therefore alleviated the traffic problems within the city. Consequently, the proposal was shelved before implementation.

4.2 Box junctions

In 1996, the City Council attempted to introduce "BOX JUNCTIONS" at most of the congested intersections in the CBD. The purpose of box junctions was to prevent motorists from entering and unnecessarily stopping in the middle of an intersection and thus causing congestion. Although a lot of money was spent painting the intersections, the legality of "box junctions" was challenged and the scheme had to be abandoned before implementation.

4.3 Proposal for an Urban Traffic and Transport Authority (UTTA)

The proposal to form an Urban Traffic and Transport Authority for Greater Harare was mooted in 1991. The authority would have been tasked with the major responsibility of addressing the negative effects of traffic growth in Harare. Despite numerous meetings held, no decision was made and it appears as though the issue has now been conveniently forgotten.

4.4 Traffic Management Local Plan

In 1995, the City of Harare commissioned a Traffic Management Subject Plan. Its main objective was to "put in place a framework for management of traffic in Harare through review of existing traffic planning and management systems, rationalisation of use of existing traffic infrastructure and other strategies for improved and efficient circulation of all modes of transport". It was hoped that the study would provide answers to the traffic problems in the city. The period that the study was being conducted provided a needed reprieve to the city fathers. Whenever questions were raised on what the city fathers were doing to resolve the traffic problem in the city, the awaited study was given as the solution. The final report of study was found to be very inadequate in terms of providing solutions. Notwithstanding the massive payment made to the consultant, the report is now gathering dust.

4.5 Banning of commuter omnibuses in the CBD

With effect from 1 August 1999, the City Council banned commuter omnibuses (privately owned public transport vehicles) from entering the CBD and had to drop passengers on the outskirts of the city. Council argued that the move was an honest attempt to reduce traffic congestion in the central area. A proposed inner city shuttle service that was never implemented was supposed to move passengers from the respective termini into the heart of the CBD. This restriction which was strictly enforced by the police threw the city into confusion. The criticisms from both members of the public and professionals forced the Commission running the affairs of the City to abandon the proposal two days after its implementation.

4.6 Introduction of one way streets

In an attempt to improve traffic flow, the City of Harare in 1997 converted four streets into one way systems. The introduction of one way streets has increased the capacity of the network and in turn marginally improved traffic flow. Further implementation of one way streets in no longer possible, as there are no more ideal streets suitable for conversion.

5 Addressing the problem: what should be done?

The response by the City Council in addressing the traffic problems clearly shows indecisiveness and crisis management. Many proposals and initiatives discussed above were never implemented. Bad governance has also compounded the problem.

The present problem calls for solutions that would support a better quality of life on a sustained manner. There are a number of alternatives that can be considered in order to address the problem of traffic and its impact on the environment. These alternatives include:

5.1 Need for good governance

In respect of good governance, the key issue is effective resource management and utilisation. Lack of good governance is one of the problems that has resulted in the deterioration of urban infrastructure in many cities of the developing world. This problem has of late affected service delivery within the City of Harare. For instance the state of roads in Harare that are now characterised by potholes is a result of mismanagement and corruption tendencies that rocked the City for the past four years. In June 1999 the entire Council had to be dismissed for mismanagement and corruption. Financial resources were often diverted from budgeted infrastructure projects to schemes that would serve the interests of a few individuals. Good governance provides a framework for the successful implementation of alternative solutions to address the problem of increasing traffic within the city.

5.2 Need for travel demand management

Transportation Demand Management (TDM) has a role to play in addressing the present and future traffic problems in Harare. In essence, TDM measures are concerned with the alteration of travel and traffic behaviour in order to enhance the efficient use of the existing road infrastructure and facilities. Its main objective is to maximise the people-moving capacity of the transportation system and employ relatively cheap methods to tackle traffic problems without resorting to major new road construction thus making the best use of the existing road network. Thus, the TDM concept would suit Harare, as the local authority has no funds to construct roads that are required to accommodate growth in traffic.

There are three methods that can be used in the application of TDM in order to manage traffic flow, namely, shifting trip dependence, reducing the need for a trip and reducing car dependence trips.

Traffic flow can be improved by shifting the trip in terms of the use of alternative routes and alternative times. The former can be achieved by encouraging motorists to choose alternative routes. Alternative times are achieved by shifting time bands through measures such as staggered working hours and flexitime. It would be more effective to encourage the public to promote these schemes voluntarily rather than making them mandatory. It is instructive to point out that staggered working hours were implemented in 1988 in all urban areas in the country with disastrous results. No proper consultations were made with stakeholders, principally the local authorities, industrialists and the general public to explain the advantages of this novel concept. Secondly, all urban areas were required to implement the staggered working hours measure whereas smaller urban communities were not experiencing any traffic problems at all, consequently creating problems where they didn't exist.

A reduction on car dependence trips is necessary in order to minimise congestion in urban areas. A car is an inefficient user of road space due to its limited capacity. Therefore making efficient use of the vehicle and using alternative modes with a larger capacity can reduce trips made by car. The former can be achieved by encouraging people to share their cars. A significant shift to public transport would meet the requirements of the latter. It is important to make public transport attractive by reducing its generalised costs if people have to abandon their cars in favour of public transport. One way of increasing the reliability of public transport is to implement bus lanes on heavily congested streets. There are a number of streets in Harare, which qualify for such schemes due to severe congestion and a high volume of buses.

The third area relates to transport-land use integration. Transport-land use integration is an important measure in reducing both transport costs and the need for travel. Residential areas in Harare are located far from work places. A combination of two measures can achieve this integration. Firstly, industrial and commercial functions need to be decentralised so that they are in close proximity to residential areas. Consequently, the need to make trips to the traditional Central Business District and industrial areas is minimised. Secondly, the use of vacant space in between work places and the present residential areas has to be developed for residential purposes. Such a move would enable buses and other forms of public transport to pick passengers in both directions as opposed to the present "unidirectional" trips in which buses pick passengers in one direction during peak periods.

5.3 Need for strategic planning

Piecemeal planning is not the solution for a large and growing city like Harare. The City of Harare needs a long-term strategic transportation plan. Such a plan should address the future provision of transport infrastructure, public transport, and the integration of land use and transport. The transportation strategic plan cannot be the responsibility of the City alone. All stakeholders, including civic society and the private sector need to be involved.

6 CONCLUSIONS

The city of Harare, like many other cities of the developing world, is experiencing unprecedented growth. Such growth is placing severe pressure on services including transport, which is central to development. Harare is not unique in this situation. Many local authorities in the developing world are faced with immense challenges in developing a sustainable urban transport system that is responsive to changing demands. Experiences of the city of Harare in an attempt to introduce "piecemeal solutions" and "crisis management" should provide ample evidence and lessons for other cities as they approach the new millenium. Such solutions are not sustainable.

The solution to construct roads to accommodate increasing traffic is not environmentally and financially feasible. Local authorities do not have the requisite financial resources and additional roads will attract more traffic compounding the environmental problems. Travel Demand Management techniques, which essentially address travel and traffic behaviour as well as the integration of transport and land use, are more appropriate in resolving transportation problems in fast growing urban areas. A long-term strategic transportation plan will be needed to address the problems in a comprehensive manner. These measures need to be complemented by good governance particularly in resource management.

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Analysis of the air quality-transportation policies in Mexico City

Analyse des politiques de qualité de l'air et transport à la Ville du Mexique

Análisis de políticas de calidad del aire y transporte en Ciudad de México

A. Villegas López

Transportes y Vialidad, Dirección General de Planeación y Vialidad, México, D.F., Mexico

ABSTRACT: Mexico City Metropolitan Area (MCMA) is air polluted, mainly from fuel vehicles, and negatively affecting population's health and productivity. MCMA needs a policy addressed to reduce toxic emissions, while maintaining economic development and transportation services supply. Criteria is defined to assess current and alternative policies. Status quo policy is based on a temporary measure consisting of a ban for cars to run normally, while other responses were supposed to take effect. Alternative policy substitutes driving ban by enforcing rapid modernization of the fleet, taxing fuels, and absorbing demand increase by expanding mass transit. Evaluation shows that alternative policy is effective and fair, and would generate ecological investment. Interests of federal government and its legal ability to control decisions are supporting the continuation of the status quo policy. Stronger state and capital city governments and a change in attitude of the federal level, would contribute to reduce air pollution.

RÉSUMÉ: L'Espace Métropolitain de la Ville du Mexique est contaminée, surtout des carburants automobiles, ce qui affecte la santé et productivité de ses habitants. Il'y a besoin de reduire des émissions, sans ignorer le dévelopment économique et le fournissement de transportation. Les politiques actuelles et alternatives s'ont évalué. Le status quo est basée sur l'interdiction de utiliser véhicules, un jour par semaine, alors que d'autres mesures étaient supposée porter fruits. L'alternative encourage une modernization des véhicules, en éstablissant des impots sur les carburants et en absorbant demande, au moyen d'un traffic en masse. L'evaluation démontre que l'alternative est plus efficace et juste et qui porrait donner lieu a un investissement écologique. Néanmoins, les intérets du gouvernement féderal et sa faculté pour controler les décisions renforcent la continuation du status quo. Des gouvernements locales plus forts, ainsi qu'un nouvel approche fédéral pourraient contribuer a la réduction de la contamination.

RESUMEN: La contaminación del Area Metropolitana de la Ciudad de México (AMCM) que genera el transporte afecta negativamente la salud y productividad de sus habitantes. Se requiere una política de reducción de emisiones, sin desalentar el desarrollo económico ni la movilidad. Se definen criterios para evaluar las políticas actual y alternativa. El status quo está basado sobre una medida denominada «Hoy no Circula», mientras otras acciones tomarían efecto. La alternativa subsituye el «Hoy no Circula», mediante la modernización de vehiculos, aplicación de impuestos a la gasolina y absorción del incremento en la demanda con transporte masivo. La evaluación muestra cómo la alternativa resulta más efectiva y equitativa, además de que generaría inversión ecológica. Sin embargo, los intereses del gobierno federal y su facultad para controlar decisiones, respaldan al status quo. Tener gobiernos locales más fuertes, así como un cambio de actitud a nivel federal, contribuiría a la reducción de la contaminación.

1 AIR POLLUTION GENERATED BY COMMUTING

The Mexico City Metropolitan Area (MCMA) is a highly air polluted region. In 1991, the Mexico City daily air quality index (IMECA by its Spanish acronym) exceeded the danger level of 200 on more than 162 days (Instituto Nacional de Ecología 1997). Several times, when IMECA level surpasses the level of 250, it is necessary for MCMA officials to declare the Stage I of the so called "Environmental Emergency Plan".

The negative impact on public health from the high levels of air pollution can severely affect the quality of life, the health care costs, the productivity of the economy, and the general well being of the MCMA population. For instance, on October 30, 1996, when the IMECA index reached one of the highest levels, a survey of the Mexican Health Care Department reported that, among people settled in the southwest sector of the city, there was a 100 percent increase in maladies' symptoms like irritation of eyes, nose and throat, and headaches (*El Universal* 1996).

Mexico City's 2,286 meters altitude "reduces the level of oxygen by almost a third. As a result, motor vehicles produce twice the carbon monoxide and hydrocarbon emissions than they would at sea level. The surrounding volcanic range traps the noxious fumes, stifles the flow of cleansing air currents, and spreads pollution." (KANDELL 1988) There is also a high solar radiation and low intensity of wind flows. All these lead to ozone production.

On the other hand, MCMA's economy is the strongest of the Republic of Mexico as it produces 36 percent of the GDP (The World Bank 1996). MCMA's population grew from 3 million in 1950 to 18 million in 1996. These factors have led to an increasing demand of transportation and to a high motorization rate that is currently of 6 inhabitants per vehicle. It was estimated that in 1994, 20.6 million trips were generated in the MCMA and forecast for year 2020 is 28.3 million.

In the MCMA there are 3.2 million motor vehicles, 85 percent of which are private cars (Secretaría de Transportes y Vialidad del Gobierno del Distrito Federal 1999). According to the 1994 Emissions Inventory, it is estimated that 75 percent out of all toxic emissions generated in the MCMA, are produced by motor fuel vehicles, including private cars, taxicabs, minibuses, buses, as well as light and heavy weight trucks. Urban transport operation generates 99 percent of carbon monoxide (CO), 54 percent of hydrocarbons (HC) and 71 percent of nitrogen oxides (NOx's); the remaining percentages come from industrial and service activities as well as electricity generation and natural pollution (Departamento del Distrito Federal *et.al.* 1997). These figures are the outcome from the MCMA's daily fuel consumption of 48 million liters, 50 percent of which is used for transport. Among urban transportation vehicles registered in Mexico City Federal District (DF by its Spanish acronym), 53 percent of emissions come from private cars. Low capacity transit services operated by private organizations like taxicabs and minibuses originate 17 percent of pollution. Another 3 percent is generated by transit: buses, trolleybuses, light rail train and metrorail. The remaining 27 is generated by light and heavy weight trucks (Secretaría de Transportes y Vialidad del Gobierno del Distrito Federal).

The MCMA includes two jurisdictions. One is the DF Government, which is the capital city of the Republic of Mexico, and where 55 percent of the region's population is settled. The second jurisdiction includes 27 municipalities of the surrounding Mexico State (MS). There is a technical commission at the regional level called Commission for Control and Prevention of Environmental Pollution in the Metropolitan Area of the Valley of Mexico (CMPCCAVM by its Spanish acronym) which is responsible for policy coordination in the environmental sector. Although most of its staff members come mainly from the GDF and MS, involved federal agencies are also part of this commission.

2. POLICY OBJECTIVE

To achieve the lowest air pollution from commuting, while meeting two supplementary goals. To provide at least the same or to increase the amount of transportation services supply. To minimize the negative impact on the overall development and efficiency of economy in the region.

3. CRITERIA

A set of criteria is established in order to judge policy options in regard to stated goal.

3.1 Effectiveness: net benefit

This criterion ranks policy options according to societal benefit actually entailed by each one, in terms of the amount of pollution "avoided" by each alternative, and in relation to the amount of passengers-trips commuted by the policy under analysis.

3.2 Economic and financial possibility: efficiency and development

This measures what is the general impact of the alternative over the economic development of the city in terms of efficiency.

3.3. Vertical equity among commuters

It measures whether the policy option procure a fair penalization among all urban transportation modes users. Penalty for polluting should be equally implemented; commuters of modes who pollute the most should be penalized the most.

3.4 Political feasibility

This measures what is the actual willingness of involved groups toward the policy option: federal government, PEMEX, GDF, MS, MCMA citizens and motorists, environmental activists, motor industry and political parties.

4. STATUS-QUO POLICY FOR THE PROBLEM: THE PROGRAM "ONE WEEKDAY WITHOUT MY CAR" (OWWMC) AS A TEMPORARY MEASURE WHILE LONG TERM ACTIONS TAKE EFFECT

Since November 1989, this program is targeted to private individual motorists. It consists of the restriction for a single car to be used once a weekday. Fine for violating the no-driving-today policy is $107.00 USD. The simple rationale assumed for the one-day-a-week driving ban is that it entails a 20 percent reduction in pollutant emissions from commuting because of three interrelated factors: 20 percent less motor vehicles running on the streets each weekday, less traffic congestion and higher average running speed on roads. According to government and independent estimates, pollution dropped by about 10 percent in the first year of the operation of this plan. Moreover, when the air quality index has exceeded the "environmental emergency" level of 250, a "two weekdays without my car" special program (TWWMC) has been implemented.

Other gasoline propelled vehicles like taxicabs and microbuses (privately operated paratransit and transit services) are included in the driving ban, although they accomplish it based on a different schedule which enables these operators to provide full transport supply during the morning rush hour. Transit diesel buses are exempted.

Since 1998 both the OWWMC and TWWMC programs have been upgraded trough exempting low emissions vehicles from the restriction.

Besides the OWWMC and TWWMC, the *status quo* policy for controlling toxic emissions from mobile sources includes a set of actions listed below:

Agreement with PEMEX to improve motor fuels, stop selling leaded fuels and introduce alternate fuels.

Contract with automobile industry to guarantee that all manufactured cars model year 1991 and subsequent ones, would be originally fitted with catalytic converters.

Compulsory Inspection and Maintenance (I&M) program with gradually tougher standards. I&M program is designed to encourage vehicle's owners to tune up their motors and foster older units replacement. There are four levels of standards as follows. Sticker "2", TWWMC: vehicles older than 1989, which have conventional carburetor and do not have catalytic converter. Sticker "1", OWWMC: model years from 1989 to 1992, fitted with full injection engines but without catalytic converters. Sticker "0", running everyday: vehicles from 1993 to 98, which are fitted with three ways catalytic converters and full injection engine. For these three categories the I&M test has to be approved each year. Sticker "00", running everyday: vehicles model year 1999 and newer fitted with three ways catalytic converter and full injection engine; this category is compelled to pass the I&M test only once for a two years period.

Maintain the expansion of metrorail network at a rate of 6 kilometers per year.

Encouraging private transit operators to substitute older low capacity vans and minivans without emissions control devices, with new, higher capacity microbuses or buses with catalytic converters.

Pollution has been controlled but has not decreased and the OWWMC and TWWMC programs have became permanent. Thus a question is whether the actions of the *Status Quo* policy are still effective for reducing the generation of toxic gases to the environment. Secondly, is there any alternative policy that can substitute this policy?

5. POLICY ALTERNATIVE

It consists of two main components: a traffic management strategy and a reinforcement of the pace and effectiveness for the expansion of mass transit. This implies two tactics: the first is to encourage commuters to use mass transit over fuel motor cars; and the second is to push motorists to use cars fitted with emissions control devices, rather than cars without such controls. Traffic management strategy is based on a set of economic incentives to motorists. Actions included in this policy are:

Internalizing congestion costs from parking on the road-way. Includes deregulation of parking fares as well as introducing parking meters in congested areas and in sectors closer to Metro stations.

Long term policy to price fuels including internalization of pollution costs and application of these funds to build up more and better motorways and overpasses, and to introduce high-tech traffic lights control system.

Strengthening the inspection and maintenance program and to establish lower toxic emissions standards. This would insure, that only vehicles fitted with catalytic converters and full injection engines are allowed to run in the city.

To encourage the substitution of private transit sedans, vans and microbuses with high emission standards diesel buses (US EPA 98 or superior).

Regarding double-deck and single buses operated by the GDF, substitution of the fleet by introducing new diesel buses (US EPA 98 or superior).

Rapid development of the construction of a comprehensive metrorail system that entails the required financial support structure, which should be based upon a profitable fare system as well as on larger capital investments.

6. EVALUATION OF ALTERNATIVE: CRITERIA APPLIED FOR ANALYSIS OF POLICY OPTIONS

6.1 Effectiveness: Net benefit

Status quo: OWWMC and TWWMC programs.- Despite the fact that unleaded fuel is actually a less environmentally aggressive combustible, its benefits can only be profited by approximately 32 percent of the gasoline powered vehicles which are fitted with catalytic converters and full injection engines. If current fleet renovation trend continues, it will take more than 17 years to have all gasoline cars fitted with such emissions control devices.

Alternative: private car fleet fitted with catalytic converters.- The option of having approximately 3.2 million cars fitted with catalytic converters and running daily in the city would reduce HC and NOx's emissions.

Alternative forecast.- Conversely, the alternative policy would be expected to reduce the actual amount of pollution. We would have 3.2 million unleaded gasoline powered vehicles fitted with three way catalytic converters and fuel injection engines, providing transportation to a lower percentage of passenger-trips. New diesel buses, replacing microbuses, meeting EPA 98 standards would carry a bigger percentage of demand and would generate low pollution per passenger. Finally, mass transit with an expanded Metro network would attend a bigger share of the modal split, producing marginal amounts of pollution.

Which option is more effective?.- As a partial conclusion about the evaluation of effectiveness, the alternative policy is superior as a result of reduced pollution from gasoline powered vehicles, lessens the incremental trend of gasoline powered vehicles, substitutes low efficient private transit vehicles with buses and expands the mass transit network at a faster rate.

6.2 Economic and financial possibility: efficiency and development

Status quo: Who bears the burden of the penalty?.- The OWWMC and TWWMC programs make private car commuting more expensive but allows motorists to continue polluting at the same or higher level than before. Moreover, the no driving ban means an inefficient allocation of resources as it entails both a waste of a portion of the car's capital cost, which reduces car's utility, and a misallocation of resources because motorists can not trade off in the market his or her lost of utility. Finally, the higher cost afforded is neither invested in pollution control technologies, nor collected by the government.

Alternative.- Although several measures proposed in the policy alternative certainly entail higher capital and operation costs for motorists, this policy encourages opportunities for both: to enforce gasoline powered vehicles' owners to internalize the cost of polluting by turning the capital higher cost into investment for emissions control technologies, and to convert the operation higher cost into tax revenue which can be used for funding mass transit development and the improvement of urban road system. Strengthening the standards of the I&M program would mean that the higher capital cost of a car would be turned into commuting with less toxic emissions generated per passenger-trip Higher parking fees would be converted into new parking lots where needed and thus fewer cars parked on the road. Introduction of parking meters is an incentive for motorists to use mass transit where available or other transit modes in congested areas. A higher fuel tax would be a way to enforce motorists to internalize the cost of polluting.

Which option encourages greater economic development?.- Although policy alternative imposes, in the short run, a set of taxes and higher costs to motorists, it also modifies driver's rational behavior to actually pollute less, and it turns both higher costs and tax revenues into environmental investment. Due to the fact that this investment generates technology upgrading and new jobs, the policy alternative is considered economically more efficient, and more likely to promote development.

6.3 Vertical equity

In 1989, before the OWWMC program was implemented, there were huge inequalities among modes of transportation in relation to the difference between its share of modal split attended and its actual contribution to pollution. While 15 percent of commuters driving cars produced 58 percent of pollution, 33 percent of passengers riding buses produced only 11.5 percent of toxic emissions. Finally, 18 percent of urban travelers used mass transit and barely contributed to pollution. The question is whether these inequalities were diminished with the introduction of the OWWMC and TWWMC programs.

Status quo.- In 1997, most pollutant commuters continued to be car drivers, which shared 20 percent of the modal split but contributed to 75 percent of air pollution. On the other hand, microbus and taxi riders contributed less to pollution as 59 percent of passenger-trips attended by this mode produced 24 percent of pollution. Mass transit passengers attending 17 percent of demand, barely contributed to pollution.

If observed trends are to continue, the *status quo* forecast shows that the number of gasoline fueled, low capacity and high emission level vehicles will be used for moving the biggest share of the modal split, while the number of diesel and electricity powered, high capacity and low emissions vehicles will meet a smaller share of the modal split. A motorist who invests more money in a car fitted with catalytic converter, which will pollute less, is penalized exactly in the same amount as a motorist who invests less money in a car not fitted with any emissions control devise, which will pollute more.

Alternative.- If the alternative policy is encouraged we can expect that the inequalities between the rate of pollution per passenger-trip generated by different modes would be made uniform. Alternative policy is more likely to fairly allocate "shares of pollution" among proportional shares of demand.

6.4 Political feasibility

Next, each political actor is classified by Status Quo or Alternative options, according to each actor's likely, explicit or implicit support or disagreement for each policy option.

6.4.1 Status Quo

Motorists.- Based on a survey of MCMA' motorists opinions about the OWWMC program and about its effectiveness for reducing pollution and traffic congestion, it can be concluded that drivers support the OWWMC program to continue. However, this is an indicator of motorists' willingness and ability to cooperate for air pollution control, rather than recognition of the program's effectiveness for reducing air pollution. Individuals surveyed did not think that the program had met two basic objectives: reducing pollution and traffic congestion, as well as to educate people about environmental protection.

Federal and MS government.- National government controls Federal involved agencies, PEMEX and MS, and all these have concurrent objectives like: protect jobs of motor industry, fuel price control, fuel monopoly preservation, and privatization of economic sectors. All these lead to an attitude of support of the current Status Quo.

6.4.2 Alternative

Opposition parties and non-governmental organizations.- The leader of the DF charter of the Democratic Revolutionary Party (PRD by its Spanish acronym) considers that "economic interests can not prevail over the health of millions of Mexican citizens". From 1997 to 2000, PRD is ruling the first DF local government. However, local government resources to rule are constrained as budget, public debt and main bills have to be approved by the federal government.

In general the opposition parties' point of view is that high pollution is due to inadequate management of mass transit services. Also, environmental protection activists as well as the green party asked "to review the OWWMC program because it is not helping anymore to reduce traffic congestion".

Local government.- GDF government is likely to support the alternative because its autonomy from the federal government political agenda. Transferring commuters from cars and private transit to mass transit, may mean more intervention of the GDF in providing transit services. Also, the federal government and PEMEX would be very reluctant to accept local taxes on fuel consumption, which would not be re-allocated to Federal programs neither would be re-invested in PEMEX. Additionally, federal macroeconomics policies would be affected by a very high increase in gasoline tax because it may affect the price index in the MCMA, and the national price index.

6.4.3 Which option is more politically feasible?

Political feasibility of the options is compared in next table.

Actors Ranked By Power and Effectiveness To Use It In The MCMA	Status Quo	Alternative
Federal secretariats	Total support	Mostly opposed
PEMEX	Total support	Total opposition
GDF	Opossed	Limited resources to support
Motor industry	Mostly supportive	Lightly supportive
MS	Mostly supportive	Indifferent
Private transit operators	Mostly supportive	Reluctant to support
Motorists	Some support	Support pending on income
Opposition parties	Opposed	Mostly supportive
Environmental activists and non motorist citizens	Total opposition	Supportive

Decisions are made at the federal level as the President has some control over GDF Chief and Mexico State governor to make them follow his/her national agenda. As federal government does not favor the alternative policy, the Status Quo option has greater political feasibility than the alternative.

7. GENERAL COMPARISON OF POLICY OPTIONS

Criteria	Status Quo: OWWMC and TWWMC Programs	Option: Traffic Management and Mass Transit Development
Effective ness	Less effective	More effective
Economi c Efficienc y	Less efficient. Smaller cost for commuters in the short run but inefficient allocation of resources and discouragement of economic development in the long term.	More efficient and investment in the long run.
Vertical equity	Unfair.	Improves equity among commuters.
Political feasibilit y	Feasible: option has been implemented since 1989.	Unfeasible: national government and motor industry effectively oppose.

8. CONCLUSIONS AND IMPLEMENTATION

The current OWWMC and TWWMC programs as well as its Status Quo policy have been implemented with relative success during the past ten years. The OWWMC and TWWMC programs continue because those are still an effective symbolic gesture of the government to show ability "to enforce a *difficult* measure required by such a high pollution circumstances". Nevertheless, it could be drawn that the temporary effectiveness of the *Status Quo* policy has not substantially reduced toxic emissions. The actual achievement of other measures in the Status Quo policy seems to be smaller than the increasing trend of toxic emissions generation in the MCMA. As a consequence, stronger impacts on public health may appear soon. In the long run, the Status Quo policy is not encouraging new investments, technology upgrading and generation of jobs in the transport and environment sectors. The federal government national agenda seems to be the main support for the Status Quo policy.

The Status Quo is politically feasible in despite of the alternative policy's advantages from the effectiveness, economic and equity points of view. Likelihood for the alternative policy to be implemented would be greater to the extent to which the interests and the ability to control of the national government could be constrained. .It would be advisable to allow both GDF and MS governments to impose local taxes on fuel consumption. National government power over the MCMA's environmental protection policies was reduced by granting home-rule to Mexico's capital city and by having local legislatures dominated by opposition parties.

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1.2 Examples of transport policies
Exemples des politiques de transport
Ejemplos de políticas de transporte

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Paris Region mobility plan (PDU): A strategy for the durable development of the region and the capital

Chantal Duchene
Dreif, France

ABSTRACT : The clean Air Act, adopted in December 1996, oblige all call cities over 100 000 of inhabitants to prepare a mobility plan of sustainable transport. This plan has to take measures to decrease the car traffic and to develop the use of public transport, bicycle and foot. At this moment, in Paris region, the traffic is increasing by 2 % per year. In Paris region, the State has in charge this plan. It is a big challenge due to the size of the region (11, 3 millions of inhabitants) and the number of elected bodies with responsabilities in transportation.

To provide support for the development of the Paris Region through the enhancement of its facilities, such is the ambition of the Paris Region mobility plan. The analysis conducted by elected representatives, professionals and associations was concerned with the population density, urban and environmental quality, social cohesion and geographical equilibrium of the first region of France. Based on the intention to implement a durable development strategy, the PDU is required to contribute the most effective countermeasures aimed at social and territorial dualisation, strengthen the advantages of the Paris Region in the face of competition from other large urban centres throughout the world, and polarise urban growth by controling its consequences.

The law and its application in the Paris Region.

The 1996 law on clean air and the rational utilisation of energy modified the article of the 1982 law establishing guidelines for transport, relating to PDU plans. The new measures included the obligation to prepare a PDU for all urban centres where the population exceeds 100, 000, including the Paris Region which was not previously concerned.

The PDU must define the principles for the organisation of passenger and freight transport, traffic control and parking. The plan must contribute to reducing private car traffic and increasing the use of alternative forms of transport, namely walking, public transport, bicycles and car sharing. The plan must also cover parking and the handling of freight, and indicate how the main road network will be developed and operated.

The horizon for assessment of urban mobility plans was set at five years by the new law, so that the immediate emphasis

was consequently on optimum management of existing facilities. The potential lies principally in this sector, as 95 % of the infrastructures will correspond to what already exists at the present time, even for more distant horizons such as those of the development plan (2015) or service plans (2020). The PDU for the Paris Region is being prepared at the initiative of the regional level of the central Government, involving the Paris Region Public Transport Authority, the Regional Council and the Paris Council.
Notwithstanding, we regard it as particularly important for the plan to be the result of an approach shared with the local municipalities, all of which will subsequently be required to adopt measures contributing to the concrete implementation of the aims of the mobility plan. This is all the more important, as the objectives defined by the law can only be achieved if coherence can be established between the policies relating to transport conducted at all levels, and those relating to urban development the operational aspects of which depend on the skills and expertise of the communes.
The organisation set up consequently involved a participate approach, involving the local authorities, including those of the departments (elected bodies at infra regional level) and municipalities in particular, the professional sector and the associations. All have participated actively in the thematic working groups set up. It was these groups which formulated action proposals, based on initial phase diagnostics, which have made it possible to correct any imperfections identified in this way.
The approach was also decentralised to departmental level of the central Government, with departmental structures in concert with the departments, communes and the professional and associative communities.
It was also suggested, at the outset of the mobility plan construction phase, that the municipalities should get together, in the form of local committees, for the purpose of defining the local level measures to be incorporated in the PDU.

Continuing increase in private car traffic.
The results of the last transport survey, conducted at the end of 1997, clearly indicate changes in transport patterns in the Paris region between 1991 and 1997. They demonstrate a continuation of earlier trends, with a 3 % increase in the modal share of private car (46 % of journeys), and stabilisation of the figure for pedestrian travel (34 %). The share for bicycles and motorcycles combined is still marginal (less than 2 %), although on the increase (6 %), in particular for travel to and from work (20 %). For the latter category, private cars picked up the 2 % lost by public transport. The same phenomenon can be observed for travel to and from school.
While motorised travel for Paris residents (16 % of the total) remained stable, the figure for the inner suburb departments (37 % of the total) increased by 16 %, at a faster rate than for the preceding period, while that for the outer suburbs (47 %) was up by nearly 30 %. Furthermore, while the number of motorised journeys in Paris itself, and between Paris and the suburbs (30 % of the total) remained steady, the figure for inter-suburban travel (70 % of the total) was up by 20 %.
Furthermore, the share represented by private cars rose by 3 % for travel in the inner suburbs, and 2 % for the outer suburbs, reaching levels never experienced

before (77 % and 87 % of journeys respectively) in these zones. Geographical breakdown expressed in vehicles/km (3 % for Paris-Paris Travel, 19 % for Paris-suburbs, 14 % for inter-inner suburban, 43 % for inter-outer suburban travel represented the major part of private car traffic.

Any further continuation of these trends would be incompatible with the guidelines established by the law on clean air and the rational utilisation of energy, and a reduction in private car traffic in particular. It is this trend, which is contrary to the aim of reinforced solidarity and the preservation of the environment, which the draft PDU sets out to reverse.

Global policy based on effective parking management.

The actions covered by the PDU, for a five-year period, are aimed at :

- 3 % reduction in private car traffic, expressed in vehicles * km, differentiated by urban zone and corresponding public transport services, as follows : 5 % reduction for travel inside Paris and the inner suburb departments, and between Paris and the other departments, and 2 % for travel within the outer suburbs and between the inner and outer suburbs. The figure for private cars, relating to the number of motorised journeys within the outer suburbs should be reduced to 85 % ;
- 2 % increase in the use of public transport, with the modal share representing one-third of travel to and from words and school, as a result of introduction of the « Imagine 'R » card in particular ;
- 10 % increase the pedestrian share for distances of less than 1 km, and for travel to and from school ;
- doubling up of the number of journeys by bicycle ;
- 3 % increase in the proportion of freight carried by rail or inland waterways.

The transport policy for the urban complex, as defined in the PDU, can only be global. This implies articulation of the measures decided at each level, namely complex, densely populated city, new towns and old urban centres, and districts. This policy is also based on more efficient operation of road and rail networks, and enhanced sharing of the space accessible to the general public. This encourages non-recourse to the use of private cars, in particular through the introduction of a global parking policy, the principal tool for controlling private car travel. This means that it will be necessary to circumvent the obstacles, including legal obstacles in particular, impeding the introduction of efficient parking policy.

This should make it possible to achieve a substantial improvement in pedestrian and cyclist comfort, and the quality of service offered by public transport, thus reducing atmospheric pollution and the emission of greenhouse gases, combating noise pollution and achieving a material improvement in road safety. What strategy then can the PDU introduce in order to reduce private car traffic ? The initial task must be to eliminate travel time differences between the various forms of transport used, taking due account of their respective zones of relevance. In particular, this strategy must target enhanced traffic conditions for means of transport other than the private car.

This consequently leads to hierarchisation of the road and public transport networks. The rail and expressway network, referred to as the master network, must provide more efficient transport on a global urban complex scale. It is then the task of the main road network, on which the various modes coexistent, to provide for transport within the densely populated zone, while structuring transport in the new towns and old urban centres.

Insofar as the cycle track system is concerned, different scales must be taken into account. This includes access to the stations for long-distance travel at metropolitan level, systems providing the means to cross the densely populated central zone, as also in the new towns and old urban centres, together with local networks on a district scale.

In addition, pedestrian routes will be developed, enabling the local population of the districts to move about in safety and comfort, while providing easy access to the public transport bus and railway stations.

Preserving global economic operation.

Strengthening of the advantages of the Paris region means preserving satisfactory economic operation on a global scale for the entire urban complex. It is on this scale that travel must be made easier, in a context where size itself is an advantage. This concerns business travel, transport of merchandise and travel to and from work. The operators of the master network (railways, motorways, expressways and waterways) must therfore present users with an appropriate operating and regulation policy, more ample and better information, real safety and realistic guarantees concerning travel times. Measures will be taken to ensure that road transit traffic uses bypass routes.

To reduce road traffic, the initial task is to encourage the transfer of users from private car to public transport, in which case the latter must be more attractive in terms of travel time and quality of service. New policy regarding parking at the place of work will lead to a progressive reduction in the number of free parking spaces. This action regarding travel to and from work will de conducted in close collaboration with the companies, and their staff representatives.

Access to stations on foot, by bicycle, bus and private car must be made easier and safer for all categories of user (including disabled persons). As regards space management, priority must be given to access for pedestrians, cyclists and buses.

The railway system will be organised so as to provide a better service throughout the day for the high population density zones of the inner suburbs, as also the new towns and old urban centres. The capacity for freight transport on the outer rail belt will be maintained.

Express bus lines , integrated in the main bus system, will be extended into the outer suburban periphery in order to provide end-to-end-links.

With longer term objectives, and urban planning policy aimed at better co-ordination between the location of residential zones, and public and commercial facilities and activities, with transport services will be implemented.

In addition, public transport facilities for tourists between the various places of interest in the Paris Region must be made simpler and easier to use.

Enhancement and development of existing facilities in inner Paris.

As a direct consequence of the density of population in Paris itself, combined with the quality of the public transport network (metro and meshed bus network), the modal sharing situation for the residential population is better in Paris than in the suburban departments.

The main problem is still unauthorised parking, and this must be reduced by substantial proportions. This will make it possible not only to reduce all private car travel, but also to achieve more efficient operation of the bus network, accompanied by greater comfort for pedestrians and cyclists, and the delivery of goods under better conditions.

The « bus 2001 » operation, initiated by the Paris city authority and the RATP (Paris Transport Operator) will be integrated in the main bus network. This network will require modification for its extension outside the « Boulevard Peripherique » (ring motorway), in common with the metro lines.

The introduction of cycle tracks will be continued, while work on pavements and road crossing will ensure enhanced pedestrian comfort and safety. Cycle tracks and pedestrian itineraries between Paris and the adjacent municipalities will be extended.

Enhanced urban conditions in the suburban complex.

The social and territorial dualisation observable at the present time, is resulting in an increasing degree of dichotomy between the central part of the complex served by the metro, with a system of public transport enabling residents to access all the amenities of the city, and outside, a more open city in the nevertheless densely populated suburban part of the complex. The degree of integration of population and facilities lessens as one moves out from the centre, and the existing transport system does not allow full benefit to be obtained from existing potentialities.

In this part of greater Paris, where the population density is as high as that of the major provincial cities of France, the policy of « recreating the city » should make it possible to reawaken the population to the advantages of doing their shopping and engaging in leisure activities, whether sporting or cultural, in situ. Residents must therefore be able to move about easily, without using their cars, in this cluster of communes which, globally, offers the full range of potentialities of a city. In this context, particular attention will be paid to strategic sites for economic redevelopment.

Access to the metro and railway stations must be made easier for pedestrians, bicycles, motorcycles and buses. Parking of private cars round these stations must be regulated, with the elimination of long-term parking on the surface, and the generalisation of short -term pay-parking. Collaboration with the companies should lead to a reduction in the number of free parking spaces provided for staff.

The main road network will ensure enhanced safety for all users. To reduce pollution, including noise in particular, the road network must be requalified wherever possible, taking proper account of local living conditions. The network will function on a co-ordinated basis between the road management authorities, ensuring improved traffic conditions for buses. New regulations will be introduced regarding parking and deliveries, in order to ensure optimum transport efficiency.

The main bus network, both on the radial and ring lines, will offer an efficient alternative to the private car, in terms of speed, regularity, frequency, aptitude, cost, safety, security, accessibility and comfort, in the same way as the trams. In particular, the bus network must serve the most sensitive districts.

Co-ordinating committees, involving the

Government, the regional and departmental authorities, together with the municipalities concerned, the associations, the Paris Region Public Transport Authority and the transport operators, will be set up for the main road arteries or centres. The task of these committees will be to determine, within one year, what improvements are required, in each case, in terms of parking, delivery, sharing of space accessible to the general public, and general regulation of traffic in favour of the buses.

Definition of the cycle track system, including provision for bicycle parking, must provide for easy access to stations and public facilities, including schools, leisure centres and shops in particular. This network must be meshed, continuous and clearly identified by efficient signs.

Public parking and delivery policies must be harmonised between the different communes, so as to be easily comprehensible for the user.

Increased centrality outside the central urban core.

It has been the objective of the public authorities to polarise development, outside the central urban core, round the new towns and historical urban centres of the Paris Region. These should be able to operate autonomously on the one hand, and in liaison with the other individual centres of the complex on the other.

This multicenterist development approach assumes a transport policy, as defined by the local technical committees, constituted on a « population catchment basin ». Scale on the basis of the technical recommendations and directions of the regional PDU. The coherence and harmonisation of parking policy, both public and private, and that relating to deliveries, must be obtained at this level.

The primary target is a materiel reduction in the number of short journeys by private car, in particular for ferrying and shopping purposes. This demands the increased use of bicycle travel and walking under satisfactory conditions of comfort and safety.

These towns must have cycle track networks, designed in particular for access to stations, public facilities, schools and leisure centres. The cycle track routes must be clearly identified with appropriate signs. Bicycles parked in the vicinity of the stations must also be protected from theft and vandalism.

The frequency, amplitude, regularity, cost, safety and security, accessibility and comfort of the public transport networks must be such as represent a genuine alternative to the private car for daily short-distance travel. As in the densely populated zone, the network must be hierarchised, with the definition of a structuring/railway station access network integrated in the main network. Where these cities have a number of stations, the internal service function must be taken into account in the rail transport operational plan.

Enhanced local living conditions

The quality of life in each district must be enhanced by development of the space accessible to the general public. Travel safety and security, in particular for children and elderly people, must be improved. Short-distance travel on foot and by bicycle will be privileged. This will lead to the development of « quiet districts », the enlargement of pavements and the consequent reduction of road width, and the introduction and clear identification of pedestrian and cycle track routes.

The public parking policy for residential areas must be aimed at restricting the use of private cars. Parking facilities for motorcycles must be properly taken into account. Appropriate attention to delivery requirements should make life easier for local traders.

This local transport policy, established at district level, must be defined by local technical committees, working closely with the communes, on the basis of the regional PDU.

A shared approach involving all partners

This global strategy is based on a shared approach, involving the participation of all municipal authorities, with the support of the business community and the population at large. This assumes a three-part base.

The first part concerns measures taken by the authorities, acting at regional and departmental level, in particular in connection with the structuring network of the Ile-de-France urban complex. The second concerns the communes, the only genuinely competent authorities (except in the case of Paris itself) regarding parking and traffic matters.

The third part relates to the direct initiative of the business community. The successive actions concerning the main network will require the introduction of regulations to which the local authorities will be subject, to make it possible to operate the main bus network at a speed and with a regularity attractive to users in particular. To encourage greater cohesion between the various players, it will be necessary to define strategie in particular with regard to parking, and contribute both technical recommendations and financial aid.

Conclusion

We now have draft version of the PDU. This is the result of an approach shared with all players involved in the transport sector. In emulation of what has already been done in Lyons, the task is now to implement a public consultation phase. This should make it possible to improve the draft, which will be submitted to the local authorities, and then subjected to a public inquiry, as required by law. It should then be possible to implement the PDU by the end of the year 2000.

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Policy formulation for an integrated multi-modal public transport plan case study: Calcutta, India

P. Kansal & V. K. Sibal
Urban Transport, RITES, New Delhi, India

ABSTRACT: Calcutta is the premier metropolis of Eastern India with a population of 12.07 million in 1991. The city has a meager 4.2% road space and its suburban system does not connect work centres. The various public transport modes in Calcutta include a Suburban Rail System, one North-South corridor of Metro System, the various types of buses being operated by different Government and private agencies, a limited ferry system for trans-river movement and shared auto rickshaws with no coordination amongst different transport modes and they are not functioning as per the roles defined for them in urban transport system planning. In view of the growing traffic demand and lack of road space in urban centres, a public transport policy for urban areas has been suggested. Specific proposals for transport network and system development alongwith necessary integration facilities have been formulated to meet the expected public transport demand.

1 INTRODUCTION

Calcutta, situated on East bank of river Hoogly in the Eastern part of the nation is one of the four major metropolis of India. Calcutta Urban area, being a part of Calcutta Metropolitan Area (CMA) is the major centre of functional activities of North-Eastern region covering a wide hinterland. The population of CMA has grown from 2.25 million in 1931 to 12.07 million in 1991. The city is nodal centre for local, regional, national and international traffic and transportation and other economic activities.

Calcutta Urban area is the study area and is defined by Vivekananda bridge in the North, Hoogly river in the West, Garia railway station in the South and EM Bypass and Salt Lake in the East. The population of study area is 4.28 million as per 1991 census which has grown at a decadal growth rate of 8% during 1981-91.

The road network in Calcutta is guided by the linear development of the city with major roads running parallel to river Hoogly. More recently, the development of some corridors is giving a radial development pattern to the city.

The Public Transport system in Calcutta consists of suburban rail, metro rail, tram, bus and ferry services. Suburban rail and Metro rail are being operated by Indian Railways, the tram system by the State Government and the bus and ferry services by a number of Government and private organisations/agencies. Intermediate public transport (IPT)services on shared basis are also available on some routes.

The existing transport systems in the study area are indicated in Figure -1.

Figure -1.

2 EXISTING TRANSPORT SYSTMS

The study area has a North-South corridor of suburban rail system with a small East-West link (not in much use). The total system length is about 32 km with 12 stations. The number of suburban passengers served by Indian railway has increased from 0.85 million per day in 1970-71 to 1.65 million per day in 1996-97 at an annual growth rate of 2.6%.

Existing Circular rail (13.5 km.) is providing direct access from North Calcutta to Central Business District (CBD) in Calcutta. Presently, it has diesel traction service operated on single line and carry about 25000 passengers per day.

Metro rail (16.4 km.) with 17 stations from Dum Dum to Tollyganj is operating 63 pairs of trains on an average weekday. At present, Metro rail is heavily under utilised, carrying only about 0.2 million passengers per day.

Major Government agencies operating buses in Calcutta are Calcutta State Transport Corporation (CSTC) and Calcutta Tramways Company (CTC). A large number of private operators operate regular sized as well as mini bus services all over the city. A total of about 5000 buses are operating on about 350 routes carrying about 4.5 million passengers and providing about 0.65 million bus-km. service per day.

Tram service, the oldest mechanised mode of transport in Calcutta has deteriorated over a period of time. The existing tram network in Calcutta is about 60 km. long. About 180 trams run on 30 tram routes on an average weekday providing 54 lakh tram-km of service. Passenger patronage of tram has decreased from 0.25 million passengers per day in 1993 to 0.20 million passengers per day in 1997.

Ferry services were introduced in 1970's to provide easy access to trans-river traffic. The system carries about 0.25 million passengers on an average weekday.

IPT, an unorganised public transport service is also running on fixed routes with fixed fare on shared basis. Auto rickshaw carry about 1.0 million and taxi carry about 1.5 million passengers on an average weekday.

Thus, the total public transport passenger trips by different modes can be summarised as:

Mode	No. of passengers (million)	Percentage
▪ Suburban Rail	1.65	18
▪ Metro Rail	0.20	2
▪ Tram	0.20	2
▪ Bus	4.50	48
▪ Ferry	0.25	3
▪ Taxi	1.50	16
▪ Auto rickshaw	1.00	11
Total	9.30	100

3 PRESENT TRANSPORT DEMAND

Extensive primary traffic surveys were carried out in the study area to assess the present traffic intensity and movement pattern by various public transport modes. These surveys included Household Travel surveys and Origin-Destination (O-D) surveys of Metro rail, suburban rail, bus and ferry passengers.

The base year O-D matrix has been generated by combining two components i.e. internal trips (55 zones) derived from the household travel survey and external trips from the data collected through O-D surveys of passengers of various modes. A per capita trip rate (PCTR) of 1.0 including the intra-zonal trips (0.9 excluding the intra-zonal trips) along with a 75% modal split in favour of public transport was derived from the data analysis. The total trip attraction of the study area works out to about 9.0 million per day. The present transport demand is assigned on the integrated multi-modal public transport network. Suitable mode change penalties have been imposed to take care of the time spent for changing the mode of transport. The trip assignment on existing transport network has been cross-checked with the ground counts of traffic at various screen lines and the model was calibrated to get the results of assignments and ground counts within the acceptable limits ie. +/- 5%.

The inner core of CBD attracts highest volume of vehicular and passenger traffic. In addition, a large number of trips pass through this area to reach their final destination. On an average week day about 0.4 million vehicles including about 40,000 buses move through this area.

Suburban rail corridor (North and South section) is the major travel corridor for suburban rail passengers. Metro rail section between Esplanade and Chandani Chowk is heavily loaded, carrying about 0.12 million passengers. Ferry and tram are not playing major role in meeting public transport demand in the study area.

4 HORIZON YEAR TRANSPORT DEMAND

Traffic counts on important locations carried out on routine basis by the State Government shows that traffic volume is growing @ 1.5% to 7.0% annually depending upon the location. The average growth rate at various screen lines is estimated at 3% per annum.

Base year traffic demand is projected for horizon year 2011 by combining the intra and inter city trips. While the intra-city trips are projected based on the expected trip generation rate, landuse distribution and development programmes, the inter-city trips are projected on the basis of estimated growth rates on various corridors/modes. Horizon year O-D Matrix is assigned on the integrated transport network

DAILY PASSENGER FLOW ON MAJOR CORRIDORS

Figure-2.

by using capacity restraint assignment technique. Total number of trips (external and internal) in the study area are estimated to be 11.32 million in 2011. Present modal split of 75% in favour of public transport is taken for horizon year 2011 also as no further increase in the share of public transport is expected in next one decade.

The Assignment of horizon year O-D matrix on existing network shows that in addition to the existing rail corridors, 5 East-West and 4 North-South road corridors will become high density traffic corridors (Figure-2).

5 PUBLIC TRANSPORT POLICY

The growing demand for urban transportation and lack of road space in urban centres to accommodate increasing vehicular traffic stresses the need for an efficient public transport system and a public transport policy at national level. The road space required by bus, car or two-wheeler to meet a given urban transport demand varies in the ratio of 1:44:73. In a city like Calcutta where area under road is only about 5%, a high capacity public transport system must be given top priority. It will significantly reduce the congestion, operating cost of vehicles and environmental pollution. The public transport modes are least energy intensive and carry a large number of passengers using less space per passenger as compared to private modes of transport. The rail based systems are comfortable, convenient and reliable and use only about 1/6th of the space required by an equivalent capacity road system providing an environmental-friendly transport service.

In the hierarchy of transportation supply, rail transit system of varying capacities should be on high density corridors followed by standard buses on the main corridors acting as feeders to rail transit, while mini-buses may operate on corridors of low traffic intensity. Personalised vehicles, non-motorised transport and intermediate modes of public transport should provide easy access to the mass transport system.

There is a definite uncertainty regarding the size of funds likely to be available for the public transport system development, and inter-governmental agreement for building primary urban public transport facility. Further, there is no clear cut institutional programme for the urban transport development including finance at national level. Uncertainties also exist at the micro level like in bus route planning and operation of trams, etc.,

Therefore, one rigid plan for public transport system development for Calcutta is not recommended. On the other hand, it has been considered useful to bring out a reasonable Perspective Plan for the public transport system which can yield to incremental development and changes through Five Year Plans and Annual Plans.

The public transport policy is based on the following principals;

- Highest priority assigned to public transport system in the total transport scenario.
- For a metropolis with transit travel demand in excess of 10 million/day, the primary mode of public transport should be rail based.
- In consonance with the growth of central city and suburban travel, priority may be assigned to enlarge transport linkages and services between central city and suburban area. At the same time, specific service for the city area need to be considered.
- Attempts must be made to increase the capacity of existing road network by re-organising/ modifying the existing traffic operations and reducing unwarranted competition amongst various modes of public transport as well as amongst various bus routes.
- It has become urgent to institutionalise the total urban transit for planning, financing, development and strategic management to start with. At a later stage, the operation of different modes may also be considered for suitable integration and coordination.
- Urban transit development plans need to be made on the consideration of marginal cost and benefit and maximisation of available capacities of the systems and subsystems.
- Urban transit development proposals should provide suitable integration among various sub systems by the provision of efficient interchanges and service linkages. As a part of integration, common ticketing system may be considered to be introduced gradually.

- In the context of the need for the comprehensive development of urban transport at least in mega-cities, it is necessary to have a national level act on urban transport defining the development objectives and laying down the rules of business including the establishment of an independent commission for fare and pricing of urban transport.

6 PUBLIC TRANSPORT PLAN

All the projects under consideration of the State Govt. and likely to be materialised by the year 2011 are included in the alternative public transport networks. These are :

a. Extension of Metro Railway from Tollyganj to Garia.
b. Doubling and electrification of Circular Railway from Dum Dum to Princep Ghat and then up to Majerhat.
c. Operation of suburban rail services on Kankurgachi Chord.
d. Extension of Metro railway from Dum Dum to Barrackpore
e. Transport infrastructure development project being implemented under financial assistance from OCEF of Japan.

The basic horizon year network also includes many new proposals that are considered absolutely essential to meet the estimated transit demand. These proposals are :

i. Improvement in frequency of operation of Tollygang – Dum Dum section of Metro Rail with suitable inter-modal transfer facilities.
ii. Introduction of 3-4 coach modern tram system (Light Rail Transit – LRT) on exclusive right of way with or without grade separation.
iii. Upgradation of existing tramways on corridors these are most suited.
iv. Improvement in efficiency of bus system with suitable bus priority and management measures.
v. Introduction of a new ferry service between Nimtala and Howrah station along with upgradation of infrastructure facilities at ferry ghats.
vi. Timely completion of already planned road improvement projects including 2nd Vivekanand bridge, Belghoria Expressway, Southern Expressway connecting EM Bypass and Diamond Harbour Road.
vii. Other important road facilities proposed to be taken up for implementation.

The introduction of modern tram system on exclusive right-of-way with or without grade separation, upgrading existing tramways on suitable corridors, the need of high capacity rail based public transport system, high cost of Metro rail and optimum utilisation of available systems/infrastructure are taken into consideration while developing integrated multi-modal public transport plan/networks.

In addition to the existing ferry services, two new ferry services on high demand corridors Nimtola-Howrah Station and Princep Ghat-Howrah Station become essential to meet trans-river traffic demand.

The predominance of bus services will continue in meeting the total urban public transport demand of Calcutta. Therefore, it becomes essential to increase the capacity of roads by widening of roads, construction of new links, construction of flyovers and traffic engineering and management measures and also through various bus priority measures. In the modified system, the buses will provide feeder service to the rail based system and therefore, the priority of improvement of road links should be based on the proposed transport plan.

Three alternative public transport networks have been developed and evaluated against common parameters (passengers served, passengers-km and passengers-km/km), keeping in view that no public transport facility will be created in parallel to existing/planned facility. The recommended public transport network is presented in Figure-3.

The recommended public transport network includes metro rail extension from Tollygunj to Garia (8 km.), a 30 km. long network of LRT/modern tram on 3 major travel corridors, a route length of 24 km. for exclusive busways and ferry services from Howrah to Princep Ghat and Howrah to Nimtala.

The proposed implementation plan (given below) suggests that the proposals relating to busways, Ferry services and suburban rail services on Kankurgachi Chord must be implemented immedi-

Figure-3.

ately (by the year 2001). The doubling and electrification of circular rail from Dum Dum to Majerhat, Metro extension from Tollyganj to Garia and 3 out of 4 LRT corridors must be completed by the year 2006. The extension of Metro rail from Dum Dum to Barrackpore and LRT corridor connecting Kasba with Majerhat are proposed to be operational by 2011. The road development programme has to be done on a continuous basis.

TRANSPORT SYSTEM	YEAR		
	2001	2006	2011
Metro			
▪ Tollyganj to Garia		▪	
▪ Dum Dum to Barrackpore			▪
Suburban Rail			
▪ Circular Rail			
➢ Dum Dum to Princep Ghat		▪	
➢ Princep Ghat to Majerhat		▪	
▪ Kankurgachi Chord	▪		
LRT			
▪ Joka to Majerhat		▪	
▪ Bidhan Nagar to Fairlie Place		▪	
▪ Joka to Tollyganj		▪	
▪ Majerhat to Kasba			▪
Ferry			
▪ Howrah to Princep Ghat	▪		
▪ Howrah to Nimtala	▪		
Busways			
▪ Dum Dum toMajerhat	▪		
▪ Park Circus-E.M. Bypass Crossing to BBD Bagh	▪		
Road Development Projects	Continuous Process		

7 COSTING AND FINANCIAL ANALYSIS

The cost benefit analysis for all the three alternatives has been carried out by taking into account the estimated social benefits and the revenue likely to be earned through fare box revenue. The Internal Rate of Return (IRR) for the recommended alternative comes to 15.3%.

The implementation of recommended public transport plan will require US$ 100 million by 2001, US$ 600 million by 2006 and another US$ 300 million by 2011. Thus, the total investment required for implementation of the recommended plan will be US$ 1.0 billion spread over a period of 12 years.

8 CONCLUSSIONS

Most of the major road corridors are heavily loaded and are not able to carry the present traffic at desired level of service, while the existing Metro Rail is heavily under utilised. There has been no significant increase in the capacity of suburban rail system over last two decades and ferry services play a very limited role. The physical and operational coordination amongst the various modes is completely missing.

An integrated multi-modal public transport system has been recommended to meet the expected public transport demand till the year 2011. Each mode of public transport has been assigned a specific role as per its capacity and operational flexibility. A definite attempt has been made to ensure shift of passengers from road based to rail based public transport modes over next decade with the development of necessary infrastructure.

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Challenges and perspectives of urban transportation for passengers in Mexico City

Defits et perspectives du transport urbain des passagers à la Ville du Mexique

Retos y perspectivas del transporte urbano de pasajeros en la Ciudad de México

F.J. Enríquez
Banobras, México D.F., Mexico

ABSTRACT: Mexico City is one of the largest metropolis in the world, facing serious problems in providing a coordinated transportation system. One of the worst outcomes is pollution caused by mobile sources; in addition, the low capacity modes have significantly increased its participation in individual's movement. This situation is aggravated in part by the lack of organization from private concessionaires, that have restrained investment in infrastructure and equipment, resulting in low service quality and limited financial support for the modernization of this sector. This document proposes various strategies to establish an action plan for Mexico City, to improve the transportation services and decrease the social cost, which is currently estimated around 8,000 million dollars annually.

RÉSUMÉ: La vielle du Mexique, une des métropoles plus grand du monde, a sérieux problèmes au dégagement du système intégral du transport. La majeur contribution á la contamination de l'environement est provoqué pour origines mobiles; additionelment, les modalités de bas capacité a incrementé considérablement son participation en mouvement du personnes. Cette situation s'aggrave pour la manque du organisation des représentants privés, dejá qui deourage les inversiones de l'infrastructure et équip, la qualité des service et a diminue éloginé les appuis financiers pour sa modernisation. Dans ce document, nous propons quelques stratégies pour établir un plan du action dans la vielle du Mexique, qui propice le amélioration des services de transport et qui deminue le coût social estimé actuelment est atour du 8,000 millions dollar annuels.

RESUMEN: La Ciudad de México, una de las metrópolis más grandes del mundo, acusa serios problemas en el desempeño del sistema integral de transporte. La mayor contribución a la contaminación ambiental es provocada por fuentes móviles; adicionalmente, las modalidades de baja capacidad han incrementado considerablemente su participación en el movimiento de personas. Esta situación se agrava por la falta de organización de los concesionarios privados, ya que ha desalentado las inversiones en infraestructura y equipo, ha mermado la calidad de los servicios y ha alejado los apoyos financieros para su modernización. En este documento se proponen algunas estrategias para establecer un plan de acción en la Ciudad de México, que propicie el mejoramiento de los servicios de transporte y disminuya el costo social, estimado actualmente en cerca de 8,000 millones de dólares anuales.

This document has as its main objective to analyze the evolution of passengers urban transportation system in Mexico City and proposes factors that would allow to design an strategy that would result in a more rational and order scheme of this important activity.

Mexico City is characterized by the metropolitan area composed of the Federal District, which is the capital of the country, and 28 adjacent municipalities of the neighbor State of Mexico, is today the fourth most populous metropolis in the world, after Tokyo, New York and Sao Paulo. It is located in the central region of the national territory and since the pre-Columbian period, the region has been an important political, economic and social center. The urban spread cover 5,000 Km^2, representing 0.25% of the national territory, corresponding to an area of 2 million km^2. According to a 1995 accounting process data, 16.6 million people reside in this area, practically distributed in equal parts amongst the Federal District and the adjacent municipalities of the State of Mexico. In respect to the total population of the country, Mexico City represents 18%.

The relative weight of the metropolis economic activity is represented by its concentration of 31% of the total GDP and 38% of the industrial GDP. The political, economic and social importance of Mexico City has caused it to constitute an important attraction pole for migrants, in addition to its natural growth that has resulted in a population increase of around 80% in the last 25 years. Within the last years, the annual rate of population growth was registered to be 1.8%, although during the sixties decade the rate of growth reached 5.6%.

The passengers public transportation service in the city is provided by a system composed of the subway, trolley buses, and an electric light train; all of which are operated by the Federal District government in addition to the privately concessionaire transportation system which operate buses, microbuses and taxis.

An important component strongly bounded to the transportation activity is constituted by the environmental factor. An annual emission of 3 million tons of pollution is attributed to the transportation sector, which represents around 75% of total emissions. From the total emissions sources linked to vehicles, around 48% correspond to private automobiles, 22% to taxis, 16% to low capacity concessionaire transportation, 11% to cargo trucks and the remaining 3% to buses and other vehicles. The solution to the air quality problem in the city constitutes a policy priority for local governments.

During 1994, the daily stretch average of the total trips in the area was estimated to be 29.2 million, according to 'origin-destination' census prepared by the National Institute of Statistics, Geography and Information. In the last 20 years, the stretch of trips approximately increased 90%.

To analyze the evolution of modal transportation, the year 1976 data was taken as a point of reference, where within that year 63% of the trips were taken in modes of high and medium capacity such as the subway, electric light train, trolley buses and buses. Out of the remaining 37%, 12% corresponded to trips taken in taxis and in low capacity public service units, and 25% in privately own vehicles.

Today, the modal transportation distribution has gone thru various transformations, which are of concern due to its decay implications, on average only 25% of the daily trips are carried out in high and medium capacity vehicles and 58% in low capacity vehicles, that is to say, the use of low capacity vehicles has considerably increased its total proportion in the modal distribution., which is in all its context inconvenient for the metropolis.

According to available information, it is of special attention to notice that the participation of private automobile trips had decreased from 25% to 17% during the analyzed period, the transportation plans for 1994 had an expected use of modal transportation participation of 20%, a target which was considerable improved. Administrative policies for environment purposes have influenced the demand for the use of cars. Policies such as the "hoy no circula", mean that one day out of the week (excluding the weekend) the use of cars of previous model to 1993 is prohibited, depending on the ending number of the license plate. These factors have contributed to the unexpected decrease in the modal participation of privately own automobile trips. Without going into greater detail about this topic, it is possible to point out that the modal participation of privately own automobile in transporting individual in Mexico City is amongst the lowest in the world.

In terms of the supply and transportation coverage, in the period between 1976-1996 the evolution was as followed: the subway network was increased from 37 to 178 Km., the units of urban bus services was reduced form 7,500 to 1,300 units, in comparison the units of taxis and collectivist vehicles of low capacity which was increased from 40,000 to 141,000 units, furthermore the privately own automobile fleet increased from 1.3 million to 2.8 million. As one may notice, there is a correlation between the modal participation analyzed, in terms of public transportation and transportation system capacity during the analyzed period, except for the subway system, which represents a lower participation, despite its increase in the network length, an issue that will later be discuss.

From the previous data one can identify the presence of a phenomenon that is important in the city life; which consists of the origins and evolution derived from a type of concessionary public transportation mode known as "microbuses". These are low passengers capacity (25 passengers), and are an inappropriate design for the transportation service. These units are operated under a self-seeking scheme "man-bus", that is to say, an organization that is inefficient. In general, for most cases of these transportation services the organization schemes have not been developed under entrepreneur criteria to be able to operate efficiently. One can continue to find an important presence of those owners of individual transportation units that control the service. In turn the result is that each individual concessionaire is concern with taking care of their own interest and their individual units, and are not concern with the quality of the service provided.

The current transportation organization schemes limits the adoption of unified programs gear towards establishing a systematized and permanent operation and maintenance approach, in addition to an inadequate control of an administrative process. Consequently other forms of profit making investment are discouraged such as groups investments, or in infrastructure, equipment, mechanic shops and tools. The current operational control method influences specially the accounting system of the expected revenue, also its organization scheme does not allow then to accumulate the necessary financial resources to be able to confront the variations amongst income and costs, and to replace the necessary units to provide the service.

In terms of the regulatory authority in the transportation service, the objectives have not been reached to their full extent. In that, the public transportation system is not self-sufficient due to the policies in concessions and fees to allow them to obtain a return on their investment and provide the quality and quantity of services to satisfy the demand.

The result is a current public service with serious deficiencies that in turn represent either a surplus or a deficit of units, also internal competition for passengers, delays or unpredictable early arrivals within the stop intervals. Also speedy or low velocity uses, accelerated depreciation of the units and continuous accidents, where the strongest and not necessarily the best stay in the market. Creating a mentality gear towards to maintaining the current model instead of promoting a new one. The concessionaire transportation approach has slowly reduced its presence in the periphery area of the city given the low investment return received.

Thus, today the transportation sector confronts serious problems in generating sufficient financial resources to acquire new units for the modernization of this service. Besides the required changes on the concessionaire policies, in terms of the applied fees in relation to the cost; this sector also confronts the situation where financial institutions are not offering any new credit to the sector and are spending their efforts in restructuring previous credits that were provided for the acquisition of units. Which is also in part attributed to the way in which the transportation sector is organized and operated.

In terms of the subway system, its participation in the total movement of passengers shows a continuos decrease during the current decade. In 1989 on average the subway system moved 4.7 million passengers during any working day, in comparison to 1997 when it only moved 4.17 million passengers, despite the fact that in that same period two new routes came into operation with an additional length of 37 km. The expansion in capacity and coverage, and the decrease in demand in turn, have had an important financial impact for the Federal District government, given that the investment and operation costs are increased and revenues decreased. Consequently it becomes necessary to increase greater subsidies to the system, in detriment of the attention to other sectors.

Therefore it is clear that if this tendency continues, the city's public transportation service for passengers will not offer an effective mobilize alternative, which implies greater cost and time consuming for every trip, more congestion in public roads and an increase in pollution. Provided that public transportation does not represent an acceptable option for the medium and higher income groups, they will continue to have a motive to use their own private automobiles. Thus a viscous cycle is established representing higher social cost given those externalities caused by this sector, consequences that arise in the city that does not have sufficient space and resources to improve the infrastructure of the network transportation system.

According to the results of the analysis "Integral Study of Transportation and Air Quality of the Metropolitan Zone of the Valley of Mexico", carried out by the Metropolitan Commission of Transportation and Network Roads, and the support of the local governments of the State of Mexico and the government of Mexico City; and including the participation of BANOBRAS and the World Bank; the annual cost of the transportation externalities caused by accidents, congestion, energy used and pollution, is greater than 8,000 million dollars, amount that quantifies the magnitude of this problematic situation.

Local governments do recognize the importance of the problem and are concentrating their efforts in solutions that would allow them to establish the bases to develop a quality transportation system to meet the needs of this great metropolis.

It is necessary to consolidate an integral vision for the transportation system that takes into account the infrastructure and services in all its domain, furthermore, it is necessary to strengthen the coordination of local governments to allowed the implementation of actions in an effective matter.

Specifically, in terms of public transportation for passengers it is recommended to establish an action plan that takes into account the following strategies:

- To promote the evolution of the concessionaire transportation system from its current self-seeking operational scheme to the integration of an entrepreneur approach to operate in a professional matter based a criteria of efficiency and quality of the service and its profitability.

- Replace the current vehicular fleet for modern buses of greater capacity and low pollution emission technology.

- Restructure the network itinerary to accomplish a better modal distribution of the transportation service, whereby high capacity modes get higher priority and provide an appropriate service that complements all different aspects of the system.

- Establish an equilibrium between demand and supply to prevent a surplus of investment on equipment in some routes or bad quality service on others due to the lack of appropriate equipment, also it is necessary to plan its operation based on the variation in the demand.

- Establish special services of greater quality and adequate fees that can motivate a decrease in the use of privately own automobiles.

- Continue to strengthen institutional governmental areas responsible for the planning, control and operation of the transportation system.

- Develop campaigns to inform, and to improve consciousness about better use of the public transportation system amongst the population.

- Consolidate a policy for fees that takes into consideration a sustainable provision of the service and that takes into account the purchasing power of the population.

CONCLUSIONS

In conclusion, Mexico City as in the case of a large metropolis in the world requires to improve strategies that would allow it to improve and make more efficient its transportation system, whereby the impact of externalities is minimized. It is important to emphasized the need to reduce the deterioration of the modal composition of the passengers transportation system, where the low capacity modes and lower degree of development subsystems have increased their participation in detriment of the higher capacity modes of transportation, such as the subway. It is therefore recommended to develop strategies that will optimize the public transportation service whereby it is promoted to develop an integral transportation system and accomplish a viable-coordination to design plans and implement actions amongst all the governments of the region.

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An assessment of transportation alternatives for Istanbul metropolitan city for the year 2010

Evaluation des alternatives de transportation pour la métropole Istanbul en 2010

Comentario de alternatives de transporte del año 2010 de la ciudad de Estambul

M. Ergun, S. Iyinam & A. F. Iyinam
Civil Engineering Faculty, Technical University of Istanbul, Turkey

ABSTRACT: Istanbul is may be the only city located on two continents and, the biggest city of Turkey has a population of nearly ten million at the end of 1998, which is 15% of Turkey's population. The main aim of this study is to asset the transportation alternatives made by Istanbul Metropolitan City Transport Master Plan. At the conclusion part, some suggestions are given to solve the city transport problems.

RESUME: Istanbul a la seul ville qui a été placé en deux continents. En 1999, la population de la ville est 10 million qui est 15% de la population de Turquie. Le but de ce travaille est evaluer les alternatives du Plan Principale de Trasportation d'Istanbul. Finalement, certaines propositions pour la solution des problems de transportation d'Istanbul ont été donné.

RESUMEN: Estambul, es la ciudad única en el mundo que situada sobre dos continentes. Población de Estambul es 10 millones teniendo cuenta el año 1999, 15% de habitantes de Turquía está vivendo en esta ciudad. Objeto de este estudio, es comentar alternativas de transportación en el Proyecto Esencial de Transportación de Estambul. Y en la parte conclusión existen algunos aconsejos referidos a soluciones de problemas transportales de la ciudad.

1. INTRODUCTION

Istanbul is maybe the only city located on two continents, Europe and Asia. This city is always in the crossing point of Europe-Middle East Goods Transportation. In addition to this transit traffic, inter city traffic uses the city transportation network. Istanbul is the biggest city of Turkey and, has a population of nearly ten million at the end of 1999, which is 15% of Turkey's population. Ten million daily trips are produced on the transportation network. This causes transportation problem during rush hours and also throughout the day.

The transportation alternatives for Istanbul Metropolitan City are explained with the basis of the Istanbul Metropolitan City Transportation Master Plan in this paper. This plan makes predictions for all transportation modes for the year 2010. Different kinds of scenarios related with different kinds of transportation modes are studied to solve city transportation problems for the future. Due to the two highway bridges across the Bosphorus, main public transport mode of Istanbul is highway transport. This causes very big transportation problems along the day. In addition to this, some other effects of the highway transport can be seen such as noise pollution, air pollution and traffic accidents.

2. PRESENT SITUATION OF ISTANBUL TRANSPORTATION

Istanbul is the biggest city of Turkey, Europe and Middle East in 1999. It is situated between Europe and Asia as a bridge from Europe to Asia and Middle East. This position has given it extra duty through the centuries.

Nearly all road freight traffic of Turkey, Iran, Iraq and ex-Soviet Union countries passes over it. Even today's crude oil traffic from Soviet Union passes from the heart of Istanbul, the Bosphorus.

After the 1950's, Istanbul became an immigration centre of Turkey with the yearly 5 % growth rate in the population, nearly 3 times bigger than Turkey's population growth. Through this immigration for better life standard and wealth, the city became a metropolitan region. This region is nearly 155 000 hectares wide (GERÇEK et al, 1998) . City development is mainly along the old E-5 Expressway from East to West. To pass the city from East to West it needs nearly 4 hours in rush hours, 3 hours other times.

Freight and passenger transport is mainly made by road transport; which means a one-sided development in transport modes. This causes severe problems for the residents of the urban area of Istanbul (HOWARD, 1995).

Istanbul accommodates 25 % of the total vehicles (nearly 1.2 million) and 30 % of the total private cars (110 cars per 1000 persons) in Turkey in 1999. The number of daily trips per capita by motor vehicles was found as 0.87 in 1987, but now it is nearly 1.00 [5]. The daily ridership by motor vehicle is nearly 10 million in 1999.

The total share of all the transport modes can be explained in Table 1. Modal split of daily trip are shown in Figure 1.

Increase in the use of private cars and public buses as a road transport mode created new demands for the construction of roads and bridges. In 1973, the first Bosphorus bridge and in 1989, the second Bosphorus Bridge was opened. The formerly unified central area began to move along the East-West suburban areas. This development in transportation not only resulted in the dissolution of the relationship with the shore, but also resulted in a web of settlements within an urban area covering an area having a 150 km. length.

Table 1.Transport system numbers in 1997.

Type	Number of Vehicle	Daily Passenger	Share (%)
Public Bus	23777	2000000	23.56
Private Bus	1144	693000	8.19
Private Car	1141344	120000	14.14
Minibus	5055	110000	12.96
Taxi	18006	395300	4.65
Services	27525	2200000	25.92
Commuter Rail	101	250000	2.94
LRT	26	120000	1.41
Tram	39	151000	1.78
City Sea Bus	17	30000	0.3
Steamship	59	300000	3.54
Private Sea Motors	236	50000	0.59

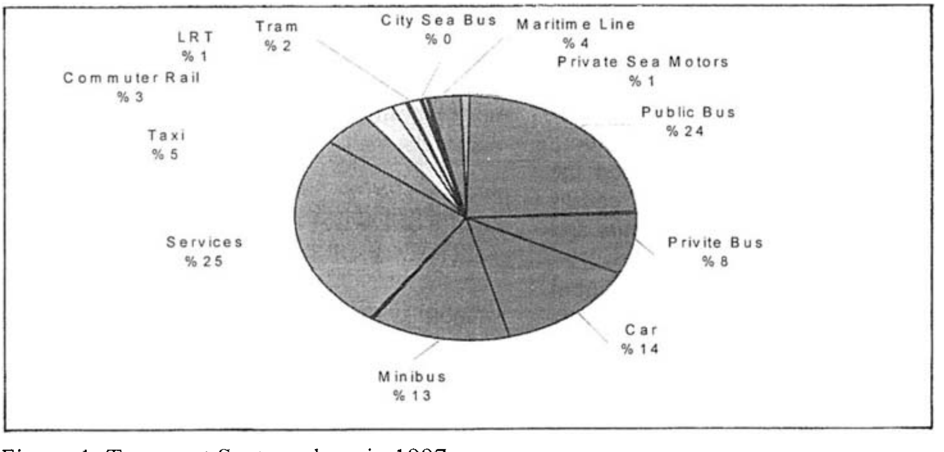

Figure 1. Transport System share in 1997.

65 % of the total population of Istanbul live on the European side, 35 % of the total population of Istanbul live on the Asian side. The employed population is distributed as 75 % and 25 %, respectively (Figure 2).

One-sided public transport system and uncontrolled growth have led the metropolitan municipality to construct new lines and to extend the rail system on both sides. In 1989, the 18km-long light rail system was built on the European side. The first subway line between Taksim and Levent will be opened at the middle of 2000.

The metropolitan municipality has prepared the Istanbul Metropolitan Area Sub-Region Master Plan (IMASMP, 1995) and Istanbul Metropolitan Area Transport Master Plan for the target year of 2010. These plans are made mainly to regulate the settlement pattern along the city and the public transport.

3. FUTURE PERSPECTIVE OF THE ISTANBUL TRANSPORTATION

Future perspective of the city transportation can be drawn by the help of the Istanbul Metropolitan Area Sub-Region Master Plan and Istanbul Metropolitan Area Transport Master Plan (ITU,.1997)

First, Istanbul Metropolitan Area Transport Master Plan was prepared in 1995. Then, Istanbul Metropolitan Area Transport Master Plan (MATMP) was used for the Istanbul Metropolitan Area Sub-Region Master Plan patters in order to stimulate the badly organised city transportation system .

The main strategies of the Metropolitan Area Sub-Region Master Plan (MASMP) can be explained as follows;

-Rule of specialisation; Within the compass of the MASMP the housing-work relation of especially those who are new comers by resolving it in a rational manner and improvement of this relation which were ill defined in the previous structure within the framework of a plan,

-Rule of Ranked Centres; In order to achieve the decentralisation on population in the entire MAS suggesting wing-attraction centres and ensuring the development of these as primary centres. Achieving the growth of the urban macroform in a linear and multi-centred fashion with a degree of ranking,

-Rule of Ranked Density; In accordance with the analysis carried out for the whole of Istanbul, decreasing the sustainable population densities gradually from the centre outwards, and decreasing the mean values.

MASMP has planned that 67 % of the total population of Istanbul will be living on the European side, 33 % of the total

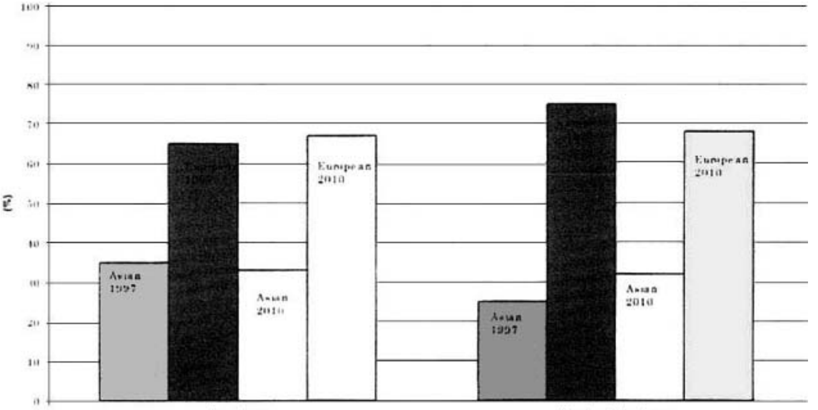

Figure 2. Change in the Population and Employment Rates.

population of Istanbul on the Asian side in 2010. The employed population will be distributed as 68 % and 32 %, respectively.

The main principles of MATMP can be expressed by following sentences;

-The service level and capacity of public transport system must be improved and the use of public transport must be promoted,

-Future transport network must be based on high capacity public rail systems (Figure 3),

-To feed the main railway lines in the east west direction generally, new lines in the north-south direction must be created using the public bus and minibuses,

-Primary proposals made by sub-cities can be assessed on the bases of all Metropolitan Area,

-Instead of being alternative, transport systems must feed and complete each other,

-To create speedy and comfortable public transport systems, special park and ride places must be planned and to increase the entrance to city centres, some measures must be taken.

3.1 Plan Alternatives

In this plan, new public transport lines and new road enhancement proposals are grouped into 9 to test for the year 2010 .

Alternative 1: No improvement in the system. Taksim - 4.Levent metro line will be finished, and some enhancements and connections which are under construction now, will end.

Alternative 2: New metro line (Ayaza a-Yenikap) and will be finished. LRT system will connect with kitelli, Ba ak Konutlar . Railway lines will reach t128 km. of length. Some new road connections will be held.

Alternative 3: Metro will be extended by adding Yenikap -Topkap -Ba c lar line. LRT will be enhanced in the two parts of Istanbul by adding, Vezneciler-Sultançiftli i, Otogar-isli, Halkal - kitelli, Harem-Kartal, and Üsküdar-Ümraniye-Dudullu lines. In addition to this, Atatürk Airport will be connected with LRT. Railway lines will be increased to 215

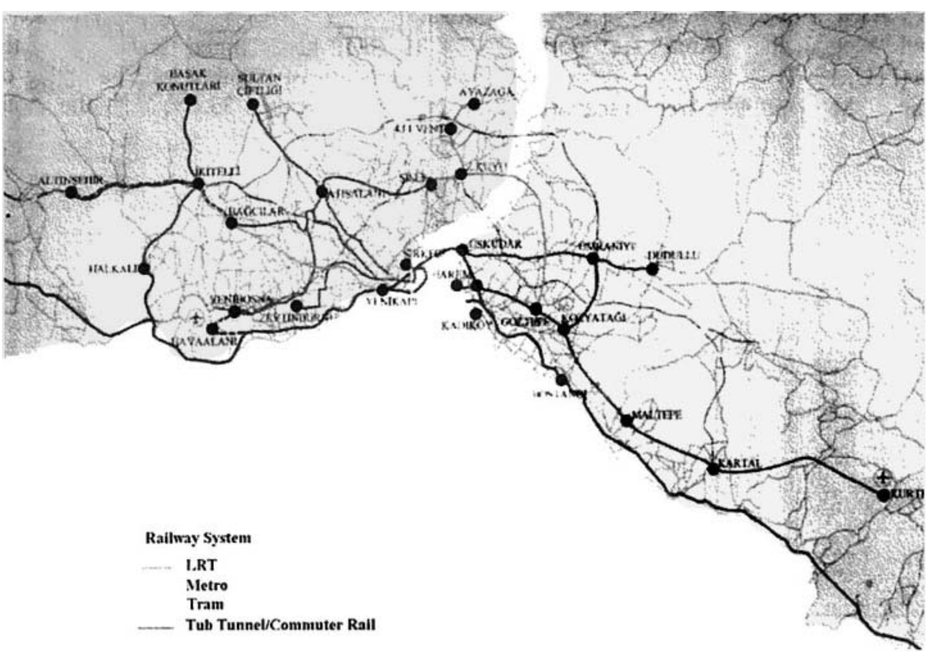

Figure 3. City Railway system network

km. of length. Bosphorus crossing connection will be integrated with new steamship and seabus lines.
Alternative 4: In addition to Alternative 3, Commuter rail lines will be increased to 3 lines and new tub tunnel will be constructed. Railway lines will be increased to 229 km. of length. Some sea connections will be cancelled.
Alternative 5: Instead of new tub tunnel, new bridge with rail line will be constructed. Railway lines on the bridge will be connected with Harem-Kartal LRT system and Taksim-Levent Metro. New bridge and road connection length will be 104 km.
Alternative 6: Tub tunnel and new bridge will work at same time.
Alternative 7: New bridge connection will be held only for the railway.
Alternative 8: In addition to Alternative 6, Metro will be enhanced to Zeytinburnu. LRT system in the Asian part will be changed from Üsküdar-Ümraniye-Dudullu to Üsküdar-Ümraniye-Kozyata .
Alternative 9: Harem-Kartal LRT system will be connected with Kurtköy Airport. Railway lines will be increased to 273 km. of length.

4. ASSESMENT

Evaluation was made under the two development scenarios for the year 2010. First scenario is based on controlled development by applying the Metropolitan Area Sub-Region Master Plan. Second scenario is based on uncontrolled development by using the present trend. The model runs using these scenarios.

To compare and evaluate the alternatives some criteria are developed. These are:

-Travel demands and Max.Morning Peak Traffic Volumes
-Number of passengers per km.
-Passenger-km.,
-Passenger-hour,
-Modal Split,
-Effect of road transport network.

5. ASSESMENT RESULTS

Evaluation was made by Transplan and Emme/2 computer program. All alternatives are tested. Results can be explained as below:
-Railway Lines:
Metro: If European part is totally finished, Peak hour capacity of metro lines can reach 47-55.000 by scenario 1, but it can reach 61-62.000 by scenario 2.
If commuter rail lines are increased from 2 to 3, Metro will attract 100.000 passengers more and it reaches 1.9 million passengers per day. Connection with LRT system in Asian part can cause a 200.000 passenger increase.
Commuter Rail: Present daily number of passengers carried by commuter rail is 250.000. If alternative 4 is applied, daily passengers will increase to 1.7-1.8 million. If alternative 9 is applied, it will increase to 2.2-2.4 million.
LRT: Otogar-Ba c lar- kitelli system will be insufficient in the future. Then, Ba c lar- kitelli section must be prepared for Metro. This problem can be solved by connecting Yenikap -Topkap -Ba c lar lines with this line Yenikap -Ba c lar line capacity will reach 200-300.000, for Yenikap - isli, 550-600.000, for i li-Otogar 250-300.000..
Vezneciler-Sultanciftli i daily traffic will reach 300-400.000. Harem-Kartal-Kurtköy lines will reach 400-800.000 depending on alternatives. Üsküdar-Ümraniye-Dudullu lines will reach 200-590.000.
Tram: Present line traffic volumes will be decreased. If the fist scenario is applied, but, new line capacity between Kad köy and Bostanc will be 100-120.000 passenger/day.
Bus: Buses are carrying 2.5 million passengers at present. This will increase in 2010 to 3.6-4.4 million. If there are no railway lines improvements, this can reach 6 million per day. If the planned bus line is applied in the morning rush hours, extra capacity can be created such as 10-15.000 passenger/hour/direction.
Minibus: 2.2-2.8 million passengers will travel by minibuses in the year 2010. If the railway lines are not constructed, this will

reach 4 million daily passengers.
Sea Transport: Daily passengers for today are 200.000. If sea transport is connected with railways, this will reach 370.000 in the 1. Scenario, 520.000 in the 2. Scenario. Tub tunnel and 3. Bridge will decrease the passengers.

6. CONCLUSION

The results of this study can be expressed with the following:

-Even if all alternatives are applied, share of sea transport will not get more than 3 %,
-If Alternative 9 is applied, railway will get the maximum share of about 55 %,
-If Alternative 9 is applied, Metro and LRT get share about 20 %,
-If Alternative 6 is applied, the share of the Bus and Minibus will decrease nearly 10%.
-Alternative 1 gives the highest share of bus, nearly 50%.
-Even all alternatives are evaluated, the share of the passenger passing Bosphorus will not pass 15%,
-The share of the private car ranks between 25% and 35% in passenger-km bases.

These results show that the transport mode of railway is the best solution to fit demand and capacity problems. Minibus and private car causes traffic problems during rush hours. To solve these problems, public transport system must be promoted and developed.

Finally, Railway based transport system in the Istanbul Metropolitan city will be the only solution for sustainable development and residents' hopes for the future.

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Experience of reforming of public transport in the city of Rostov-on-Don

L'acquis de la réforme du transport en commun à Rostov-sur-le-Don

La experiencia de la reforma del transporte social en Rostov-sobre-Don

V. Zyrianov
Rostov State Building University, Rostov-on-Don, Russia

E. Shepelev
Rostov City Government, Rostov-on-Don, Russia

R. Sanamov
Transport Company 'Rostovpassagirtrans', Rostov-on-Don, Russia

ABSTRACT: The urban passenger carrier in Russia traditionally has a heightened social significance. It is connected to rather low quantity of private vehicles and considerable fraction of the passengers having the rights of preferential travel according to their social status. Therefore reforming of public transport has a some of features. In the given paper the outcomes of reforming of public transport in Rostov-on-Don are reviewed. The purpose of reforming - change of policy with a high scale of municipal participation on policy oriented on the market, permitting to lower load on the municipal budget. These problems were decided on the basis of the analysis of directions of reforming of a management system of a urban passenger carrier in other countries, analysis of legitimacies of change of operational parameters, forecasting of change of conditions of transportation on the basis of methods of mathematical modeling and optimization.

RÉSUMÉ: En Russie le transport en commun possède une signification sociale traditionnellement élevéé. Cela est lié à la quantité insuffisante des automobiles individuelles et à la grande quantité des passagers ayant les billets de faveur. C'est pourquoi la reforme du transport en commun a quelques particularites. Dans cet article il s'agit des résultats de la reforme du transport en commun à Rostov-sur-le Don. Le but de la reforme est de changer la politique avec une grande participation municipale contre la politique orientée vers le marché et qui permet de reduire la charge du budget municipale. Ces problemes étaient resolus à la base de l'analyse des directions de la reforme du système d'administration du transport en commun dans les autres pays, l'étude des changements reguliers des coefficients d'exploitations techniques et les pronostics des changements des conditions du transport à la base des méthodes de la modulation máthèmatique et de l'optimisation.

RESUMEN: El transporte urbano de pasajero in Rusia tradicialmente tienes una importancia social. Esto es ligado con relativamente reducido cantidad de los automoviles propios y considerable parte de los pasajeros que tienen privilegios de viaje. Por eso en la reforma del transporte urbano hay unos particularidades. En esto articulo podemos ver los resultatos de la reforma del transporte municipal en Rostov-sobre-Don. La reforma tienes por objeto una bajada de la carga sobre el presupuesto municipal. Estas problemas solucinaba sobre el fundamento del análisis del direcciones de la reforma de la sistema del conduccion del transporte urbano de pasajero en paises, sobre el estudio de la ligalidades del medicion de los indices técnico y de explotacion, sobre el prognostico del cambio del condiciones de acarremiento sobre el fundamento del métodos del confeccionar un modelo matematico y optimisación.

1. INTRODUCTION

Rostov-on-Don is one of the first cities of Russia, where the process of reforming drove pursuant to the project TACIS on implementation of reforms of a system of public transport. The population of city makes more than 1 million inhabitants. The system of public transport consists of 1000 buses, 116 trolley buses and 115 trams. The annual volume of transportation makes about 500 millions passengers, from them 66 % is transported by buses. Density of an enroute network of public transport changes in different regions of the city from 0.5 up to 4 km/km^2.

For development of public transport it was necessary to decide following problems: to execute change of a management system, to make optimization of an enroute network, to raise the level of traffic engineering, to supply ecological safety. The scheduled management system has shown an economical and operational ineffectiveness, required the considerable subsidies and has resulted in a decrease of quality of services. Therefore the organizational part of reforms was directed on preservation of a unified infrastructure of a urban passenger carrier, creation of a integrated system of public transport with participation of carriers of different patterns of ownership. On the basis of analysis of experience of European countries the system with usage contestability and competition was formed at an entrance on the market of urban passenger transportation.

Similar targeted transport policy during 1996-99 years has supplied official fastening in the market of transport services of the large commercial companies. From a completely municipal urban passenger carrier there was a transition to a system, in which about 50 % of buses belongs to the independent companies. It has allowed to eliminate lack of payload delivery rates, which one made in 1994 year about 39 % and to improve the quality of transport service.

For fulfillment of these problems the analysis of development of a urban passenger carrier was executed. The experimental researches and simulation of motion of buses and traffic flows are conducted. The optimization of an enroute network, forecasting of the characteristics of traffic flows, estimation of quality of operation of a transport network is carried out.

2. REFORMING A MANAGEMENT SYSTEM OF PUBLIC TRANSPORT.

In Rostov-on-Don, as well as in all Russia, the management system of public transport was scheduled, thus the buses and infrastructure were in the full state or municipal property. The economical and political reforms in country at transition to market principles have resulted also in change of a management system of a urban passenger carrier. The purpose of these changes consist in maintenance high quality of transport service at minimization of the municipal subsides. The first steps in this direction were made in 1994-95 years.

For creation of the substantial program of re-structuring of public transport of Rostov-on-Don the analysis of directions of reforming of management systems of a urban passenger carrier in European countries was conducted. The information on activity of public transport in more than 20 countries of Europe is classified to such tags as structure and functions of a management system, type of sponsorship, condition of entry and exit to and from the market of transportation, form of the control above the fares and quality of transportation (Andersen, 1992). The launching conditions of organization of passenger traffic in Rostov-on-Don were taken into account also: unified public sector of transport services, essential shortage of buses, presence of a significant amount of the passengers having the rights of preferential travel according to their social status.

On the basis of this analysis is designed and the intermediate system between only market and scheduled-franchising with differentiated fare policy and usage of the gear of a competition realized at signing on the market of transportation. In Rostov-on-Don the system of franchising will be used, at which one the independent transport companies bear responsibility for the incomes and costs. The structure of control is designed on the basis of principles of logistics. The features of usage of logistics methods in control of a urban passenger carrier are encompass byed a diversity of nature of services and form of organization of an infrastructure of a urban passenger carrier. The transport logistics allows to smooth inconsistencies between the purposes of operators and passengers, between operators of different patterns of ownership, which one work in one market of transport services, between the operators and local authorities.

Functions of a municipal Department of a Carrier is the development of an enroute network on the basis of demand for transportation, conditioning for a competition, mining of competitive conditions and realization of competition. The access on urban routes is possible only as a result of a scoring on competition. The municipal Department of a Carrier determines also fare policy, which one is differentiated for buses of different patterns of ownership. For the municipal Transport Company the rigid fare is set, and independent operators only high bound, a particular fare they determine on demand for transportation. The municipal Department of a Carrier has no the right to interpose with a production activity of public transport and independent operators.

Controlling provides a system of monitoring, estimation both quality control of transport service and safety of transportation. The most relevant link in this system is Center of mission control. In its function the automatic monitoring above an occurrence of buses in any point of city enters. The computer system on a radio channel determines actual parameters of motion of buses and compares by their given train diagrams. The outcomes will be used for an estimation of regularity of motion.

At the initial phase of transition to a competitive system the access to the market of transportation was received by many small-sized operators and personal owners of buses. This process originated as well in many other countries (Banister & Berechman & De Rus, 1992). In further as a result of perfecting conditions of a tender for the right to maintain urban routes number of operators received access on the market was reduced with 26 per 1997 up to 8 in 1999. The mean size of operator was considerably increased, and the small-sized operators were not held in the market of urban passenger traffic owing to competitive strife. As a result of targeted activity there was a transition from set of small-sized carriers to large commercial operators, which one can ensure indispensable quality of transportation and the activity which one yields to the control. The structure, adding up to the present time, of buses on a pattern of ownership is adduced in a Figure 1.

Creation of a competitive system of passenger traffic in Rostov-on-Don with team-working operators of different patterns of ownership has allowed substantially improving the quality of transport service. Last years of existence in city of a scheduled management system of a passenger carrier (1992-94 years) the deficit of buses reached 40 %. Now there is an excess of buses permitting in practice to realize principles of competitive strife at organization of tenders.

3. OPTIMISATION OF ENROUTE NETWORK

For implementation of capabilities, which one form during reforming a management system of an urban passenger carrier, it is necessary to introduce respective alterations to organization of transportation. The most effective means is the optimization of an enroute network in view of a new situation.

The optimization was conducted at usage of the modeling programs on the basis of the integrated information on macro and microlevels. The macrolevel characterizes features of moving and seizure of the inhabitants, location of the main objects of gravitation, volumes of transportation of the passengers, road network, possible number of buses. The information of a microlevel contains the items of information on an enroute network, organization of road motion on particular segments, running speed, stops and paths of the approach to them.

Criterion of optimization is the average time of trip on an enroute network of Rostov-on-Don. The limitations are served capacity of a lane of a road, maximum frequency of buses, capacity of the bus and allowed directions of traffic. For obtaining authentic outcomes by optimization the researches of the factors influential in criterion of optimization were conducted.

The experimental researches have shown, that in Rostov-on-Don there are three main transport corridors with high traffic density of buses, till 150 buses per hour in one direction. The change of headway between buses in these conditions is described by a negative exponential distribution (Fig. 2). This type of distribution was applied at simulation of motion.

The modes of motion of buses and automobiles considerably differ in central business district and behind its limits. Most composite conditions of motion in central business district. The range of an alteration of speed of buses makes from 3.1 m/s up to 6.8 m/s at an average speed of 4.14 m/s (14.9 km/h). The normal law describes the distribution of a running speed of buses (Fig. 3).

The two-fluid models of the kinetic theory of a traffic flow were applied to simulation of motion of buses and vehicles (Herman & Ardekani, 1984). For

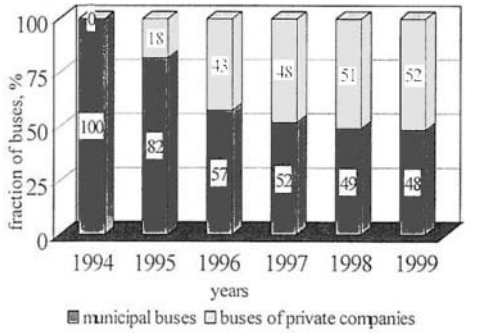

Figure 1. Modifying of the structure of the owners of buses.

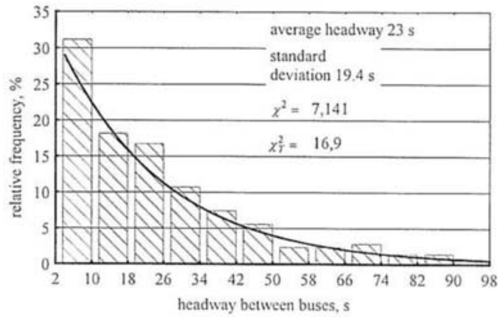

Figure 2. Distribution of headway between buses.

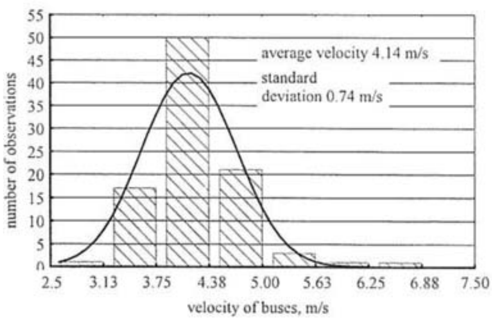

Figure 3. Distribution of velocity of buses.

the description of motion of shuttle buses the writers have elaborated following version of model:

$$t_s = t_d + t - t_b^{\frac{1}{n+1}} t^{\frac{n}{n+1}} \quad (1)$$

where t_d = stop time of the bus on stops per unit distance; t_b = trip time of trip without the registration of delay time on adjustable interceptions per unit distance; t_s = stop time per unit distance; t = trip time per unit distance; n = coefficient.

For an estimation of parameters of motion of a traffic flow the following version of two-fluid model was used:

$$t_s = m[(-(\frac{t - t_f}{n})^3 - t_{sn}) / (\frac{t - t_f}{n})] + t_{sf} \quad (2)$$

where t_f = time of motion in free conditions per unit distance; t_{sn} = stop time, at which one takes place change of behavior of relation $t_s = f(t)$; t_{sf} = stop time in free conditions per unit distance; m = coefficient.

For optimization the model of a transport network of city was built. With the help of an electronic map of city the coordinates of all intersections and bus stops of a network are determined. The calculation of shortest distances between all intersections and bus stops is made by Floyd algorithm. For traffic flows the problem of optimization is stated as follows:

$$\min_{x_{ij}^k} \sum_{(i,j)\in N} F \quad (3)$$

at limitations:

$$\sum_j x_{ij}^k - \sum_j x_{ji}^k = q_i^k, \; i \in I, \; k = 1, r \quad (4)$$

$$\sum_{k=1}^{r} x_{ij}^k \le c_{ij}, \; (i,j) \in N \quad (5)$$

$$x_{ij}^k \ge 0 \quad (6)$$

where F = object function, time of trip; q = traffic volume; c = capacity of a road; x = distribution of frequency on an arc (i,j); k = traffic volume of k-type vehicles.

At distribution of buses on routes the time of trip is minimized in view of headway between buses, quantity of the passengers, running speed in substantial conditions.

The problem of optimization of distribution of transport flows was resolved by a modified method of Lagrangian multiplicities. As a result of calculations in the perspective scheme of an enroute network 20 main present bus routes are saved and are formed 63 new.

Table 1. Change of the characteristics of motion after optimization of a network.

Name of a parameter	Value of a parameter: Present network	Value of a parameter: After optimization	Change
Fraction of the passengers touring without transfer	60%	71%	+ 11%
Fraction of the passengers touring with one transfer	36%	28%	- 12%
Fraction of the passengers touring with two transfers	4%	1%	- 3%
Average number of transfers per trip	0.45	0.30	- 33%
Average trip length	5.1 km	4.8 km	- 6%
Average trip time	0.55 h	0.50 h	- 9%

The change of parameters is listed in Table 1.

Thus, reforming of a management system and optimization of an enroute network has allowed substantially improving the quality of transport service of the population of Rostov-on-Don.

4. CONCLUSIONS

The management system of public transport, created in Rostov-on-Don, with usage of contestability and competition at entering to the market, participation in transportation of the independent operators automated monitoring system of position of the bus in any point of an enroute network has shown the efficiency. The quality of transport service was improved, and the municipal subsidies to public transport have decreased.

The experimental researches, simulation and optimization have allowed receiving the new information on the characteristics of motion of buses and traffic flows.

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How the US achieves multi-modal, environmentally-sensitive transportation corridor planning

Planification multimodale des couloirs de transport sensibles à l'environnement aux Etat-Unis

Cómo se logra una planificación de corredores de transporte multimodal sensible al medio ambiente en los Estados Unidos

Julie Hoover
Parsons Brinckerhoff, New York, N.Y., USA

ABSTRACT: A new federally-mandated transportation planning process has been in place in the United States for six years. It calls for metropolitan areas to undertake regional studies that identify priority corridors for subsequent detailed analysis, called major investment studies (MISs). Key MIS characteristics are: multi-modal planning, mandatory interagency collaboration, strong public involvement, options for complying with federal environmental regulations, and transportation linkages with air quality and land use. Overall, these provisions have been extremely transit- and environmentally-friendly and, thus, are of high potential interest to CODATU conference participants. Some have fallen short of expectations but others have wildly exceeded them. This paper focuses on selected features that have the highest applicability in other countries of the world. Collectively, the MIS procedures represent a bold experiment to improve local planning and decision-making. Like many innovations, there are opponents who prefer the *status quo* and, therefore, the future of the MIS process is uncertain.

RAPPORT ANALYTIQUE: Un nouveau processus fédéral de planification des transports est en vigueur aux États-Unis depuis six ans. Il exige, dans les zones métropolitaines, la réalisation d'études régionales, dites « études d'investissements majeurs » (MIS) appelées à identifier les couloirs prioritaires à soumettre à une analyse détaillée. Les études MIS se caractérisent essentiellement comme suit: planification multimodale, collaboration interorganisations obligatoire, forte implication du public, options de conformité avec la réglementation fédérale relative à l'environnement et considérations d'usage du terrain et de qualité de l'air liées aux transports. Dans l'ensemble, ces dispositions se sont avérées extrêmement favorables aux transports et ne nuisent pas à l'environnement; elles pourront dès lors intéresser au plus haut degré les participants à la conférence CODATU. Certaines n'ont pas produit les résultats escomptés mais d'autres ont largement dépassé leurs objectifs. Ce document porte sur les points présentant la plus grande applicabilité dans d'autres pays du monde. Collectivement, les procédures MIS constituent une tentative audacieuse d'amélioration des processus locaux de planification et de prise de décision. Comme beaucoup d'autres innovations, elles ont leurs détracteurs, qui préfèrent le *status quo*, et leur avenir est donc incertain.

RESUMEN: En los últimos seis años se ha aplicado en los Estados Unidos un nuevo proceso de planificación del transporte por mandato federal, según el cual las áreas metropolitanas deben realizar estudios regionales que identifiquen los corredores principales para su posterior análisis en detalle, lo que se conoce como estudios de inversión de gran escala (o por su sigla inglesa MIS—*major investment studies*). Los elementos claves de los MIS son la planificación multimodal, la colaboración obligatoria entre agencias, una participación significativa del sector público, las opciones para cumplir las regulaciones federales sobre el medio ambiente y la relación del transporte con la calidad del aire y el uso de los suelos. En términos generales, estas disposiciones han sido extremadamente benignas desde los puntos de vista del transporte y del medio ambiente y, por consiguiente, son de sumo interés para los participantes de la conferencia CODATU. En algunos casos no se han satisfecho plenamente las expectativas, pero en otros los resultados han sido sobresalientes. Este documento se centra en ciertas características que tienen la mayor aplicabilidad en otros países del mundo. En forma colectiva, los procedimientos de los MIS representan un experimento audaz para mejorar los procesos de toma de decisiones y planificación al nivel local. Al igual que muchas innovaciones, existen detractores que prefieren mantener el statu quo y, por lo tanto, el futuro del proceso de los MIS es incierto.

The Intermodal Surface Transportation Efficiency Act ("ISTEA") passed in the United States in December 1991 sparked revolutionary new ways of planning, decision-making, and allocating money for federally-funded transportation projects. A subsequent transportation authorization bill approved in June 1998, this time named the Transportation Equity Act for the 21st Century (TEA-21), incorporates and frequently strengthens ISTEA's most positive provisions.

Because these two bills have been extremely transit- and environmentally-friendly, they contain a number of provisions of potential interest to CODATU members. Some have fallen short of expectations but others have wildly exceeded them. This paper will focus on one of the most effective features that has potential applicability in other countries of the world—multi-modal, environmentally-sensitive transportation corridor planning.

THE NEW U.S. PLANNING PROCESS

The ISTEA-mandated planning process calls for metropolitan regions to undertake regional studies that identify priority corridors for subsequent detailed analysis, called major investment studies (MISs). The results of an MIS would then feed back into the regional planning process and be subjected to their fiscal constraints and required tests related to air quality standards. If successful, the recommended strategy then moves into project development. This process is illustrated in Figure 1.

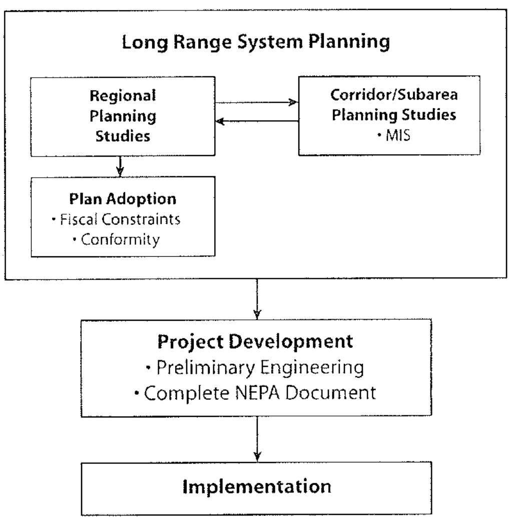

Figure 1: Metropolitan Long Range Transportation Planning Process

MISs are triggered when a local agency identifies the need for both a major transportation investment and federal funds. They are very comprehensive studies of a broad range of alternative solutions, typically taking at least 18 months and costing a million dollars or more. In an MIS, considerable time up-front is spent defining the problems, needs, and opportunities to be addressed. Then all reasonable alternatives are identified and subsequently screened. Their primary purpose is to provide information about the likely impacts and consequences of alternative investment strategies so that better decisions are made.

SELECTED KEY MIS FEATURES

- Multi-modal planning

The idea that planners compare highway and transit alternatives and then pick the best overall multi-modal strategy from numerous perspectives is probably unique or at least not very common. Yet this is the type of planning ISTEA mandated and U.S. planners have been practicing since late 1993 when MIS guidance was issued.

In the past, officials from local modal agencies (highways or transit) developed plans for their modes independently. Different federal regulations and funding programs resulted in an un-level playing field, heavily biased against transit. MIS requirements eliminated most of these barriers by mandating a new uniform multi-modal planning process.

In the beginning of an MIS, all "reasonable alternatives" must be considered and planners

Figure 2: Planners in Orange County, CA, are considering a wide range of modal options to solve their mobility problems.

are encouraged to think creatively about the possible options that might meet the study goals and objectives. Alternatives are then screened to a manageable number, typically four to six, and evaluated in-depth. Sometimes two or more screenings are necessary.

Many transit and highway projects have a d- vanced as originally conceived, although transit solutions have emerged in a few corridors initially predicted to be roadways and an increasingly prevalent outcome is packages of multi-modal strategies—featuring both roadway and transit elements, and, more often, ITS and land use and other policy changes as well.

- Mandatory interagency collaboration

The new multi-modal planning triggered the obvious need for corresponding interagency collaboration. If planners are considering highways, transit, and other transportation solutions together, representatives of implementing agencies for each mode must be at the table. Thus, the federal guidance requires a broad range of stakeholders to form a special oversight group for each MIS. Participants must include: the state department of transportation (DOT), relevant transit agencies, environmental resource and permitting agencies, affected local officials, federal highway and transit agencies, operators of other major transportation modes and, where appropriate, community development agencies, major governmental housing bodies, and other potentially affected agencies. Providing overall coordination and leadership is the metropolitan planning organization (MPO).

As might be expected, there have been some problems. Some agencies have resented relinquishing full control over their studies, animosities between competing modal agencies and/or others have occasionally adversely affected co-operative planning and study schedules, and some key participants have unfortunately declined to be involved. Overall, however, the experience has been highly positive and resulted in far more multi-modal outcomes than pre-ISTEA planning had produced. In St. Louis, for example, the three principle agencies (state DOT, transit agency, and MPO) have set up a joint office where their staffs work closely on all MISs in the region and are actively engaged in multi-modal planning.

- Strong public involvement

ISTEA's legislators agreed that increased citizen involvement would yield numerous benefits including better planning and enhanced chances of project implementation, and they required public participation prior to transportation decisions at several critical points. The implementers, however, struggled over exactly how to achieve this.

It was generally recognized that every pla n-ning situation is different and that public involvement approaches and techniques specifically tailored to local circumstances were needed. Thus, highly prescriptive federal regulations such as requiring all MISs to have a certain number of meetings or a citizens advisory committee risked impairing local flexibility, resulting in routine "cookie-cutter" approaches instead of the creativity that was hoped for. Yet it was clear that many planning activities did not provide sufficient opportunity for effective participation, and that something more was needed.

The ultimate solution was a set of performance-based criteria for public involvement programs requiring planning efforts to have the following characteristics: be proactive, be early and continuing, provide complete information, provide timely public notice, feature broad public outreach including special efforts to engage populations traditionally under-served like low income and minority populations, and be responsive.

These criteria prescribe very little in the way of concrete requirements but are designed to prompt local agencies to more vigorously solicit public input. In essence, they represent a compromise between those who oppose any new federal regulations and groups wanting more rigorous requirements. It is difficult to measure

Figure 3: ISTEA's public involvement provisions call for proactive outreach to all groups of people potentially affected by a planning effort.

their exact impact but there is much evidence suggesting they have had an extremely positive effect, sparking notable improvement in almost all agencies. While the performance criteria represent a good interim step, they are not the ultimate solution because many agencies still have deficiencies in their public involvement practices and decision-making responsiveness.

- Early environmental considerations

Transportation affects environments and communities in very fundamental ways. Prior to ISTEA, many agencies delayed their environmental investigations until late in the planning process and focused their efforts on mitigating adverse impacts. By requiring localities to consider such effects at the very beginning of a corridor planning process, MIS guidance has fostered renewed sensitivity to environmental concerns as part of transportation decisions, stimulated more environmentally-sensitive planning, and avoided much costly subsequent controversy.

For example, in Miami, the early collaborative interagency process and public involvement meetings on the East-West Corridor MIS identified several environmentally-sensitive sites including a golf course and park and Flagler Street in Little Havana. Alternative routings avoiding these areas were developed early in the study. In an especially unique collaborative effort, Lincoln, Nebraska planners reduced a flood plain and the number of buildings at risk from 1000 to zero through construction of a new channel and acquisition of 50 properties, allowing new roadways to be constructed. (No federal highway dollars are allowed in flood plains). In Virginia, an "Environmental Overview" was a major resource in the early screening of alternatives on an interstate MIS. Many more benefits of considering environmental concerns from a study's beginning can be cited.

- Options for complying with federal environmental regulations

In an effort to provide greater flexibility to local governments, the federal MIS guidance provided two options for the timing of preparing formal environmental documentation, called an "Environmental Impact Statement" (EIS). The EIS could be prepared concurrently with the MIS or after it. This proved the least successful component of MISs as it provoked considerable local confusion and some MIS sponsors who opted for deferring the MIS later found themselves duplicating/repeating various analyses. In TEA-21, Congress instructed the federal agencies to eliminate the MIS as a separate activity and better integrate it into formal environmental processes, while retaining the basic MIS principles, more effectively melding them into current planning and environmental processes.

- Transportation/air quality relationships

The MIS requirements were effectively integrated with a national bill, the Clean Air Act Amendments , to support efforts to improve air quality in metropolitan areas which do not meet national air quality standards for ozone, carbon monoxide, and particular matters. Solutions are being forged at the regional level, with the MPO serving as a forum for coordinated and cooperative decision-making. Transportation projects judged to adversely effect air quality, such as many single-occupancy-highways, will not survive the MIS/MPO approval processes while projects which contribute to improved air quality conditions are given special status.

- Transportation/land use linkages

The United States has traditionally lagged behind many countries of the world in coordinating land use and transportation. The MIS guidance calls for land use to be analyzed for all modes and a corresponding mandate requires sponsors of transit projects seeking discretionary federal "New Start" funds to submit their projects to a rating process. Localities scoring high stand a better chance of obtaining large amounts of New Start funds, the biggest source of federal money.

Figure 4: Portland, Oregon leads U.S. efforts to link land use with light rail transit.

Some communities have received over a billion dollars in New Start funds for a single transit project.

While the rating criteria cover a broad range of factors, it is known that the land use evaluation is second in importance only to local financial commitment. Specifically, federal officials are interested in the degree to which local land use policies are likely to foster transit-supportive land use, measured in terms of the kinds of policies in place and the commitment to these policies. Six factors are considered in an aggregate high/medium/low rating: existing land use, containment of sprawl, transit-supportive corridor policies, supportive zoning regulations near transit stations, tools to implement land use policies, and the performance of land use policies.

The second round of evaluations took place this year. Most projects did not score very well, with commuter rail rated the lowest and light rail the highest. However, projects in final design scored lower than those in less advanced phases, suggesting the land use criteria are having an impact on emerging projects.

Transit operators who already have strong r e-lationships with their local land use agencies or reside in countries with strong centralized controls will find little of benefit in the U.S. experience. In countries where these linkages and controls have not yet been established and federal funding is critical, our experiment with land use evaluations may be of interest.

CONCLUSIONS

Focusing on planning provisions for transportation corridors in need of major capital investments is a useful way of introducing good planning principles that reinforce broad national goals. Officials in the United States determined that multi-modal planning, mandatory interagency collaboration, early environmental considerations, environmental options, and linkages with air quality and land use could help them achieve broader national objectives, and they put enforcing provisions into their planning guidance for corridor studies. All succeeded except the environmental options, which caused considerable local confusion and were generally misunderstood. Other countries might consider the benefits of focusing on corridor planning requirements—either on an *ad hoc* basis or by incorporating provisions into your national legislation. When you are contemplating a hundred million dollars or more of transportation investments, it makes sense to do careful advance planning—ensuring that the outcome is the best investment from multiple perspectives. It is also prudent to work out what to do in terms of local planning and policy changes to maximize your investment from a community perspective.

The U.S. MIS procedures represent a bold national experiment to improve local transportation planning and decision-making. Many practitioners and local stakeholders thought it was successful, but others were less enthusiastic. These typically included some highway proponents and conservative state and local officials who resist any federal intervention in local. The problems associated with the environmental options provision opened the door for a widespread political attack on the entire MIS process, and its future at present is uncertain. A "lesson learned" for other countries is to make sure any fundamentally new planning legislation fits compatibly with your existing practices and procedures, unless you simultaneously change them. Also, the power of adversaries of progressive change should never be underestimated, regardless of the technical merits of your initiative.

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Le plan des déplacements urbains de l'agglomération lyonnaise

Christian Philip
SYTRAL, Premier-Adjoint au Maire de Lyon, France

ABSTRACT:

Le Plan des Déplacements Urbains de l'agglomération lyonnaise

Vers un nouvel espace urbain

Jusqu'à une époque récente, les villes ou communautés urbaines compétentes, en France, pour les transports en commun se préoccupaient surtout, en ce domaine, de problèmes techniques, financiers ou de la bonne irrigation des différents quartiers par un réseau efficace.

La préoccupation d'une politique globale, intégrant urbanisme, circulation, déplacements quel qu'en soit le mode et aménagement de l'espace public, est tout à fait nouvelle.

L'évolution des textes traduit cette évolution des mentalités.

La loi du 30 décembre 1996 sur l'air et l'utilisation rationnelle de l'énergie oblige toutes les agglomérations de plus de 100.000 habitants à se doter d'un Plan des Déplacements Urbains ("PDU").

Cette loi donne aux PDU des objectifs et un contenu obligatoires : "diminution du trafic automobile", "développement des transports collectifs et des moyens de déplacements économes et peu polluants", "usage coordonné de tous les modes", "affectation appropriée de la voirie aux différents modes", autant d'éléments qui marque le volontarisme du législateur.

C'est la première fois en France qu'un texte à portée législative insiste sur l'importance d'une politique publique cohérente de mobilité et en impose les conclusions : les déplacements automobiles doivent cesser d'avoir une part croissante dans l'ensemble des déplacements urbains et l'espace urbain doit avoir d'autres vocations que de les faciliter.

Ce texte, destiné à encadrer les décisions des collectivités locales, s'inscrit dans une double orientation : la protection de la santé individuelle d'abord, puisque le préambule de la loi affirme le droit de chacun à respirer un air pur qui ne lui soit pas nocif ; la protection de l'environnement ensuite : la notion de "coûts sociaux", déjà évoquée dans les textes relatifs à l'urbanisme, qui permettait de dépasser des approches strictement financières, comprend désormais explicitement les atteintes à l'environnement. La pollution n'est pas seule en cause : ce sont les nuisances au sens large du terme qui sont visées, l'altération de l'espace urbain et, à terme, même si le mot n'est pas prononcé, la dégradation de la qualité de vie en ville.

Pour la première fois, la volonté de rationaliser les déplacements et de maîtriser leur développement est clairement exprimée, alors que jusqu'alors la civilisation urbaine s'était construite sur d'autres priorités.

L'agglomération lyonnaise a été la première agglomération française à se doter d'un PDU, témoignant ainsi sa volonté de s'inscrire dans ce mouvement de renouveau urbain.

Agglomération millionnaire, avec de multiples centres secondaires parfois fortement peuplés, composée de 55 communes fédérées dans une communauté urbaine, l'agglomération lyonnaise est marquée par une image de pollution liée à son histoire industrielle mais aussi à sa géographie et ses choix.

Située sur un couloir de circulation national et international, la ville a joué depuis 30 ans la carte de l'ouverture au trafic automobile. Une autoroute traverse ainsi le cœur de la ville, d'autres s'y déversent presque directement. Cette ouverture se mariait bien avec une vocation industrielle. Comme bien des villes, Lyon et sa région ont connu une urbanisation de plus en plus diffuse, rendant ainsi inévitable le recours à la voiture pour les déplacements quotidiens. L'élargissement du pôle d'emploi, dont

PHOTO 1

PHOTO 2

témoigne l'augmentation régulière des mouvements alternés quotidiens de moyenne portée (30, 50, voire 100 kilomètres) vient amplifier ce constat.

La ville traditionnelle est sortie des murs, elle s'est étalée, mais le bassin de vie s'est encore davantage élargi. Il englobe plusieurs cités proches qui deviennent dépendantes les unes des autres.

Il n'est donc pas surprenant que l'automobile ait une part croissante dans l'ensemble des déplacements. Cette part atteint, aujourd'hui, à Lyon, près de 80 % des déplacements dits mécanisés, hors marche à pied.

Cette proportion n'a cessé de croître, notamment pour les déplacements provenant des zones les plus excentrées de l'agglomération. Si les tendances se poursuivent à l'identique, l'anneau de congestion qui se forme progressivement autour de la ville va se boucler et s'épaissir. Certaines voies internes à la ville elle-même supporteront, d'ici à 10 ans, une croissance de 30 ou 50 % de trafic, ce qui représente une perspective inacceptable.

La ville n'a pas, en effet, réussi à se protéger contre un trafic de transit ou d'échange qui perturbe tous ses quartiers, même les plus centraux. Elle ne l'a d'ailleurs pas véritablement tenté jusqu'ici.

L'élaboration du Plan des Déplacements Urbains a été l'occasion d'une prise de conscience sur les conséquences de ce constat et a marqué la volonté de réagir.

Les grands choix adoptés en 1997 peuvent être rappelés en quelques mots :

- réduction de la voirie là où le trafic automobile d'échange peut se reporter sur des voies mieux adaptées,
- partage différent de la voirie interne à la ville au bénéfice des transports en commun, des piétons, des vélos : avec la création de sites propres pour le tramway, les trolleybus, les bus ou les vélos, avec l'élargissement des trottoirs, l'espace public doit donner moins de place à l'automobile et davantage à des modes moins polluants, mieux compatibles avec une vie urbaine de qualité,
- stationnement en ville réglementé différemment et plus strictement (tarif, durée...), de manière à mieux protéger certains quartiers,
- meilleure attractivité des transports en commun : confort accru, fiabilité des temps de parcours garantie grâce à des sites propres et à la priorité aux feux,
- tarification des transports publics mieux adaptée, avec le souci d'en faciliter l'usage pour les catégories modestes en menant une politique de prix incitative et en adaptant le coût de certains titres en fonction des ressources. La volonté en l'occurrence est de "recoudre" la ville en permettant aux habitants des quartiers en difficulté, souvent des quartiers excentrés, de se rendre plus facilement au centre-ville.

Un réseau de lignes fortes de surface desservant la totalité de l'agglomération et perçant la ceinture de congestion est en projet.

Pour traduire ces engagements, le PDU se fixe des objectifs quantifiés à 10 ans sur la réduction des nuisances (bruit et pollution notamment), sur la réduction des temps de trajet en transports en commun : il ambitionne l'établissement de meilleures conditions de concurrence avec la voiture et vise ainsi un renversement des tendances, avec un arrêt de la croissance des déplacements automobiles et une augmentation, au moins de quelques points, des autres modes.

Au-delà de la présentation de ce constat et des objectifs que nous poursuivons, je voudrais engager ici une réflexion sur l'environnement entendu au sens de l'espace urbain et montrer combien cette notion est importante pour la réussite d'un projet comme le PDU.

L'espace urbain est en effet modelable et transformable grâce à une politique active en faveur des transports en commun, des piétons ou des vélos.

PHOTO 3

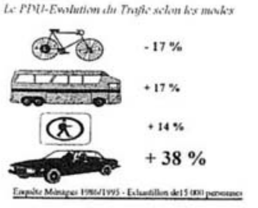

PHOTO 4

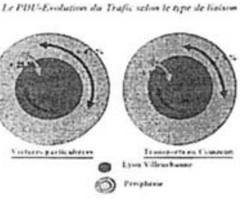

PHOTO 5

PHOTO 6

PHOTO 7

C'est aussi une réalité qui touche très intimement à la vie quotidienne des habitants et à la conception qu'ils se font de leur propre liberté.

De fait, les Plans des Déplacements Urbains traitent bien évidemment de la mobilité des habitants, mais aussi, en réalité, de sujets plus vastes et plus délicats.

Pendants des dizaines d'années, nos villes se sont transformées en s'étendant géographiquement, en absorbant leurs périphéries, en s'étirant vers les aéroports ou les zones industrielles et commerciales lointaines. A l'occasion des PDU, une réflexion sur les "formes urbaines" s'est enclenchée. Elle se traduit aujourd'hui par le refus d'accepter que les opérations d'urbanisme ou la création de grands équipements ne soient pas accompagnés, dès le départ d'une préoccupation "transports". Jusqu'alors, ceux-ci étaient le parent pauvre qui s'essoufflait à suivre l'extension urbaine. Désormais, la préoccupation est inverse : elle est de densifier l'occupation de l'espace autour des axes de transports existants, en considérant que ceux-ci structurent la ville et qu'elle doit se renforcer prioritairement autour d'eux.

Au-delà, peut-être devons-nous abandonner l'ambition de créer ex nihilo des quartiers neufs ou des zones d'activités aux portes des cités traditionnelles. Peut-être, pour améliorer la ville, devons-nous d'abord travailler sur le tissu existant, le transformer progressivement, lui apporter des aménagements. C'est moins facile, c'est sans doute moins visible. Mais probablement l'urbanisme de demain sera-t-il plus modeste et plus soucieux des quartiers actuels, de leur amélioration et, quand ce sera nécessaire, de leur évolution vers un espace véritablement urbain.

Un partage différent de la voirie est, au demeurant, une occasion inespérée de transformer l'espace urbain existant.

En milieu urbain, un projet d'infrastructures de transports perdrait beaucoup d'intérêt s'il n'était considéré qu'en lui-même, en fonction de sa rentabilité potentielle, voire même du seul service rendu. En fait, la réalisation d'un tel projet concentre tous les choix d'une politique urbaine : elle offre l'occasion de repenser l'affectation de la rue, la largeur des trottoirs, la place des vélos, l'organisation des carrefours, la politique du stationnement du quartier et le type de trafic automobile qui va y être accepté. Ces choix sont compris au départ surtout comme des contraintes pour la vie locale, pour les livraisons ou la desserte des riverains. Mais c'est aussi une chance : dès lors que sont présentés les enjeux à long terme, l'impact sur l'environnement, l'embellissement de la ville, ces choix sont mieux acceptés : un récent sondage effectué au niveau national montrait que 76 % de la population était convaincue de la nécessité de limiter l'automobile en ville, essentiellement dans le souci d'un aménagement plus convivial de l'espace public. Le PDU est ainsi une occasion de travailler "sur la ville", de la recréer.

Pour autant, il faut souligner l'extraordinaire ambivalence des habitants quant à la modification de leur espace urbain.

A Lyon, l'élaboration du PDU a été un moment heureux : peu de voix se sont élevées pour en contester les conclusions. La très grande majorité des habitants consultés a choisi, parmi les scénarios présentés, celui qui était le plus ambitieux, le plus volontariste, celui qui devait promouvoir une ville nouvelle. Tous les sondages, nationaux ou locaux vont dans le même sens : pour en évoquer deux parmi les plus récents, 76 % des français, 80 % des femmes conductrices souhaitent la réduction, voire la disparition en ville du trafic automobile. A Lyon, 82 % de la population ont été favorables au principe du tramway quand la réalisation de deux lignes a été annoncée. Le sondage montrait que les habitants plaçaient la pollution au premier rang de leur préoccupation et approuvaient massivement la politique issue du Plan des Déplacements Urbains.

Cependant, lorsque l'on pousse plus loin l'interrogation, la réalité est plus complexe et plus ambiguë. Une chose est d'accepter une perspective lointaine, théorique, rationnelle, une autre chose est de voir, demain, sa propre rue se modifier. Une

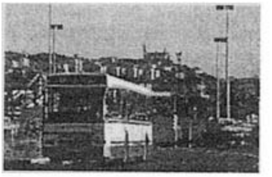

PHOTO 8

PHOTO 9

PHOTO 10

chose est de savoir qu'il faut lutter contre les nuisances et la pollution, une autre est de s'engager concrètement dans cette lutte et de modifier ses propres habitudes.

Le même sondage selon lequel 80 % des femmes souhaitent la disparition de la voiture en ville indique que 70 % d'entre elles n'aimeraient pas qu'on leur interdise l'accès en voiture à leur quartier... La population est bien évidemment sensible aux nuisances et pointe le bruit, les accidents, la congestion parfois et la laideur de la ville. Mais chacun cherche d'abord à s'en protéger individuellement... tout en redoutant les disciplines collectives.

Le Ministre français de l'Equipement et des Transports a fait réaliser, il y a quelques mois, des films sur la manière dont les habitants de quelques grandes villes percevaient leur cité, ses problèmes, son avenir. Lyon était du nombre. Certains habitants ont été alors d'une remarquable lucidité : nous savons bien, disaient-ils, qu'il serait absolument nécessaire de prendre des mesures contraignantes sur l'automobile et de mieux protéger notre espace de vie. Mais nous n'en avons pas envie. Et nous attendons des hommes politiques qu'ils nous y conduisent néanmoins : nous leur serons reconnaissants d'avoir ce courage, que nous n'avons pas nous-même spontanément.

De ces réactions, nous devons tirer, nous autres décideurs, une conclusion politique : l'appel au consensus, l'appel au civisme sont très probablement, dans ce contexte, inopérants ou, du moins, insuffisants. Il faut plutôt avancer et témoigner de la volonté d'agir, montrer certaines réalisations exemples, illustrer, donner à voir.

Une des chances de notre PDU, c'est d'avoir été rapide dans sa volonté de concrétisation : nous faisons ainsi la démonstration que le changement est politiquement voulu, qu'il est possible et, au demeurant qu'il n'apporte pas seulement des contraintes. Nous montrons qu'il y a une contrepartie positive qui est l'embellissement de l'espace urbain qu'apporte notamment la construction de deux lignes de tramway, dans le calme retrouvé d'une rue moins fréquentée par les voitures, dans l'élargissement des trottoirs, dans les plantations d'arbres, dans le souci de retrouver, en ville, la promenade.

Cependant, tout n'est pas gagné et "l'esprit PDU" mettra longtemps a être accepté et pleinement intégré aux réflexes quotidiens des habitants.

La concertation sur le PDU et sur le tramway et le dialogue engagé à cette occasion avec les habitants ont ainsi mis en lumière, à Lyon, l'ambivalence de l'opinion publique vis-à-vis des transports en commun, qui n'ont pas une image socialement valorisante et sont, du coup, considérés comme une nécessité plus que comme un choix. Il est clair que la prise de conscience sur l'impératif du développement des transports en commun commence à pénétrer une partie de l'opinion, même lorsque ses options l'inclinent, par tradition plus que par réflexion, à assimiler voiture et sauvegarde de la liberté individuelle. Mais, il y a souvent encore du dédain vis-à-vis de ce qui est considéré comme une nécessité sociale destinée à des clients captifs qui ne disposent pas d'autres choix. Dans ce cas, accepter les améliorations destinées au réseau apparaît envisageable. Mais donner une vraie priorité aux transports en commun, voire structurer autour de lui l'espace urbain est infiniment moins admis. Lors de la concertation sur les itinéraires du futur tramway, mille suggestions ont été faites pour lui trouver d'autres chemins, pour qu'il passe dans des rues confidentielles, résidentielles, à l'écart des grands axes de circulation et des axes commerçants. Il n'est pas évident pour tous qu'un tramway doit être avant tout visible, passer par les principales artères, marquer sa place. Les transports en commun ne sont pas encore un bien véritablement commun... Leur revalorisation et leur appropriation par tous restent encore une ambition.

Enfin, il sera sans aucun doute difficile d'acclimater dans des villes comme Lyon, où la circulation reste encore, malgré tout, relativement fluide, l'idée que l'espace est un bien commun à organiser ensemble et que cette organisation relève de décisions politiques.

Une étude qualitative a été effectuée en 1997 à Lyon pour mieux comprendre le comportement des lyonnais en matière de circulation et de stationnement et, notamment, savoir pourquoi ils ne respectaient pas ou peu certaines règles, par exemple le paiement du stationnement payant, qui est faible à Lyon en comparaison d'autres grandes agglomérations.

Cette étude révèle que la voiture est complètement intégrée à la vie de la ville et que les habitants la perçoivent comme le moyen le plus pratique de circuler. Lyon est une ville où l'espace n'est pas encore très raréfié. dans ces conditions, les lyonnais considèrent la rue comme un espace ouvert dans lequel on doit pouvoir circuler et stationner librement et gratuitement. Le sentiment que l'espace est un bien commun et rare et doit, de ce fait, relever des choix de la cité est encore peu répandu. la contrainte est mal acceptée : elle est d'abord considérée comme attentoire à la liberté d'aller et de venir.

La légitimité de politiques publiques visant à terme une meilleure gestion de l'espace n'est pas encore acquise. Cet état d'esprit est d'autant plus répandu que l'on s'éloigne du centre et que l'espace est moins contraint. Dans les villes que le tramway va traverser aux abords de Lyon, la suggestion d'une extension du stationnement payant pour compenser, par une meilleure rotation, les places de parking supprimées par le tramway était reçue dans un silence d'incompréhension... Pourquoi payer pour ce qui doit être accessible à tous ?

Ce constat renforce bien évidemment la nécessité d'une référence à un plan d'ensemble qui insiste sur les tendances à l'œuvre et permette d'agir avant qu'il ne soit trop tard. Il renforce également l'importance de prendre son temps pour modifier le jugement des habitants et faire passer les choix de mobilité de la sphère des choix personnels à la sphère des choix politiques. La perception de l'espace est encore individuelle, personnelle, parfois égoïste. Il faut que demain, l'espace soit ressenti comme un bien véritablement commun. Il faut trouver un équilibre entre une ville ouverte, vivante, mobile et une ville cependant mieux protégée, avec des espaces préservés. C'est au prix de cette évolution que les politiques de déplacements pourront être acceptées et influer sur le fonctionnement de la ville, en restaurant, à tous les sens de ce terme, l'urbanité aujourd'hui trop oubliée.

Photothèque SYTRAL X

1.3 Methods of choice of a transport policy
Méthodes de choix d'une politique de transport
Métodos de eleccíon de políticas de transporte

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Urban transport standard
Standard urbain de transport

V.N.Bougromenko & E.G.Myasoedova
Research and Consulting Company Geogracom, Moscow, Russia

ABSTRACT: Strategic planning (of sustainable development) implies a shift from technical, branch indices to humanitarian ones characterizing standards of living. In context of urban transportation the solution is urban transport standard, which is an aggregate of the indices of end consumption of transport services minimally required to sustain normal living conditions, such as mobility, level of transport discrimination, level of ecological safety, net contribution of urban transport to GDP.

RÉSUMÉ: La planification stratégique (du dévelopement durable) signifie un transfert des indices techniques et industruels aux indices humanitaires décrivant des standards de la vie. Dans le contexte du transport urbain la solution est le standard urbain de transport – un ensemble des indices de la consommation finale de tels services routiers nécessaires au minimum pour maintenir des conditions normales de la vie que la mobilité, le niveau de discrimination transport, le niveau de sécurité écologique, la contribution nette du transport urbain à PIB.

The advent of the new millennium necessitates new conceptions of social development reflecting modern tendencies. With regard to the specific character of transportation as an infrastructure, it can be said that its role in sustainable development of the society is rather ambiguous. And it is even more so with urban passenger transportation.

Transport policy in the countries with social market economy aims at revival of public transportation and curb on the number of individual vehicles. The 90-es were marked by increasing role of rail transport in the infrastructure. It was mainly due to ecological problems in the cities. Efforts to privatise urban passenger transport (UPT) were reduced to nothing, the reason being low profitability of UPT or its absolute unprofitable nature. Thus, UPT falls under more and more active patronage of the state authorities. However, the methods of state "intervention" should be controlled by the end goals of its existence – a universal well-being, including concern about the future generations. Therefore, there is a connection between this process and sustainable development in its broader meaning. This connection is the very essence of UTS.

The future of public urban transportation depends on the priorities that will be given to the following three major tasks:

- fulfilment of social duties with regard to those sections of the population that do not have individual vehicles;
- maintenance or improvement of economic stability in the districts where services are provided;
- minimal damage to the environment.

The most important component of the social sphere functioning is the state social regulation, implying legal regulation of social development with application of the most significant social norms and standards. Thus, social norms and standards established by laws and other norm-bearing documents determine the degree of fulfilment of the constitutional rights and guarantees, regulate social protection of the population, and set up branches of the social sphere.

The main pre-conditions of development of the social standards for urban passenger transportation are the infrastructural character of the transportation, tight connection of its functioning with all branches of the economy and social sphere, direct influence of urban transport malfunctions on the consumer and industrial markets, as well as on the living conditions of the present and future generations.

Economic expediency consists in effective provision of the population with the needed passenger communications to the extent when the cost of the system (in its broad meaning) is still offset by the contribution to the well-being of the society.

To achieve this goal, urban transport system should meet the following requirements:

- to be a well balanced combination of public and private transport with consideration of local, socio-economic, technical and ecological abilities and limitations;
- to be convenient, reliable and safe, while using limited resources of energy, land, etc. more rationally.

From the point of view of programme-target planning, the functioning of UPT should be characterised by target and resource indices – social norms.

In the context of urban transportation social norms are scientifically grounded qualitative and quantitative characteristics of the optimal state of business and household activity, which depend on passenger transportation.

Urban transport standard (UTS) is a combination of target indices (norms) of end consumption of transport services, achievement of which guarantees sustainable development. UTS ensures that the citizens will receive minimally required level of transport services.

Unlike purely branch indices (such as volume of passenger conveyance, average trip distance, coefficient of transport pool on line, prime cost of conveyance), characterising the work of urban transport, the indices that constitute UTS are the results of UPT functioning, reflecting normal transport conditions of business and household activity.

The value of social norms cannot be considered constant. It is subject to complex dynamic modifications, because any normative requirement should have "an open-ended structure", which means capability to change quantitative parameters and the list of these characteristics.

The range of the indices and qualitative characteristics of their parameters are determined by:

- current level urban development (population size, level of real income per capita, features of architectural planning, life expectancy, level of social expenditures in the city budget);
- potential development of a city (industrial potential, type of the demographic structure of the population);
- city size.

On the whole UTS should reflect value orientations of the society that can be translated into reality in 5-20 years and used for the following issues:

- strategic planning of urban development with regard to town-planning, economic and social features;
- creation of a new mechanism of procuring financial support for development of urban passenger transportation (shift from paragraph-by-paragraph financing to per capita financing) leading to a more effective use of budget means.

The following sets of norms can be singled out:

- direct quantitative expression of degree of various requirements, or norms expressing the absolute degree of a certain requirement;
- norms expressing a relative degree of a certain requirement.

Each city receives its own set of indices developed with consideration of its architectural planning features, level of real income per capita a year, level of social expenditure in the city budget, level of ecological safety, and planning period, which can be 5.5 – 10 or more than 10 years.

The goal of urban transport policy is establishment of the required end state that can range from a very high standard of living to a very specific threshold value. Elimination of difference found between the actual and designed (normative) values of UTS is the end goal of urban passenger transport development from the point of view of sustainable development.

UTS can consist of the following main indices:

1. Transport mobility of the population.

Transport mobility is one the main indices describing the transportation system of a city. It is an integral index reflecting a contradictory set of factors:

- rhythm of the city life;
- town-planning features and planning structure;
- current state and development of the transportation system;
- city economy.

Taking into consideration complexity and contradictory nature of this index, only one part of it can be incorporated in UTS – transport mobility with social and cultural purposes (trips/person a year). In other words, minimal level of travelling with the above-mentioned purposed in mind, the level that is guaranteed to each citizen given present state of the urban transport system.

Social and cultural trips have been set aside with a purpose, because the rest of the trips (to work, college) is obligatory and unavoidable. In the future telecommunications will help us to study and work without leaving our respective homes, however, seeing friends, going to theatres, museums, etc. is a free choice of our own, and it requires a "live" trip. Thanks to the technical progress unavoidable trips are supposed to decrease in number, while "free will" ones should continually increase.

2. Ratio of public to private transport means.

Ratio of development level of public urban transport (PUT) to individual transport (IT) greatly influences the parameters of the road network, as well as the economic characteristics of the system in general.

Low density of geographical distribution and locations of work places and service centres favours development of individual transportation, while PUT is economically justified by a higher density of building and concentration of production. Decision in favour of predominant development of IT deteriorates conditions of PUT functioning, making it not always economically justifiable, because the number of users decreases. PUT and IT should not be competing, but exist in harmony and complement each other.

PUT is an important factor of urban economic development. The future of this type of transportation should be connected with the solution of such problems as:

- fulfilment of social duties with regard to those sections of the population that do not have individual vehicles;
- maintenance or improvement of economic stability in the districts where services are provided;
- abatement of pollution caused by PUT.

Thus, the optimal ratio of PUT to IT guarantees that each and every citizen will enjoy normal transport conditions.

3. Reliability of UPT (Level of Integral transport accessibility).

Integral transport accessibility (ITA) is the index reflecting the quality of urban transport environment. It is given in the form of average weighted loss of time spent on passenger conveyance. An urban transport network should be considered reliable if it makes it possible for one to get from any place to any other place within the period called normative time inclusive time needed to reach an embarkation place, waiting time and changes on the way. Note that ITA norm is determined with respect to functional peculiarities of each location in the city. Level of transport accessibility is measured in % as ratio of actual average weighted loss of time spent on passenger conveyance to normative loss.

4. Level of transport discrimination of the population.

Level of transport discrimination of the population shows in % what part of the citizens live outside the zone of normative accessibility. Similar to index 3, it is calculated with the help of expert system Geograd.

5. Convenience of transportation by UPT.

Convenience in PUT system is determined by a set of heterogeneous factors, technical equipment, technologies, transport organisation and management influencing passengers' physical and mental state during transportation.

From the point of view of convenience a specific character of PUT is defined by the following circumstances:

- in PUT system the notion "convenience" refers to the whole trip – "from door to door", and not only to transportation;
- relatively short period of time taken up by transportation proper if compared with other phases of a trip;
- day-by-day multiple use of PUT system.

In general, it can be said that inconvenience of PUT system increases passengers' physical and mental tiredness. Therefore, the degree of quality called convenience should be measured in the units of passengers' physical and mental tiredness.

In the course of study of the convenience issue it is necessary to subdivide the notion of convenience into measurable attributes. Keeping in mind that certain characteristics of convenience can be set apart as independent indices or reflected in other indices, the main criterion of convenience can be the index giving number of people standing on one square meter of the salon of a vehicle.

6. Specific lost free time fund.

Total unproductive loss of time spent on chase after transport services of socially guaranteed minimum by each city-dweller a day (measured in hours). Quantitative representation of this standard makes it possible to assess the quality of UPT functioning and evaluate its social (public) usefulness.

7. Share of UPT in total pollution.

Development of urban transport systems has brought forth a problem of evaluation of influence of transport functioning on the ecological situation in a city. The problem can be solved by establishing strict norms that would determine the level of ecological safety and encouragement of muscular transport modes. The main negative results of influence of the transport on the urban environment are air and noise pollution. Share of UTP in total pollution is estimated in % of total pollution from all sources. Moreover, there can be additional standards:

- level of noise pollution (decibels per 1 vehicle);
- level of toxic fumes (million ton/million pass.-km).

8. Level of development of muscular transport modes.

Share of muscular transport modes (e.g. bicycles) in total number of trips undertaken by city-dwellers (%).

9. Accident level due to UPT.

Traffic safety during passenger conveyance is the challenge for all transport modes. Emergency situations on roads are a phenomenon accompanying the motorization of the society and leading to significant losses.

Traffic safety is the criterion of choice made in favour of this or that means of conveyance.

On the basis of analysis of safety issue in Russia and abroad some specific indices-criteria were established:

- number of accidents involving fatal injuries per 10^5 passengers;
- number of accidents involving fatal injuries per 10^4 vehicles.

10. "Effectiveness" of UPT.

This index is calculated as ratio of results to costs. Results are monetary estimation of the share of transport in the gross domestic product of a city (or the gross added value) calculated on the basis of the methodology developed by Geogracom company. Costs are the whole sum allotted for development of the urban transport system (subsidies from the city budget, taxes and other sources). If the value of this index is more than 1, then financial support of the urban transport system is expedient.

All 10 parameters of UTS are determined for a concrete city on the basis of the following factors:

1. Current level of development and structure (number of citizens in a city (N), city surface (F), characteristics of architectural planning structure (K);
2. Potential level of development and period of strategic planning.

Type of architectural planning structure influences the average distance of a trip undertaken by one citizen in a given city. It is believed that average trip distance (L av.), city surface (F) and coefficient of town-planning structure (K) are interconnected by the following formula (Velmozhin & Gukov 1998):

$$L\ av. = 1.2+0.25\ K\sqrt{F} \quad (1)$$

Coefficient of town-planning structure (K) depends on the type of this very structure:

1 – linear with cross-distribution with regard to the mains of major gravity centres of the population, K=0.6-0.9;

2 – compact town-planning structure with centripetal distribution of major gravity centres of the population, K=0.7-1.1;

3 – compact with lengthwise distribution with regard to the mains of major gravity centres of the population, K=0.9-1.2;

4 – linear with lengthwise distribution with regard to the mains of major gravity centres of the population, K=1.2-2.0.

This connection between mobility of the population and town-planning structure is conditional. However, it is sufficient for the purposes of strategic planning.

Besides, there are some strategic parameters characterising the potential level of city development and defining normative parameters of the UTS indices:

- real income per capita
  1000-5000; 5001-10,000; over 10,000 (dollars a year);
- index of economic provision of social guarantees – expenditure on social needs (% of the city budget)
  less than 20%; 20-40%; over 40%;
- level of ecological safety – specific pollution (carbon monoxide), mg/m^3
  less than 1; 1-3; over 3;
- determination of strategic planning period
  up to 5 years; 5-10 years; more than 10 years.

Geogracom has developed a methodology of automated calculation of UTS. For example, Table 1 represents parameter values that are suggested, depending on the desired (strategic) level of income per capita, for a city with up to 500 thousand citizens (group 3 according to the conventional classification, Vaksman 1996) and a linear architectural planning structure with cross-distribution with regard to the mains of major gravity centres of the population.

Table1. Influence of the level of real income on parameters of the UTS indices.

Indices	Real income (US$ per capita)		
	1000-5000	5001-10,000	over 10,000
1. Transport mobility of the population with social and cultural purposes, trips/person a year	150	200	250
2. Ratio of public and individual transport, %	75:25	50:50	20:80
3. Reliability of urban transportation, %	over 80	over 90	over 95
4. Level of development of muscular transportation, %	over 5	15-20	over 30
5. Level of transport discrimination of the population, %	less than 10	less than 5	less than 3
6. Level of comfort and convenience of conveyance, persons/sq. m	less than 5	less than 4.5	less than 3.5
7. Specific lost fund of free time a day, hours a day per person	less than 0.3	less than 0.15	less than 0.15
8. Share of transport pollution in the total pollution, including public urban transport	60 10	65 8	75 5
9. Accident level through fault of transport:			
number of fatal injuries per 10^5 passengers;	less than 12	less than 12	less than 10
number of fatal injuries per 10^4 vehicles.	less than 10	less than 10	less than 6.5
10. Efficiency of urban passenger transportation	1.12	1.2	1.2

The obtained values served as a basis for perspective UTS indices that should be corrected with regard to the following factors:

- economic provision of social guarantees (level of expenditure on social needs in the city budget);
- level of ecological safety.

Final values of the indices depend on the potential of general development of a city (low, medium, high) that is determined in the expert mode on the basis of two indices – industrial potential of a city and demographic structure of the population.

Industrial potential of a city is determined by possible expansion of the economy (increase in output volumes of products and services) – advantageous location, availability of materials, labour and capital resources, possible change of the city status.

Demographic structure of the population, depending on the ratio (%) of the age groups (up to 14 years of age, 15-49 years, over 50 years), can be progressive (30-50-20), stationary (25-50-30), and regressive (20-50-30).

Table-nomogragh 2 makes it possible to determine approximately the indices with regard to potential urban development and planning period.

Table 2. Correction factors of UTS, showing potential urban development and planning period.

Indices	Potential urban development								
	High			medium			low		
	Planning period, years *								
	1	2	3	1	2	3	1	2	3
1. Transport mobility of the population with social and cultural purposes, trips/person a year	+10	+10	+12	-5	-5	0	-10	-8	-5
2. Ratio of public and individual transport, %	-3 : +3	-5 : +5	-6 : +6	0	-1 : +1	-5 : +5	+5 : -5	+6 : -6	+1 : -1
3. Reliability of urban transportation, %	+5	+6	+10	0	+1	+3	-5	-6	-1
4. Level of development of muscular transportation, %	-1	-2	-3	+2	+1	0	+5	+3	+1
5. Level of transport discrimination of the population, %	-3	-2	-1	0	+1	+3	+3	+4	+5
6. Level of comfort and convenience of conveyance, persons/sq. m	-2	-2.5	-2.5	0	-0.5	-0.5	+3	+2.5	+2.0
7. Specific lost fund of free time a day, hours a day per person	-0.1	-0.15	-0.15	0	-0.01	-0.03	+0.1	+0.15	+0.2
8. Share of transport pollution in the total pollution, including public urban transport	+5 +2	+6 +1	+10 0	0 0	-1 -1	-3 -3	+5 +6	+4 +5	+3 +4
9. Accident level through fault of transport:									
number of fatal injuries per 10^5 passengers;	+2	+3	+5	0	-1	-1	-1	-2	-3
number of fatal injuries per 10^4 vehicles.	+2	+3	+5	0	-1	-1	-1	-2	-3
10. Efficiency of urban passenger transportation	0.1	0.15	0.2	0	0.01	0.05	-0.1	-0.15	-0.2

* Note: 1- up to 5 years; 2- from 5 to 10 years; 3- more than 10 years.

Study of works on development and functioning of urban transport by home and foreign authors has led to systematisation and application of some already formed tendencies and dependences that can be used as limitations during calculation of the UTS indices. As a result of multiple comparisons between simulated situations, we have succeeded in determining a possible range of values for indices-orientations (see Table 3), and that confirms their trustworthiness. For example, the extreme situations for the second index are as follows: in 1997 the ratio of the public to private transport in Kazakhstan was 78 to 22%, while Australia demonstrated the ratio of 29 to 71%.

Table 3. Range of values for indices-orientations.

Indices-orientations	Range of values
1. Transport mobility of the population with social and cultural purposes, trips/person a year	$100 \leq M1 \leq 350$
2. Ratio of public and individual transport, %	$80{:}20 \leq M2 \leq 20{:}80$
3. Reliability of urban transportation, %	$0 \leq M3 \leq 100$
4. Level of development of muscular transportation, %	$0 \leq M4 \leq 45$
5. Level of transport discrimination of the population, %	$0 \leq M5 \leq 35$
6. Level of comfort and convenience of conveyance, persons/sq. m	$3 \leq M6 \leq 9$
7. Specific lost fund of free time a day, hours a day per person	$0.1 \leq M7 \leq 1.5$
8. Share of transport pollution in the total pollution, including public urban transport	$10 \leq M81 \leq 80$ $5 \leq M82 \leq 30$
9. Accident level through fault of transport:	
number of fatal injuries per 10^5 passengers;	$3 \leq M91 \leq 25$
number of fatal injuries per 10^4 vehicles.	$2 \leq M92 \leq 20$
10. Efficiency of urban passenger transportation	$1 \leq M10 \leq 1.5$

With the help of the methodology of calculation of the UTS parameters we received the indices-orientations for Nalchik. They can be used for the purposes of strategic planning and creation of a new financing mechanism for development of urban passenger transportation. Table 4 contains UTS for Nalchik. The following strategic parameters were chosen: real income per one citizen is from 1000 to 5000 dollars a year, level of social expenditure is from 20 to 40% of the budget, level of ecological safety is medium. These strategic norms will be valid for more than 10 years given medium potential of development according to the industrial potential and demographic structure of the population.

Table 4. Urban transport standard of Nalchik (UTS).

Indices-orientations	Values
1. Transport mobility of the population with social and cultural purposes, trips/person a year	150
2. Ratio of public and individual transport, %	70 : 30
3. Reliability of urban transportation, %	over 85
4. Level of development of muscular transportation, %	over 10
5. Level of transport discrimination of the population, %	less than 13
6. Level of comfort and convenience of conveyance, persons/sq. m	less than 4.5
7. Specific lost fund of free time a day, hours a day per person	less than 0.2
8. Share of transport pollution in the total pollution, including public urban transport	50 10
9. Accident level through fault of transport:	
number of fatal injuries per 10^5 passengers;	11
number of fatal injuries per 10^4 vehicles.	9
10. Efficiency of urban passenger transportation	1.17

As a matter of fact, Table 4 can be called a "profile" of the transport system of Nalchik as it will be in 10 years In other words, it gives us an idea of the future transport conditions in Nalchik.

As soon as the strategy of sustainable development by means of transport is outlined, the expert system itself (on the basis of the database) generates proposals that will make achievement of the given ten UTS parameters possible. Thus, now we are speaking not so much about effectiveness of separate transport projects, but about efficiency of life in the city in general. Such a shift is due to the fact that every generated technical proposal (increase in traffic frequency on routes, enlargement of the transport pool, reconstruction of tracks, construction of a motor-transport depot, set up of a "green line") is transferred directly into the indices important to each and every citizen-taxpayer. Reports about reduction of specific consumption of fuel or quantitative indices of transport functioning are of little interest to taxpayers, but UTS indices are of great importance to them. Every department in charge of urban transport development should report back to the citizens through the indices of UTS increase.

Later expert system Geograd will combine heterogeneous proposals into a satisfactorily substantiated investment programme and will add up some financial scenarios of its implementation with regard to its multiple peculiarities.

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Etalonnage de la performance des réseaux locaux de mobilité – Proposition pour une coopération internationale

Benchmarking of the performance of local mobility networks – Proposal for international cooperation

Marcamiento de las performencias de las redes locales de movilidad – Propuesto para una cooperacion international

Y. Mathieu – *OGM Bruxelles, Belgique et Missions Publiques, Paris, France*

P. Vincent – *Centre d'Etude sur les Réseaux, les Transports, l'Urbanisme et les Constructions Publiques, Lyon, France*

ABSTRACT: In the light of a recent European Commission initiative on benchmarking local passenger transport systems, this contribution sets out a description of an experimental method and considers the different fields of possible application in the future.

RESUME: Cette contribution propose de s'appuyer sur une récente initiative de la Commission Européenne sur l'étalonnage (benchmarking) des performances des systèmes locaux de transport de passagers pour décrire une méthode expérimentale et envisager les différents champs d'application possibles dans l'avenir.[1]

RESUMEN: Esta contribution propose de apoyarse sobre una reciente initiativa de la comision europëa sobre el benchmarking (marcamiento de las perfomancias) des pruebras des systemas locales de transporte de pasageros para describiun metodo esperimental y examinar los diferentes compos de posibles applicationes en el futuro.

1. Le contexte

a – Le contexte européen

Comprenant environ 370 millions d'habitants, l'Union Européenne (U.E.) est actuellement composée de 15 Etats membres. 12 autres Etats souhaitent y adhérer. L'urbanisation y est importante puisque près de 800 agglomérations réunissent chacune plus de 100 000 habitants.

La diversité européenne invite à renforcer les comparaisons entre les systèmes de transport qui y existent :

- sur le plan institutionnel, l'organisation des pouvoirs locaux en matière de gestion de réseaux locaux et de transport de passagers prend des formes diverses : entre les milliers de collectivités locales investies en France du pouvoir d'organisation des transports urbains et les vastes communautés de transport allemandes, on trouve de nombreuses situations intermédiaires.
- En cela, il n'y a pas de forme unique du pouvoir de décision. Chaque pays voire chaque région est une particularité. De même, les modalités d'exploitation des réseaux sont très différentes d'un pays à l'autre. On trouvera dans certains cas une très forte régulation publique, tandis que dans d'autres, la capacité du marché à se réguler sera promue.
- sur le plan légal, certains pays ont pris des dispositions incitant les autorités locales à viser une réduction du transport par automobile (ex : loi sur l'air en France).
- sur le plan économique, il existe des différences de niveau de vie entre les régions d'Europe. Chaque pays a son propre système fiscal. Par ailleurs, le rôle joué par la tarification dans le débat usager/contribuable n'est pas uniforme : dans certains pays, les transports publics sont très subventionnés, tandis que dans d'autres ils ne le sont pas ou peu.
- sur le plan de l'aménagement du territoire et du code de la route, la place réservée aux transports publics et aux modes doux varie de situations où aucune priorité n'est donnée à des situations à l'implantation des entreprises ou de centres commerciaux est conditionnée à l'utilisation des transports publics.

- sur le plan du management de la mobilité, certains territoires ont créé des agences spécifiques dotée de plans à long terme, d'autres ont signé des contrats de partenariat impliquant les forces de police ; il existe ailleurs des agences conseil en mobilité, chargées de conseiller les citoyens et les entreprises

- sur le plan social, les approches sont diverses. A titre d'illustration, les structures et niveaux des tarifications sociales dans les transports publics sont très différentes : ici, on aide beaucoup les familles nombreuses tandis que là, on préfère favoriser la mobilité des demandeurs d'emploi.

- enfin, sur le plan culturel, la place donnée aux différents modes de transport dans la cité varie considérablement : en schématisant, on peut dire que les pays du nord se déplacent beaucoup à bicyclette, les pays du sud en automobile, et les pays du centre en transports publics.

Une telle diversité est riche d'enseignements, car elle permet d'identifier des bonnes pratiques, tant en termes de management du progrès que de résultats obtenus.

Dans le prolongement du livre vert de la Commission Européenne « Un réseau pour les citoyens », et afin de donner aux agglomérations européennes la possibilité, par l'étalonnage des performances, de promouvoir le développement des modes de transport « doux » (les transports collectifs ou partagés, la bicyclette et la marche à pied), la Commission Européenne (DG Transport) a lancé en juillet 1998 un exercice pilote d'étalonnage des performances des réseaux locaux de mobilité. Quinze agglomérations européennes se sont portées volontaires.
L'expérience doit être étendue à une soixantaines de territoires en 2000 (voir www.eltis.org/benchmarking).

b – L'étalonnage des performances dans le secteur des services

L'étalonnage (« Benchmarking ») des performances est une méthode de management du progrès et de recherche d'amélioration de la qualité déjà bien connue dans le secteur industriel.

Il consiste, pour une entreprise ou une unité de production, à rechercher autour d'elle les meilleures pratiques de production d'un produit et à en tirer les enseignements pour définir et mettre en œuvre des actions d'amélioration de la qualité du produit. Il s'agit d'une démarche de management continue, où l'entreprise est dans un processus permanent d'évaluation de la qualité de sa production, est à l'écoute des meilleurs pratiques réalisées dans son secteur ou dans d'autres secteurs avec lesquels des enseignements de processus seront possibles, et cherche de la sorte à progresser continuellement dans ses produits.

Dans le secteur des services, et en particulier dans celui des réseaux locaux de mobilité, la pratique de l'étalonnage des performances est encore peu répandue. Or il apparaît que c'est là aussi une méthode très prometteuse de management du progrès et de la qualité.

Au cours des dernières années, plusieurs initiatives d'étalonnage des performances ont été prises par différents réseaux, notamment sous l'égide de l'UITP, association internationale des opérateurs. Et, bien sûr, les groupes de transport qui exploitent plusieurs réseaux étalonnent en interne leurs performances, mais l'accès au méthodes utilisées et aux résultats obtenus n'est pas public.

De son côté, la Commission Européenne (DG Transport) a décidé de lancer en 2000 un réseau thématique et un projet de recherche sur l'étalonnage des performances appliqué à l'ensemble des domaines de sa politique de transport[2], dans le 5ème programme cadre européen de recherche et développement.

2. La méthode proprement dite d'étalonnage des performances du système local de transport de passagers

L'étalonnage des performances repose sur les points forts suivants :

- Les réseaux locaux de mobilité :

Il ne s'agit pas seulement de mettre en perspective les réseaux de transport public des différentes agglomérations étudiées, mais d'analyser l'ensemble des modes de déplacement, en insistant plus particulièrement sur les autres modes de transport que la voiture individuelle : marche à pied, deux roues, transports publics. Il s'agit donc d'une démarche portant sur la mobilité locale globale dans une perspective de développement durable. L'on vise à rendre les citoyens et les visiteurs moins dépendants de la voiture particulière en propriété propre.

- Le groupe des agglomérations volontaires :

La démarche repose sur la mise en commun, par un groupe d'agglomérations volontaires, de leur expérience. L'exercice pilote européen a montré que la diversité des expériences était un critère plus important que l'homogénéité des tailles de population ou la densité. Ce n'est pas nécessairement dans des villes comparables en taille ou en densité que vont être trouvées les « bonnes pratiques » utiles pour progresser, tant en terme de résultats que de méthodes.

❑ Le parti pris du citoyen et de l'usager :

La comparaison des performances ne peut pas être celle d'une liste de produits et de services offerts par l'autorité organisatrice des transports de voyageurs et l'opérateur. Il faut se placer résolument du point de vue du citoyen et de l'usager, et examiner les réponses aux besoins et attentes.
Pour cela, 10 critères de qualité de la performance ont été identifiés. Ils sont cohérents avec les réflexions en cours au sein du CEN[3]. Ils servent de support à l'analyse de différents indicateurs. En outre quatre « domaines » (environnement, partage modal, accessibilité et financement) font l'objet d'un examen particulier.

❑ La mise en perspective dans le temps :

Un des principes fondamentaux de l'étalonnage des performance, c'est que l'on va chercher dans le présent et le passé des autres de quoi éclairer son propre futur. Autrement dit, pour définir un plan d'action d'amélioration de la qualité du système local de transport de personnes dans une perspective environnementale et durable, il faut pouvoir caractériser les évolutions passées et la façon dont elles ont été conduites. Et il faut aussi être capable de projeter dans l'avenir les indicateurs qui caractérisent la performance.

Dans ces conditions, l'étalonnage des performances n'est pas une comparaison contemplative de résultats, de moyens et de méthodes actuels : il s'agit de leur mise en relation dans les différentes agglomérations concernées par rapport à ce qui s'est passé au cours des 10 dernières années, et au cours des 10 prochaines années (tant dans un scénario « fil de l'eau » que dans un scénario « volontariste »).

❑ Une auto-évaluation partagée :

Avant de se comparer, il est indispensable de bien se connaître. L'étalonnage des performances comprend donc une auto-évaluation, par chacune des agglomérations du groupe, de la performance son propre système de transport de personnes.

Les deux principales caractéristiques de la méthode d'auto-évaluation sont un système d'indicateurs hiérarchisé à deux niveaux (15 et 35), et la mise en place d'un groupe de travail local pluridisciplinaire et plurimodal.

Sur ce dernier point, en effet, il apparaît qu'on ne trouve nulle part de système institutionnel qui concentre en un seul organisme local toutes les compétences nécessaires à la collecte de données, l'analyse, la prévision et la gestion de l'ensemble du système local de transport de passagers tous modes confondus. L'exercice pilote d'étalonnage des performances a d'ailleurs révélé que cette mise en commun de compétences locales ouvrait souvent un dialogue nouveau porteur par lui-même de progrès.

La méthode commune d'auto-évaluation permet dans un second temps de procéder à de premières comparaisons entre les agglomérations.

❑ Un thème d'approfondissement commun.

L'étalonnage des performances étant tourné vers l'action, les membres du groupe ont pour objectif ultime de définir et mettre en œuvre localement un plan d'action d'amélioration de la performance de leur système local de transport de personnes.

Ils choisissent donc un thème d'amélioration commun et l'approfondissent ensemble. Ce travail collectif peut prendre différentes formes : auto-évaluation individuelle complémentaire en profondeur sur ce thème et mise en commun ; recherche et analyse (littérature professionnelle, Internet, visites si possible...) de « bonnes pratiques » existant ailleurs ; travail commun de caractérisation d'une « bonne pratique ».

Un exemple de thème d'approfondissement commun sera donné dans la présentation. Il portera, ou bien sur « l'information intégrée des usagers des transports publics », ou bien sur « le bus aussi performant que le tram », « les secrets des bonnes décisions dans le domaine de la mobilité », « comment convaincre des automobilistes de changer leurs habitudes ? » et des exemples de « bonnes pratiques ».

Ensuite, chaque agglomération peut définir son plan d'action sur ce thème, en se référant à des éléments tangibles. Ultérieurement, le groupe peut se réunir à nouveau pour faire le bilan de la réalisation des plans d'action et conduire une nouvelle démarche d'étalonnage des performances.

Le principal bénéfice de cette démarche est une forte réduction du coût d'accès à une information pratique et utile. Au plus le nombre de participants s'accroît, au plus la base de donnée est riche. Le principe d'échange d'information sous-jacent au processus (et non de la vente de l'information) permet de limiter le coût au travail réalisé et aux déplacements. De plus, le cadre méthodologique permet d'assurer une grande accessibilité de l'information, un niveau semblable d'implication des différents partenaires, et la permanence de la démarche dans le temps associée à un renouvellement continu des thèmes abordés. Enfin, ceux-ci sont toujours relié à des préoccupations de terrain (sinon, ils ne sont pas traités). Le caractère opérationnel est donc assuré.

Ces points forts étant soulignés, la méthode repose sur les étapes suivantes :

- Constitution d'un groupe de territoires volontaires (adoption d'une charte)
- Description des caractéristiques institutionnelles (au sens large) locales.
- Auto-évaluation de la performance du système local de transport de personnes au regard d'un développement durable avec mise en perspective dans le temps.
- Comparaison entre territoires et analyse.
- Choix d'un thème d'approfondissement.
- Approfondissement de l'auto-évaluation ; recherche et analyse de « bonnes pratiques ».
- Définition et mise en œuvre d'un plan d'action local.
- Eventuellement, mise en commun des résultats obtenus et analyse, en vue de l'organisation d'un nouveau cycle d'étalonnage des performances.

3. La transposabilité de la démarche et son développement

3.1. Les différences, souvent importantes, entre les systèmes institutionnels, les modes de financement et la culture des différents pays, qu'ils soient européens ou répartis dans le monde entier, ne sont pas un obstacle au développement des démarches d'étalonnage des performances.

Il est néanmoins important que les spécificités locales soient bien connues de tous, et c'est le premier travail commun à accomplir : décrire les caractéristiques des systèmes dans lesquels se développe la mobilité des personnes, afin que chacun ait une bonne connaissance du cadre dans lequel se situent les autres membres du groupe. Bien sûr, cet exercice n'est pas à faire dans le cas où les partenaires proviennent tous de territoires du même pays.

Ensuite, il est important que la complexité de la collecte des données qui seront nécessaires aux comparaisons entre les territoires soit compatible avec les systèmes d'information et de prévision existant localement. De ce fait, il faut prévoir plusieurs niveaux d'indicateurs. Les partenaires choisissent de façon concertée le niveau de complexité correspondant à leur situation.
Concernant le champ d'application futur de l'étalonnage des performances dans le domaine de la mobilité, il est possible d'identifier 5 directions possibles :

a – L'étalonnage dans un cadre contractuel fortement réglementé : les autorités organisatrices de transport sont parfois confrontées à des opérateurs en situation de monopole (en particulier pour le transport ferroviaire urbain), et qui, pour des raisons diverses, ne peuvent pas être soumis à la concurrence (c'est à dire à un système d'appel d'offre ou de concurrence directe). Dans ce cas, l'étalonnage est un instrument qui peut être conçu pour développer une recherche effective de la performance dans le contrat liant l'autorité organisatrice et l'exploitant. Celle-ci peut être trouvée en s'appuyant sur les performances d'autres compagnies ou industries comparables.

b – Etalonnage des systèmes : les systèmes sont caractérisés par les notions d'interconnexions et de compatibilité des services. C'est le cas de l'intermodalité dans les transports.
L'étalonnage des performances peut être utilisé pour étudier et améliorer les processus sous-jacents et les moyens nécessaires à la réalisation de ces interconnections et compatibilités.
L'étalonnage de la performance des systèmes est aussi pertinent pour améliorer les systèmes construits autour d'un mode de transport (air), d'un espace de mobilité (déplacements urbains), d'une problématique de transport de marchandises (intermodalité), etc.

c – L'étalonnage des performance inter-secteurs : L'étalonnage des performance entre différents secteurs permet aux autorités de piloter en continu la performance de secteurs spécifiques et de maîtriser la façon de réagir à des outils particuliers de leur propre politique. De même, les secteurs eux même (par leurs organisations représentatives) peuvent avoir intérêt à être capables de montrer objectivement leur performance (par exemple dans le domaine environnemental) vis à vis d'autres secteurs.

Quand un organisme régulateur est en charge d'un marché, l'étalonnage des performances est pertinent pour cet organisme pour comparer la performance d'opérateurs en place. L'étalonnage de ces performances locales avec d'autres secteurs d'activité est stimulant pour une performance accrue.

d – L'étalonnage du cadre réglementaire : le ministère néerlandais des affaires économiques a montré que l'étalonnage des performances pouvait être utilisé, dans l'industrie, pour améliorer le cadre réglementaire dans le but d'attirer les entreprises. Dans le même ordre d'idée, une démarche d'étalonnage peut aussi être entreprise pour renforcer les éléments clé du cadre réglementaire des transports dans la perspective d'un développement favorable à l'environ-nement.

e – Etalonnage des performances des politiques : Les instruments permettant de réaliser les objectifs politiques peuvent être étalonnés selon leurs impacts et leurs coûts. La comparaison avec d'autres pratiques peut conduire à détecter des instruments plus efficaces que ceux qui avaient été utilisés jusqu'à présent.

Conclusion : Perspectives pour l'étalonnage des performances dans les transports de personnes et les réseaux de mobilité a – Du côté des opérateurs :

Au niveau européen, mais aussi mondial, se développent deux types de phénomènes. D'une part, on assiste depuis plusieurs années à une extension importante de la dérégulation dans la gestion des services publics locaux de transport. De ce fait, les exigences d'efficacité dans la réalisation des investisse-ments et l'exploitation des réseaux sont de plus en plus grandes.

Dans le même temps se constituent des groupes puissants qui opèrent à l'international dans des contextes très différents. Il est un fait que l'étalonnage des performances entre leurs diverses composantes (filiales, établissements) fait partie des méthodes utilisées pour renforcer leur positionnement sur le marché.

Lorsqu'il est organisé entre des compagnies distinctes (Nova, Comet, au sein de l'UITP), la confidentialité qui entoure toujours les résultats montre la haute valeur économique des informations obtenues.

b – Du côté des autorités chargées de définir et d'organiser les politiques de déplacements :

Le développement de réseaux internationaux d'autorités publiques crée un climat positif pour la multiplication des démarches d'étalonnage des performances dans les différentes acceptations possibles telles que décrites auparavant.

Au niveau local, de plus en plus d'autorités publiques ressentent le besoin, face à des opérateurs qui développent eux même leurs propres systèmes d'étalonnage, de mettre en place un système d'information spécifique.

Pour les prochaines années, la tendance pourrait prendre deux formes différentes :

- Ou bien les autorité publiques développent leur propres démarches et réseaux d'étalonnage indépendamment des opérateurs. Cela signifie en particulier qu'elles mettront en place leurs propres bases de données et systèmes d'information. Ceux-ci leur seront utiles à la fois pour la définition des politiques de déplacement au niveau local, et pour l'amélioration dans la gestion des réseaux de transport (définition des réseaux, caractérisation des performances à atteindre, procédures d'évaluation).

- Ou bien les autorités publiques et les opérateurs s'associent dans le processus, dans le but de créer une dynamique locale pour améliorer les performances. Cela leur permettra de mettre en place des actions complémentaires là où l'action de l'un ou de l'autre des partenaires agissant seul ne permettrait pas d'atteindre les résultats visés. Dans ce cas, l'étalonnage des performances devient un outil de véritable partenariat.

Il est possible que les deux voies co-existent, selon l'intensité de la volonté de coopérer qui sera observée au niveau des acteurs de terrain. Différentes initiatives, comme la mise en place d'un réseau thématique sur le sujet par la Commission Européenne[4] vont dans le sens d'un développement de la coopération.

[1] Athens, Bremen, Dresden, Edinburg, Genoa, Graz, Ile de France, Lisboa, Merseyside, Nantes, Oulu, Praha, Strathclyde, Stuttgart, Terni

[2] réseau thématique BEST Benchmarking European Sustainable Transport, initié par la DG transport et couvrant tous les domaines de sa politique de transport (fret, passagers, tous modes) sur les 15 pays de l'Union et les 12 ayant demandé leur accession à l'Union

[3] CEN = Comité Européen de Normalisation, au sein duquel une norme européenne portant sur la qualité des services de transport de personnes est en phase finale d'adoption (prévu fin 2000 ou début 2001). Cette norme s'inspire des résultats des travaux de Quattro, projet de recherche européen présenté dans Codatu VIII par Yves Mathieu (The value of public transport : mass production and quality) voir www.ogm.be/mobility pour les rapports de synthèse en 5 langues et www.cur.nl/quattro pour le rapport final en ligne.

[4] réseau thématique BEST, op.cit.

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Towards comprehensive transportation and air quality strategy in Mexico City

Vers la réussite d'une stratégie intégrale du transport et la qualité de l'air de la Capitale Mexicaine

Hacia una estrategia integral de transporte y calidad del aire en la Ciudad de México

M. Reyes Juárez del Ángel & I. Reyes Juárez del Ángel
Felipe Ochoa e Asoc., Mexico D.F., Mexico

SUMMARY:

The Metropolitan Zone of Mexico City (ZMVM) is one of the largest settlements in the world and has a severe air pollution problem. The urban transportation needs keep growing proportionally as population grows and the city expands. The ultimate solution to meet these needs requires a comprehensive vision, based on the integration of urban policy, which gradually, will shape a new structure of efficient, safe and environmentally clean transport.

Among the complexity of the ZMVM air pollution problem, out stand several aspects related to the transport system. For the first time in Mexico, this research focused on developing an integral strategy for transport and air quality.

The proposed methodology combines traditional aspects of transport project evaluation (cost-profit), with new indicators in order to arrive to a hierarchically arranged list of projects.

A linear program model was used to allow selection of those projects or actions that, at the same time, report the best profits to the transport system, and are the ones that better contribute to reduce the air pollution in Mexico City.

The model results constitute a typical application of operation researching techniques in investment programming.

RÉSUMÉ:

La Zone métropolitain de la vallée du Mexique est une des zone urbaine la plus peuplée du monde et elle a une sévère problème de pollution atmosphérique.

Les nécessités du transport de la capitale constinue en augmente, en même temps que la polulation, ainsi que la ville s'étende.

La satisfaction appropiée des nécessités requierent d'une vision intégrade basée sur la politique urbaine, qui d'une façon graduelle donnent la forme a une nouvelle structure du transport, efficace, sûre et d'une ambiance propre.

Entre le complexe du probléme de la pollution ambientale de la zone métropolitaine de la capitale mexicaine, dépassent des aspects divers rélatives aux sistèmes du transport.

Cette recherche propose un premier essai pur développer une stratégie qui intègre les objectifs du transport et de la qualité de láir.

La métodologie proposée combine des aspects traditionneles en se qui concerne les projects du transport (coût/bénéfice) avec des nouveraux indicateurs des projects pour leur hiérarchization.

On Utilise une modèle de programmation linéal qi permettera selectionner les projects ou action, qui en même temps qu'apportent les mayeurs bénéfices au sistème du transport vout rèduire en plus la pollution de l'air de la capitale ces resultats du modèle constituent d'application tipique du técnique de recherche en opérations des programmes d'inversion.

RESUMEN:

La Zona Metropolitana del Valle de México (ZMVM) es una de las áreas urbanas más pobladas del mundo y tiene un severo problema de contaminación atmosférica. Las necesidades de transporte de la Ciudad continúan en aumento, en la medida que la población crece y la ciudad se expande. La satisfacción adecuada de estas necesidades requiere una visión integral, basada en una integración de políticas urbanas que, gradualmente, den forma a una nueva estructura de transporte eficiente, seguro y ambientalmente limpio.

Entre la complejidad del problema de contaminación del aire de la ZMVM, sobresalen diversos aspectos relativos al sistema de transporte. En esta investigación se plantea un primer intento en México por desarrollar una estrategia que integre los objetivos del transporte y la calidad del aire.

La metodología propuesta, combina aspectos tradicionales de la evaluación de proyectos de transporte (costo-beneficio), con nuevos indicadores de los proyectos para la jerarquización de los mismos.

Se utiliza un modelo de programación lineal que permite seleccionar aquellos proyectos o acciones, que al mismo tiempo que reportan los mayores beneficios al sistema de transporte, son los que más contribuyen a reducir la contaminación al aire en la Ciudad de México.

Los resultados del modelo constituyen una aplicación típica de técnicas de investigación de operaciones en la programación de inversiones.

1. PLANTEAMIENTO

La Zona Metropolitana del Valle de México (ZMVM) es una de las áreas urbanas más pobladas del mundo y tiene un severo problema de contaminación atmosférica. La población de la ZMVM ha crecido de medio millón de habitantes a principios de siglo, a más de 17 millones en 1995, y se proyecta que alcanzará casi 18 millones de habitantes en el año 2000 y 21 para el 2010. Actualmente, en la ZMVM se asienta el 18% de la población del país, se genera el 31% del producto interno bruto y se consume el 17% de la generación nacional de energía.

En esta investigación se plantea un primer intento en México por desarrollar una estrategia que integre los objetivos del transporte y la calidad del aire.

Se identifican diversos proyectos que, atendiendo la problemática del sector transporte, contribuyen al mismo tiempo a reducir los niveles de contaminación. La metodología propuesta ubicada en el marco de la investigación de operaciones en la programación de inversiones, combina aspectos tradicionales de la evaluación de proyectos de transporte (costo-beneficio), con nuevos indicadores de los proyectos para la priorización de los mismos.

Se utiliza un modelo de programación lineal que permite seleccionar aquellos proyectos o acciones, que al mismo tiempo que reportan los mayores beneficios al sistema de transporte, son los que más contribuyen a reducir la contaminación al aire en la Ciudad de México.

2. DIFICULTADES DE MONETARIZACION DE EFECTOS SECUNDARIOS

Si bien es cierto que desde un punto de vista ortodoxo la evaluación económica llevaría a la monetarización de los conceptos para agregarlos en un solo indicador tal como el VPN de las corrientes de beneficios netos marginales descontados a una tasa anual predeterminada, existen rubros de beneficios como la reducción de accidentes y la reducción de emisiones contaminantes para los que la información técnica y económica existente no permite cuantificar apropiadamente sus efectos secundarios o externalidades para modelarlos a nivel individual de cada proyecto. Y con ello, no se tiene suficiente información para reflejar vía precios sombra el costo o beneficio imputable a cada medida de transporte en estos rubros. (3), (4)

La monetarización de efectos secundarios por reducción de emisiones contaminantes se intentó por primera vez en Santiago de Chile (5); sin embargo, el modelo utilizado en aquel país depende fuertemente de los beneficios a la salud por reducción en las emisiones y deja de lado los beneficios al transporte de cada proyecto de mejoramiento identificado. En México existen investigaciones en curso en el Instituto Mexicano del Petróleo (IMP) para el desarrollo de modelos de calidad del aire asociados a las características del Valle de México para efectos de cuantificación de inventarios de emisiones de fuentes fijas y móviles.

Sin embargo, aún cuando se dispusiera de un modelo de emisión de contaminantes en un nivel de grandes zonas (para fuentes fijas y móviles), no se cuenta con un modelo de dispersión de contaminantes y de calidad del aire que permita su estimación para los principales tipos de contaminantes (en particular para las partículas sólidas en suspensión) (6); por otra parte, aún están en proceso investigaciones en México que vinculan los indicadores de la calidad del aire y su repercusión económica en términos de los beneficios a la salud, expresados en daños a largo plazo por muertes prematuras o costo de los tratamientos médicos. (7)

Aun desde el punto de vista del transporte en la ZMVM, son limitados los esfuerzos de aplicación de modelos de transporte que permitan simular los efectos de la operación de los diferentes modos de transporte y su repercusión en variables agregadas como costos totales de operación vehicular, vehículos-km totales, velocidad promedio y reducción de contaminantes. Por ello, en esta investigación las evaluaciones realizadas para cada medida o proyecto, proponen la estimación de los beneficios económicos individuales según el nivel de cada uno de éstos, y agregándolos posteriormente en una medida global.

La evaluación económica de cada medida, en lo particular, fue realizada en términos unitarios. La unidad de intensidad de cada medida podía ser un módulo o paquete, de manera que el resultado de la evaluación pudiese combinarse más adelante con los resultados de otras medidas. Así, por ejemplo, para el caso de la evaluación de la medida de extensión de líneas del metro, se realizó la evaluación de un hipotético módulo de diez km de línea que produciría un Valor Presente Neto (VPN) de $X millones de pesos/10 Km línea y se asume que si esta medida se llevase a una intensidad de 20 Km, el VPN correspondiente sería directamente proporcional ($(20/10). X millones de pesos) respecto al resultado anterior. De igual manera se expresaron en términos unitarios los resultados de la reducción de emisiones contaminantes, por ejemplo, ton/año de hidrocarburos (HC)/10 km línea de metro.

El otro aspecto a resolver es la manera de combinar las diferentes medidas de cada sector e integrarlas en una estrategia o en una serie de tácticas. Las medidas seleccionadas ofrecen beneficios netos al transporte o reducciones a las emisiones contaminantes, o ambas cosas. Conforme a un esquema de aditividad de los beneficios, la hipótesis implícita es que la intensidad de cada medida debería ser tanta como fuese posible según las restricciones técnicas, presupuestales, de reducción de emisiones contaminantes a la atmósfera y de demanda. Para tomar en cuenta tales restricciones se propone el uso de un modelo de programación lineal, como se indica más adelante.

3. EVALUACIONES DE MEDIDAS DE TRANSPORTE

Para la integración de la estrategia general, se toman como punto de partida las medidas de acción propuestas en cada una de las investigaciones específicas; del conjunto de propuestas se seleccionaron las 31 medidas que se resumen en la tabla 1, en la que el umbral máximo corresponde al nivel máximo de aplicación de cada medida.

Para definir los programas de acción por escenario [1] se siguió un proceso de evaluación que representa un avance importante con respecto a la evaluación tradicional de proyectos de transporte, en tanto que la selección de las acciones y su nivel de aplicación en cada horizonte se hizo con base en dos criterios básicos:

- El Valor Presente Neto (VPN) de cada medida, como un indicador de sus beneficios potenciales para los usuarios y para los prestadores de servicio; el VPN se calcula comparando los costos de inversión, con los beneficios al sistema de transporte integrados por los ahorros en tiempos de viaje de los usuarios, la reducción de los costos de opera-

(1) Se seleccionaron tres escenarios u horizontes de planeación, correspondientes a los años 2000, 2010 y 2020.

ción de los vehículos, y en algunos casos los ahorros originados por la reducción de accidentes [2]. (8)

Los costos de inversión se obtienen de la aplicación de índices de costo resultantes del análisis de las estadísticas disponibles en las dependencias correspondientes del Distrito Federal y el Estado de México.

Los ahorros en los tiempos de viaje de los usuarios se valúan conforme a los lineamientos del Banco Mundial; de la misma forma, los ahorros en los costos de operación de los vehículos se obtienen aplicando el modelo VOC - también del Banco Mundial -. (9)

En todos los casos, se evalúan las situaciones con y sin proyecto para cada medida.

- La reducción de emisiones contaminantes asociada a cada medida en particular; esta reducción se calcula aplicando factores de emisión por tipo de vehículo, y comparando la situación con y sin proyecto para cada medida. Los factores de emisión se obtienen a partir de la siguiente información:
  - Resultados de pruebas de laboratorio del Instituto Mexicano del Petróleo.
  - Resultados de estudios de detección remota de contaminantes efectuadas en la ciudad de México, y
  - Factores de emisión generados con la aplicación del modelo Mobile5-MCMA (10).

4. FORMULACIÓN DEL MODELO

Un modelo de programación lineal se utiliza con el propósito de determinar el nivel de aplicación óptimo de cada medida en cada uno de los horizontes de planeación seleccionados. La función objetivo del modelo busca maximizar los beneficios al sistema de transporte, es decir, maximizar el VPN asociado a una combinación específica de medidas.

En el modelo, la función objetivo está sujeta a un conjunto de restricciones que permiten asegurar condiciones óptimas - desde el punto de vista del modelo lineal propuesto -, en la selección de los niveles de aplicación de las medidas, y al mismo tiempo cumplir con los objetivos de calidad del aire; las restricciones consideradas son las siguientes:

- Técnicas (se refiere al nivel factible de aplicación de la medida).
- Metas de reducción de emisiones contaminantes
- Recursos financieros
- Satisfacción de la demanda de viajes

Las expresiones que conforman el modelo de optimización son las siguientes:

$$\text{Maximizar } Z_t = \sum_{i=1}^{31} VPN_i \cdot x_{i,t}$$

Función Objetivo (Maximizar el VPN)

Sujeto a las siguientes restricciones:

Expresión	Concepto
$\sum_{i=1}^{31} rc_{j,i} \cdot x_{i,t} \geq RC_{j,t}$	Metas de reducción de contaminantes
$\sum_{i=1}^{31} I_{k,i} \cdot x_{i,t} \leq IT_{k,t}$	Monto de inversión
$\sum_{i=1}^{31} G_{k,i} \cdot x_{i,t} \leq GT_{k,t}$	Gastos de operación
$\sum_{i=1}^{31} D_i \cdot x_{i,t} = DT_t$	Restricción de demanda [3]
para	
$x_{i,t} \geq 0$	Restricción de factibilidad
$x_{i,t} \leq RT_{i,t}$	Umbral máximo de las medidas (restricción técnica)

en donde:

Z_t : Función objetivo en el corte de tiempo t.

VPN_i : Valor presente neto por unidad de acción de la medida i

$x_{i,t}$: Valor que tomará la medida i en el "corte" de tiempo t, que representa el nivel de aplicación óptimo correspondiente

$rc_{j,i}$: Reducción anual del contaminante j por cada unidad de la medida i

$RC_{j,t}$: Metas de reducción anual del contaminante j en el corte de tiempo t; j representa alguno de los siguientes contaminantes: HC, CO, NO_x, SO_2, PST.

$I_{k,i}$: Monto de inversión por cada unidad de la medida i por parte del sector k

$IT_{k,t}$: Máximo monto acumulado de inversión que se esperaría del sector k en el corte de tiempo t

$G_{k,i}$: Monto del gasto de operación por cada unidad de la medida i por parte del sector k

$GT_{k,t}$: Máximo gasto de operación que se esperaría del sector k en el corte de tiempo t.

A su vez,

$k \in$ {'sector público', 'sector privado'}

(2) El efecto en la reducción de accidentes se calculó solamente para aquéllas medidas que implicaban una reducción en los vehículos-kilómetro recorridos por las unidades de transporte de superficie.

(3) Para el horizonte 1998-2000 se usó el signo de mayor o igual en esta restricción.

D_i : Demanda de transporte satisfecha por cada unidad de la medida i

DT_t : Demanda total de transporte público en el corte de tiempo t.

De esta forma, se asegura que la prioridad de aplicación de cada una de las 31 medidas seleccionadas - y sus niveles de aplicación para cada horizonte-, arroja la combinación de acciones con las que se obtienen los mayores beneficios al sistema de transporte, al mismo tiempo que se cumplen con las metas de reducción de contaminantes en el horizonte de planeación correspondiente.

Dado que la combinación de medidas para cada horizonte se obtiene con la aplicación de un modelo de programación matemática, dicha combinación es óptima [4], es decir, no existe otra combinación posible de niveles de aplicación de las medidas que generen un "mejor" valor de la función objetivo (los beneficios al sistema de transporte), para las restricciones impuestas.

En este modelo, se usó como función objetivo el VPN de cada medida; pero también es posible definirla como la aportación de cada medida en la reducción de contaminantes.

Se incluye como restricción la cantidad de recursos disponibles para financiar la aplicación (inversión) y los gastos de operación de las medidas; en este caso, se partió del análisis del comportamiento histórico de los montos de inversión y de gasto corriente tanto del sector público como del privado, para determinar en cada horizonte niveles que fueran consistentes con ese comportamiento; de esta forma, se asegura la factibilidad de implantación de las medidas seleccionadas.

Finalmente, se incluye una restricción de demanda, que permite asegurar que, a nivel agregado, la capacidad asociada a los modos de transporte disponibles, sea igual a la demanda total estimada en cada horizonte de planeación; esta restricción solamente se considera para el transporte de pasajeros. De esta forma, se asegura que en todos los casos se satisface la demanda, pero también que no habrá un exceso de oferta que pueda afectar el desempeño de los sistemas de transporte.

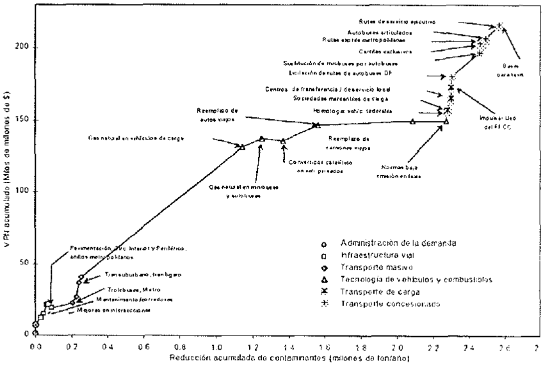

Figura 1 Valor presente neto acumulado y reducción acumulada de contaminantes por grupo de medidas (%) (suponiendo que cada medida se lleva a su nivel máximo de aplicación)

Tabla 1
Resumen de medidas, sus umbrales máximos al año 2020 y Resultados del Modelo

	COMPONENTE	UNIDAD	Umbral Máximo	1998-2000	2001-2010	2011-2020
	Administración de la Demanda					
	Implantar restricciones de acceso al área central	Autos/hr	35,000	-	18,353	16,647
	Incrementar los cargos de estacionamiento	Autos/hr	35,000	-	35,000	-
	Impulsar el transporte especializado escolar y de personal	viajes/día	525,000	525,000	-	-
	Infraestructura Vial					
	Mejoramiento de intersecciones metropolitanas	Intersecciones	500	300	200	-
	Reforzar el mantenimiento de corredores metropolitanos	Km	241	241	-	-
	Pavimentación de vialidades en zonas marginadas	Km	500	300	200	-
	Concluir la construcción del Circuito Interior y el Anillo Periférico	Km	60	30	30	-
	Construir anillos y corredores metropolitanos	Km	241	-	241	-
	Transporte Masivo					
	Ampliar la red de trolebuses	Km	1,192	40	386	
0	Ampliar la red del Metro	Km	76.4	-	4.5	71.9
1	Construir líneas de tren regional	Km	68	24	44	-
2	Ampliar la red del tren ligero	Km	74	-	30	44
	Tecnología de Vehículos y Combustibles					
3	Uso de gas natural en vehículos de flotillas	Vehículos	785,500	34,500	751,000	-
4	Uso de gas natural en minibuses	Microbuses	27,739	6,000	21,739	-
5	Uso de gas natural en autobuses	Autobuses	12,201	-	-	12,201
6	Instalación de convertidores	Vehículos	298,194	178,916	119,278	

[4] Una solución óptima es la mejor solución posible dado un conjunto de valores de los parámetros de la función objetivo y de las restricciones; cualquier otra solución o combinación factible de variables genera un valor subóptimo de la función objetivo del modelo utilizado.

	catalíticos en vehículos privados					
7	Reemplazo de autos viejos	Autos	260,429	198,780	61,649	-
8	Reemplazo de camiones viejos	Camiones	269,376	41,727	227,649	
9	Normas de baja emisión de contaminantes en taxis libres y de sitio	Taxis	91,652	21,150	70,502	-
	Transporte de Carga					
0	Homologar los vehículos federales de carga a las normas locales	Vehículos	39,122	-	-	39,122
1	Fomentar la creación de sociedades mercantiles de transporte de carga	Vehículos	7,500	2,500	5,000	-
2	Fomentar la instalación de centros de transferencia de carga	Vehículos	22,000	-	8,848	13,152
3	Fomentar la instalación de centros de servicio local de carga	Vehículos	7,950	4,000	3,950	-
4	Impulsar el uso del ferrocarril en transporte de largo arrastre	Trailers	1,500	700	800	-
	Transporte Concesionado					
5	Continuar el programa de licitación de las rutas de autobuses en el D.F.	Vehículos	6,000	-	6,000	-
6	Impulsar el programa para la sustitución de minibuses por autobuses	Autobuses	11,990	3,300	8,690	-
7	Adecuar y ampliar la red de carriles exclusivos para autobuses	Km	300	114	186	-
8	Implantar el programa de rutas exprés metropolitanas	Km	300	300	-	-
9	Incorporar autobuses articulados en corredores de demanda intermedia	Km	300	241	59	-
0	Implantar rutas de transporte público de servicio ejecutivo	Km	200	200	-	-
1	Establecer bases para el servicio de taxi libre	Taxis	52,000	52,000	-	-

Tabla 2 Inversión, beneficios al transporte y reducción de emisiones contaminantes por horizonte

INDICADORES:	HORIZONTE 1998-2000	2001-2010	2011-2020
Inversión (Millones $):	**27,025**	**120,028**	**86,150**
• Pública	9,008	34,322	45,505
• Privada	18,017	85,706	40,645
Beneficios al transporte:			
• Valor Presente Neto (Millones $, al 12% anual)	50,672	145,599	18,211
• Relación Beneficio-Costo	2.2	1.5	0.7
Reducción de emisiones contaminantes (Ton/año):	**607,337**	**1,844,108**	**41,677**
• Hidrocarburos (HC)	44,138	101,494	4,933
• Monóxido de Carbono (CO)	544,851	1,670,202	16,019
• Óxidos de Nitrógeno (NOx)	16,339	64,980	19,353
• Óxidos de Azufre (SOx)	312	427	220
• Partículas (PST)	1,697	7,006	1,153

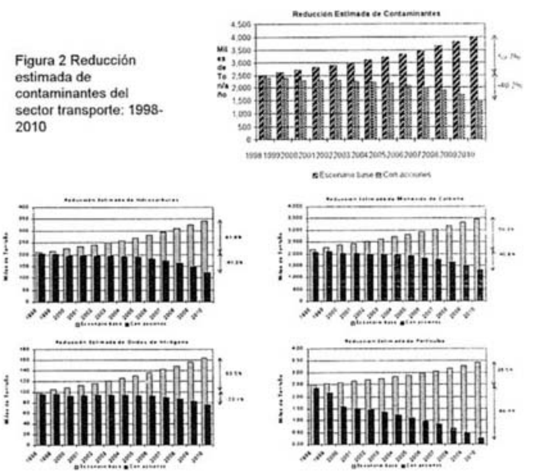

Figura 2 Reducción estimada de contaminantes del sector transporte: 1998-2010

5. RESULTADOS OBTENIDOS

Con la aplicación del modelo referido se prepararon los programas de inversión para cada uno de los horizontes seleccionados (Tabla 1). Los beneficios al sistema de transporte y la reducción de emisiones que se obtendría con la aplicación de la estrategia, así como los montos de la inversión requeridos son los que se indican en la tabla 2.

Con la aplicación de las medidas incluidas en los programas de inversión, se logra para el 2010 una reducción de las emisiones contaminantes del 40% con respecto al total de emisiones del sector en 1998, como se indica en la Figura 2.

6. CONCLUSIONES

En esta investigación se plantea una forma de combinar medidas de transporte de manera integral, buscando racionalidad económica en la programación de inversiones bajo criterios de decisión definidos.

El modelo aplicado, de tipo lineal, proporcionaría resultados útiles para la planeación a corto y mediano plazo. Dada la naturaleza propia de las diferentes medidas y sus variantes y cambios tecnológicos, es muy importante tomar con reserva los resultados del largo plazo.

No puede soslayarse tampoco el hecho de que las medidas se agregan en forma lineal, sin incorporar explícitamente efectos sinérgicos inherentes entre ellas. Esto debiera realizarse en etapas futuras. Para ello, el proceso de identificación y evaluación de cada medida se vuelve muy importante, debiéndose reflexionar en forma externa al modelo, sobre la forma de interpretar adecuadamente los resultados.

Aún así, los resultados parecen útiles para definir líneas generales de acción en un contexto de recursos escasos, e interpretación del costo de oportunidad de las distintas restricciones (técnicas, económicas, financieras, ambientales).

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Transportation Gap modeling – A tool for determining stability

Le modelage pour 'Transportation Gap' – Un outil pour déterminer de stabilité

La modelacíon por 'Transportation Gap' – Una herramienta para determinar sostenbilidad

C. Montalbo Jr. & H. Ishida

Institute of Policy and Planning, University of Tsukuba, Japan

ABSTRACT: This paper has two objectives. The first is to propose a quick-response analytical tool to evaluate the effects of transportation policies on urban transport operations in an Asian city. The second is to perform TG modeling using financial and operational data for Metro Manila. Using the parameters demand density and city size, performance domains of the different modes and the resulting TGs are modeled. Policy variables (loan interest rate and government subsidies) are incorporated in the TG models. The effects of changing the values of these policy variables on the performance domains and on the resulting TGs were simulated and analysed.

RÉSUMÉ: Cette recherche a deux objectifs. Le premier objectif devrait proposer un outil analytique rapide pour évaluer d'effets de règles d'action de transport sur le transport urbain pour Manila de Métro. Le deuxième objectif devrait exécuter "le modelage de TG" l'utilisation données financière et opérationnelle pour Manila de Métro. Les domaines d'exécution de modes de transport et "TGs" résultant sont modelés. Ceci est fait la taille de densité de demande et ville qui utilise. Les variables de règle d'action sont utilisées dans les modèles de TG. Ces variables sont des subventions de taux d'intérêt de prêts et gouvernements. Les effets de règles d'action sont simulés et sont analysés.

RESUMEN: Esta tesis tiene dos objectivos. El primero es proponer una herramienta analítica de respuesta rápida para evaluar los efectos de las políticas de transporte en las operaciones de transporte urbano en la ciudad asiática de Metro Manila. El segundo es el de hacer modelación "TG" usando datos financieros y operacionales para Metro Manila. Utilizando los parámetros de densidad de demanda de viaje y tamaño de la ciudad, los dominios de desempeño de los diferentes medios de transporte y los resultantes "TGs" son modelados. Variables de acción (tasa de interés de préstamos y subsidios del gobierno) son incorporadas en los modelos "TG". Los efectos de cambiar los valores de estas variables de acción en los dominios de desempeño y en los resultantes "TGs" fueron simulados y analizados.

1 INTRODUCTION

Prior to the regional financial crisis, Asia has been the center of rapid and dramatic economic growth in the world. Socio-political and economic activities and functions have grown accompanied by changes in the urban landscape of the countries' capitals. But the economic recession in the region has led to fewer resources available to the provision of transportation. With scarce resources and with economic uncertainty still lingering in Asia, questions remain concerning the future of transportation in the region. It is therefore important that operations of transport modes be sustainable, that is efficient and effective. To be able to achieve this, it is necessary to evaluate the effects of transport policies on the viability and sustainability of transportation. This paper proposes a quick response tool called Transportation Gap (TG) modeling that can perform this evaluation.

2. ANALYTICAL FRAMEWORK

The characteristics of a city influence the kind of mode that is appropriate to it. A transport mode is appropriate for a certain level of travel demand density and city size. Urban rail, for instance, is best for big cities with corridors of high travel demand. Buses suit medium size cities with relatively lower travel demand. Smaller scale and less expensive transport systems are suitable for smaller areas with smaller demand densities. It is therefore logical to identify the optimum domain of modes using travel demand density and city size as parameters.

Considering a cartesian coordinate system where the vertical axis is demand density (such as in persons per hour-km) and the horizontal axis is route length or distance, the performance domain of a transportation mode is defined as follows:

- Upper bound: physical capacity of the mode in terms of demand density (Line A)
- Lower bound: financial capacity of demand (Line B)
- Right bound: maximum distance of the mode (Line C)

The performance domain of a mode can be viewed as the optimum domain of application of that mode. It represents the set of conditions, i.e., demand density and city size, where the mode operates within its physical capacity and financial viability. It is dependent on the mode's physical and financial characteristics. Because modes differ in characteristics, they are expected to have different domains. The so-called transportation gap (TG) is the area(s) in the cartesian plane that is not covered by any of the domains of the existing transportation modes. Figure 1 illustrates this.

The domains and the resulting TGs are functions of policy variables. It is therefore possible to check the effects of changing the values of the variables on the domains and TGs. Policy simulation will be done and the effects of different policy variables on the TG will be analyzed.

2.1 Study Flow

Figure 2 shows the flow of TG modeling used in this study. It consists of four modules: the physical capacity module, the financial capacity module, the domains and TGs module, and the policy simulation module. Recent actual data are used in the physical capacity and financial capacity modules. With the output from these two modules, performance domains of the modes are established and resulting TGs are determined. Policy simulation is performed using different variables. New domains and TGs are established.

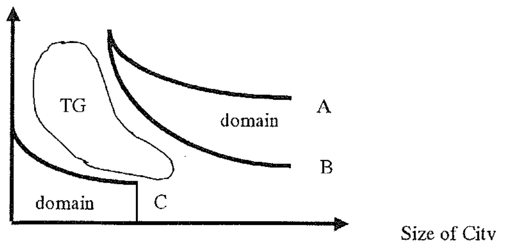

Figure 1. Domain of a Mode.

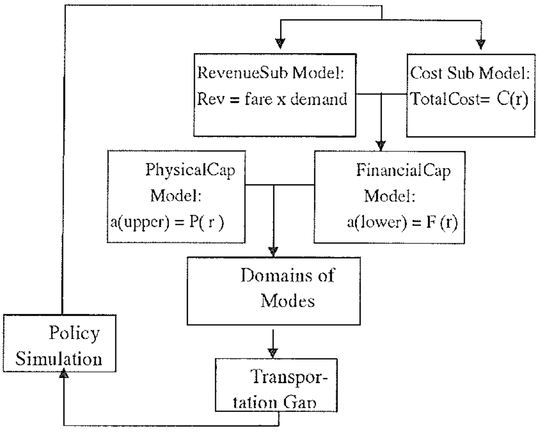

Figure 2. Flow of TG Modeling.

3. TG MODELING

3.1 Assumptions

The study assumes a simple urban form. It is assumed that trip demand is proportional to population density and for purposes of simplicity, it is assumed to be uniform throughout a city. In order to make the different modes comparable, it is assumed that all trips are made through one-meter wide equivalent of transportation facilities such as railways or roads and are linearly accumulated from right to left, where the city center is assumed to be located.

The two parameters defining the domain of a mode are demand density a (in terms of person per hour-km) and size of city r (in terms of the length of the transportation facility, in kms). The upper bound of the domain of a mode is the demand density *a(upper)* equivalent to the physical capacity of that mode. The physical capacity of trip demand is calculated as:

Physical capacity *a(upper)* = (Capacity of the mode per meter of right-of-way) / (size of city r) (1)

The lower bound is delineated by the demand density *a(lower)* that will result in break-even operations for public transportation modes. This is applicable to the public transportation modes which, under ideal conditions, should operate without financial deficit. This financial capacity of demand density is calculated by:

Total cost = Total Revenue (2)

where total cost includes initial investment cost (construction and rolling stock), operating costs, and other pertinent costs. Total revenue includes farebox and other sources. Both total cost and total revenue are on annual basis; hence it is necessary to estimate the annual equivalents of the costs. Annual operating costs may be readily calculated. For initial investment costs, the annual equivalents are estimated using Capital Collection Method which distributes costs into annual amounts over a certain length of time:

$$M = P \{i \ (1+i)^n\} / \{(1+i)^n - 1\} \qquad (3)$$

where M is the annual amount, P is the total amount of investment, i is the interest rate, and n is the number of years over which the total amount is distributed.

The resulting expression for total cost is in terms of r; that for total revenue is in terms of r and *a(lower)*. Therefore, the *a(lower)* for which there will be a minimum of break-even operations can be computed. This defines the lower bound of the domain. The figure below shows these operations.

3.2 Modeling Results

The LRT Line 1 of Manila is a 15-kilometer fully elevated urban railway. With an initial investment cost (construction and rolling stock) of 3.49 billion pesos (1.29 billion government equity and 2.2 billion foreign loans mostly from the government of Belgium), it opened in 1984 and runs in a north-south direction from Monumento to Baclaran. It is owned and operated by the Light Rail Transit Authority (LRTA), a government entity. A private company, the Metro, is contracted by the LRTA to manage the operations in exchange for a fixed management fee.

The following are the data and equations used in developing the domain of LRT for the present case (base case). Policy variables used in the study are loan interest rate (i) and operating subsidy (*SUB*) for LRT.

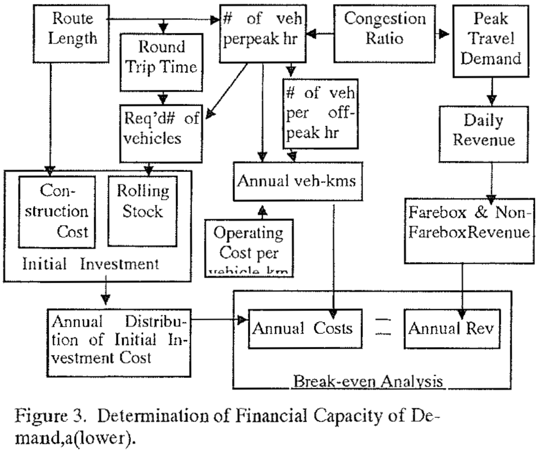

Figure 3. Determination of Financial Capacity of Demand,a(lower).

- operating speed, v = 30 kph
- individual car capacity = 374 persons
- # of cars per train, *form* = 2 cars per train
- # of trains per peak hour, *pn* = 25 trains per peak hour
- # of trains per off-peak hour, *opn* = 12 trains per off-peak hour
- round trip time, *prh* = (2 r / v) x 60 + 15 , where 15 minutes is the turn-around time at terminal or depot
- required # of trains, *tn* = prh / (60 / pn) x 1.10 x form = 3.67 r + 13.75 where reserve ratio of trains is 1.10
- required # of trains at peak hour, *ptn* = pn x 2 = 50
- required # of trains for off-peak time, *optn* = opn x (oh - 1) x 2 = 360
- yearly train-kms, yok = r {(270) (ptn + optn) + 95 (0.80) (ptn + optn)} = 141,940 r where in a year, 270 days have full operation and 95 days have 80% of operations.
- operating cost per train-km = 227.82 Pesos per train-km
- interest rate, i = 8%
- project life, n = 30 years
- fare = 10 Pesos flat rate

Physical Capacity Module:

a (upper) = capacity at peak hour for 1-meter wide right-of-way / r = (374) (2) (25) / 4 r, with LRT right-of-way equal to 4 meters.

a (upper) = 4.675×10^3 / r

Financial Capacity Module:

Total Annual Cost = (annual operating cost + annual component of initial investment cost + annual loan payments) (1 - SUB), where SUB is annual government subsidy

Total Annual Revenue:
Revenue per hour,

$$Rev = \int_0^r 10a(2)dx = 20ar$$

where 10 is the flat fare per person; a is the demand density in person per hr-km; 2 is for round trip; and dx is the incremental trip length in kms.

Revenue per day = (20 a r) / 0.25 = 80 a r

Revenue per year = (80 a r) (270) + (80 a r) (95) (0.80) = (27.68×10^3) a r

To get demand density for break-even operations:
Total Cost per year = Total Revenue per year

This will yield *a (lower)* as a function of r.

Though it exists, the domain of LRT is small, with values of revenue and operating costs close to each other. Although LRT is operationally and technically successful, it has dismal financial performance due mainly to considerable foreign debt servicing. Simulating the effects of changing the interest rates and government subsidy will be shown later.

Using operational and financial data for buses, a similar procedure is performed to delineate the domain of the bus. The only basic difference between LRT and bus is the absence of infrastructure investment for the latter; initial investment is only for rolling stock. The superimposed domains of the LRT and bus and other urban modes is shown in Figure 4. The TG is the area(s) not covered by the domains of all the existing modes including the LRT, bus, jeepney (a form of paratransit), and the private car.

Transportation gaps are found in the space between the domains of the LRT and the private car and that between the domains of bus and jeepney. There is a big TG between LRT and the other public transportation modes, showing the contrast between high-technology and low-technology modes. The TG between bus and jeepney may be served by other modes of transport that are not yet included in the present analysis. An example is the Tamaraw FX (i.e., airconditioned 10-passenger capacity taxi vehicle plying fixed routes).

3.3 Policy Simulation

The following policy variables were used in simulating the new domains of the LRT.

Table 1. LRT Policy Variables.

LRT	Interest Rate *i*	Subsidy *SUB*
Base Case	8 %	0
Case 1	5 %	0
Case 2	3 %	0
Case 3	8 %	0.25
Case 4	8 %	0.50

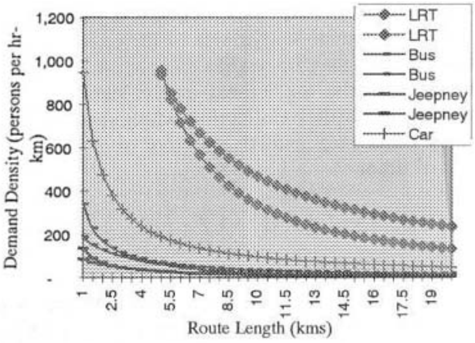

Figure 4. Domains and TGs of Urban Modes.

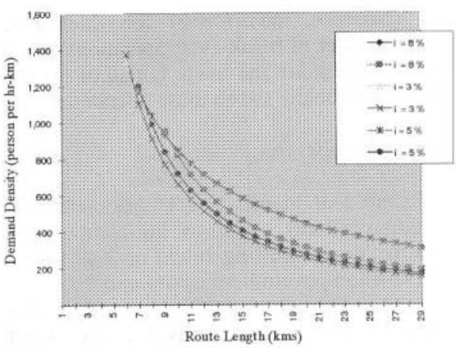

Figure 5. Policy Simulation: Effect of Interest Rate on Manila's LRT (i = 8%, 5%, 3%).

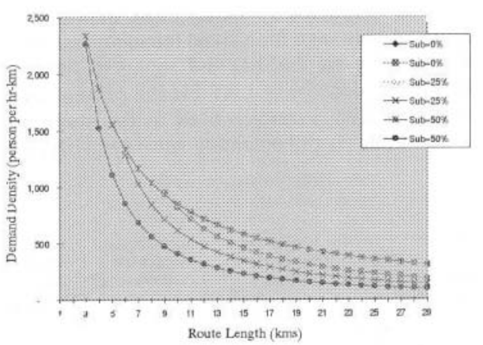

Figure 6. Policy Simulation: Effect of Operating Subsidies on Manila's LRT (SUB = 0%, 25%, 50%).

Different values of interest rate *i* and government subsidy on operating costs *SUB* are used. In the base case, average *i* is 8% (loans mostly from the Belgian government) and subsidy from the national government is minimal. In the early stages of its operations, the largest expense was the payment of interest on loans, almost amounting to 40% of total costs. Considering softer loans such as those with lower interest rates from international financing agencies (e.g. OECF or Overseas Economic Cooperation Fund with 3%), the resulting domain slightly increases. Considering higher government subsidies (25% and 50% of total operating costs) yields larger increases in the domain. Simulating the combined effects of lower *i* and higher *SUB* is expected to result in increase of LRT's domain. Such increases in the domains consequently reduce the resulting transportation gaps. Figures 5 & 6 show this policy simulation.

4. CONCLUSION AND FUTURE RESEARCH

With economic uncertainty in the Asian region, the sustainability of urban transport operations has never been more important. It is necessary to be able to evaluate the effects of transport policies on the viability of operations. This study proposes a quick-response tool (Transportation Gap or TG Modeling) that shows the optimum domain of operations of a transport mode and the effects of policy changes on the mode's viability. This tool also shows the relationship between travel demand density and city size, thereby showing the appropriateness of a mode to a city with respect to the mode's and city's characteristics.

Using actual operational and financial data for Metro Manila, the performance domains and resulting transportation gaps (TGs) are identified. It was shown that more favorable values of interest rates, and availability of operating subsidies from the government can expand the domains and thereby decrease the transportation gaps.

This study has only assumed a uniform travel demand distribution. Although this assumption is sufficient for the purposes of the present study, it may be too simplifying so as to compromise the analysis results for the case of Metro Manila. Hence, more realistic assumptions on demand distribution are warranted to improve the analysis and more closely model reality. Forthcoming stages of the study will include other demand distribution assumptions and other policy variables for the TG models.

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Effects of public transport service standards on cost
Les effets de la qualité du service des transports en commun sur le coût
Effectos del modelo de servicio de transporte público en los costes

Romano Del Mistro
Department of Civil Engineering, University of Pretoria, South Africa

Victor Baloyi
Urban Public Transport, Greater Pretoria Metropolitan Council, South Africa

ABSTRACT: The paper discusses the findings of a study done in Greater Pretoria to develop an understanding of the implications of route spacing and volume capacity ratio (v/c) on the cost of public transport services and the quality of service. The study found that within the range of the parameters used in the study;
- Increasing the walking distance was generally found to reduce the travel time due to increased vehicle frequency from a larger route catchment.
- Because of the peaking nature of demand, v/c ratios of less than 0,7 in the case of random vehicle arrival and 0,9 in the case of scheduled vehicle arrivals do not significantly affect passenger travel times.

RÉSUMÉ: Cette communication examine les conclusions d'une enquête faite dans l'agglomération de Pretoria pour permettre de comprendre les effets du rapport de l'espacement des lignes et du volume de la capacité sur le coût des services des transports en commun et la qualité du service. L'enquête a trouvé que dans la série des paramétres utilisés dans ette étude:
- Le fait d'augmenter la distance de marche réduit en général la durée du voyage parce qu'il y a unc plus grande fréquence de véhicules provenant d'un plus vaste secteur de lignes.
- A cause de l'augmentation de la demande aux heures de pointe, les rapports v/c inférieurs à 0,7 dans le cas de l'arrivée au hasard des véhicules et inférieurs à 0,9 dans le cas de l'arrivée réguliére des véhicules n'affectent pas de façon significative la durée du voyage des passagers.

RESUMEN: El trabajo apresentado los seguintes resultados de un estudio hecho en Greater Pretoria para desarrollar un acuerdo sobre la implicación del recorrido espacial y la proporción de capacidad de volumen en el coste de los servicios del transporte público y la calidad del servicio. El estudio concluyó que dentro de la clasificación de parámetros usados:
- El incremento de las distancias a pie generalmente ayudaba a reducir el tiempo de viaje necesitado debido al aumento de la frecuencia de los vehiculos desde una ruta de captación mayor.
- Debido a la demanda creciente, la proporción v/c de menos de 0,7 en el caso de la llegada de un vehículo fortuito y 0,9 en el caso de las llegadas de los vehiculos con horario establecido, no afecta de manera significativa al tiempo de viaje de los pasajeros.

1 INTRODUCTION

1.1 *Context*

It is the intention of the government in South Africa to devolve the responsibility for providing urban public transport (PT) services to the metropolitan authorities.

As such it will become the responsibility of each authority to balance the costs of the services offerred with the income from fares and the subsidy that can be afforded by the authority.

Since the quality of services can affect the cost, it is important that the authority has an understanding of which factors affect costs and to what extent. (The affordability of fares, willingness to pay and perceived quality of services would be the subject of other studies). In preparation for the devolution of responsibility, the Greater Pretoria Metropolitan Council commissioned a study to determine these relationships.

1.2 *Public transport standards*

A list of PT standards have been developed over the years in South Africa. To a large extent these are based on research work done in the late 1980's by van der Reis and Morris (NITRR,1987).

These standards include:

- Average walking times at both origin and destination of 15 minutes.
- At most one vehicle change.
- A maximum waiting time of 15 minutes at the interchange.
- A maximum travel distance of 40 km or 1 hour (DOT;1996).
- A maximum fare of 10% of income.
- No overcrowding; interpreted to be no standing passengers for in-vehicle travel times over 30 minutes (GPMC; 1998).
- Other less easily quantifiable parameters such as safety, security, comfort and convenience.

1.3 *Structure of the paper*

The following aspects are dealt with in this paper:

- The PT situation in Greater Pretoria.
- An outline the study itself.
- The impact of walking distance (actually the impact of route and stop spacing) on costs and service quality.
- The impact of the ratio between PT spaces required and PT spaces supplied on cost and service quality.
- Discuss the impact of the number of transfers on cost and service quality.

2. THE GREATER PRETORIA AREA

2.1 *Public transport trip factors*

Figure 1 shows the Greater Pretoria Metropolitan Council area.

The Central Business District (CBD) is shown as zone 14 and the following aspects are relevant:

- The spatial extent of the GPMC area is 45 km from north to south and 30 km from east to west.
- Zones 101, 102, 111, 112 and 12 are the major generators of public transport trips; being the zones created during the implementation of the apartheid settlement policies as the residential areas for the black population.
- Zones 335 and 329 are major low income residential areas external to the GPMC area from which workers commute; with one-way travel distances of over 100 km.

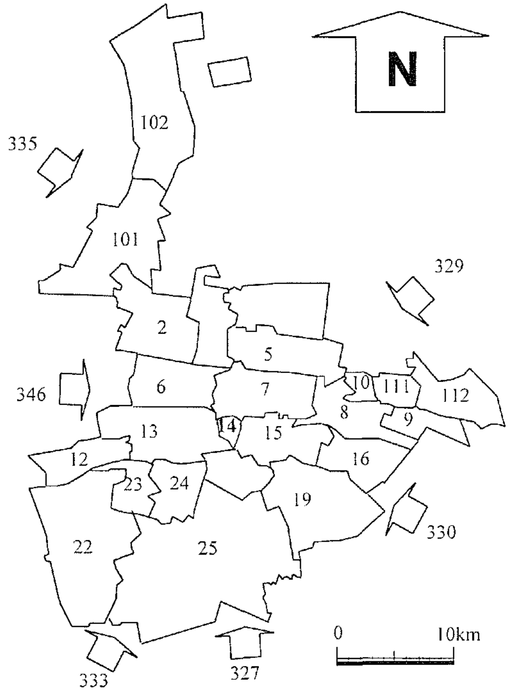

Figure 1. The Greater Pretoria region

Table 1:Major public transport trip generators (One-way trips in the peak hour)

Zone	Production	Attraction
INTERNAL		
Total internal	133253	196598
12	17146	*4944*
101	11078	*1480*
102	32134	*4312*
111	10637	*2740*
112	18747	*4931*
7	*4484*	10448
8	*3413*	18290
13	*3341*	15244
14	*4622*	40704
15	*5182*	22756
25	*5353*	23165
EXTERNAL		
Total external	63522	177
335	25694	N/a
327	19255	N/a
329	12618	N/a

- Zone 327 represents an external zone to the south which also includes Greater Johannesburg and the East Rand; at a distance of between 50 and 70 km from the CBD.

Table 1 shows the public transport trips generated by the zones with the highest public transport patronage.

In summary it can be said that in terms of peak hour PT trips:

- 32,3% are externally produced
- Less than 1% are externally attracted
- 5 Internal zones produce 45,6% of all and 67,3% of those produced internally
- 6 Internal zones attract 66,4% of all PT trips
- The remaining zones have relatively low levels of PT trip generation

2.2 *Other parameters*

Other relevant parameters for the study area are:

- The public transport trip generation rate varies between 0,06 and 0,24 one-way trips/person in the peak hour (i.e. between 0,17 and 0,69 one-way trips /person/day)
- Residential and job densities range between 0 and 200 per ha
- Average annual household income for zones 101, 102, 111 and 112 range between US$1600 and US$ 3000. (The exchange rate might not always correctly reflect the relationship of cost of living in different countries.)
- The average PT travel time is 67 minutes, with 57% travelling more than 1 hour.
- The average PT travel distance if Greater Pretoria is 43,11km (Del Mistro 1998).

Three PT modes are prevalent in South Africa; the suburban train with up to 14 coaches, the bus with up to 90 passengers and the minibus with up to 15 seats.

3. THE STUDY

3.1 *Structure of the study*

The study included the following:

- A review of the parameters that constitute quality of service for public transport based on the literature review (as described in 2.1 and 2.2).
- The development of a cost model to calculate public transport costs.
- The development of a analytical method to evaluate cost implications of alternative public transport standards.

3.2 *Analytical method*

The public transport system can take various shapes; e.g. linear, direct, radial, hub-and-spoke, grid, dispersed radial; etc. (e.g. Albers 1981; Del Mistro 1998; Jones 1990; Shaw 1997; Sinz and Blach 1994, Warren 1993). In this study three network types were considered; namely the direct, radial and hub-and-spoke (Figure 2).

The study used the trip distributions of three different suburbs to calculate the cost of providing PT services for communities with the following ranges in trip making parameters:

- Population of zone: 10 000, 50 000, 100 000.
- Residential density: 10, 50, 100, 150 p/ha.
- PT trip generation rate: 0,2 and 0,7 one-way trips/person/day.
- Maximum walking distance to PT: 500, 1000 and 1500 metres.
- PT volume/PT capacity; 0,7 and 0,9.

The PT costs were calculated using a PT cost model (GPMC 1998). It was assumed that the cost of trips on the line-haul section of the trip would not be dependent of the number of trips generated from the trip generating area. Instead the cost would be that achieved if the line-haul section was operating at volumes which had achieved the economies of scale.

Many alternative scenarios were run and the cost of servicing each of these was studied using regression analysis techniques and visual inspection of graphical output.

Regression equations were developed for the 3 networks and 3 trip distribution patterns using only one of the three modes in each case. (This is obviously a theoretical approach as this is not practical.) The R^2 of these equations ranged between 0,33 and 0,99. (GPMC 1998). While this approach appears to have potential for more precise investigation, especially when applied to appropriate operating conditions for each mode, its findings are not transferable to other cities and as such it is not pursued further in this paper.

3.3 *Effect of walking distance on service quality*

The catchment area of a PT stop is the product of the route spacing and the stop spacing. Some authors estimate the average walking distance as a quarter of the route spacing (Vuchic and Musso 1991). This might be a good approximation when stops are close together. In South Africa walking distances to PT are of the order of 1km. In this study the average and 90 percentile walking distances were found to be equal to 0,53 and 0,83 of the maximum distance respectively.

3.4 *Effect of vehicle frequency on service quality*

Vehicle frequency can be reflected in the v/c ratio variable (i.e. passengers/spaces offerred). A study used the following range of variables:

- The number of stops ranging between 1 and 10
- The v/c ratio ranging between 0,5 and 1.1,
- The passengers being normally distributed within the peak period.
- Vehicles arriving either on a regular basis or

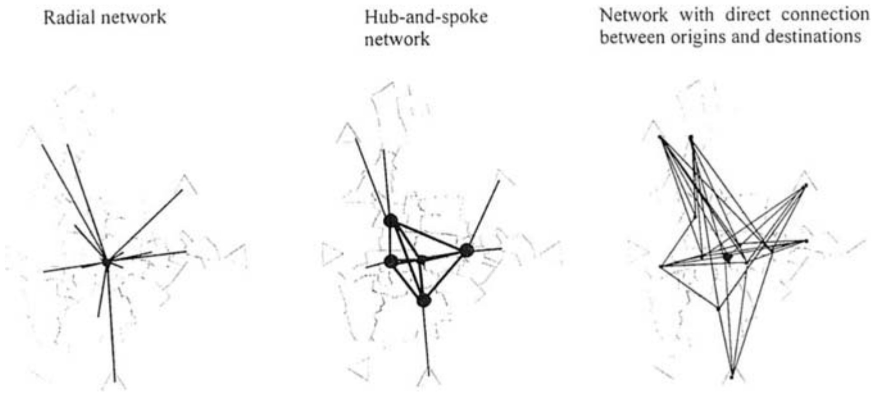

Figure 2: Networks used in the study (Albers and Del Mist

randomly in proportion to the demand for each of the 3 peak hours.

In the case of random vehicle arrivals, 10 runs were made and outliers were omitted to determine the average value.

Figure 3 shows one example of the delay for scheduled and random vehicle arrivals of vehicles, that for the range of 15 to 2 000 passengers/vehicle serving a catchment area producing 5000 one-way daily passengers at 6 stops.

The study indicates that delay increases rapidly if the v/c ratio exceeds 0,7 for random vehicle arrivals and 0,9 for scheduled vehicle arrivals.

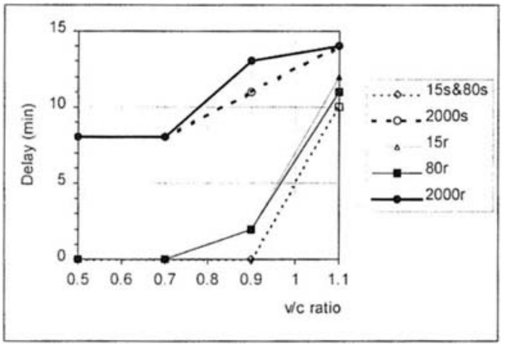

Figure 3 Effect of v/c on delay for random and scheduled vehicle arrivals (The number refers to the passengers/vehicle and the r and s refer to random and scheduled vehicle arrival patterns)

3.5 *Effect of walking distance on cost*

It can be expected that increasing walking distance (i.e. route and stop spacing) should reduce the cost /PT trip. Reductions in costs are achieved by increasing the average number of passengers/vehicle until the practical capacity is reached for all vehicle trips. This is obviously achieved earlier for smaller vehicles and for networks which aggregate passengers; e.g. radial and to a larger extent hub-and-spoke.

It was found that increasing the walking distance above 500 metres did not produce reductions of more than 10% in PT costs for all hub-and spoke operations for bus and minibus and for radial operations for the minibus.

Conditions for which reductions greater than 10% in PT cost were achieved shown in Figure 4.

From this figure it can be seen that cost reductions greater than 10% can be achieved when the walking distance was increased:

- From 500 to 1500 metres for:
  - Bus services operating between 5000 and 15000 one-way daily passengers with trip densities less than 10 PT trips/ha and serving areas generating between 15000 and 40000 one-way daily passengers with trip densities less than 15 PT trips/ha.
  - Minibus services between 5000 and 25000 one-way daily passengers with trip densities less than 5 trips/ha.
- From 500 to 1000 metres for:
  - Bus services operating in all conditions outside those listed above.
  - Minibus services operating at less than 25000 one-way daily passengers with trip densities less than 10 trips/ha and between 15000 and 25000 one-way daily passengers.

3.6 *Effect of passenger/space ratio on cost*

Based on the findings of the effect of v/c ratio on delay (Section 3.4) the effect of changing the v/c from 0,7 to 0,9 was examined further.

Changing the v/c ratio for the minibus services reduced the cost per passenger by more than 20 per

DIRECT: BUS Population	PT trips /person /day	Residential density (persons/ha) 10	50	100	150
10 000	0.2	1000	●	●	●
	0.7	1000	●	●	●
50 000	0.2	1500	1000	1000	1000
	0.7	1500	1000	1000	1000
100 000	0.2	1500	1500	1000	1000
	0.7	1500	1500	1000	1000

RADIAL: BUS Population	PT trips /person /day	Residential density (persons/ha) 10	50	100	150
10 000	0.2	1000	●	●	●
	0.7	●	●	●	●
50 000	0.2	1000	●	●	●
	0.7	●	●	●	●
100 000	0.2	1000	●	●	●
	0.7	●	●	●	●

DIRECT: MINIBUS Population	PT trips /person /day	Residential density (persons/ha) 10	50	100	150
10 000	0.2	1000	●	●	●
	0.7	1000	●	●	●
50 000	0.2	1000	1000	●	●
	0.7	1000	●	●	●
100 000	0.2	1500	1500	1000	●
	0.7	1000	●	●	●

● A change in maximum walking distance (from 500 and 1500 metres) has no effect on cost

Figure 4: Effect of increasing walking distance on cost/ passenger

DIRECT: BUS Population	PT trips /person /day	Residential density (persons/ha) 10	50	100	150
10 000	0.2	●	●	●	●
	0.7	●	●	●	●
50 000	0.2	●	●	□	□
	0.7	●	■	■	□
100 000	0.2	●	□	□	■
	0.7	●	■	■	■

RADIAL: BUS Population	PT trips /person /day	Residential density (persons/ha) 10	50	100	150
10 000	0.2	□	□	□	□
	0.7	■	■	■	□
50 000	0.2	■	■	■	■
	0.7	■	■	■	■
100 000	0.2	■	■	■	■
	0.7	■	■	■	■

HUB-AND-SPOKE: BUS Population	PT trips /person /day	Residential density (persons/ha) 10	50	100	150
10 000	0.2	□	□	□	□
	0.7	□	□	□	□
50 000	0.2	■	■	■	■
	0.7	■	■	■	■
100 000	0.2	■	■	■	■
	0.7	■	■	■	■

■ A change in the v/c ratio (from 0,7 to 0,9) has a significant effect on cost (i.e. >20%)

□ A change in the v/c ratio (from 0,7 to 0,9) has a effect on cost (i.e. between 5 and 20%)

● A change in the v/c ratio (from 0,7 to 0,9) has no significant effect on cost (i.e. <5%)

Figure 5: Effect of v/c ratio on passenger cost

cent regardless of operating conditions and network shape.

Changing the v/c ratio for bus operations had a more mixed result in PT costs, as can be seen in Figure 5. This would indicate that costs would be reduced by more than 20% in the case of daily one-way passenger volumes greater than 7000 and 10000 for radial and hub-and-spoke operations respectively.

3.7 *Effect of the number of transfers on service quality and cost*

The three alternative networks provided three different modal/vehicle transfer situations.

It was found that increasing the number of transfers:

- Increased travel time significantly.
- Reduced the cost of train and bus travel.
- But increased the cost of minibus travel. This was probably due to the fact that the indirect routing, which occurs in networks that require transfers, increased vehicle travel distance and cost, without producing any reduction in the cost/passenger through increasing average vehicle occupancy.

4 CONCLUSIONS

Increasing the maximum walking distance (alternatively the route and stop spacing):

- Obviously increases the walking time.
- Generally decreases the total travel time; probably due to the increased frequency of vehicles.
- Produces savings greater than 10 % in cost for the following conditions:
  - For bus services carrying more than 10000 one-way daily passengers for all PT trip generation rates and for less than 10000 one-way daily passengers at very low trip generation rate.
  - For minibus services at low trip generation rates relative to population size and trip generation rates.

Increasing the volume/capacity ratio:

- Significantly increases the waiting time if the v/c ratio is above 0,7 in the case of random vehicle arrivals and above 0,9 in the case of scheduled vehicle arrivals
- Generally produced savings in the cost of services of over 20% if the v/c ratio was increased from 0,7 to 0,9 except for low volume conditions (i.e. less than 7000 daily one-way passengers).

Increasing the number of transfers:

- Significantly increases the travel time.
- Significantly reduces the cost/passenger for train and bus trips
- But increases the cost/passenger for minibus services. This occurs because the network structure forces additional travel to and from vehicle interchange facilities; without producing reduced unit costs due to increased vehicle occupancy.

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Demographic changes and motorization in the world at the horizon 2025

Changements démographiques et motorisation dans le monde à l'horizon 2025

Cambios demográficos y motorización en el mundo al horizonte 2025

Yves Bussière

INRS-Urbanisation, University of Quebec, Montreal, Que., Canada

ABSTRACT

From three case studies (Montreal, Puebla, Marrakech), the paper adresses the question of the evolution of motorization more globally, at the level of large areas in the world (North vs South) and attempts to identify structural vs behavioral factors of motorization increase, by mode, at the horizon 2025. We propose a simplified long term demographic model of travel demand by mode which leads to three main conclusions: 1- the presence of demographic multipliers in the evolution of motorization, which will accentuate the impact of changes in behavior; 2- even though health problems due to motorization will inevitably be concentrated in large megalopolises, the more global environmental effects of motorization such as the global warming will be generated mainly in mid-sized cities of the South; 3- a large part of the growth in motorization will come from the motorized two wheels which, too often, are neglected.

RÉSUMÉ

À partir de trois études de cas (Montréal, Puebla, Marrakech), la communication traite de l'évolution de la motorization de manière plus globale, à l'échelle des grandes régions du monde (Nord vs Sud) et tente d'isoler les facteurs structurels des facteurs comportementaux dans la croissance de la motorisation, par mode, à l'horizon 2025. Est proposé un modèle démographique simplifié de la demande de transport par mode qui conduit à trois principales conclusions: 1- la présence de multiplicateurs démographiques dans l'évolution de la motorisation, qui s'amplifient avec les changements de comportements farvorables à l'automobile; 2- même si les problèmes de santé occasionnés par la motorisation seront surtout concentrés dans les grandes métropoles, les effets environnements plus globaux tels que l'effet de serre, seront générés surtout dans les villes moyennes du Sud; 3- une grande partie de la croissance de la motorisation viendra de la progression des deux roues dont on oublie trop souvent l'importance.

RESUMEN

Con tres estudios de ciuades (Montreal, Puebla, Marrakech), la ponencia trata de la evolución de la motorización de manera mas global, al nivel de la grandes areas del mundo (Norte vs Sur) y hace una tentativa ahislar los factores estructurales de los factores de comportamiento en el crecimiento de la motorización, por modo, hasta 2025. Proponemos un modelo demografico simplificado de la demanda de transporte por modo con quien llegamos a tres conclusiones principales: 1- la presencia de multiplicadores demograficos en la evolución de la motorización, amplificados con los cambios de comportamientos favorables al automovil; 2-mismo si los problemas de salud provocados por la motorización seran concentrados en las grandes metropolis, los impactos mas globales en el medio ambiente como el calentamiento de la planeta, seran producidos principalmente en las ciudades medias del Sur; 3- una fuente importante del crecimiento de la motorización sera las dos ruedas, cuales, muchas veses, son olvidados.

1 PURPOSE AND SCOPE

This paper is an attempt to adress the question of the evolution of motorization globally, at the level of large areas in the world (divided in countries of the North and countries of the South) and to identify structural and behavioral factors of motorization increase, by mode, at the horizon 2025.

We first base our analysis on three case studies (Montreal, Marrakech, Puebla) representative of three levels of economic development, and propose a simplified travel demand long term forecasting model of travel demand by mode which is centered on two main factors: the structural effects which can be considered as heavy tendencies and therefore may be incorporated in simulations, and the behavioral factors which are more difficult to predict but nevertheless determinant in future world demand of motorized vehicles and subject to the influence of policy making. The results illustrate the importance of demographic structural tendencies on motorization.

We also attempt to generalize the approach to adress the issue of world motorization, at the level of 13 large areas in the World and try to identify some important environmental issues in the next decades in terms of motorization and sustainability.

2 STRUCTURAL VS BEHAVIORAL FACTORS

In a context of lack of data we look forward to isolate a certain number of *structural factors* which will induce motorization growth, the most straightforward being:

- Demographic growth
- Change in the age structure
- Urban form (centralized vs sprawl)

To these we could add *behavioral factors* linked to income level and life-style which could induce:

- Changes in the number of trips (mobility factor)
- Changes in the average length of trips (due to urban sprawl)
- Changes in modal split (choice of mode)

However, these latter factors are difficult to measure at a global level and we will choose a simpler approach.

3 MODELING TRAVEL DEMAND

We propose a simplified travel trip general model which puts into relation population structures and travel behavior, i.e.:

Demand (mode "m")

= Pop x Mobility x Choice of mode

D (m) = P x D/P x Dm/D

The proposed model is a direct trip generation model by mode, and assumes the following form:

$$D_m^{t+n} = P^{t+n} \times D_m^{t} / P^{t}$$

$$= P^{t+n} \times D^{t}/P^{t} \times D_m^{t}/D^{t}$$

where:

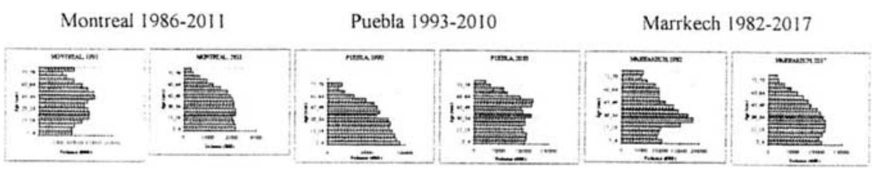
D_m^{t+n} = total number of trips by day, mode m, at time t+n

P^t = existing population at time t

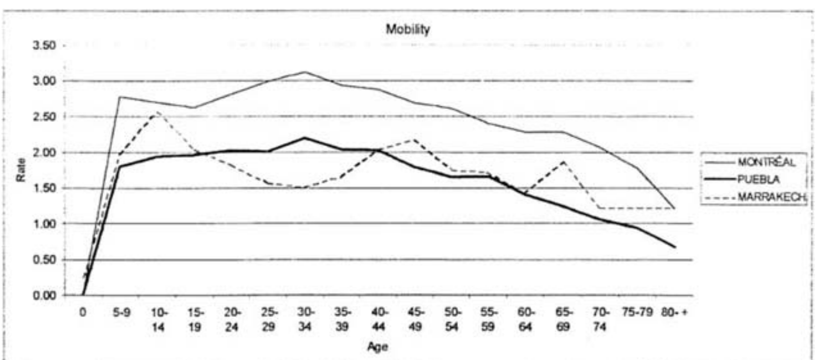
Pt+n = future population at time (t+n)

D_m^t = total number of trips per day for mode m at time t

D^t = total number of trips per day for all modes at time t



Graph 1: Population growth by age, in the three case studies



Graph 2: General (daily) mobility by age, in the three case studies

As indicated, this model equation may be applied for any number of selected strata (age, sex, geographic region, socio-economic grouping), on the assumption that trip generation rates by mode differ for each stratum. Global travel demand, then, may be obtained by a simple summation of the disaggregated demand, as follows:

$$D^{t+n} = \sum\sum\sum\sum D_{a,r,s,m}{}^{t+n}$$

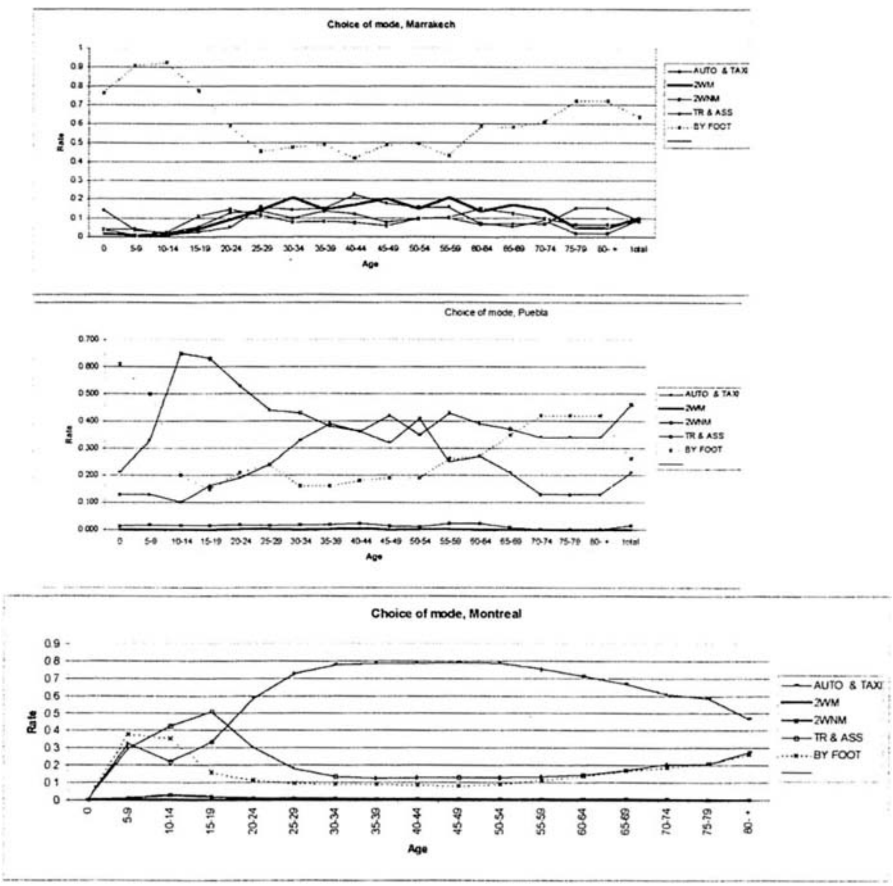
4 THREE CASE STUDIES: MONTREAL, PUEBLA, MARRAKECH

We applied the precedent model to three case studies representative of contrasted socio-economic situations (Table 1): Montreal, Canada, representing a high standard of living (gross national income per capita GNIPC- of $20,320 US) with high levels of mobility and motorization; Puebla, Mexico representing an intermediate case with a GNIP level of $3,479 US and medium motorization and finally the case of Marrakech, Morroco representing low GNIPC ($1,040 US) and very low automobile motorization but a strong presence of two wheels (motorized and non motorized). Corrected for household size, this gives a ratio of income of roughly three to one between Montreal and Puebla as well as between Puebla and Marrakech.

Table 1: Socio-economic data, Montreal, Puebla, Marrakech

	Pop	Pers/ Hshld	GNI/ pop*	GNI/ Hshld (000)	Ratio
Mtl	3 M	2.5	$20,320	$50 800	3.25
Pue.	1.3M	4.5	$3 470	$15 615	1.00
Mar.	0.6M	5.4	$1 040	$5 616	0.36

* Source: World Bank.



Graph 3: Modal choice by age, in the three case studies

This contrasted situation was used as a starting point to develop a more general approach. The travel data of the cases of Puebla and Marrakech was extracted from surveys conducted by the author with collaborators.

We also observe important differences in demographic structures and tendencies for the future: low growth and aging due to the backlash of the baby-boom in Montreal, characteristic of "rich countries" of the West, medium growth in the case of Puebla, characteristic of emerging countries, and, finally, very high demographic growth, characteristic of the poorer countries. Table 2 summarizes these characteristics for the three case studies. Even though the periods vary for the three case studies. Even though the periods vary for the three case studies, they represent long term evolutions.

Table 2 : Comparative age structure in Montreal - Puebla - Marrakech

a)- Projected population growth: Montreal – Puebla - Marrakech

Δ %	Montreal 1986-2011	Puebla 1993-2010	Marrakech 1982-2017
Total	15.0%	34.0%	125%
Annual	0.6%	1.7%	2.3%

b)- Age structure changes - Montreal – Puebla - Marrakech (%)

Age	Montreal 1986-2011		Puebla 1993-2010		Marrakech 1982-2017	
0-14	18.6	14.2	26.8	17.8	35.4	27.5
15-64	71.2	70.5	68.3	75.5	60.9	67.0
65- +	10.2	15.3	4.9	6.7	3.7	5.5

Sources: Census and projections by INRS

5 TRAVEL BEHAVIOR CALIBRATION

The travel behavior is summarized by the general mobility and modal choice in tables 3 and 4.

Table 3: General mobility - Daily trips/capita (5 yrs+)

Montreal (1993)	Puebla (1994)	Marrakech (1993)
2.66	1.89	1.85

Table 4: Choice of mode in the three case studies

Mode	Montreal 1993	Puebla 1994	Marrakech 1993
Walking	15%*	27%	64%
Public transp.	17%	48%	9%
Auto	63%	19%	7%
Taxi	0.4%	1%	2%
Bicycle	x	2%	8%
2 Wheels Motor.	x	x	10%
Other	5%**	x	x
Total	100%	100%	100%

Sources: Calculed from O-D Surveys. * Walking and bicycle
** School bus.

6 LONG TERM TRAVEL DEMAND PROJECTIONS: MONTREAL, PUEBLA, MARRAKECH

Applying the preceding travel behavior to the population growth by quinquennal age groups to take into account the life cycle, gives us, at constant behavior, the results presented in table 5; they take into account the composition of the population as well as the urban form, the three case studies having been divided in zones representing the center, the inner suburbs and the outer suburbs. The results gives a relatively stronger growth of motorization in the poorer countries due to the important effect of the age structure. This effect would have been amplified, if generation effects could have been taken into account.

We may summarize the preceeding results by introducing the concept of the *demographic multiplier*, which we could as being the relative growth of a mode compared to population growth. Table 6 summarizes these results. We find a non negligible demographic factor in the case of poor countries, represented here by Marrakech, where, for a population growth of 1%, we encounter a growth of 1.43% for the automobile and 1.21 for transit.

Table 5 : Long term annual rates due to demographic changes

Variable/City(*)	Montreal	Puebla	Marrakech
Population	0.4%*	1.7%	2.3%
Trips			
-Total (D/P)	0.35%	1.68%	2.21%
-Auto	0.43%	2.14%	3.35%
-Pub.Tr.	0.22%	1.55%	2.83%

(*)Montreal: 1986-2011; Puebla: 1993-2010; Marrakech: 1982-2017

Table 6: Annual Growth rate by mode for a population growh of 1% (in%)

	Montreal	Marrakech	Puebla
Total trips	0.88	0.94	0.97
Walking	x	0.79	0.72
Bicycle	x	1.09	1.70
Taxi	x	1.21	1.07
Total auto	1.08	1.43	1.24
-Auto driver	*x*	*x*	*1.52*
-Auto pass.	*x*	*x*	*0.67*
Pub. Tr.	0.55	1.21	0.89
Motorcycle	x	1.35	1.21
Other	x	x	1.66

The demographic factor appears to be an important structural factor enhancing motorization and it could have a strong impact in emerging economies where motorization is progressing rapidly by changes in revenue and behavior patterns.

7 GENERALIZATION OF THE APPROACH ON WORLD REGIONS (NORTH VS SOUTH)

The purpose of trying to generalize the approach to other world regions is to adress the following question: Where will the environment issues be in the future?

- ✓ In which regions of the world will we see the strongest population growth?
- ✓ Where will we see the fastest growth of motorization and for what modes?
- ✓ In what type of urban areas will we see the fastest growth?

8 DEMOGRAPHIC FORECASTS IN DIFFERENT WORLD AREAS: NORTH VS SOUTH

We classified according to revenue per capita and cultural affinities, the world poulation in 13 world regions (GNP per capita in $US, from The World Bank Atlas, 1994).

-North America and New Zeland ($21 731)
-Latin America ($2 743)
-Eastern Europe ($2 245)
-Western Europe ($19 673)
-North Africa ($1079)
-Black Africa ($533)
-China ($380)
-India ($310)
-Indonesia ($670)
-Japan ($28 220)
-Hong Kong and Singapour ($15 565)
-Rest of Asia ($1742)
-Others ($1 092)

The Graph 4 illustrates the important differences in the demographic evolutions of these world regions. We did our simulations on the basis of the 13 regions, by quinquennal age groups, at the horizon 2025.

9 MOTORIZATION FORECASTS IN 13 WORLD REGIONS: NORTH VS SOUTH

The hypothesis:

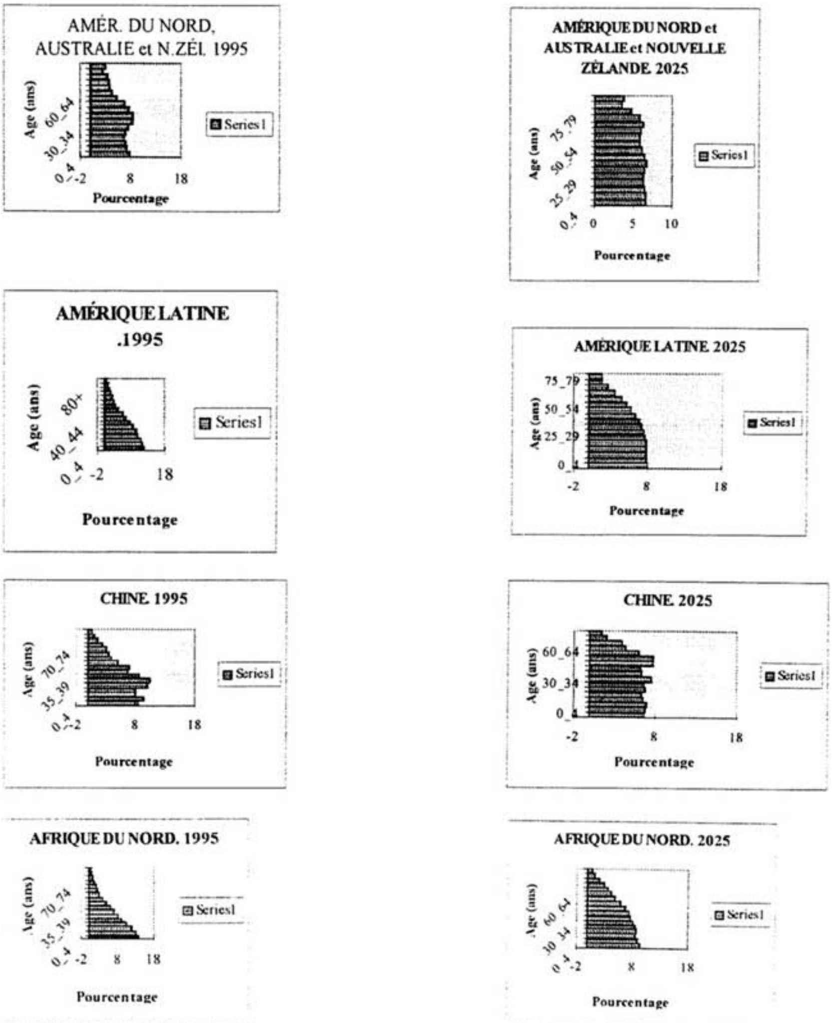
- ♦ Choice of 13 world regions according to different levels of economic development
- ♦ Demographic projections of the United Nations by quinquennal age groups: 1995 - 2025
- ♦ Calibration of travel behavior. It was made using various data found in the litterature to determine a *level* of mobility and of choice of mode and using the O-D surveys to attribute to these levels a curve which would simulate the *life-cycle* in different socioeconomic situations of high revenue (Montreal), medium revenue (Puebla) and low revenue (Marrakech).
  - ✓ Mobility: the general mobility, i. e. the number of daily trips per capita.
  - ✓ Choice of mode: modal split in percentage of total trips, for all modes.

10 PERSPECTIVES IN WORLD MOTORIZATION

Two extreme scenario were made to determine the variables at play.

SCENARIO 1- Paradigm of low motorization (actual behavior)
Simulation applying future demographic changes to estimated structure of actual behavior - measures structural effects due to demographic changes in the case of low motorization in developing countries.

SCENARIO 2- Paradigm of strong motorization (behavior of Montreal)
All behavior in the world would be identical: South behavior reaches North actual behavior exept for motorized two wheels which we kept identical to scenario 1 since Montreal data does not reflect this reality. Estimated by applying Montreal actual behavior to all regions - measures



Graph 4: Population growth, by 5yr age groups, example of various world regions,

structural effects of extreme strong motorization in developing countries.

10.1 RESULTS - SCENARIO 1 (LOW MOTORISATION)

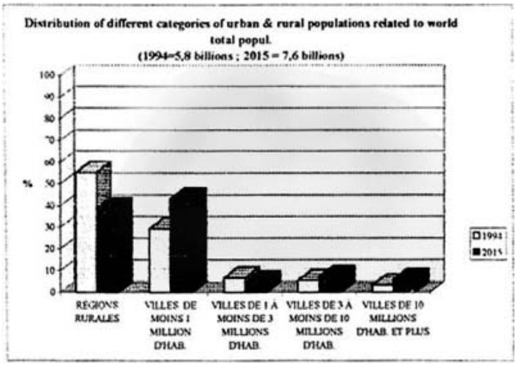
Table 7: Estimation of the number of daily trips (5 yrs +) in the world, 1995-2025 ('000)

	1995	2025	globalΔ	ann. Δ
Total Popul.	5 716 424	8 294 338	45%	1.25
Auto + taxi	1 576 081	1 868 203	19%	0.58
2 Wh. motor.	1 980 000	3 013 386	52%	1.41
TOTAL	3 556 081	4 881 589	37%	1.05

10.2 RESULTS - SCENARIO 2: (STRONG MOTORIZATION)

Table 8: Estimation of the number of daily trips (5 yrs+) in the world, 1995-2025 ('000)

	1995	2025	glob.Δ	ann..Δ
Total Pop.	5 716 424	8 294 338	45%	1.25
Auto + taxi	1 576 081	12 409 148	687%	6.63
2 Wh. motor.	1 980 000	3 013 386	52%	1.41
TOTAL	3 556 081	15 422 815	334%	4.10



Graph 5: World population growth by city size, 1994-2015

11 DISCUSSION AND CONCLUSIONS

11.1 Forces at play

The preceding results show the importance of the demographic factor, not only the level of growth, but the relevance of the evolution of its composition by age groups. However, the demographic multiplier as shown below will have an impact only when motorization has begun, which may sound trivial but is crucial.

We can also see that changes of behavior illustrated by scenario 2 are extremely important. This means that, as behabior changes, motorization may increase considerably, and it will be accelerated by the demographic multiplier effects. Forecasting future motorization with more precision will need a detailed approach taking into account other factors (rural vs urban; city size; income effects) as well as incorporation generation effects (Madre and alii.,2000). However, the scenarios presented give us a highlight of the forces at play.

11.2 Demographic multiplier effects:

Table 9: Ratio: Δ mode/Δ total popul.

Scenarios	Auto + taxi	2Wheels Motor.
1- Actual Behavior	0.41	1.16
2- Paradigm Mtl	1.19*	**

*with rates much higher in economically emerging developing countries (India: 1.41; Indonesia: 1.42) ; and lower elsewhere, China: 1.14). ** does not apply since the level of 2 wheels motorized in Montreal is too low to be representative and not significant because the O-D Surveys are done in late fall when the use of motorcycles is ending.

11.3 Growth much higher in medium-sized cities

The megalopolises account for only 4 % of the world population and this proportion should be stable at the horizon 2025, even in a context of strong demographic growth (graph 5).

11.4 Motorization and Pollution

-Local effects: Air pollution; deterioration of the patrimony; health problems. Mainly affects large urban centers in the North and in the South. (Mexico - 16 millions; Sao Paulo - 16,4 millions; Paris - 10 millions, Le Caire - 10 millions; New Delhi - 10 millions).

-Global effects: The cumulative effect at the level of the world population is less perceptible since it is not always visible locally (on environment or health). However it generates irreversible effects: Global warming effect, degradation of the ozone layer.

The motorized two wheels may polllute less than automobiles, but their impact pollution is significant, and more so for the two stroke motors, even though they are too often neglected in pollution studies (MEET, 1990).

11.5 Conclusion

We may conclude that even though health problems due to motorization will inevitably be concentrated in large megalopolises, the more global environmental effects of motorization such as the global warming will be generated mainly in mid-sized cities of the South where travel demand management is difficult, if not impossible. Furthermore, a large part of the growth in motorization will come from the motorized two wheels.

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Travel demand analysis with the RP/SP combining technique for developing countries

Analyse de la demande de voyage par la technique combinée RP/SP pour les pays en voie de développement

Análisis de la demanda de trayectos en los países en vías de desarrollo utilizando una combinación de las técnicas RP/SP

D. Dissanayake & T. Morikawa
Nagoya University, Japan

ABSTRACT: Most metropolitan areas in developing countries are suffering from severe traffic congestion and resulting air pollution due to lack of public transportation and rapid motorization. Providing mass transit system is expected to be the most efficient solution for the problems. Introduction of new transportation modes, however, complicates the demand analysis because data of actual usage of such modes do not exist. Although the stated preference (SP) technique is a powerful tool in such situation, the reliability of elicited preference is unknown. Revealed preference (RP) data are also scarce in developing countries. This study is the first attempt of applying the Ben-Akiva and Morikawa's RP/SP combining technique to urban transportation in developing countries in order to alleviate the data scarcity problem. The technique is applied to the mass rapid transit project in Bangkok. The paper also proposes the framework of urban transportation demand analysis which incorporates the car-ownership model and travel mode choice model.

RÉSUMÉ: La plupart des zones métropolitaines dans les pays en voie de développement souffrent de l'encombrement grave du trafic et de la pollution atmosphérique résultante dus au manque de transport public et de motorization rapide. La disponibilite massive d'un systeme de transit pourrait être la solution la plus efficace pour juguler cette situation. L'introduction de nouveaux modes de transport, cependant, complique l'analyse de la demande parceque les données de l'utilisation réelle de tels modes n'existent pas. Bien que la technique Stated Preference (SP) soit un outil puissant dans une telle situation, la fiabilité de la préférence obtenue est inconnue. Les données Revealed Preference (RP) sont également rares dans les pays en voie de développement. Cette étude est la première tentative applicant la technique combinée RP/SP de Ben-Akiva et le Morikawa au transport urbain dans les pays en voie de développement afin de surmonter le problème d'insuffisance de données. La technique est appliquée au projet de transit rapide à Bangkok. L'etude propose aussi le cadre de l'analyse de la demande de transport urbain en integrant le car-ownership model et le model du choix du mode de transport.

RESUMEN: La mayoría de las áreas metropolitanas en los países en vías de desarrollo sufren de una severa aglomeración del tráfico con la resultante contaminación del aire debidas a la falta de un buen servicio público de transportación y al incremento rápido de la motorización. La solución más eficiente a estos problemas es posible que consista en proporcionar un sistema de tranportación en serie. La introducción de nuevas formas de transportación, sin embargo, complica el análisis de la demanda dado que, actualmente, no existen datos sobre tales formas de transportación. Aunque la técnica de preferencia especificada (SP por sus siglas en inglés) es una herramienta poderosa en tales situaciones, se desconoce la confiabilidad en el logro de la obtención de preferencias. A su vez, los datos sobre la Preferencia Revelada (RP por sus siglas en inglés) son escasos en los países en proceso de desarrollo. Este estudio es el primer intento de aplicación de la combinación de las técnicas de Ben-Akiva y Morikawa RP/SP al sistema de transportación urbana en los países en vías de desarrollo para tratar de disminuir el problema de la escasez de datos. La técnica se ha aplicado al proyecto de tráfico en forma rápida y masiva en Bangkok. El estudio propone, además, el sistema de análisis de la demanda de transportación urbana con un modelo que incluya el uso de automóvil propio y un modelo con medios alternativos de viaje.

1 INTRODUCTION

Effective travel demand policies for the developing countries should be implemented because increase in travel demand creates some adverse environmental effects such as traffic congestion, air pollution, and noise pollution. Therefore, expansion and refinement of the existing transportation system is required to fulfill the overall task. However, there exist ample approaches, which can be meaningfully solve the increase in travel demand, the introduction of new mode seems superlative regarding to the environmental concerns if the new mode is in the form of subway, LRT, MRT or even zero-emission vehicles.

Dissagregate demand modeling which describes the behaviour of transport user with discrete variables (Discrete Choice Analysis (DCA), Ben-Akiva & Lerman 1985) is very popular in transportation planning. DCA is based on the principle of utility maximization where the utilities of the alternatives are considered as random variables. Vovsha (1997) mentioned that there exists an absolute dominance of multinomial and nested logit models over other mode choice models due to the simple analytical framework. A cross-nested logit model is recently estimated to forecast the mode choices if new transit modes come into effect (Vovsha 1997). The mode choice models for commuter trips have been extensively investigated during last two decades.

Estimation of discrete choice models are basically relied on revealed preference (RP) data for actual travel behaviour. There, however, is also a substantial interest on stated preference (SP) data, which is based on hypothetical travel scenarios. Although SP techniques have several advantages over more conventional RP techniques, the reliability of the elicited preferences relating to SP techniques is questionable (Wardman 1988, Morikawa 1989). In recent years, some considerable attention was made on RP and SP combining technique, which allows to improve the accuracy of parameter estimates while exploiting the advantages of both RP and SP (Morikawa 1989, Ben-Akiva & Morikawa 1990). Abraham & Hunt (1997) estimated a nested logit model for commuter travel by using RP data and wide range of system attributes has been identified as important. There also exists some substantial interest of mode choice modeling with repeated SP observations which can be successfully used to minimize the errors in individual choice response (Fujiwara & Sugie 1995, Mehndiratta & Hansen 1997).

This study evaluates the urban travel demand in developing countries by using RP/SP combining technique (Ben-Akiva & Morikawa 1990) when the new transit mode is introduced into the system. Empirical analysis is based on the future Mass Rapid Transit (MRT) project in Bangkok, Thailand.

Since the mode choice and the car ownership are inextricably linked, development of integrated model is important for future investigations on travel demand. Discrete choice analysis is widely used for estimating car ownership among the other techniques such as general linear models (Said 1992) and nonlinear analysis (Button et al. 1993). The factors influencing on car ownership under rising economic conditions are also discussed.

2 DATA DESCRIPTION

This study uses SP data on the future MRT project in Bangkok, which provides wide coverage of all the sectors in Bangkok metropolitan region. Person trip survey data in the Bangkok Metropolitan Area are also used as RP data. RP survey and SP survey were conducted in 1995/96 and 1996, respectively. The travel modes, which are currently provided in the study area, include bus, train, car, taxi/tuktuk, and motor cycle, and MRT is added in the SP survey.

2.1 *RP data*

The RP survey was carried out as a part of the Urban Transport Database and Model Development Project (UTDM).

The RP survey was conducted to collect almost all types of data relating to the travel behaviour. Additional database for home interview survey was provided by Bangkok Environmental Improvement Project (BEIP), which supports to strengthen the overall database. Survey items include characteristics of trip makers and their households, and attributes of the trips that were made on the surveyed day. Each trip is described by the characteristics of mode (unlinked) trips. Location-based information such as trip length is calculated using an Arc-View software which is helpful for easy reference and meaningful comparison whenever necessary.

2.2 *SP data*

The research group of Infrastructure and Transportation Planning laboratory at the Nagoya University conducted a SP survey to obtain information on user preference regarding the future MRT project (Anurakamonkul 1997).

SP survey was conducted by either direct interviews or mailed questionnaires. The SP questionnaire was prepared to achieve explicit coverage of requirements relating with commuter travel. More specifically, the transport users were asked to select the choices, which are best suited to solve their personal constraints, among hypothetically created travel scenarios. Also, attributes for the choices are described in the forms of travel time, travel cost, travel speed, reliability (minimum delays), safety, comfort, service frequency, accessibility of intramodel transfers, and access/egress time.

3 MODEL ESTIMATION USING SP DATA

3.1 *Modeling approach*

The new transport mode, MRT, is planned to introduce into the existing transportation system in Bangkok, which creates overall set of transportation alternatives consisting of MRT, bus, car, rail and motor cycle. Although there will be five alternatives in reality, user preference is expressed on MRT, bus, and car in the SP survey.

By considering the responses of each individual regarding the most important and the second most important factors for the mode choices, the most dominant attributes are found to be the travel time and the travel cost.

By applying discrete choice modeling, the utility functions of selecting modes: MRT, bus, and car are formulated as follows:

$$U_{mrt} = \alpha_1 + \beta_1 tt_{mrt} + \beta_2 \frac{tc_{mrt}}{inc} + \varepsilon_{mrt} \tag{1}$$

$$U_{bus} = \alpha_2 + \beta_1 tt_{bus} + \beta_2 \frac{tc_{bus}}{inc} + \varepsilon_{bus} \tag{2}$$

$$U_{car} = \beta_1 tt_{car} + \beta_2 \frac{tc_{car}}{inc} + \varepsilon_{car} \tag{3}$$

where α and β are unknown parameters; ε is the random component of utility; and *tt*, *tc*, and *inc* are the travel time, the travel cost, and the user income, respectively.

3.2 *Model estimation results*

For the model estimation, market segmentation approach is employed by categorizing transport users into smaller sub-groups. Therefore, each sub-group behaves with similar pattern of perceptions and allows to maintain the homogeneity within the sub-group.

The model is estimated for each user sub-groups, for instance, transport mode (ordinary bus, air-conditioned bus, car, and motor cycle) and income class (low income, middle income and high income).

3.2.1 *Estimation based on transport mode*

The estimation results for segments based on current modes are shown in Table 1. The parameter estimates for each user group have the expected signs and most of the estimates are significant at the 5% confidence level. In addition, goodness of fit measurements are also reasonable.

MRT constants, for instance, are significantly positive for the models of ordinary bus, air-conditioned bus, and motor cycle indicating the user intention to switch to future MRT. The negative signs on the estimated MRT and bus constants in the car user model indicate that their willingness to use car over MRT and bus if travel time and cost are the same among these modes. This inherent model preference may be an indication of belief, convenience, freedom as well as comfort of the car travel. Having a car by investing huge sums make him to use a car rather than changing the mode, even though unchosen modes are comparatively better than a car.

The coefficients for the travel time and the travel cost are readily interpretable; for instance, negative sign indicates that when the travel time and the travel cost for a particular mode increases, utility of selecting the same mode decreases by keeping all the other things constant.

Value of time (VOT) for all user groups are estimated with respect to the income class as shown in Table 1. VOT increases with increasing income for air condition bus user and car user models, which enhance the true behaviour of transport user.

Table 1. Estimation results of mode-choice model based on transport mode.
Parameter/(t- statistics)

Variables	User Category			
	Ordinary Bus	Air-cond. bus	Car	Motor cycle
MRT constant	2.11	0.56	-0.66	0.91
	(6.3)	(2.7)	(-4.0)	(2.6)
Bus constant	0.33	-0.10	-3.04	1.85
	(0.5)	(-0.2)	(-5.2)	(1.8)
Travel time (hrs)	0	-1.79	-1.41	-2.79
	(-0.1)	(-2.3)	(-2.0)	(-2.1)
Travel cost/inc/10^3	-0.65	-0.64	-0.47	0
	(-3.7)	(-3.4)	(-2.1)	(-0.8)
SP observations	221	239	374	70
$L(0)$	-242.8	-262.6	-410.9	-76.9
$L(\hat{\beta})$	-158.2	-204.9	-277.0	-62.9
ρ^2	0.348	0.220	0.326	0.182
VOT (low income)		34	47	
VOT (mid. income)		90	104	
VOT (high income)		225	377	

3.2.2 *Estimation based on income class*

Parameter estimation results for income classes: low, middle, and high are shown in table 2. Estimated coefficients are also consistent in the sense of behavioural analysis of transport users.

MRT constant is significantly positive for low-income class indicating that they have an intention to use MRT. For transport users belonging to high-income class have significantly negative coefficients for MRT and bus constants by expressing their negative tendency for those modes.

Almost all income classes have significantly negative coefficients for both the travel time and the travel cost which make sense by describing their willingness to receive maximum utility with contributing less time and cost. Therefore, some trade-off between the time and the cost is expected to select the best choice.

VOT for each income class is estimated as shown in Table 2. From the low-income class to the middle income class, VOT increases with income and it make sense as transport users in the middle income class are willing to pay more money to save units of time than the low-income class. But there is some divergence for VOT regarding to the high-income class, which possess indirect relationship with model preferences. They show smaller VOT, which may imply that they have no intention of mode change from car to transit. Most probably, vehicle availability and convenience of travel may result this divergence.

Table 2. Estimation results of mode-choice model based on income class.
Parameter/(t- statistics)

Variables	Income Class		
	Low 0-25,000 Baht	Middle 25,000-60,000 Baht	High Over 60,000 Baht
MRT constant	1.29	0.24	-0.70
	(7.5)	(1.2)	(-3.0)
Bus constant	0.16	0	-2.62
	(0.4)	(0.1)	(-4.7)
Travel time(hrs)	-0.47	-2.69	-2.09
	(-0.9)	(-2.3)	(-2.3)
Travel cost/inc/ 10^3	-0.22	-0.64	-2.75
	(-2.8)	(-2.2)	(-3.3)
SP observations	492	423	325
$L(0)$	-540.5	-464.7	-357.1
$L(\hat{\beta})$	-421.1	-355.3	-51.5
ρ^2	0.221	0.236	0.296
VOT(Bhat/hr)	26	139	84

4 COMBINED ESTIMATION OF CHOICE MODEL USING SP AND RP DATA

4.1 *Basic formulation*

There exist some common attributes, which are equally applied for both RP and SP choice models. But, some of the attributes have close relationship with either RP response in the sense of actual market behaviour or SP response as biased factors. For RP/SP combined analysis, Morikawa & Ben-Akiva (1990) proposed a methodology that is successfully applied in travel demand analysis.

RP model

$$U_i = \boldsymbol{\beta}'\boldsymbol{x}_i + \gamma y_i + \varepsilon_i \tag{4}$$

SP model

$$U_i = \boldsymbol{\beta}'\boldsymbol{x}_i + \boldsymbol{\lambda}'z_i + \xi_i \tag{5}$$

where U_i is the utility of transport mode i; β', γ' and λ' are vectors of unknown parameters; x_i is the vector of attributes that are commonly applied for RP as well as SP; y_i is the vector of attributes that affected the actual choice; z_i is the vector of attributes that represents biases related to SP responses; and ε_i and ξ_i are random disturbance for RP and SP data sources.

For the empirical analysis: the travel time and the travel cost are selected as common attributes for RP and SP. In addition, socio-economic variables such as car ownership is entered to the utility function of car users in RP and SP models to evaluate the relationship between car ownership with car utility. RP-mode (present mode of transportation) is incorporated into the SP model to illustrate the bias associated with present mode on SP choice.

4.2 *Model estimation results*

The choice models: RP, SP and RP/SP are estimated and the parameter estimation results are shown in Table 3.

Table 3. Estimation results of mode-choice models: RP, SP, & RP/SP.
Parameter/(t- statistics)

Variables	RP	SP	RP/SP
Travel time (hrs)	-1.43	-1.15	-1.61
	(-4.2)	(-3.4)	(-5.0)
Travel cost/inc/10^3	-0.08	-0.40	-0.32
	(-0.9)	(-5.6)	(-4.0)
Car-ownership	4.68	1.44	4.10
	(7.7)	(6.4)	(6.8)
Bus constant (RP)	2.65		1.94
	(6.2)		(4.9)
MC constant (RP)	1.06		0.44
	(2.5)		(1.1)
Rail constant (RP)	0.26		-0.62
	(0.5)		(-1.2)
Taxi constant (RP)	-0.79		-0.58
	(-1.1)		(-0.9)
Bus constant (SP)		0.91	2.89
		(2.9)	(5.4)
MRT constant (SP)		2.03	5.69
		(9.8)	(5.8)
RP mode		1.31	2.98
		(8.4)	(4.0)
μ (scale parameter)			0.44
			(5.3)
N	206	1240	1446
$L(0)$	-331.5	-1362.3	-1693.8
$L(\hat{\beta})$	-192.2	-967.2	-1170.5
ρ^2	0.420	0.290	0.309
VOT (low income)		35	61
VOT (mid. income)		95	168
VOT (high income)		318	550

All the estimated parameters for each model have the expected signs and most of the values are significant at 5% confidence level. High values for goodness of fit for all models dominating that the validity of RP & SP data over all the models.

The coefficient for the travel cost in the RP model, however, is insignificant, which is common in

RP data analysis due to multicollinearity among attributes.

There is very high coefficient for car ownership in RP model implying that the strong relationship between car ownership and car use.

By considering mode specific constants for RP model, bus and motor cycle are significant with the expected sign. However, mode specific constant for taxi, and rail are not significant, the negative sign make sense on the user refusal relating to the expensive taxi fares and inefficient rail service in Bangkok. On the other hand, rail and taxi constants are very close to zero implying their less contribution and independence for the explanation of RP.

Mode specific constants for bus and MRT are significant for SP as well as RP/SP models and it is meaningfully interpreted by the user preferences.

The coefficients for RP mode dummy in SP and RP/SP are very significant and positive in sign, which elicits the users' hidden preference relating to their RP mode.

Significantly estimated scale parameter, μ, lies between 0 and 1, implying that the SP model contains greater random noise: approximately twice relative to the RP model.

5 FRAMEWORK OF DEMAND ANALYSIS FOR DEVELOPING COUNTRIES

5.1 *Overview on car ownership modeling*

In developing countries, car ownership and usage increase with rapid economic growth, resulting in some transportation problems. Basically, lack of public transportation facilities offers poor level of service representing traditional, unsafe, and over-crowded means of transportation (Khan & Willumsen 1989). Therefore, the transport users have to be decisive in the sense of solving their transportation needs by selecting the best mode. Car travel is found to be an attractive solution to overcome the burdens of discomfort and physical dissatisfaction of public transport although it is hard to afford.

In general, increase in car ownership not only creates the congestion, accidents and environmental problems but also it takes up additional road space as well.

Train (1980) mentioned that the factors such as the number of cars belonging to the household and number of workers using cars for commuting are very useful for the efficient analysis on transportation policies. Dargay and Gately (1999) developed a model to investigate the income effect on car ownership and found that the ownership grows twice as fast as income for the lowest and middle income levels and ownership saturation is approached for the highest income levels. There is an increasing interest on car ownership modeling for developing as well as developed countries during last two decades. The main difference of car ownership modeling for developing countries is identified as its sensitivity for country-based fiscal policies in addition to all the other factors which are equally applicable for both models (Khan & Willumsen 1989, Vasconcellos 1997). By considering the policy measures, car ownership charges, generally referred to as road-user charges consist of acquisition charges: import duties and car purchase tax; ownership charges: road tax and other car ownership taxes; and user charges: fuel tax, tax for oil, road tolls, and other road pricing measures (Khan & Willumsen 1989).

However, most previous studies on mode choice modeling assumed that car ownership is an exogenous variable, for instance, availability of cars and number of cars belonging to the household. Since mode choice and car ownership are endogenous for each other, it is important to develop some combined analysis of car ownership and mode choice modeling.

Although there has been some substantial improvement on car ownership modeling in recent years, the integrated analysis with car ownership and mode choice modeling is rarely found. Train (1980) described that modeling with one of the choices, either car ownership or mode choice, does not simultaneously accommodate the desires of the other model, and therefore, proposed a methodology to create the interaction between the models by eliminating the uncertainties associated with separate models.

The validity as well as the consent regarding the proposed policies in the previous approaches is rather low due to the limited number of explanatory variables in the models (Train 1980). Therefore, considerable attention is required to include numerous explanatory variables such as household size, the number of workers in the household, and the number of children, income, age, parking facilities, costs of alternative modes, and costs related to car use and fiscal policy measures.

5.2 *Proposal of modeling framework*

An extension of the concept on mode choice modeling is proposed to create on overall decision making process related to travel demand analysis. Therefore, consideration has placed on integrated analysis of car ownership with mode choice modeling, and the framework is proposed by observing all possible factors, which are closely related to the modeling approach (Fig. 1).

6 CONCLUSION

This study proposes a methodology to analyze travel demand, incorporating SP and RP data upon the introduction of new mode into the system.

The findings of this study provides further evidence that transport users' stated preferences can be

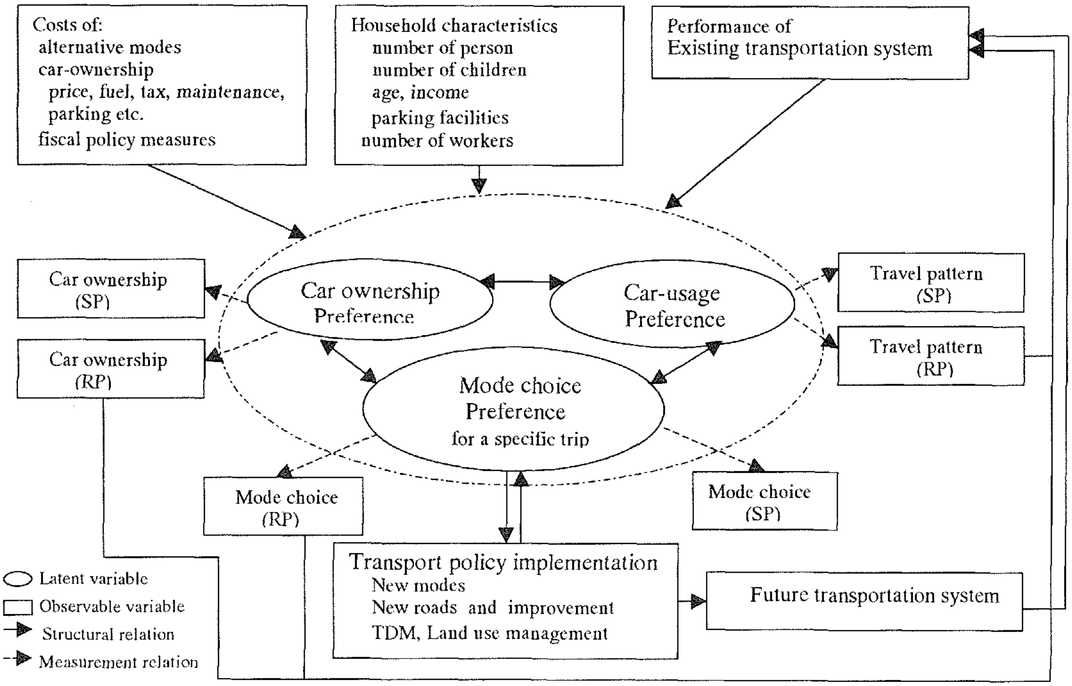

Figure 1. Proposed framework for the integrated approach

Profoundly used as an accurate guide to represent the actual underlining preferences. Market segmentation analysis, which is based on SP data, is readily interpretable for the preferences of each sub-group.

Furthermore, combined analysis of stated preferences and the revealed preferences collectively represent the true behaviour of the transport user. Therefore, the realistic results that we obtained by the combined analysis can be effectively applicable for decision-making activities related to the transportation industry.

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Transportation planning under uncertainty: The case of Metropolitan Jerusalem

Planification de transportation sous l'incertitude: le cas de Jerusalem Metropolitain

Planificación de transporte con incertidumbre: El caso de la Zona Metropolitana de Jerusalén

A.R.Hamideh & K.C.Sinha
Purdue University, West Lafayette, Ind., USA

J.D.Howe & M.H.Zuidgeest
International Institute for Infrastructural, Hydraulic and Environmental Engineering, Delft, Netherlands

ABSTRACT: Metropolitan transportation planning is a complex process often involving many jurisdictions and public and private interests. It is even more complex in areas that are shared by different peoples and where political uncertainties overshadow the planning process. Metropolitan Jerusalem, shared by Israelis and Palestinians, is one of such areas where transportation planning, particularly for the Palestinian Authority, is a complicated and challenging task. This paper addresses the issues and challenges associated with transportation planning from the Palestinian context in the Metropolitan Area of Jerusalem. This area comprises the highest Palestinian and Israeli urban agglomeration in the West Bank and is expected to experience a considerable increase in travel demand because of the increase in both population and job opportunities. This paper discusses an approach for transportation planning in Jerusalem that is based on the traditional four- step planning procedure, but incorporates inherent uncertainties in input data and plan outcomes.

RÉSUMÉ: La planification de tranportation metroplitain est une procede complexe qui entraine souvent plusieurs jurisdictions et des interets privees et publiques. C'est encore plus complique dans les territoires partagees entre des peuples differents et la ou les incertitudes politiques obscurent la procede de planification. Jerusalem Metropolitain, partagee par les Israeliens et Palestinians, est une de ces territoires dans laquelle la planification de tranportation, est une tache compliquee et de defi, particulierement pour l'Autorite Palestinienne. Cette presentation addresse les issues et defis associes avec la planification de tranportation dans le contexte Palestinien. Cette presentation discute aussi les facons possibles de collection de donnees et d'analyse d'autres present et future strategies de transportation pour Jerusalem en particulierement et pour le Cis-Jordanie et Gaza generalement.

RESUMEN: La planificación de sistemas de transportación en zonas metropolitanas es un proceso muy complicado el cual envuelve diferentes jurisdicciones además de los intereses públicos y privados. Este proceso es mucho más complejo en regiones compartidas por pueblos con diferentes características económicas y sociales donde las incertidumbres políticas rigen el proceso de planificación. La Zona Metropolitana de Jerusalén es un ejemplo de este tipo de región dado el hecho de que el territorio es compartido por Israelitas y Palestinos. La planificación de sistemas de transportación para los planificadores en esta región es un reto, y aún mas para los de la Autoridad Palestina. Este estudio discute los temas relacionados con el proceso de planificación de sistemas de transportación en Jerusalén desde el contexto Palestino, incluyedo alternativas y técnicas de análisis. Por último, estrategias futuras para el sistema de transportación en Jerusalén y en los Territorios Palestinos son presentadas.

1 INTRODUCTION

Transportation planning in the Jerusalem area involves the analysis and modeling for two transportation systems under different travel conditions (with and without travel restrictions) for two ethnic groups (Israelis and Palestinians). The economic, social and political factors are different for these two systems. The data for these parameters are not readily available and future estimates are fraught with uncertainty. While several transportation studies have considered the Israeli perspectives for the transport sector, not much consideration has been given so far on the Palestinian needs (Garb1998). Consequently, collection of planning data and the analysis of current and future travel patterns in the West Bank and Gaza are difficult exercises. There is a myriad of travel and other restrictions in the area, causing a severe distortion in travel patterns and travel costs of both passengers and goods.

At present there are various initiatives on behalf of international aid agencies for investment in physical infrastructure in the area as the Peace Process proceeds. Therefore, it is necessary to undertake a systematic planning process that must be robust enough to accommodate the various political scenarios and to assess investment needs. This paper discusses possible approaches for the analysis of alternative current and future transportation strategies for Metropolitan Jerusalem in particular and the Palestinian Territories in general.

2 CHARACTERISTICS OF THE AREA

Jerusalem is located in the central region of the West Bank and Israel, as shown in Figure 1. The Metropolitan Area of Jerusalem covers about 2100 km^2. The municipal area is 123 km^2: about 70 km^2 in East Jerusalem and the remaining area in West Jerusalem.

Metropolitan Jerusalem had a population of about 1.20 million inhabitants in 1996, almost evenly distributed between the two ethnic groups. It is expected to reach about 1.9 million inhabitants in the year 2010 with the Palestinians representing 63% (MOPIC 1997a).

The total number of employed persons in 1996 was about 0.30 million distributed as 40% Palestinians and the remaining Israelis. The overall geographical distribution of employed persons in 1996 followed more or less that of population. The number of Palestinians employed in the urban areas of Ramallah, Jerusalem and Bethlehem represented 40.0% of the total in the West Bank. Almost this same percentage (38%) represented the proportion of the Palestinian population of the West Bank living on these areas. The total number of employed persons could increase to about 0.57 million by the year 2010. Of this total, 54% are expected to be Palestinians (MOPIC 1997a).

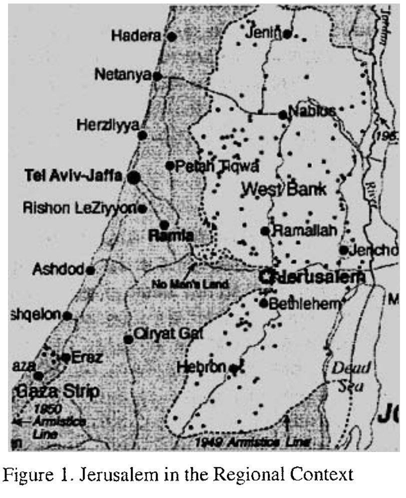

Figure 1. Jerusalem in the Regional Context

In 1996, the Palestinian per capita GDP was approximately USD 1550. Jerusalem had the highest GDP per capita at about USD 1900, representing 12.5% and 54.5% more than the GDP values in the West Bank and the Gaza Strip, respectively (MOPIC 1997b). The relatively improving economic conditions of the residents of Metropolitan Jerusalem during the past years have resulted in a considerable increase in the motorization rate (number of private vehicles per 1000 inhabitants). It is expected to increase by about 40% during the period 1996- 2010.

3 THE PEACE PROCESS AND UNCERTAINTY

Several agreements signed between the Israelis and the Palestinians since the initiation of the Middle East Peace Process at Madrid in October 1991 have resulted in consecutive transfers of territories and some civil powers to the PA, such as transport.

The Gaza- Jericho Agreement signed on May 1994 resulted in the transfer of 80% of the Gaza Strip and some other territories in Jericho in the West Bank as Area A to the PA.

The Oslo II Interim Agreement signed in September1995 resulted in a total of about 3.0 % of the total area of the West Bank (main cities and towns), comprising about 0.46 million Palestinians, under full Palestinian control (Area A). Area B, comprising about 0.86 million Palestinian residents living mainly in rural communities, represented about 24% of the area of the West Bank. The PA has some civil authority in Area B, but with Israel overriding security responsibilities and land use control. Area C includes some Palestinian built up areas, Israeli settlements (about 180 settlements), military outposts and Jerusalem. This area represents the remaining 73% of the total area of the West Bank and includes about 0.25 million Palestinians (MOPIC 1997b).

The Wye River Memorandum (WRM), signed in October 1998, specified that Israel is expected to cede another 13% of the West Bank in three phases over 12 months. Its implementation was delayed and only the first phase took place. A new redeployment agreement signed in Sharm Al- Sheikh in September 1999 ratified what was previously agreed upon with some modifications. As a result, 40% of the area of the West Bank would become under the control of the PA (about 18% in Area A and 22% in Area B). Figure 2 shows the pre- WRM areas of control.

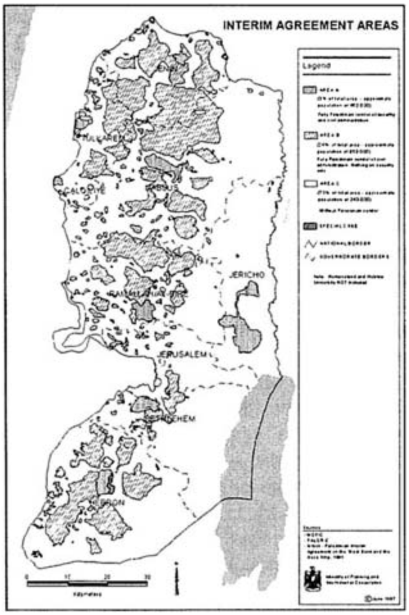

Figure 2. Designation of Areas of Control

4 COPING WITH UNCERTAINTY

Recognizing and addressing uncertainty is a critical task for effective planning. In the case of Jerusalem, the main source of uncertainty stems from political conflict of two peoples (Israeli and Palestinian) that share the same land under changing contexts. There is great imbalance in power between these two groups and conflicting political goals are many. There is also a large gap in the information available to each side as well as in the expertise and the economic resources. All these issues need to be considered while addressing uncertainty and its impact on the transportation planning process in the Palestinian Territories.

To cope with uncertainty, a suitable and robust methodology is required to analyze probable conditions and to predict future impacts. An incremental planning process within a long- range framework is the approach that is proposed in the present paper. This can enable to accomplish, in a synoptic way, some of the elements included in transportation planning: setting goals, identifying alternatives, evaluating means against ends, and finally, providing conclusions and recommendations.

Timing is a strategic issue in transportation planning. It involves, not only the time needed to prepare a plan, but also the schedule of the sequence of actions included in the plan itself. As the planning horizon becomes extended, the precision of a plan becomes less likely to be robust. We therefore propose to adopt a series of short-range strategic plans within the framework of a broad long-range plan.

5 ANALYSIS SOFTWARE

The Geographic Information Systems (GIS) software package TransCAD was used (Caliper 1997). It allows the integration of spatial and other forms of tabular data in different formats and from different sources into a GIS transportation database that can be used to support various aspects of policy assessment and transportation planning and analysis. It also allows its use taking into consideration the lack of detailed data. The determination of an origin-destination (O-D) matrix from limited traffic counts is just one example.

6 MAJOR ISSUES

Major issues in transportation planning in the Palestinian Territories involve congestion due to inadequate infrastructure, the ever increasing use of private cars, an inefficient public transport system, and the high cost of freight transportation. There are also extreme limitations regarding private investment, the use of land and other natural resources, and the availability of skilled personnel. At the same time, there is a rapid pace of population growth and attendant urbanization, creating urban sprawl. These extremes have resulted in negative environmental impacts in the area, which are aggravated by administrative and political changes in the region.

On top of some of the traditional problems, the accessibility and mobility of the Palestinians are greatly affected by the travel restrictions that have been in effect since 1993. Accordingly, the Israelis are not allowed to enter the areas controlled by the PA while the Palestinians are not allowed to enter Israel or Jerusalem. Moreover, Palestinians living in the Gaza Strip are restricted from traveling to the West Bank and vice-versa. About ten checkpoints are distributed on the major roads around Jerusalem and there are many other between Israel and the Palestinian Territories. More than 90% of the Palestinian population in the West Bank and Gaza Strip are affected by travel restrictions.

This situation has resulted in the splitting of the transportation system into two: one Palestinian and the other Israeli. The roads being constructed to connect Israeli settlements, some of which are not allowed for Palestinian use, have accentuated the physical segregation. In fact, Palestinian residents of areas other than Jerusalem are left with only one road alternative that links the southern and northern parts of the West Bank.

At present, "Wad Al Nar" (the Valley of Fire) is the only road alternative connecting the southern and northern parts of the West Bank available for Palestinian traffic. Inadequate geometric design, steep slopes and unacceptable levels of service and safety characterize this road. For the Palestinian residents, the use of this road has doubled their travel distance (circuity) and consequently, increased their travel time and out of pocket travel costs. The difference in travel distance between restricted and non-restricted conditions may reach as high as 28.0 km. Due to the difficult road conditions, the public transportation service is almost non- existent. Similarly, this situation drastically affects freight traffic. The overall effect is the erosion of the socio-economic interaction and geographical integrity of the Palestinian areas and population in Jerusalem and the southern and northern parts of the West Bank.

A major problem for planning is related to the constraints faced by the Palestinians in both the data collection and the analysis processes. Although some of the data collection problems are also faced in other urban areas around the world, a unique aspect is the magnitude of political constraints imposed by the Israeli authorities on the Palestinians regarding data collection. Palestinians are only allowed to gather transport-related data in Area A. They are also not allowed to undertake any census or implement projects in areas other than Area A without the consent of the Israeli authorities. In addition, the PA does not have the required tools and equipment necessary for data collection, as these are not allowed by Israel to be imported directly to any Palestinian private or public institution.

7 METHODOLOGY

As the data available are not sufficient to develop a reliable analytical model, a scenario approach within sketch planning was applied to accommodate missing data and inherent uncertainty. The approach primarily involved the use of socio-economic data and physical characteristics of the road network under consideration to generate synthetically travel characteristics (Hamideh 1998).

The procedure was to assess the outcome of a set of possible "if- then" scenarios. To obtain a baseline reference, the 1996 road network was used to replicate travel patterns within acceptable margins of error. The main task was to code that part of the network carrying most of the traffic, to define the values of its attributes (i.e., free flow speed, capacity, etc.) and to find an adequate parameter that represents the attractiveness for making a trip from one zone to another.

For this purpose, two modeling techniques were applied (Hamideh 1998). The first one was the conventional Urban Transportation Planning System (UTPS) four- step model while the second one was based on simplified methods by which an origin-destination (O-D) trip matrix is obtained from traffic counts (Ortuzar & Willumsen 1994). For the second technique, two cases were considered: the use of a seed matrix and the use of an a-priori matrix. A seed matrix can be used when there is no prior information on flows or a base year O-D matrix (Caliper 1997). For the seed matrix, small values were given for cells where trips were expected to be produced and/ or attracted (i.e., 0.1). For the a- priori matrix, the overall 1996 O-D matrix during the peak hour generated by the UTPS model was used.

8 ANALYSIS

The statistical methods applied to the calibrated network to validate the results revealed that the four-step model could be successfully adopted to generate results for strategic planning (Hamideh 1998). Although the zoning system was a very coarse one, comprising 14 traffic zones (or boroughs), it proved to be adequate. Trip generation was determined for each zone based on our review of official land- use plans and the possible socio-economic interaction. For home based work (HBW) trips, the approach was to determine the type of employee (i.e. restricted or unrestricted) a job may attract and how job choices are affected by restrictions versus preferences. Unlike the traditional approach, the adopted procedure considered the effect of level of service on trip generation. This elasticity was achieved by considering the existence of two groups of travelers: restricted and unrestricted.

For trip distribution, the gravity model was found to be suitable for the case study despite the limited information on trip characteristics and zonal origin and destination totals. About 33000 HBW car trips were estimated during the peak hour in 1996 for Jerusalem, of which only 17% was made by restricted travelers. For the Metropolitan area of Jerusalem, the mean travel time for restricted travelers was determined to be 50% more than that for travelers not facing any travel constraints (37 minutes compared to 25 minutes, respectively). As a result, restricted travelers made about 2500 extra person hours of travel during the AM peak hour only in 1996.

For traffic assignment, there was a need to adapt an algorithm that considers two separate road networks: one for the unrestricted home based work trips and the other for home based work trips facing travel restrictions. The Method of Successive Averages (MSA) proved to be an effective approach. The algorithm adapted took into consideration, not only the effect of congestion, but also the effect that restricted and/ or unrestricted road use may have on the overall performance as well. The network assignment process indicated that some links such as the road along the "Valley of Fire", had V/C ratios ranging between 0.70- 0.90. However, several major links were already congested. These were located at the western entrance of Jerusalem (Highway #1) and at the northern entrance of the city (Main Road # 60). The overall average speed in the Metropolitan Area of Jerusalem for the unrestricted population of trip makers was determined to be 60 kph, compared to 35 kph in the major urban areas in Municipal Jerusalem.

9 FORECASTING

Several cases were analyzed for the horizon year 2010 (Hamideh 1998). These include a do- nothing alternative, the upgrading of some links of the road network and the implementation of an official road plan proposed by the Israeli authorities. While some case-scenarios assumed the existence of travel restrictions, others considered that travel restrictions would no more be in use (i.e. peace scenario).

The results of the analysis revealed that the capacity of the 1996 base year road network would not accommodate the traffic originated by the expected land use scenario in the year 2010. If nothing were done during the 14-year period, the number of links with congested conditions would increase by ten fold, representing about 20% of the coded network considered in the analysis. Among these links is the only connection now available for the Palestinians to travel between the southern and northern parts of the West Bank. Trip makers facing travel restrictions would perceive more the negative impacts of these new travel conditions. Their average mean travel time would be 55% more than trip makers without constraints (42 and 27 minutes, respectively). As a result, the total extra person hour travel during the AM peak hour would increase by three fold compared to the case in 1996, reaching about 7200 hours.

The analysis revealed that some links of the most important road facilities (Highway #1 and Main Road # 60) would be expected to carry twice as much traffic as in the year 1996. These values could reach about 12500 pcph at the western entrance of Jerusalem and 13500 pcph close to the Old City (near the CBD), respectively. The most severe congestion problems are predicted near these two locations.

This study analyzed whether the 2010 Master Road Plan officially proposed by the Israeli authorities plan could accommodate the expected traffic in the year 2010 resulting from the 2010 land use scenario. The proposed plan includes the upgrading of existing major arterials and the construction of new road facilities. The new facilities include north-south and east-west road alternatives that will form a full ring road around Jerusalem (Municipality of Jerusalem 1997). The simulation indicated that the mean travel time for the restricted group would still be higher than that for the unrestricted group (33 minutes compared to 23 minutes, respectively.

Further analysis indicated that releasing travel restrictions within a peace scenario would increase congestion as a result of the additional demand to use major road facilities. The proposed 2010 road plan would not be capable to satisfy the travel demand originating from a possible peace scenario in the year 2010.

Parallel to the problem of congestion, adverse environmental impacts can also be expected. Land use changes would have a strong influence on the general quality of the environment. It is likely that air pollution from road vehicles and vibration from heavy road traffic would continue to be the major environmental problem in Jerusalem (Municipality of Jerusalem 1997).

10 ACTIONS

The actions to be considered for the Metropolitan Area of Jerusalem can not be isolated from those for the Palestinian Territories. At present there are several transport sector initiatives in the West Bank and the Gaza Strip, most of which are supported through donor-assistance. Preliminary estimates of expenditure needs for the transport sector for the next three years have ranged from USD 500 million to US 750 million.

It is useful to consider three aspects of transport strategy from the Palestinian context. First, there is the urgent need to build and improve transport infrastructure and services at the local level. The second aspect of transport development is the efficient linkage of markets between Jerusalem and the rest of the Palestinian Territories. The third aspect of transport development is to link Jerusalem to regional and international markets. This can be achieved by strategic planning of the different components of the transportation system (air, rail, road, etc.) within a logistic chain that aims at the integration of these components. Thus, an integrated transport system that accommodates both local and regional needs should be considered allowing adequate multi-modal transport.

At the local level, buses and jitneys provide the public transport service. All existing bus services and operations belong to the private sector without any coordination and the level of service provided is low. Much can be done to improve the bus transport service through changes in regulatory policies.

There is an urgent need to rehabilitate a significant portion of the road network and to add new roads. In this regard, there is a need to upgrade Main Road #60 and to provide road bypasses to avoid through traffic in major urban centers, such as Ramallah, Jerusalem and Bethlehem.

Another issue is missing critical links, such as the connection between the Gaza Strip and the West Bank. Metropolitan Jerusalem would experience a considerable increase in travel demand along its road infrastructure if the corridor is implemented and travel restrictions are released. Therefore, it is important to integrate this corridor with the road network in the West Bank in the most efficient way. The use of some of the Intelligent Transportation Systems (ITS) technologies could be helpful in covering many of the aspects related to the operation of the proposed corridor. This would enhance better levels of service along the corridor itself and along the road network in the West Bank, mainly the bottleneck of Jerusalem.

Although roads would continue to be the critical element in the Palestinian transport system, the potential of a rail- based environmentally effective mass public transportation system in Jerusalem and its vicinity should also be considered. Based on brief analysis of the expected pattern of urban and industrial development for the year 2010 and the traffic volumes that were forecast for the different scenarios, a comparison of possible alternatives revealed the suitability of a light rail transit system (LRT).

11 CONCLUSIONS

Transportation planning in the Palestinian Territories faces major challenges and uncertainty, particularly due to the absence of a permanent geopolitical map. A robust approach based on scenario-analyses can be effectively used to provide broad planning guidelines.

The transport sector is expected to play an essential role in the Metropolitan Area of Jerusalem and in the region as a whole by inducing and facilitating socio-economic development. An efficient and integrated transport system is imperative for the economic well being of the Palestinians as well as Israelis. It is important therefore for the Palestinian Authority to undertake a systematic planning process for transport systems in the area, even though the process may be fraught with much uncertainty.

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Development of mode choice for Delhi

V.K.Sibal & A.Madhugiri
RITES, New Delhi, India

ABSTRACT : Delhi, the capital of India has a population of about twelve million in 1999, which is likely to increase to thirteen million by the year 2001. The city is dependent on buses only as means of mass transport. Surveys conducted in 1994 indicated that buses are catering to around 62 % of the total vehicular trips and the residual 38 % trips are catered by private modes. The Government of India has recently approved implementation of a Mass Rapid Transport System for the city for a cost of around Rs 60 billion (1996 Prices). Forecasting the modal split in favour of mass transport with the implementation of MRTS was a task not taken up for long. The Master Plan developed by the development agency of Delhi has forecasted a modal split of 75 % in favor of mass transport, based on trend analysis. The need for systematically ascertaining the mode choice for the future taking into consideration the various combination of fare levels and time of travel was felt it and was decided to develop a mode choice model. Fresh consumer preference survey was carried out in 1998, within Delhi Urban Area, with a sample size of 5000 commuters. The Performa was to get the perceived values for time and cost for the commuters. As the value of time and cost would grossly depend on the economic status of the commuter, the commuters were divided into two groups : vehicle owners and non-vehicle owners. This method was found to be better than attempting to obtain information about income of commuters which is generally not realistic. Based on the opinion of the commuters, the perceived walk time, waiting time, in-vehicle time, parking time, travel cost, parking cost and convenience were modelled and the value of time for the two groups (vehicle and non-vehicle owners) was derived. The analysis yielded stated preference coefficients, which relates to perceived value of time. Logit model was use to get modal split. A sensitivity analysis was carried out to ascertain the fare elasticity of ridership on the proposed MRTS.

1. INTRODUCTION

Delhi, the capital of India has a population of about twelve million in 1999, which is likely to increase to thirteen million by the year 2001. The city is dependent on means of buses only as mass transport. Surveys conducted in 1994 indicated that buses are catering to around 62 % of the total vehicular trips and the residual 38 % trips are catered by private modes. The Government of India has recently approved implementation of a Mass Rapid Transport System for the city. The Modified First Phase of the system consist of a network of 55.3 km as shown in figure 1.

The Master Plan (1981-2001) prepared by the development agency of Delhi has forecasted a modal split of 75 % in favor of mass transport. Based on this assumption, the ridership on the Modified First Phase of MRTS was worked out as 1.95 million trips per day in the year 2005. This approach of making assumption about modal split has obvious limitations and is open to criticism. The modal split is a major component in the four-stage transport planning process and development of a systematic approach towards development of a modal split model was long overdue.

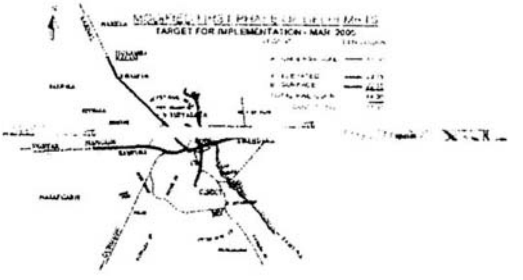
2 DEVELOPMENT OF MODAL SPLIT MODEL

2.1 Field Surveys Conducted

A comprehensive Consumer Preference Survey was carried out in Delhi in 1998 to ascertain the commuter preferences covering the following :

- Consumer's expectation of the acceptable level of quality of service in terms of waiting time at the point of embarking transfer, total time spent for the journey and the level of crowing in the public transport system,
- Consumer's acceptability of the hassle involved in one or two inter-modal transfers, and
- Price sensitivity to the desired quality and level of service.

A sample of passengers at major railway stations, bus stops, bus terminals and parking lots were interviewed to ascertain the following travel information :



- Socio-economic status
- Origin-destinations
- Perceived travel costs
- Distance, time and costs of access links
- Reasons for choosing a mode.

The information was used to analyse broad pattern of public transport demand status, accessibility, provision of feeder services and reasons for mode choice. Respondents were offered a number of time, cost and frequency parameters in order to determine the degree to which people are prepared to pay more for improvement in rail services and potential rail transfer.

Sample size for this survey was about 5. 000 passengers. Stratified random sampling technique was used to administer the survey. [Reference 1].

The analysis of the data yielded the following information :

- Demographic profile
- Distribution of occupational profile
- Distribution of working hours
- Distribution of public transport accessibility
- Distribution of household income and vehicular ownership
- Purpose-wise trip details of chosen mode
- Details of use of concessional tickets

- Mode-wise expenditure pattern
- Distribution of mode used, time spent, cost incurred, distance travelled and mode interchanged for both chosen and non-chosen mode
- Distribution of information related to personal mode used for journey (chosen and non-chosen mode)

the survey showed the following preferences :

- Its frequency during peak period should not be less than 15 minutes
- More than one interchange is not preferred
- Interchange should be commuter friendly _ with feeder service and parking facilities
- It should involve a walk of less than 500 m.

2.2 Modal Split

As the modes available for travel would be different for vehicle and non-vehicle owning groups in the study area, separate models were developed for these two groups. Modal split was projected for the private vehicles and public transport for the vehicle owning group and only public transport for non-vehicle owning group. The modal split for the similar modes was added to get the final modal split. The model was used to calibrated for both vehicle owning and non-vehicle owning groups for the base year and then projected for horizon year (2005).

2.3 Mode Choice Model

The input to the mode choice model consists of the following components :

- Travel time by each mode on each stage of a trip ;
- Travel cost by each mode on each stage of a trip ;
- Modal choice coefficients from stated preference survey.

The shortest path algorithum was used to output travel time and distance matrices. These were converted to the time and cost matrices for each mode. For example, MRT fare (cost) for a given option was calculated from the distance travelled on the MRT.

As the stated preference survey did not include MRT as an option, no Attributed Stated Preference Coefficent (ASC or bias) was calculated for that alternative. Small ASCs in favour of MRT over bus, and of car over MRT were therefore introduced. [Reference 2]

A standard multinomial logit expression was applied to calculate the probability of choosing a mode :

$$\text{Probability}\{Mode\ M\} = \frac{e^{\beta X m}}{\sum_{n=1}^{n=\text{no.modes}} e^{\beta X n}} \text{ ------- (i)}$$

where:

M = mode whose probability of being chosen is to be calculated;

$$\beta X n = \sum_{i=0}^{i=2} \beta^i X_n^i \text{ ------------- (ii)}$$

β = vector of coefficients;
β^0 = ASC (bias) for the relevant mode,
β^1 = coefficient of time,
β^2 = coefficient of cost.

Xn = vector of attribute values for mode n;
X^0 = 1 for mode n,
X^1 = travel time for mode n,
X^2 = travel cost for mode n.

Mainline rail trips and trips with an external trip end (inter-city trip) were assumed not to transfer to MRT. This action is justified by the relatively small numbers involved and the small likelihood of switching to MRT.

Trip matrices for the year 2001 were used for assignment and calculation, with separate matrices for vehicle and non-vehicle owning household trips.

The analysis yielded coefficients as shown in Table 1.

Table 1 Modal Choice Coefficients

Attribute	Non-vehicle owning household	Vehicle owning household
Time coefficient, mins	0.04711	0.00362
Cost coefficient, Rs	1.024	0.02155
Bus bias	-	0.45524
Rail bias	4.05760	3.67532
Value of time. Rs/hour	2.76	10.08

Notes
Coefficients based on disutility of travel
Time and cost refer to total trip

Values of time are shown in Table for information. It is proposed that these are plausible estimates of behavioural values of time for mode choice.

Calibration of the modal choice model was obtained by adjusting the ASCs until agreement was reached with base year survey results.

The modal split based on the MRT fare of Rs 6.00 (1998 prices) is given in Table 2. As seen from the table, the total projected intra city trips in Delhi in the year 2005 would be 15.57 million of which 22 % would be carried by private transport, 66 % by buses and 12 % by MRTS gives a modal split of 78 % in favour of public transport. The modal split for public transport varies between 75 % to 80 % for different fare levels of MRTS.

Table 2 Modal Split - 2005

Item	Number
Total Intra City Trips	15.570 million
Private	3.43 million (22%)
Buses	10.24 million (66%)
MRTS	1.90 million (12%)

By way of illustration, link flows are indicated in the following figures . These are not intended to be exact assignments as far as routing is concerned, but rather indicate the corridors that would be used in the absence of congestion.

Figure 2 and Figure 3 show the numbers of passenger trips (in proportion to band

Figure 2 Assignment of Vehicle Owning Trips, 2001

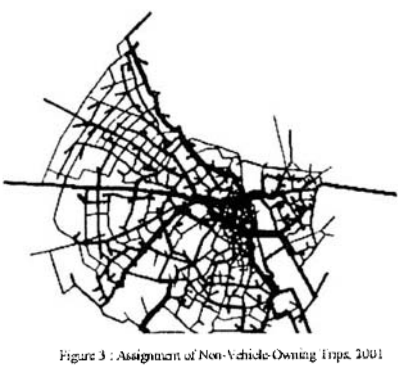


Figure 3 : Assignment of Non-Vehicle-Owning Trips, 2001

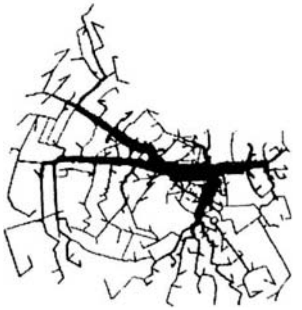


Figure 4 Assignment of MRT Trips at Flat Fare Rs 6.00, 2001

width) by commuters from vehicle and non-vehicle owning groups respectively. At a flat of Rs 6.00, the numbers of passengers predicted to transfer to MRT is shown by the bandwidths in Figure 4.

3. FARE ELASTICITY

3.1 Objective

The objective of the fare elasticity tests is to test the effect of different fares and fare structures on MRTS ridership and revenue there from, and on any other factors of importance such as bus ridership and viability, and relief to the road network.

The optimum strategy can then be determined based on certain criteria. Ideally one would want to maximise some combination of the following revenue, profit, ridership, road decongestion, safety, etc. No attempt was made here to state how these elements should be combined to pursue the optimum goal, but the results presented here would enable the impact of different optimization strategies.

Using the calibrated models, tests were undertaken to examine the consequences of applying different fare structures and levels. Fare levels per trip ranged from Rs 3/- to Rs 8/- for flat fares, and from Rs 3/- to Rs 12/- for graduated slab fares.

3.2 The procedure

The shortest path algorithm was used to obtain distance and travel time matrices for each mode. Bus fares were calculated on the basis of bus travel distance and the current (1998) slab bus fare structure. MRT fares were calculated on the basis of MRT travel distance and a variety of MRT fare structure options. Out of pocket expenses for travel by car were based on perceived running costs, as derived from the Stated Preference Survey. The fare/cost and time matrices for the three main competitive modes - MRT, bus and private vehicle for the vehicle for the vehicle owning and non-vehicle owning groups - were input to the modal choice modal, and the number of passengers forecast to use MRT was derived. Revenue and other statistics were then readily calculated. All costs are expressed at 1998 prices.

3.3 Fare Elasticity Results

Results are shown in Table 3. Details of the slab fare structure are shown in Table 4. For the range of fares tested, it was observed that the higher the fare the greater the revenue.

Table 3 Fare Test Statistics

Item	Flat Fare, Rs				Slab Fare Range, Rs		
	3	4	6	8	3-7	3-10	4-12
Passengers	2710	2414	1903	1573	2300	1922	1657
Total Revenue, Rs	8130	9656	11416	12587	10603	11208	17136
Passenger-Km	30340	27776	22446	18178	24568	19248	16856
Revenue/Psgr-Km, Rs	0.258	0.348	0.509	0.692	0.432	0.582	1.017

Notes: Figures in thousands
Flows refer to weekday 2005; prices are at 1998.

Table 4 Slab Fare Rates

Distance, Km	Fares, Rs		
	3-7	3-10	4-12
< 5	3	3	4
5-10	4	5	6
10-15	5	7	8
15-20	6	9	10
> 20	7	10	12

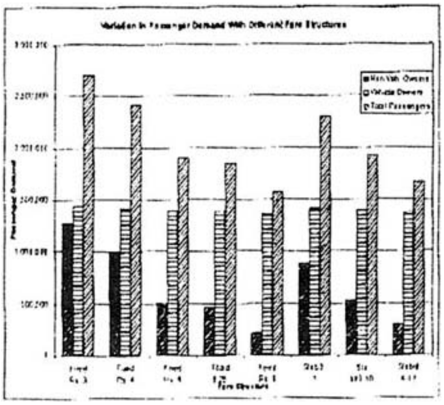


Figure 5 Ridership by Fare

Table 5 Slab Fare Rates by Vehicle Owning Status

Item	Flat Fare, Rs				Slab Fare Range, Rs		
	3	4	6	8	3-7	3-10	4-12
Passengers, NVO	1271	992	514	215	887	532	296
Passengers, VO	1438	1421	1388	1355	1412	1389	1370
Passengers, Total	2710	2414	1902	1573	2299	1921	1666

Notes
Figures in thousands
Flows refer to weekday 2005, prices are at 1998
VO/NVO refer to trips by members of vehicle and non-vehicle owning households

A detailed analysis shows that there is a large section of travellers, from vehicle owning groups, which is not sensitive to cost of travel in the ranges tested, while travellers from non-vehicle owning groups are sensitive to cost and are responsible for most of the shift in ridership. The breakup of ridership on MRTS for the vehicle owning and non-vehicle owning group is presented in Figure 5 and also shown in Table 5.

Table 6 MRT Trip Length Distribution by Fare

Trip Length, Km	Flat Fare, Rs					Slab Fare Range, Rs		
	3	4	6	6.25	8	3-7	3-10	4-12
	Percent distribution of trips							
0-2	4.46	4.23	4.49	4.57	5.13	5.25	6.29	6.12
2-4	7.99	7.34	7.33	7.42	8.22	9.42	11.27	10.63
4-6	11.76	11.20	10.83	10.88	11.64	12.52	13.72	13.78
6-8	13.85	13.41	12.46	12.39	12.37	14.08	14.34	14.22
8-10	15.21	15.12	14.33	14.22	13.76	15.87	16.44	16.36
10-12	8.30	8.26	7.81	7.75	7.50	7.50	6.78	7.08
12-14	9.77	9.36	9.14	9.08	8.66	8.66	7.94	8.17
14-16	4.60	4.85	5.15	5.15	4.91	4.41	3.94	4.07
16-18	5.13	5.45	5.78	5.77	5.52	4.28	4.03	4.19
18-20	4.94	5.28	5.61	5.60	5.35	4.64	3.95	4.20
20-22	6.20	6.59	7.23	7.28	7.28	5.48	4.91	4.84
22-24	3.68	3.95	4.29	4.30	4.10	3.17	2.70	2.72
24-26	4.61	4.97	5.55	5.58	5.57	4.21	3.70	3.61
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Average trip length, Km							
Average	11.15	11.46	11.76	11.75	11.52	10.64	9.97	10.06

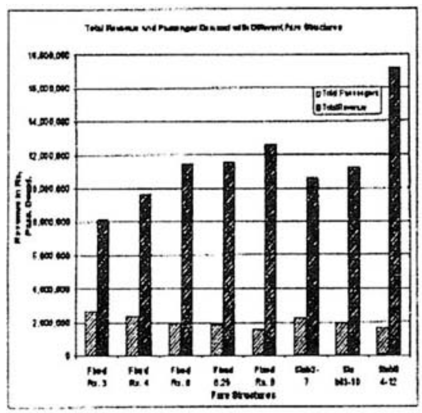


Figure 6 Revenue & Ridership by Fare Structure

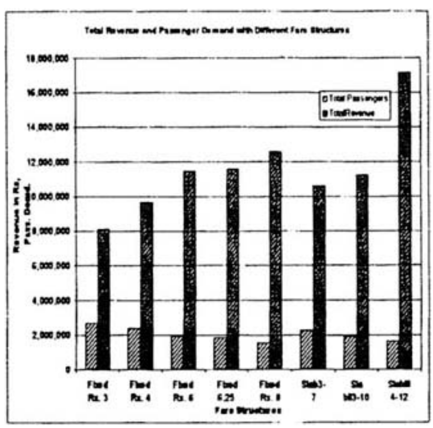


Figure 7 Revenue & Ridership by Fare Structure

It is seen that with the MRTS flat fare of Rs 3 the proportion of commuters from Vehicle owning and non-vehicle groups is 1 : 1 whereas with a flat fare of Rs 8.00 the ratio increase to 6 : 1 (approx) showing shift of Non vehicle owning groups to buses.

The trip Length Frequency Distribution, with various fare structures is show in Table 6. As seen from the table, maximum passengers travel between 6-8km, irrespective of the fare structure and the minimum between 22-24 km. The maximum trip length of 11.76 km per passenger is seen for a flat fare of Rs 6.00 per trip.

The maximum passenger kilometer carried is when the MRTS fare is a flat fare of Rs 3.00 per trip as seen from Figure 6. This is obious because at low fares non-vehicle owning groups will converge to MRTS.

As seen from Figure 7, the maximum revenue of Rs 1714 million is generated from the fare box with a slab fare of Rs 4-12 which is generated from 1.66 Million passengers per day in the year 2005. This is because the vehicle owning group is captive to MRTS and also the particular trip length frequency distribution for the fare level.

4. SWIMMING UP

- Master Plan (1981-2001) assumed a modal split of 75 % in favour of Public Transport.
- Stated Preference Survey was conducted by RITES in 1998.
- Logit model was developed based on the survey data.
- The model projected a modal split of 78 % in favour of mass transport with the introduction of Modified First Phase of Delhi MRTS.
- The analysis showed that vehicle owners are not very sensitive to cost of travel by MRTS whereas non-vehicle owning group are.
- The ridership and passenger kilometre of MRTS, from Vehicle Owning & Non-vehicle owning groups is in the ratio of almost 1 : 1 with a flat fare of Rs 3.00 per trip.
- The ridership of MRTS, from Vehicle Owning & Non-vehicle owning groups is in the ratio of almost 6 : 1 with a flat fare of Rs 8.00 per trip.
- Maximum ridership is generated with a fixed fare of Rs 3.00 per passenger trip.
- Maximum revenue is generated with a slab fare structure of Rs 4-12.

Acknowledgement

The Authors would like to thank, RITES management for them use their database for this paper.

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Improving urban transportation in Mexico City

Amélioration des transports urbains à Mexico

Mejorando el transporte urbano en México City

Peter Stöveken

BPI-Consult, Jaakko Pöyry Group, Wiesbaden, Germany

ABSTRACT: Improvement of the environment is one of the main tasks of the government in Mexico City District. A large part of the emissions results from the traffic in the city with heavy congestion during the peak hours. After analyzing the existing situation a cost-benefit-model was set up to evaluate different measures to improve the transport conditions in the city by a) general policies to reduce car use and to shift car use to public transport, b) concrete measures to improve the public transport system and c) measures to improve the technology. The concrete measures are planned for the "Calzone De La Viga", an important, 8 km long road from the south of the city to the center. Because of the present state of the project the cost-benefit-model, the results and the conclusions for other metropolitan areas in developing countries will be presented at the CODATU World Conference in April 2000.

RÉSUMÉ: L'amélioration de l'environnement est l'une des tâches majeures du gouvernement du District de Mexico. Une grande partie des émissions est générée par la circulation dans la ville, et notamment par les embouteillages au moment des heures d'affluence. Suite à une analyse de la situation actuelle, un rapport coûts-avantages a été dressé afin d'évaluer différentes mesures destinées à améliorer les conditions du transport conditions en ville grâce à a) des politiques générales de réduction de l'usage de la voiture et de passage du trafic automobile au transport public, b) des mesures concrètes d'amélioration du système de transport public et c) des mesures d'amélioration de la technologie. Des dispositions concrètes sont prévues pour le « Calzone De La Viga », une route importante longue de 8 km du sud de la ville au centre. Au vu de l'état actuel du projet, l'analyse coûts-avantages, les résultats et les conclusions pour d'autres zones métropolitaines de pays en développement, seront présentés à la Conférence mondiale CODATU en avril 2000.

RESUMEN: La mejora del medio ambiente es una de las principales tareas del gobierno en México Distrito Federal. Una gran parte de las emisiones se debe al tráfico en la ciudad con una gran congestión en las horas punta. Después de analizar la situación actual se estableció un modelo de costo-beneficio para evaluar diferentes medidas para mejorar las condiciones del transporte en la ciudad mediante a) políticas generales para reducir la utilización del automóvil y desviar su utilización hacia el transporte público, b) concretar medidas para mejorar el sistema de transporte público y c) medidas para mejorar la tecnología. Las medidas concretas están planificadas para la "Calzone De La Viga", una importante vía de 8 km de largo desde el sur de la ciudad al centro. Debido al actual estado del proyecto el modelo de costo-beneficio, los resultados y las conclusiones para otras áreas metropolitanas en países en vías de desarrollo se presentarán en la Conferencia Mundial de CODATU en abril del 2000.

1 INTRODUCTION

Improvement of the environment is one of the main tasks of the government in Mexico City District (Departamento de Distrito Federal – DDF). A large part of the emissions results from the traffic in the city with heavy congestion during the peak hours. The public transport is mainly based on a very good metro network within the city, but also on thousands of midi-buses (peseros) of varying ages, which have relatively high pollutant emissions and capacity for only 30-40 persons. On behalf of the GTZ (Gesellschaft für technische Zusammenarbeit, Germany). BPI-Consult worked out different measures to improve the transport conditions in the city. There are three main aspects to be analyzed:

a) general policies to reduce car use and to shift car users to public transport (e.g. road pricing, parking pricing, parking restrictions, time-dependent or regional regulation of car use, improvement of public transport, coordinated public transport fare and ticketing system)

b) concrete measures to improve public transport (e.g. segregated bus lanes, bus priority at junctions, reduction of travel time, improvement of comfort, coordination between the metro and bus system)

c) technical measures to improve bus technology (e.g. low-emission buses, alternative fuels)

The concrete measures are planned for the "Calzone De La Viga", an important, 8 km long road from the south of the city to the center. A cost-benefit-model has been developed which shows the effects of different combined measures (general policies, improvements to public transport, improved bus technologies) on traffic flow and environment.

The project started in May 1999 and will be finished in early 2000. There is very intensive cooperation with the DDF, the Mexico City District Minister of Transport (Secretaria de Transportes y Vialidad - SETRAVI) and the Mexico City District Minister of Environment (Secretaria del Medio Ambiente - SMA). The results can be used to decide on general strategies and implementation on other roads.

2 URBAN TRANSPORTAION SYSTEM AND ENVIRONMENT

The metropolitan zone of Mexico (Zona Metropolitana de Ciudad de Mexico - ZMCM), at an altitude of 2,200 metres is divided into Mexico City (Distrito Federal - D.F.) and 11 surrounding municipalities of the state of Mexico. About 17 million inhabitants live in an area of 5000 square kilometres, 50 per cent in D.F. and 50 per cent in the municipalities. For the last 20 years an enormous urbanisation in the peripheries has caused growing transport and environmental problems. Current prognoses predict more than 20.3 million inhabitants by the year 2010, 11.6 million of them in the peripheries (Figure 1).

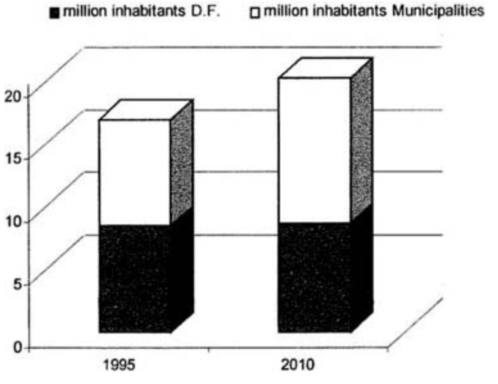

Figure 1: Population in the Mexico City area

There are several different public transport systems, each of them operating independently with no common fare and ticketing system and no common route and transportation planning. The modal split of public transport in the ZMCM and the partition in the different systems is shown in Figure 2.

Eleven Metro lines (1-9, A, B) operate with varying degrees of patronage. Two-thirds of the total demand is served by the lines 1, 2 and 3. The occupation level of some other lines is not very high. Numerous private companies with small- and midi-sized buses play the most important and an increasing role in public transport. On many streets different companies with midi-sized buses compete with each other. At some junctions 900 small- and midi-sized buses can be counted during one hour. The urban bus system (Routa 100) is in poor condition. The buses are old and overcrowded. More and more services are being given to private bus companies.

In Figure 3 the age of vehicles is shown. The taxis and small buses are not as old as the private cars and normal-sized buses. 26% of all private cars and 36% of all normal-sized buses are over 20 years old.

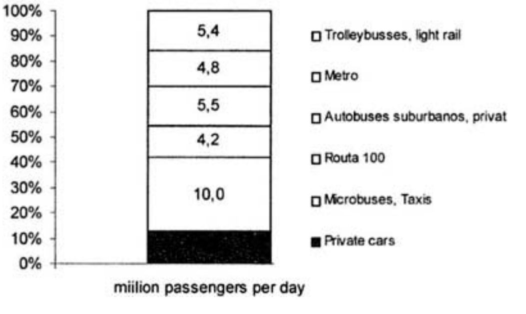

Figure 2: Public transport in the metropolitan area

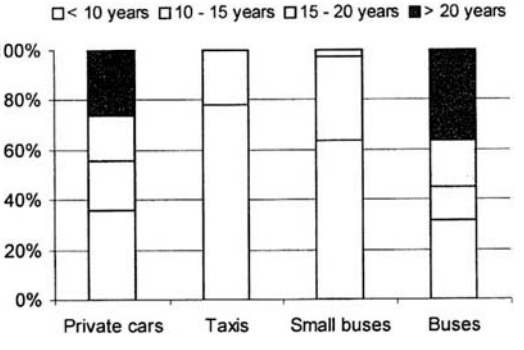

Figure 3: Age of vehicles

The environmental situation in Mexico City is very often bad. Because of the high altitude of ZMCM the oxygen concentration is 23% lower than at sea level and there is less complete combustion of fuel in petrol engines. Moreover, the intense sun in the summer months causes high nitrogen oxide concentrations. In the case of inversion weather conditions, which occur frequently, the self purification of the air is impeded. The contribution of transportation to this situation is very large (Figure 4).

3 ANALYSIS OF THE CALZADA DE LA VIGA AREA

The analysis area is the Calzada de La Viga, a street with a length of 8 km between Fray Terasa de Mier and Canal National. The corridor connects important development areas in the south-east with the center (Figure 5).

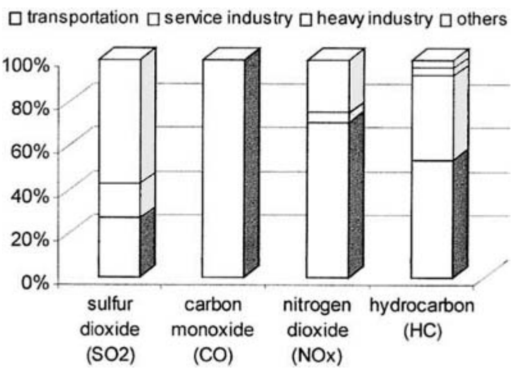

Figure 4: Percentage of pollutant emissions due to transportation

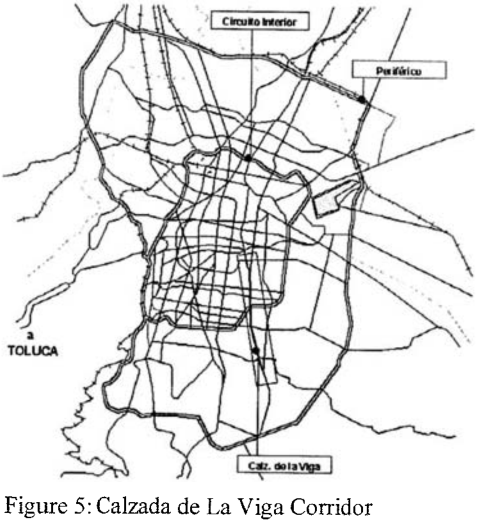

Figure 5: Calzada de La Viga Corridor

The Calzada de La Viga is a one-way street, runnig south-north between Canal National and Eje 3. The cross sections vary, but the typical division of traffic lanes is shown in Figure 6. There are 3 traffic lines on each side of a grass strip in the middle of the street. The nearside lanes are bus lanes with a contraflow bus lane in the north-south direction.

Formerly the bus lanes were separated off with hemispheres, nailed into the asphalt, which could only be crossed at very low speed (confibus system). But residents and businessmen with shops next to the bus lanes raised objections so that the yellow hemispheres were dismantled on most sections.

4 TRAFFIC FLOW ON THE CALZADA DE LA VIGA

Because of the south-north orientation traffic problems occur chiefly in the morning. During the peak hour between 8 o´clock and 9 o´clock the maximum demand is 6000 vehicles between the crossings of Rio Churubusco and Eje 6 Sur. The average speed is shown in Figure 7.

The main hindrances for all vehicles are the signalled crossings. For buses significant delays result from cars being driven and parked on the bus lanes, even on the contraflow lanes. Five typical conflict situations are shown in Figures 8-12.

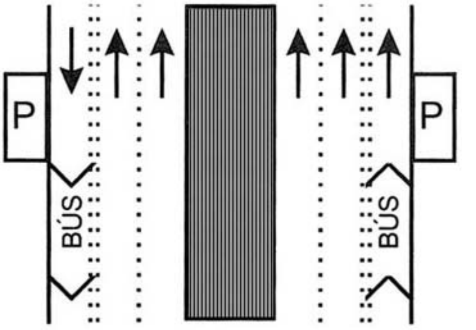

Figure 6: Typical cross section (Calzada de LaViga)

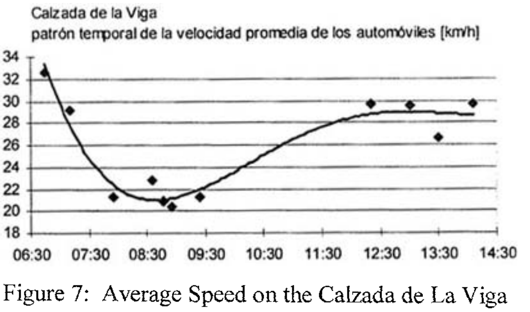

Figure 7: Average Speed on the Calzada de La Viga

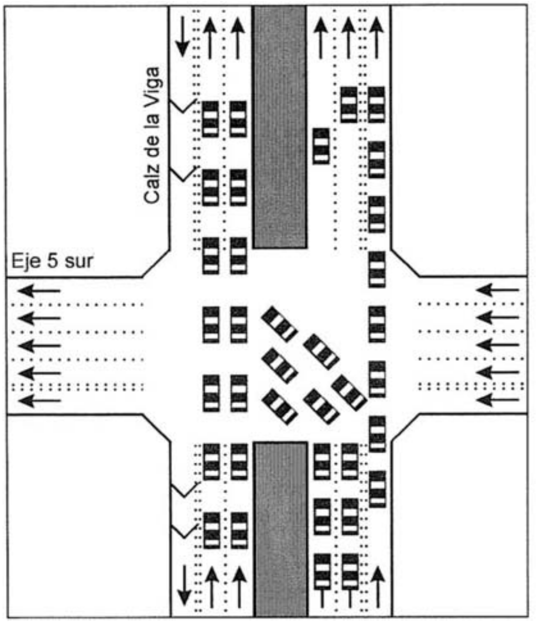

Figure 8: Conflict Situation 1) Vehicles turning left from the right hand traffic clash with vehicles going straight on in the left hand traffic lanes

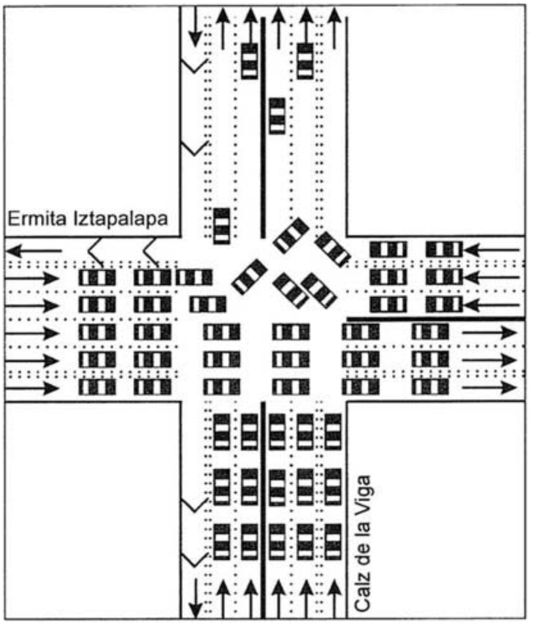

Figure 10: Conflict situation 3) Vehicles turning right into the main street clash with vehicles turning left into the main street

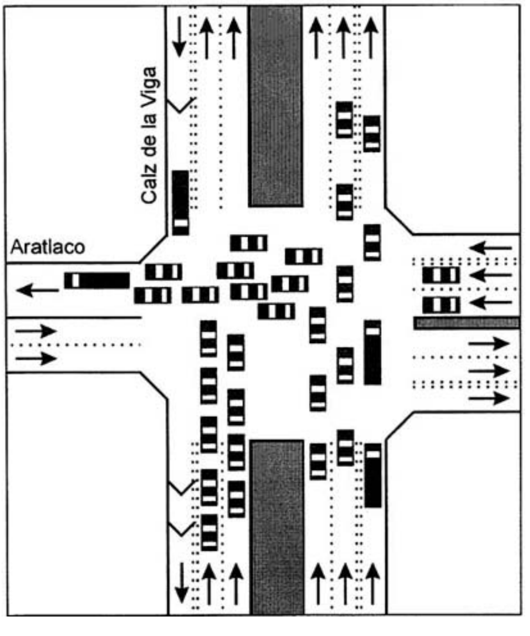

Figure 9: Conflict situation 2) Clearing of the intersection is hindered by parked cars or buses at stops near the crossing

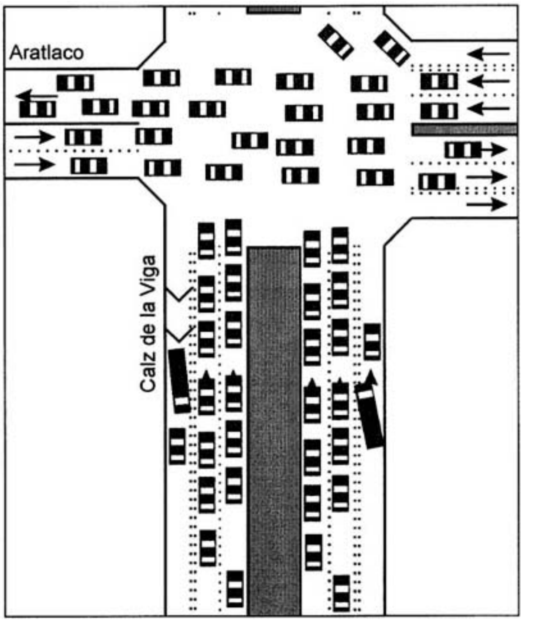

Figure 11: Conflict situation 4) Buses on bus lanes are obstructed by parked cars

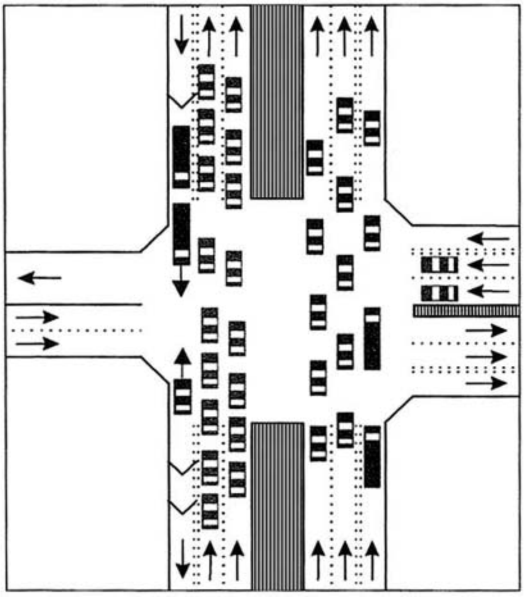

Figure 12: Conflict situation 5) Buses in bus lanes are obstructed by cars driving in the opposite direction

5 TYPES OF MEASURES TO IMPROVE THE ENVIRONMENT

The main task is to improve the environment. For this there exist three different types of measures: a) Reduction of traffic quantity, b) Improvement of traffic flow, c) Improvement of engine technology. Every single measure improves the situation, but the most effective way is to combine all feasible measures. The network is shown in Figure 13.

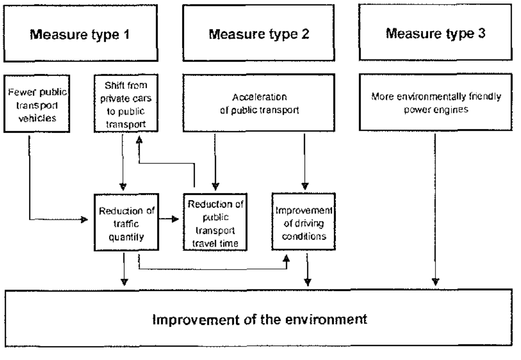

Figure 13: Network of measures in urban transportation to improve the environment

Reduction in number of public transport vehicles	**Shift from private cars to public transport**	**Acceleration of public transport**	**More environmentally friendly technology**
Substitution of normal-sized buses for mini- and midi-sized buses by normal-sized buses	Increased costs for private car use, incentives for public transport use	Bus priority with special signalling at intersections	Driving limitation and prohibition for old vehicles
Extension of the Metro	Parking restrictions	Bus lanes (confibus system)	Restrictive emission limits
Improved transfer conditions between the Metro and the buses	Prohibitions and supervision of car use	Special traffic lane partitions and channelisation at intersections	alternative fuel (gas, hydrogen, ..)
	Bus priority	Optimizing of bus stop positions	Electric power
	Fare and ticketing system	Removal of special hindrances	Hybrid vehicles
	Improvement of comfort	Supervision (e.g. bus lanes)	
	Improvement of information		

Figure 14: Feasible measures to improve the environment

6 SCOPE OF WORK

The following individual and combined measures for the Calzada de La Viga will be developed and evaluated (Figure 14).

All measures will be analyzed for the Calzada de La Viga. For this a cost-benefit model will be drawn up to calculate the effectiveness of single measures as well as of combined measures.

Because of the current position of the project at the time of writing (September 1999), concrete results cannot be described. But at the CODATU World Conference 2000 the procedures, the cost-benefit-model, the results and the conclusions for other metropolitan areas in developing countries will all be presented.

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1.4 Urban transport and environment
Transport urbain et environnement
Transporte urbano y medio ambiente

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Road traffic noise characteristics in Delhi urban area
Las características del ruido de tráfico por las calles de las áreas urbanas de Delhi

P.K. Sarkar
School of Planning and Architecture, New Delhi, India

R. Rohatgi
MDP Consultants (Private) Limited, India

ABSTRACT: In this paper, an attempt was made to conduct a research on traffic noise characteristics in Delhi urban area. Major contribution in this research is the determination of Passenger Car Equivalency. The concept of Passenger Car Equivalency is that how much a vehicle is noisier than a car. Further attempt was made to develop relationship between traffic noise and weighted traffic flow, and between traffic noise and speed of vehicular traffic using the data collected as a part field survey.

ABSTRATO:En esta ponencia se ha hecho una tentativa para llever a cabo una investigacio'n sobre las carac-ter isticas del ruido de tra'fico en las a'reas urbanas de Delhi. La mayor contribuctio'n a esta investigacio'n es la determicio'n de la equivalencia del coche pasajero y cuanto ma's ruideso es un hehi'culo que un coache. Adem'as, se ha hecho un intento para desarrollar la relacio'n entre el ruido de tra'fico y la circulacio'n ponderada entre el ruido de tra;fice y la velocidad del tra'fico vehicular que utilizen los datos coleccionados como parte de una investigacio'n del terreno

1 INTRODUCTION

1.1 *Background*

Noise defined as unwanted or excessive sound, is an undesirable by-product of our modern way of life. It can be annoying, can interfere with sleep, work or recreation, and in extremes may cause physical and psychological damage. While noise emanates from many different sources, transportation noise is perhaps the most pervasive and difficult source to avoid in society today. Road traffic noise is a major contributor to overall transportation noise. Noise from road traffic may be regarded as more or less continuous sound, which fluctuates from hour to hour during the day in almost regular pattern and from moment to moment with passage of individual vehicle. Delhi, being the fastest growing city of the India, has witnessed tremendous increase in the motor vehicle ownership within last decades. The present growth of traffic on roads in Delhi is about 12 percent. This has resulted in high degree of noise levels on major arterial roads and feeder roads and even in residential areas. The acoustical division of the National Physical Laboratory, New Delhi has found an average noise level of over 90 dB during the peak hour, seldom falling below 60 dB.

Among all pollutant due to traffic, noise is unique in its spontaneity as it leaves no residual evidence. Hence it is given very low priority for control. Much have been written on 'Noise Problem' with least implementation effected. Unless the environment is kept healthy, safe and calm by applying suitable corrective measure, there is a danger that the motor vehicle, which is a boon to mankind, might turn out to be the worst source of annoyance. Therefore there is a strong need to understand the noise problem and its characteristics in order to control it and to ensure a healthy and calm environment.

1.2 *Objectives of the Study*

Objectives of the study were to assess the road traffic noise characteristics, to develop relationship between road traffic noise and stream flow variables, development of passenger car noise equivalence and finally to assess the reduction in noise due to traffic management schemes. Study brings out the basic understanding of the traffic noise with respect to traffic volume, speed and composition and also the contribution of individual vehicle type in road traffic noise. However, the study is confined to road traffic noise generation by traffic volume consisting of individual vehicle as the source of noise. The effect of road surface, gradient and distance is not taken into account. Further the findings of this study can be implied to urban arterial only.

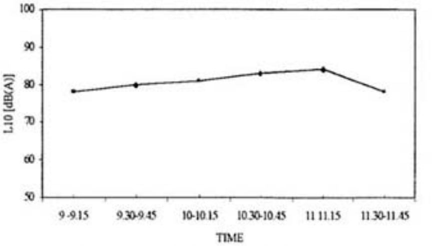

Figure 1. Level Time Characteristics- Peak Hour

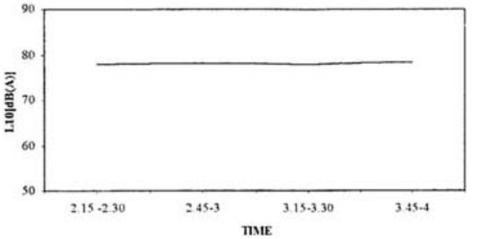

Figure 2. Level Time Characteristics- Off Peak Hour

2 DELHI URBAN AREA: A PROFILE

2.1 *Population Motor Vehicles*

Delhi, being the capital of India, is experiencing migration of population due to employment opportunities resulting in the expansion in all directions due to absence of any natural barrier. The growth of population in last decade was about 4.5% and the current population is nearly 11 million. The growth of vehicle is about 12% annually in Delhi with a total vehicle population aggregating to about 4 million. This whole vehicle population is being catered to by about only 17000 km of radial road network. Traffic volume on these major arterial corridors varies between 25000 – 100000 vehicle/day and the journey speed varies between 8.5km per hour to 35 km per hour.

2.2 *Selection of Corridor/ Data Collection*

All the major corridors were analyzed based on nature and magnitude of traffic. The Vikas Marg – Barakhamba Road was selected for study. This corridor has a wide range of variation of traffic. Four survey points on these corridors were selected such that the factors of interest should vary and all other factors like site conditions, gradient, surface etc. are constant. The Following data were collected for the analysis:

- Classified Traffic Volume Count
- Spot Speed Data
- Traffic Noise Data from Individual Vehicle

3 ROAD TRAFFIC NOISE CHARACTERISTICS

3.1 *Level Time Characteristics*

There are two fundamental characteristics of road traffic noise: Spectral Characteristics which is related to propagation of noise and was out of the scope of this study; and Level-Time Characteristics which is related to rise and fall of the noise level. Level – Time characteristics can be short term as well as long term. Data collected from all the four points were analyzed and level – Time characteristics were developed for peak as well as off-peak hours as shown in Fig 1 and 2 repectively.

The Following points emerged out of this analysis:

- L10 levels are fairly constant over daytime, irrespective of peak and off-peak hours.
- L10 level varied from 78 to 85 dB(A), seldom falling below 78 dB(A).
- L90, that is the background noise varies from 68 dB(A) to 72 dB(A).
- Leq ranges from 75 dB(A) to 81.5 dB(A).
- Peak noise levels ranges from 85 dB(A) to 101 dB(A)
- Maximum Peak Noise Levels were observed to be quite high, ranging from 104 dB(A) to 114 dB(A), which can even cause hearing damage.

4 DETERMINATION OF PASSENGER CAR NOISE EQUIVALENCE (PCNE)

4.1 *Passenger Car Equivalence(PCNE)*

Each vehicle in the stream having mix traffic conditions has different noise generation characteristics than other vehicle and this fact makes the road traffic noise problem little complex. In order to understand the behavior of road traffic noise, or to understand the various relationships, it is necessary to convert all vehicles into some equivalence based on their noise generation characteristics. The Passenger Car Noise

Equivalence (PCNE) of a particular vehicle represents that, how many times that vehicle is noisier than car. Joyce, Williams and Johnson developed the concept of PCNE, in 1975.The calculations for PCNEs were carried out in two stages. First, the average noise level produced by each category of vehicle; Data obtained by noise survey conducted in the early morning and picking up the instances when only one particular vehicle is passing, were used to plot a cumulative frequency curve as shown in 3, 4, 5 and 6. From the plotted curve the 90^{th} and 50^{th} percentile were obtained to determine the average sound level generated by the different type of vehicles at the test site: After calculating the average noise level generated by each category of vehicle, PCNEs were calculated using following equation. The average noise levels in terms dB as worked out with respect to car , motorised two wheeler, Three wheeler(Auto Rickshaw) and Bus/Truck are 67.1, 72.5, 74.2 and 78 respectively.

$$PCNE = (10)^{(L-67.1)/10}$$

Where 67.1 dB (A) is the average noise level of car and L is the average noise level generated by individual vehicle. The PCNE values obtained are given below with their rounding off:

4.2 *Table 2. PCNE Values*

Vehicle	Car/ Van	Scooter	Auto-Rickshaw	Bus/ Truck
PCNE	1		6	12

5 DEVELOPMENT OF RELATIONSHIP BETWEEN ROAD TRAFFIC NOISE AND TRAFFIC PARAMETERS

5.1 Road Traffic Noise-Traffic Flow relationship

The relationship between traffic volume and traffic noise was developed in two stages, first the weighted traffic flow (V) for each sample was calculated by multiplying corresponding PCNEs and then the relationship was developed in the form of linear regression equations. The relationship was developed for 2-lane and 3-lane carriageway(one direction) which was as follows:

2-lane (One direction) carriageway

L10 = 13.98 + 16.04 Log10(V) - Two-way

L10 = 18.08 + 14.53 Log10(V) - One-way

3-lane (One direction) carriageway

L10 = 8.05 + 17.23 Log10(V)

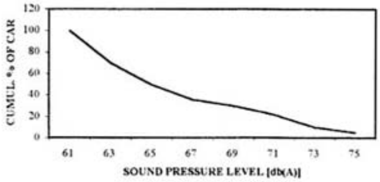

Figure 3.Distribution of cumulative % of Noise of Car

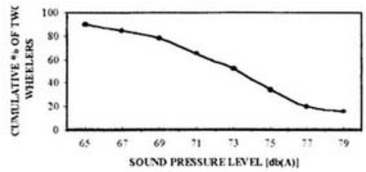

Figure 4.Distribution of cumulative % of Noise of Scooter/Motor Cycle

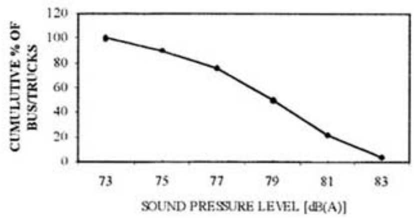

Figure 5.Distribution of Cumulative % of Noise of Bus/Truck

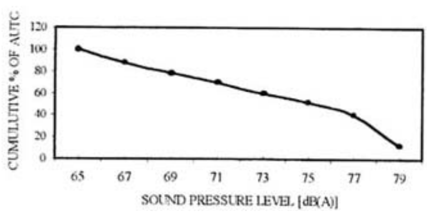

Figure 6.Distribution of Cumulative % of Noise of Auto-Rickshaw

V is the Weighted Flow in PCNE/Hour

Fig 7 and 8 represent the above relationship. The salient features of this relationship are as follows:

- There is a logarithmic relationship between traffic volume and traffic noise.
- In the lower traffic range, even the small increase in traffic volume causes a significant change in noise level.
- Doubling of traffic level causes increase in L10 value by 4-5 dB(A) and it reduces by same

amount if the traffic volume is reduced to half.

- Noise levels are lesser in one way streets as compared to two-way streets. By converting two-way street into one-way street we can reduce noise levels by 0.8 to 2.2 dB(A).

5.2 Road Traffic Noise- Composition Relationship

The objective of developing this relationship was to determine how much each category of vehicle is contributing to the road traffic noise. Multiple linear regression equations were developed between L10 as a dependent variable and logarithmic of number of vehicles/ hour (for four categories) as independent variables. Following were the equations obtained

2-lane (one direction) carriageway

$$L10 = 27.58 + 2.76 \text{ Log } Vc + 3.26 \text{ Log } Vtw + 3.74 \text{ Log } Vat + 9.05 \text{ Log } Vb$$

3-lane (one direction) carriageway

$$L10 = 24.58 + 2.25 \text{ Log } Vc + 3.5 \text{ Log } Vtw + 4.01 \text{ Log } Vat + 10.24 \text{ Log } Vb$$

Where Vc- No. of Cars / Hour
Vtw- No. Of Two Wheeler / Hour
Vat- No. Of Auto (Three Wheeler)/ Hour
Vb-No. Of Bus/Trucks / Hour

The above relationship is valid for the following composition range:

Car	25 to 35%
Two Wheeler	35 to 45%
Auto (Three Wheeler)	10 to 20%
Bus/Trucks	10 to 15%

The salient features of this relationship are as follows:

- Buses and Trucks are contributing maximum to the stream noise; the mode, which is contributing next to Bus/Trucks, is Auto Rickshaw (Three Wheeler).
- Using the above equations, graphs were plotted between % increase in Bus/Trucks composition (Keeping Share of other mode constant) and noise level, as shown in Fig 9 and 10. It was found that by increasing percentage of Bus/Trucks by 5%, keeping others constant, the noise level rises by 1.3 dB (A).

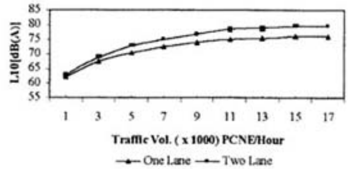

Figure 7. Traffic Noise-Traffic flow Relationship (4-Lane)

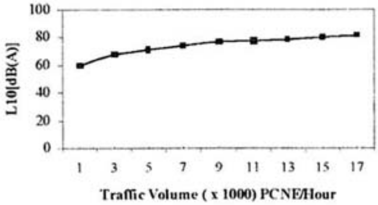

Figure 8. Traffic Noise-Traffic flow Relationship (3-Lane)

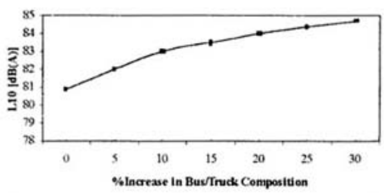

Figure 9. Bus/Truck Composition – Noise (2 lane)

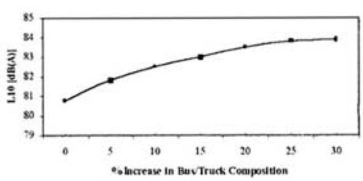

Figure 10. Bus/Truck Composition (3 lane)

5.3 Road Traffic Noise- Speed Relationship

In primary survey, the data on spot speed of four categories were collected in each sample of 15 minutes noise measurements and traffic volume counts. The average speed was calculated taking the average of spot speeds of all four categories of vehicles and it was assumed as the mean stream speed during that sample. This assumption was made because in urban conditions, the spot speed in a short stretch can be treated as mean speed of traffic in that stretch.

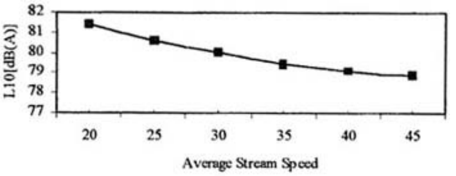

Figure 11. Speed – Noise relationship (2-lane)

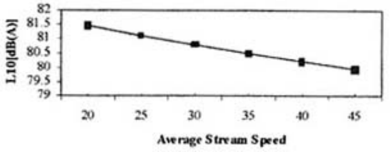

Figure 12. Speed- Noise relationship (3lane)

Using the above collected data, linear regression equation was developed for both 2-lane and 3-lane (one direction), the equation obtained were as follows.:

2-lane (one direction) carriageway

L10 = 87.46 - 4.545 Log S

3-lane (one direction) carriageway

L10 = 88.21 – 5.613 Log S

Where S is the average Stream Speed in KMPH. Graphical representation is shown in Fig 11 and 12.

As seen from the relationship the noise level rises as the speed decreases. Further if we double the speed, the noise levels reduces by 1.37 dB(A) in 2-lane dual and 1.68 dB(A) in 3-lane dual

Impact of traffic Management techniques on Traffic Management Schemes

After having made the in-depth study, the relationship developed was used to test different traffic management techniques with view to reducing noise level. The following are the results obtained in regard to the various traffic management techniques if applied on the present arterial road undertaken for the study.

S.No.	Traffic Management Technique	Max. Noise Reduction dB(A)
1	Diverting about Half of traffic	3 – 4
2	Banning of Heavy Vehicle (5% reduction in Heavy Vehicle)	1.3
3	Provision of One-way streets	2
4	Synchronisation of Signals, access controls etc.	1.5
5	Segregation of traffic	2 – 3
6	Ban on Using Horns	1 - 2

6 CONCLUSIONS

The study is finally conclusive with the following major observations.

- By means of traffic management techniques we can reduce maximum of 10 dB(A)
- Existing Noise Levels are quite high, in the order of 78 to 85 dB(A), and the traffic volume is also increasing at the rate of about 12%. % in Delhi and similar urban cities, therefore only Traffic Management Techniques will not be able to solve the problem alone.
- There is a strong need to review the other noise control techniques and their effect on the surroundings.

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Transport policy and environmental considerations

T. Kalyana Sundaram & S.A. Verma
RITES, New Delhi, India

ABSTRACT: The interest of Transport Policy Planners and the Environmental Protection groups are mostly in conflict even though both groups claim to meet the requirements of the same section of the society. The Environmental Protection Programmes and Environmental laws strive to address long term objectives of Environmental Protection and Management. All major transportation projects in India require Environment Impact Assessment and obtaining environmental clearance. This paper deals with the process of urbanisation in India and the various technical, social, political and economic aspects of transport policy aims of the Governments and how these meet the Environmental requirements. It also discusses the environmental setting and the economic conditions which played key roles in the delay and subsequent approval of the proposed Mass Rapid Transport System (MRTS) for Delhi.

1 INTRODUCTION

Modern India's tryst with Environment can be traced back to the Stockholm Conference on Environment in 1972 in which India actively participated. The awareness on Environment resulted in the enactment of the early Acts on Environment, the Indian Wild Life Act (1972) and Water (Prevention and Control of Pollution) Act, 1974. These Acts supplemented the Indian Forest Act 1927, and other provisions in Municipal Bodies Act, to maintain hygiene and cleanliness in public places. The Air (Prevention and Control of Pollution) Act, 1981 and The Environment (Protection) Act, 1986 are the other principal acts which emphasise the protection of a clean environment. The real thrust on Environment in India came to be felt in mid Eighties. The Government under the relevant Ministry began formulating national standards, emission norms and design criteria for environmental parameters which had hitherto not found mention in the Bureau of Indian Standards. Obviously, the approach was Industry specific. The focus, as elsewhere, was on the need to control and mitigate air, water, and noise pollution caused as a consequence of setting up and operating an industry or undertaking a major development project.

2 ENVIRONMENTAL REGULATIONS AND CONTROL PROCEDURES

It has now become mandatory for all development projects including transportation projects to carry out Environment Impact Assessment (EIA) and submit the report to the Ministry of Environment and Forests and obtain environmental clearance in order to establish their environmental and social desirability and get approval for the project. An entire range of parameters affecting the environment are studied in great detail under the appraisal process. Project performance is checked against emission standards, statutory norms and other established criteria for compliance. The Ministry of Environment has prepared a set of guidelines for transportation projects including rail/road/highways, airports, ports and harbour for conducting EIA and preparing Environmental Management Plan.

3 URBANISATION IN INDIA

3.1 *Urban Agglomerations and Population*

Over the years, there has been a population explosion in India and rapid urbanisation is taking place not only due to natural growth but also from large scale migration from rural to urban areas and from smaller to larger cities. The main reasons are the high population growth, high dependence on agriculture with primitive agricultural practices resulting in low income, meager and fragmented land holdings, little or no rural development and lack of infrastructure and low industrial production. The tendency of the Government to pay more attention to metropolitan cities is also one of the reasons for migration in the country, at large. This has compounded the problem of already bulging urban cities. Total number of cities with population of hundred thousand and above were only 51 in 1951. This is expected to go up from 301 in 1991 to 781 by 2021. More than 65% of total urban population presently lives in these 301 cities. It has been estimated that cities with population of more than a million will jump from 23 at present to 51 by the year 2021. This rapid urbanisation in India has put tremendous strain on the civic services leading to decline in quality of life.

Table 1.Registered Motor Vehicles In 6 Largest Metropolitan Cities of India as on 1996

City	Two Wheeler	Car/ Jeep / Taxi	Three Wheele	Buses/ Others	Total
Delhi	1403050	488148	70459	134498	2096155
Bangalore	498272	95833	25165	35118	654388
Chennai	461638	127848	18630	33258	641374
Calcutta	222069	213890	6304	74254	516517
Mumbai	246404	219607	26195	54720	546926
Hyderabad	410173	61034	19957	28563	519727

Source: MOST, Government of India

3.2 *Intra-city transport and Urban Infrastructure*

With the rise in per capita income, mobility rates are increasing. Intra city urban transport demand is increasing due to three factors: increasing population, mobility rate per person and trip length. In addition, city roads also cater to a large volume of inter-city transport demand comprising originating or terminating and through traffic. A total demand of 614 million passenger trips is expected in these cities by the year 2021 of which 430 million passenger trips will be vehicular modes. It is estimated that by 2021, more than 50% of intra-city vehicular trips will be catered to by public transport. More than 180 million inter-city passenger trips and 17.2 million tonne freight traffic are estimated to be generated in 2021 in these cities signaling a growth of more than 145% over the corresponding figures for 1994. However, the road network in most of the cities is characterised by narrow carriageways, poor surface quality, absence or inadequacy of footpaths and low journey speeds. This results in traffic bottlenecks and consequently heavy pollution.

3.3 *Personalised Vehicles and Mass Transport*

The principal modes of mass transport available to commuters in Indian metropolitan cities (except Mumbai, Calcutta and Chennai which have well established suburban rail systems) are bus, minibus and three wheelers. In Delhi, which has a population of about 13 million, only buses meet the mass transport needs. Inadequate mass transport, improved socio-economic levels and the considerable increase in motor vehicle production have significantly resulted in an alarming increase in personalised vehicles which have reached the proportions of an explosion as given in Table1. It could be seen that two wheeler population in most cities accounts for 60-80% of total vehicular population. In India, cars and two wheelers have been growing annually at the rate of 10-20% and 8-15% respectively. This growth can be directly attributed to inadequacy or absence of mass transport. The scooter/motor cycle ownership is expected to increase from average level of 102 in 1994 to 393 per thousand in 2016 and car ownership from 14 to 48 per thousand population.

4 TRANSPORT POLICY-AIMS AND OBJECTIVES

4.1 *The Planning Process*

Countries, including India, have been competing for scarce resources to boost development. Trade, commerce and other economic activities thrive in areas where accessibility is high. Adequate means of communication are imperative for economic growth of a country and transport is recognised as a principal factor promoting economic growth. Giving due considerations to all these facts, very early in its planning process, India took upon development of all modes of transport through land, water and air. However, transport sector in general and Urban transport in particular, has because the priorities of water, shelter, employment, and power have been overriding and have occupied greater attention of governments. Augmentation of urban transport systems has not kept pace with high growth in population and transport demand. The result is that level of service is falling generally in cities.

4.2 *Transport Policy*

The aim of transport policy in India has been the provision of transport to facilitate the efficient operation of the economic, social and political life of the country at the lowest social cost. In practice this means assuring adequate transport capacity and efficient operations to meet the needs generated by peoples' activities. The transport policy in India has been implemented through regulations and controls on fares and operations of the system. Presently, this is a controversial area of public policy. When India embarked on the process of liberalisation in the early 1990s, privatisation and deregulation became the buzzwords. Thus domestic air space was opened for operation by private airlines. In the road transport, private sector was invited to join government efforts in providing economical and reliable mass urban transport on a much larger scale and on very favourable terms. In Delhi, private bus operators have been involved in a significant way to supplement the state owned Delhi Transport Corporation (DTC) buses to provide mass transport, even though there are pronounced increase in accident rates because of the lack of discipline in the private bus operators.

5 URBAN TRANSPORT SCENARIO IN DELHI

In Delhi, a city with a population of about thirteen million, buses are the predominant mode of public transport. There is a EMU service which carries only 1% of projected demand. Figure 1 depicts the modal share in Delhi along with three other metropolitan cities of India. Against the authorised strength of 3500 DTC buses, there were only 2992 fleets available with a share of 672 buses running on inter-state routes as per DTC statistics of 1998. Nearly 2664 privately operated buses were contracted to supplement the existing fleet of DTC; however their number has since gone down. By 2001, the passenger kilometers to be covered would be around 131.9 million. With this rate of increase in traffic, the present mass transport system is bound to fail.

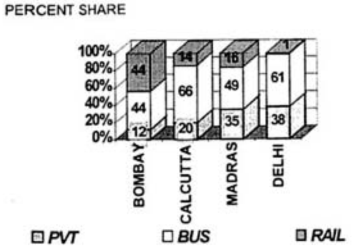

Figure 1. Transport – Modal Share (1994)

6 ENVIRONMENTAL CONSEQUENCES

6.1 *Growth of Vehicular population in Delhi and its consequences*

The effect of unplanned growth in terms of little or no thought to environmental consequences has begun to daunt the developed and developing countries alike. The vehicular population of Delhi, which is already very high, is growing at the rate of 0.3million additional vehicles per year. This is matched by the high population growth which is expected to be 14.3 million in year 2001, 17.1 million in 2006, 19.5 million in 2011, and 21.0 million by 2016 AD. The growth of low capacity personalised vehicles is the increasing cause of acute road congestion, parking problems, fuel wastage, road accidents, and air and noise pollution.

6.2 *Air Pollution*

Transport is a major source of environmental pollution. Vehicular traffic accounts for 67% of air pollution in Delhi. It is estimated that about 3,000mt of air pollutants are emitted every day in Delhi. The number of air pollutants involved is very large indeed with about 400 compounds emitted by petrol and diesel vehicles.

The Central Pollution Control Board (CPCB), New Delhi has been monitoring ambient air quality of Delhi since 1987 for Suspended Particulate Matter(SPM), Sulphur dioxide and Nitrogen dioxide. Table 2 compares the Annual Mean Average for the years 1989 and 1997.

6.3 *Other Environmental Problems*

The fact that the Suspended Particulate Matter content in Delhi which is primarily responsible for giving the City the opprobrium as the fourth-most polluted city in the world has shown a decline. However, the other pollutants have almost doubled in less than a decade. The main sources of pollution in Delhi are given in Table 3.

Table 2. Annual average of pollutants

Parameter	Annual Average- $\mu g/m^3$	
	1989	1997
Suspended Particulate Matter	373	348
Sulphur dioxide	8.7	16.7
Nitrogen dioxide	18.5	32.9

Source: CPCB, New Delhi

Table 3 Sources of Pollution in Delhi

Source	%age contribution
Vehicular	64
Domestic	8
Power Plants	16
Industries	12

Source: CPCB, New Delhi

Deleterious effects of air pollutants is too well known; they cause Chronic Pulmonary disease, Cardiovascular diseases, and even lung cancer. Mortality and morbidity have been associated with increased air pollution. While there is a solution in using alternate fuels such as CNG and in reducing led and Sulphur content in fuels to a tolerable level, there is no solution to eliminate CO from emissions of petrol driven vehicles. The use of electric vehicles is also not feasible because of high initial cost of conversion, limited usage for city conditions and also difficulty in manufacturing batteries in such large quantities. Discarding of used batteries would create problems of solid waste and disposal.

7 ECONOMIC AND ENVIRONMENTAL CONSIDERATIONS IN SELECTION OF DELHI MRTS

7.1 *Economic Considerations*

In the absence of MRTS, Delhi will need around 10,000 buses in year 2001 itself.

With a view to reducing the problems of Delhi commuters, Government of India(GOI) and Government of National Capital Territory of Delhi(GNCTD) have launched the Multi-Modal Mass Rapid Transport System(MRTS) for Delhi.

Like that of Singapore Mass Transit Project, which had a gestation of some 14 years, Delhi MRTS Project also had a gestation period of more than 20 years from 1974, when the first planning started. Economic considerations played a major role in approving the Delhi MRTS; the project was initially visualised in early 1970s, conceptualised in late 1980s and could take-off only in mid 1990s.. This was mainly due to the initial high priority of the developing country on food, drinking water and shelter through public housing, water supply and drainage, free or subsidised meals and other basic requirements such as elementary education and primary health than projects of this nature requiring heavy investments.

A major factor for consideration in such capital-intensive projects is the availability of finances. Initially in the feasibility stage of the project(1989) and even in early stages of DPR(1991-95), it was thought that the project could be financed by Property Development to a major extent. However the idea was rightly questioned by the Union Cabinet, otherwise the proposal would have led to further environmental problems and project delays, since the concept and investment in property development is yet to pickup in India and monuments would have been constructed without any takers as happened in Malaysia. The success of Hongkong need not have been repeated in Delhi since the culture of the city, income and economic parameters are entirely different. The project had to wait for nearly another five years before partial funding(56%) could be obtained from Japan's Overseas Economic Cooperation Fund (OECF).

7.2 *Socio-Political Forces at Play*

Any decision on such a gigantic project would pervade every strata of society. India being a vibrant democracy, a large number of pressure groups are able to bear upon the government their own vested interests. Thus the alignment was shifted, modified, rerouted, extended or shortened not necessarily for technical reasons. The Modified First Phase which presently under implementation is a result of factors which are also social and political in addition to being technical. Another political consideration-the idea of "High Speed Tram Project was floated by then Delhi Government (1994-95) even as the DPR for the project was under final stages of preparation, and put back the sanctioning of the project atleast by one year.

7.3 *Environmental Considerations*

All major transport projects require environmental clearance from Ministry of Environment and Forests (MOEF). A detailed Environmental Impact Assessment was made and a comprehensive report clearly brought home the environmental advantages of having such a project, for a city like Delhi with existing high pollution load due to vehicular traffic. Table 4 shows the levels of air pollution with and without MRTS. It is estimated that the level of air pollution will become one and a half times in 2001 than that of levels in1991.

7.4 *Rehabilitation of Project Affected People*

The construction of a mega project like the MRTS, Delhi right in the heart of the city and passing through residential, commercial and environmentally

Table 4. Estimated Air Pollution Levels in 2001(Ton/year)

Pollutant	191	2001	
		Without MRTS	With MRTS
Carbon monoxide	167,345	230,714	193,764
Particulate Matter	14,086	26,170	26,008
Sulphur dioxide	5,414	9,989	9,829
Nitrogen oxide	33,847	61,384	59,510
Hydrocarbons	28,285	49,943	46,703
Total	248,977	378,200	335,814

Source: RITES,EIA for MRTS, Delhi,1995

sensitive areas has posed its own set of challenges. The first impediment is the resettlement and rehabilitation of Project Affected People (PAP). The general policy of the Government so far had been to provide monetary compensation in lieu of lost land. However, in this project the government has made a conscious decision to take all necessary steps and provide financial and material help along with land and other supportive infrastructure for the rehabilitation of Project Affected People. Acquisition and relocation of religious structures enroute the alignment was another sensitive issue which required deft handling.

7.5 *Project Details*

The present proposal of a modified first phase of the Delhi MRTS project will cost approximately INR 48600 million (at April 1996 prices) and will comprise a network of 11 km underground(Metro) along with 44.30 km of elevated/surface(Rail) corridors. It will have 45 stations in all. An estimated sixty thousand passengers per hour per direction will be carried by MRTS, Delhi with a headway of three minutes. The first section, elevated/surface corridor of 8 km length is planned to be commissioned by March 2002.

7.6 *Environmental Considerations during Construction*

While it is easier to anticipate impacts and plan mitigation for the three phases of project cycle namely project design, siting and operation it is relatively difficult to predict construction related impacts in view of the number of imponderables involved. Moreover, construction impacts being temporary in nature were not given the attention they deserved in India even though the adverse effects of construction related impacts has been addressed to in Europe and America for quite sometime now. As awareness in India is growing on negative long-term construction related impacts; environmental design and control criteria have become a focus of increasing attention of environmental planners, statutory government enforcement agencies and the public alike. However there is a total lack of any criteria which can form the basis of an Environmental Control System to predict, monitor and control adverse impacts and, together with auditing and reporting procedures, help establish key components of an Environmental Management System. The MRTS Delhi is likely to throw up a number of environmental challenges during construction. It became imperative to anticipate critical issues in light of experience from other south-asian countries and develop a project specific environmental criteria for this project. To this extent Delhi MRTS Project can be considered a pioneer in applying construction related environmental controls. Thus, the main requirement during construction to monitor and control the pollution on noise, air and water and manage effectively construction related liquid and solid waste shall be met through Contractual obligations.

8 CONCLUSION

Environmental considerations have played a key role in formulating the future transport policy since by signaling the Delhi MRTS project, the planners and decision makers have demonstrated their understanding and concern for deteriorating urban environment and the need to reverse the process. This has sent a clear signal to other state governments to adopt MRTS or LRT as a means of future transport in other metropolitan cities such as Hyderabad, Pune, Bangalore, Kanpur, Lucknow and many others, which face problems similar to Delhi. A conscious decision to adopt an environmentally friendly mode of transport is a manifestation of a significant change in the mindset of transport policy planners in India.

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Urban mobility in developing cities: Difficulties of measures, uncertainty of trends and of sustainability appraisal

La mobilité urbaine dans les villes en développement: difficultés de mesure, incertitude des tendances et de l'évaluation de la durabilité

La movilidad urbana in ciudades en desarollo, difficultades de medidas

X.Godard
INRETS, Institut National de Recherche sur les Transports et leur Sécurité, Aix-en-Provence, France

RÉSUMÉ : On connaît peu la mobilité urbaine et son évolution dans les villes en développement. De multiples obstacles limitent la qualité de l'information disponible. Trois exemples sont donnés de villes (Dakar, Tunis, Sao Paulo) où un effort d'enquête a été mené mais oblige à des interrogations pour en interpréter les résultats. Ce travail d'analyse et de recoupement des données est une nécessité pour fonder toute démarche se préoccupant d'une politique durable intégrant l'environnement.

ABSTRACT : One knows few things about the mobility and its evolution in developing cities. There are multiples obstacles limiting the quality of information. One considers three case of cities (Dakar, Tunis, Sao Paulo) where comprehensive surveys were implemented, with results which call for analysis and debate for their interpretation. These tasks of analysis and consistency checking between multiple data are very necessary for any approach of sustainability integrating environment concern.

The knowledge of urban mobility is weak in developing cities as we can observe through many examples. The absence of appropriate information seems to be the rule. This situation is contrasted with the case of developed cities like in France where many surveys bring information on mobility behavior of various groups and on the global mobility level in the cities, even with some doubtful data. The question of sustainability gives new reasons to advocate the need to design a good information system on mobility and its modal components, though developing cities are confronted to resources scarcity.

We will examine some classical difficulties for building a data basis on urban transport, and we will consider the appraisal of the mobility evolution in cases of Dakar, Tunis and Sao Paulo, considered as examples of the methodological difficulties to interpret the available data. On this basis we want to insist on the caution one has to have in analyzing, debating and concluding about the sustainable trends of urban transport systems.

DIFFICULTIES TO IMPLEMENT A DATA BASIS

The difficulties of knowing mobility pattern and level come usually from many factors, among them : cost of surveys, rapid changes in mobility shapes and in transport supply, insufficient concern of institutions.

More precisely, one can refer to the experience of building urban transport indicators in some western african cities conducted in 1998 by Sitrass, one network of researchers and experts working in Sub-Saharian Africa. One can observe a set of difficulties which limit the possibility of using these indicators from a sustainable way, ie for helping the observation of the evolution of the urban transport sector, in order to appraising the efficiency of passed action. The obstacles one had to overcome can be summarized from the following way :

- No availability of wanted data : no statistical memory by the institutions in charge of the sector ; changes of institutionnal organization ; trend to a personal management of data and reports so that each responsable, when he leaves for another job, does not left available the documentation he had in charge...

- No location (library or something like) where reports and data are gathered and managed for being accessible to whom needs. Documentation is left to the attack of natural elements, or to the robber, visitors who take documents without return...
- Available data are often too old, without correct updating. We have many cases where old data are used in reports 10 or 15 years after, although everyone knows or should know they are very far from the present situation.
- Persons in charge of a wanted information are not very accessible by the indicators responsable. One knows the information circulation is very bad. That means there can often be a volontary attitude to refuse to give the available information and make it public. That comes from the idea there can be some power in the information, and it must be paid from a manner or another.
- administrative obstacles : one must apply a very formal procedure for getting the information (request addressed to the Director, with a very limited hope to get an answer in a correct deadline
- No consistency or adaptation of some indicators usually used in the international middle shaped by developed world approach. The better example is the indicator : number of buses for 1000 inhabitants , out of scope in cities where the transport supply is made with numerous low capacity vehicles.
- Weak involvement or attention given by administrative responsable for data basis and indicators because they are busy with more immediate stakes.

The production of indicators for different time periods is necessary to check the evolution and eventually to manage it towards the objectives of improving the transport efficiency and to improve the mobility conditions. But the observation is one cannot produce meaningful indicators reflecting the real evolution from year to year. For instance the minibuses fleet in Dakar is presented in official documents as amounting around 2000 to 3000 vehicles, with the same estimation in 1992 and in 1998.

The comparison between cities situation based on standardized indicators is useful for a good appraisal of the transport sector state, its efficiency and its sustainability. Nevertheless, there are many methodological questions, which can limit or cancel the learnings of the exercise if they are not solved. Mistakes can therefore be made in diagnosing the situation of the transport system in a city.

QUESTIONS ON THE MOBILITY LEVEL AND ITS EVOLUTION

Debate on mobility level is directly involved by sustainability concern. Is mobility level necessary to increase for social reasons? Has it to decrease for decreasing the environmental pressure? Is it possible to increase non motorized mobility only? The answer should involve the consideration of trip length besides the number of trips but this more detailed information is more rarely available. One limits in this paper the approach to the trips number.

If the mobility is difficult to be appraised for a given period, one has some cases where an effort has been made, offering useful information. But if one considers the sustainability concern, one has to try to estimate the trends in the mobility level, in its structure determined by the urban expansion and the modifications of the population, the way of life, the economic context, the transport supply... This estimation of trends is more difficult and weak in developing cities.

In many cities there is no available information on the mobility level. In other many cities we can have only one survey implemented during the recent period, since 1970 or 1980, thanks to the planning studies. But the information is often old and difficult or impossible to use for a diagnosis in Year 2000. In a limited number of cities, one has available observations for two or three years during the period, which permits comparison and analysis of the evolution. Unfortunately new methodological difficulties appear again for the interpretation of the observed evolutions. From a summarized way, one has to wonder if the evolution in the mobility level is the reflect of the reality or the reflect of differences in the manner the surveys were designed and managed.

DAKAR CASE

Dakar is a pilot-city in the urban Sub Saharian African Transport Programm (SSATP) managed by the World bank.. The first urban transport project was launched in 1997, one of the major components was the creation of Cetud, acting as an organizing authority. A set of studies in all the aspects of the urban transport policy were implemented, mainly on the organization of public transport. The major study dealt with « the organization of public transport, the definition of the network to be franchised, and the ability to pay ». This study made by Systra (1998) aimed to propose a scheme combining the roles of :

- the urban train (PTB)
- the buses (an urban network and a set of suburban lines)
- the artisanat sector of minibuses and shared taxis.

The basis for the scheme design is the knowledge of the mobility, which was considered through O/D matrix and modal share for the year of study. As the study deadlines were very short, the consultant used an adapted survey approach characterized by rapidity and lightness : one implemented surveys on street with a sample of representative points in the conurbation. This methodology was useful for knowing the present state of public transport use, nevertheless it was affected by biases for knowing the mobility structure and level for the whole population : the potential bias comes from the fact one registers with a higher probability the mobility of mobile persons, and people without mobility are not taken in account..

Only a home survey on a representative sample can give a complete estimation of the mobility, but one knows the multiple obstacles to the implementation of these surveys : cost, rigidity and complexity, long time period for getting useful results.

Such a survey is designed in Dakar, under the Cetud responsability, with help of Inrets and Let experts. It has been prepared for many years, since 1996, but has been submitted to funding uncertainty and break in the preparation, as its implementation has been postponed twice. It was planned to be implemented in the period of december 1999-february 2000. Paradoxically this survey comes after the set of studies aiming to designing the scheme of transport organisation in Dakar, and not before. That comes from the difficulty of coordinating studies funded by various institutions, and also from the classical argument of the emergency and the necessity to decide rapidly.

This home survey should bring many information on mobility behavior linked to urban activities and to accessibility to urban services, so that to explore the present expressed needs but also the latent demand which cannot be satisfied because inadequate transport supply. It will highlight the debate on mobility level and the sustainable ways to meet the needs in the multimodal system.

Systra has estimated the average mobility level to 2,3 trips by person (more 5 years) by day, among them 1,3 motorized trips, to be compared to 1980 level which was estimated to 1 : ther would be an increase of 30% of individual motorized mobility, despite of the economic crisis. One can wonder if this level is not overestimated, considering the available information on the transport system in Dakar. The comparison between the estimated traffic in the different modes and the results of this survey suggest the overestimation of motorized mobility and may be the underestimation of walking.

This debate is important from the point of view of the project financial viability, as the urban bus network franchising call for tender was based on these estimations of patronage. The risk for a private operator comes from the fare receipts and the expected patronage able to pay the fares, in a competition scheme with minibuses operators.

It is important also from the point of view of global sustainability, for having a good image of the present situation which has to be compared with the situation to be observed in 5 or 15 years for appraising the evolution and checking if it is in the right direction, for environmental or social concern.

TUNIS CASE

Tunis case is interesting because transport policy was made in favor of public transport, with the LRT operation since 1986(five lines in operation now). It has been combined with a traffic scheme which limits the private car in the center.

One benefits in the Tunis case from households surveys implemented in 1978, 1985, 1994. The global mobility level estimated would decrease strongly if one consider the global results : the mobility level (walking included) was estimated to 3,37 in 1977, 2,06 in 1985, and 1,76 in 1994. Many explanations have been given for this surprising results of decreasing mobility when level of life and motorization are increasing : evolution of peripheral areas, location of schools, increasing the gap between social groups, change in the age pyramid, and so on.

Nevertheless the 1994 survey has been submitted to questions dealing with the adjustments factors between the sample and the whole population. There has been probably many bias, which have not been clearly identified. This has conducted the consultants preparing the transport master plan to select higher hypotheses of mobility : the rate of dayly trips which is used in this study, based on traffic counts, is 1,2 trips compared to the household survey estimation of 0,87.

Actually the main question is the balance between public transport modes and private car. The previous mobility estimations do not give the same image of the increase in the car use and in the efforts to be made for keeping the first role in the mobility system to the public transport system. The official objective of the policy was to maintain the public transport priority, with a share of 55% of tips. But forecasts based on trends show this share could decrease to 40 to 45%. The debate has direct consequences on the investments which are programmed in the sector.

SAO PAULO CASE

Sao Paulo represents a very large conurbation, concentrating industry and offering high incomes for a part of population. Its transport system is based on bus operators and a metro, but the increasing car ownership pushes to the increase in car use in daily mobility, which involves difficult congestion problems.

In Sao Paulo were implemented household-surveys in 1977, 1987 and 1997. It is a source of analysis of the mobility and the modal use evolution. The results are surprising on some points so that one wonders how to interpret them. In 1987 one had observed a stagnation or light decrease of motorized mobility compared to 1977 situation. In 1997, the first results suggest the same fact is registered with a light decrease in the motorized mobility : estimation of 1,23 daily trips by person in 1997, compared to 1,32 trips in 1987. It is too early to have a good view on these parameters which have to be confirmed after the adjustments of data. Beyond the mobility indicator there is the change in the modal share and the increase of private car share in the mobility : 40% in 1987, 46% in 1997.

The main point deals with the necessary detailed analysis of the mobility patterns for appraising the share to be given to the evolution of behavior, to the evolution of urban structure and to the sampling difficulties in such surveys, as we observed in the previous cases..

NECESSITY OF MULTIPLE SOURCES OF INFORMATION

The effort in favor of adapted surveys implementation has to be complemented by efforts of analysis, based on treatment of various sources of information. It is a necessary condition if one wants to have a sound debate and correct design of solutions which can have a chance to be sustainable.

The only way to cope with the difficulties of getting a good information on mobility and modal use is to multiply the sources of information and to analyse them so that to find progressively their consistency, by adjustments of the data.

The sources are :

- Mobility surveys, at home or elsewhere
- Households consumption surveys where transport expenses appear
- Patronage and revenues of transport operators : the revenues of operators are the expenses of households
- Traffic counts where the intensity of traffic is measured and the relative importance of each mode.
- Vehicles fleet
- Gazoline consumption

ENVIRONMENTAL SUSTAINABILITY AND MOBILITY INFORMATION

A right appraisal of urban mobility and its evolution in a city influences the projects diagnosis and their financial feasability : it conditions finally the evaluation and decision of the investments projects, even if many other factors are taken in account.

The new concern with the environment calls for new and accurate measures of pollution emissions, and one guesses many problems of measures and interpretation can appear. It is necessary to distinguish two types of environment concern, the indicators and the measures problems being very different :

- local environment and particularly the pollution
- green house effects, called to be considered more and more on the international scene.

Anyway this concern for environment calls also for a better view of the mobility and transport system making possible a better action. This is true for the local pollution level, but also for global pollution with green house gaz emissions. In this second level, the global approach of mobility and modal usage is of first importance. That is why a necessary step is to reinforce the knowledge about mobility and its measure, in developing cities like in developed cities.

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Estimation of vehicular emission coefficients for countries without emissions inventories: A case study of Kenya

Timothy George Oketch
Institute of Traffic Studies (Verkehrswesen), University of Karlsruhe, Germany

ABSTRACT: The recognition of the contribution of vehicular emissions to atmospheric pollution has led to much research and inventory build up particularly in the industrialised countries. Consequently, emissions data for use in planning analysis is readily available in there, but in the vast majority of developing countries, Kenya included, and this is not the case. It is generally accepted that due to a variety of factors, the emissions rates for vehicle fleets in developing countries are higher than those of similar vehicles in developed countries. These factors include poorer maintenance conditions, the longer service life and the amount of load the vehicles have to carry. However, there is hardly any prior research aimed at trying to cost effectively estimate the actual emission parameters in these countries. This paper proposes a new approach that has been developed and applied to estimate emission coefficients for CO, HC and NOx in Kenya. The main premise of this approach is to acceptably estimate adjustment factors with which emissions coefficients from industrialised countries can be modified to suit the vehicle fleet in a particular developing country. Descriptive data which included age, make, country of manufacture and the presence or absence of emissions control equipment was used to classify vehicles into various technology layers. Each layer was associated with a specific emissions rate, which was then modified by maintenance, age and mileage and loading factors to estimate the Kenyan situation. The maximum values of the adjustment factors were derived based on literature, theoretical framework and on empirical data obtained using a floating vehicle in Germany. These values represented the worst case scenario and two other scenarios were built with lower values. The Kenyan situation was thought to be best described by the middle scenario. Emissions coefficients for Kenyan vehicles were estimated to be up to two to three times higher than typical values in industrialised countries (for Germany up to two times). It was not possible to directly validate these emission values but as a good indicator, comparison of the actual fuel consumption data was done between vehicles in Kenya and those in Germany under similar driving conditions. It was found that the consumption rates in Kenya were also significantly higher (up to 65% higher), thus lending credence to the estimated factors. It was therefore concluded that, whereas the proposed method is not expected to estimate emission rates with a high accuracy, it could nevertheless give acceptable results for use in countries devoid of emission inventories.

1 INTRODUCTION

Air pollution is an important public health problem in most major cities in developing countries and pollutant levels in a majority of these cities exceed those recommended by the World Health Organisation. Epidemiological studies show that air pollution in developing countries results in serious health complications and deaths which translates into huge sums of money in health costs and lost productivity each year (Faiz 1996). The economic losses and the associated degradation in quality of life impose a significant burden on people in all sectors of society and especially the urban poor.

In the less industrialised nations, motorised transport is the dominant source of urban air pollution. It is estimated that transport account for 90% CO, 50%HC 50% NOx and 50% lead emissions although these values may vary with location. This problem is compounded first and foremost by the fact that in most but poorest developing countries, economic growth has triggered a boom in the number and use of motor vehicles. Secondly very little is being done to encourage a balanced mix of transport modes consisting of both motorised and non-motorised modes as well as private and public transport.

Developing countries unlike the OECD countries for example have unique and chaotic factors, which negatively influence their pollution problem both at the present time and in the future. They are characterised by high and correlated rates of motorization, urbanisation and population growth. It is predicted that by the year 2005 the world will be over 50 % urbanised and 80% of the world population will be living in developing countries. In addition the vehicle fleet is comparatively old and there is lack of consistent inspection and maintenance of vehicles.

The recognition of the contribution of vehicular emissions to atmospheric pollution has led to much research and inventory build up particularly in the industrialised countries. Consequently, emissions data for use in planning analysis is readily available there, but in the vast majority of developing countries, Kenya included, and this is not the case. Researchers in the latter countries are therefore faced with a dilemma of what emission coefficients to use, whether or not to use those from developed countries and if so from which country.

It is generally accepted that due to a variety of factors, the emissions rates for vehicle fleets in developing countries are higher than those of similar vehicles in developed countries. These factors include poorer maintenance conditions, the longer service life and the amount of load the vehicles have to carry. In order to accurately establish the emission characteristics of vehicles in a particular locality, it is necessary to carry out actual emission measurements. However, due to monetary constraints this will still remain undone in many countries for a considerable time to come. The question is what can researches do in the meantime?

This paper proposes a method, which can be used to quickly and cost effectively estimate the emission coefficient for developing countries without any actually measured emission-inventories. The main premise of this approach is to acceptably estimate adjustment factors with which emissions coefficients from industrialised countries can be modified to suit the vehicle fleet in a particular developing country. Descriptive data which included age, make, country of manufacture and the presence or absence of emissions control equipment is used in this exercise as they are readily available or can be easily determined. The pollutants considered are carbon monoxide CO, hydrocarbons HC, nitrogen oxides NOx and lead Pb.

The paper is divided into five sections the first being this introduction. The second section outlines various steps covered and in the method and the data requirements. The third section shows how the methodology was applied in Kenya and describes the collection of data necessary for this exercise in Kenya. Results including typical emission coefficients for Kenya are presented in section four. Discussions of these results and some international comparisons are also given in this section. Lastly conclusions and recommendations are give in the fifth section.

2. TRANSFER METHODOLOGY

2.1 Overview

Vehicles in developing countries come mainly from Europe, Japan or the United States which account for 70% of the world sales of cars and light commercial vehicles less than 5 tonnes (Madhavan, 1998). Several indigenous vehicle manufacturers are coming up in developing countries particularly in India, South Korea, Malaysia and China although most of these are done in partnership agreements with established manufacturers in industrialised nations. Further still, the market share of such indigenous vehicles are still comparatively low.

Most developing countries either directly import motor vehicles or manufacture vehicles under license from established firms in industrialised nations. Where the later is the case, in most cases however, vehicles are still manufactured in accordance standards of the home country of the firm. This is because either the host country does not have its own standards, or the existing standards in the host country are less stringent than those of the firm. It is important to add that standards used by firms in the host countries at any one time do not necessarily correspond to the latest ones existing in their home countries.

Those developing countries with some emission regulations are basically using borrowed standards from those industrialised countries with which they engage in most trade or have historical ties. It is therefore a common trend that some Asian countries derive their standards mostly from Japan or the USA and South American countries from the US and Europe. Most African countries do not have any standards although their vehicle fleets are composed mainly of western European and Japanese makes. Consequently, most vehicles all over the world can be classified as having been manufactured under either west European, Japanese or American legislation and technology.

The process of transferring emissions data from industrialised countries to developing ones would therefore involve the following:

Division of vehicles into different layers representing different technologies under which they were manufactured;

Obtaining a base emission rate for each layer. The base emission rate is taken as the typical emission rate for that technological layer in its home country (or region);
Adjustment of the base emission rates for poorer maintenance conditions, age and mileage factors and loading factors.

2.2 Division of Vehicles into Layers

A layer refers to a group of vehicles manufactured under a certain emissions legislation that limits the emissions of one or more pollutants. Each type of vehicle (private car, light duty trucks, buses, heavy-duty trucks and motorcycles) can be classified into layers reflecting the emissions legislation they were manufactured to. Emission legislation started way back in the 1970s and since then they have become even more stringent. An example for gasoline cars category is given in the table 1 below.
Each layer corresponds to a different standard, although not necessary all the standards are included as some were superseded with new ones before they could take effect. An example is the ECE 83 which in practical terms was not implemented by any European country in anticipation of the adoption of the consolidated emissions directive (CONCAWE 1994) Depending on the age and make or the source country, the vehicle fleet in any country can therefore be classified into these layers and the proportion of vehicles falling into each layer fl determined. It can be seen in the above table that for prognosis of future emissions, layers not yet implemented should also be included but they remain inactive in the analysis of the present situation. For such classification, only basic data about age distribution, make of vehicle and country of origin are needed.

2.3 Base Emission Rates

The base emission rate for any layer is the typical emissions for vehicles in that layer for the specific regulatory, vehicular and traffic conditions prevailing in its home country or region.
They represent traffic conditions (age distribution, maintenance) of the respective country of origin and are assumed to be representative of all vehicles in the layer. Data for these rates are readily available in most industrialised nations but emissions from vehicles in the same layer in developing countries are expected to show considerable deviations from them due to factors already mentioned.

For the purposes of this study, data used was from European and Japanese sources. The fleet of vehicles in Kenya is composed of vehicles from Japan and the European Union and there was no need to include the American data. From Europe, detailed data for each of the technological layers were obtained from Umweltbundesamt UBA, 1994 in Berlin (German situation) as well COPERTII report (Computer Program to Calculate Emissions from Road Transport, 1997) which aggregates vehicular emissions for several European countries. Data from Japan was obtained from the Environmental Agency of Japan JEA, 1994 and Japanese Automobile Manufacturers Association JAMA, 1998. Further information is also available from the COPERTII report for vehicular emissions in several European countries.

Table 1: A comprehensive list of possible technological layers for gasoline cars

Layer Description for Gasoline Private Cars		Year	Standard				% Share
			CO	HC	NOx	Unit	
1	Japan1	1975	2.7	0.39	1.6	g/km	f_1
2	Japan2	1978	2.7	0.39	0.48	g/km	f_2
3	Japan3	2003	0.81	0.12	0.14	g/km	f_3
4	EC15.2	1977	80	6.8	10	g/km	f_4
5	EC15.3	1979	65	6	8.5	g/km	f_5
6	EC15.4	1984	58	19.0		g/km	f_6
7	ECE 83	1988	30	8.00		g/km	f_7
8	EC 92 –consolidated	1992	3.16	1.13		g/km	f_8
9	EC 97	1997	2.2	0.50		g/km	f_9
10	EC 00	2000	2.3	0.2	0.15	g/km	f_{10}
11	EC 05	2005	1.0	0.1	0.08	g/km	f_{11}
12	US1	1975	15	1.5	3.1	g/mile	f_{12}
13	US2	1977	15	1.5	2.0	g/mile	f_{13}
14	US3	1981	7.0	0.41	1.0	g/mile	f_{14}
15	US4	1996	3.4	0.25	0.4	g/mile	f_{15}
16	US5	2004	1.7	0.13	0.2	g/mile	f_{16}

The data is in form of emission rates for different vehicle types manufactured under different regulations. The UBA data gives emissions for year 1980 through to 2010 for specifically defined traffic situations that correspond to driving at certain speeds for the urban traffic. COPPERTII report gives emissions as a function of speeds for the different pollutants whereas JAMA data gives typical emissions at various speed ranges.

2.4 Adjustments for Maintenance Condition, Age/Mileage, and Loading

2.4.1 Maintenance

Routine inspection and maintenance largely affect the emissions from motor vehicles and where they are not in place, common problems such as idle mixture, ignition, timing choke and induction system malfunctions occur, and these significantly increase emissions. Direct relationships between emissions and the maintenance condition do not exist but there are clear trends that emissions can increase many times over for some pollutants if proper inspection and maintenance conditions are not in place.

Since the 1970s and early 1980s when much research was done to quantify the merits of mandatory inspection and maintenance programs, there is hardly any further reported work on the subject. Klausmeier 1980, reported that HC and CO emissions from vehicles with defective fuel systems can be twice as much as for those in good order and that reductions in pollutant emissions by regular inspection and maintenance was also dependant on the type of mechanic among other factors. Repairs done by owners themselves (and other mechanics with hands on experience only) might even have a negative effect on the emission reductions.

Among uncontrolled vehicles, differences in HC and CO emissions between properly adjusted and maintained engine and one that is poorly adjusted can amount to a factor of four or more. CO emissions can increase by up to 400 % through normal drift of engine settings between routine services (Faiz, 1996). In addition, malfunctions of or tampering with emission control equipment can cause emissions to rise up to 20 or more times (Faiz, 1996). Other earlier reports (Klausmeier, 1980, TÜV Rheinland, 1979) gave similar trends but with somewhat lower factors for older vehicle models. Consequently, a ceiling factor of 2.5 for vehicles in bad condition looks reasonable.

2.4.2 Age and Mileage

Emission factors generally increase with age and mileage due wearing out of engine components. William and Everett, 1983 reported some correlation for the increase of CO and HC emissions for vehicle brands manufactured between 1971 and 1982. Similar studies in Germany (Hassel, 1995) found strong correlation for vehicles fitted with regulated catalysts and concluded that the emissions for CO, HC, and NOx would practically double by a mileage of about 120,000 km.

For uncontrolled vehicles or those fitted with unregulated catalysts, such correlation, if they exist, are expected to be lower mainly due to the fact the air fuel mixture for stoichiometric is not controlled. However electronic control devices for stoichiometric have been used for Japanese vehicles since 1970s (Faiz, 1996, JAMA 1998) and these are capable of reducing emissions even in the absence of catalysts. As a result, vehicles using such gadgets with or without catalysts are also expected to show consistent deterioration of emissions with age.

Adjustment factors for age would therefore depend on the layer in consideration with sensitive ones (e.g. with regulated catalytic converters) having higher values but insensitive ones remaining unchanged. To simplify the exercise, one encompassing factor with a maximum value of 1.5 is suggested for all vehicles with the average for any traffic situation depending on composition of its layers.

2.4.3 Loading

When vehicles are heavily loaded, they require more power for motion and consequently consume more fuel thus producing more emissions. The base emission rates assume average loading patterns but on the contrary, the situation in many developing countries is such that most vehicles, particularly those used for passenger or for goods transport, are heavily loaded. Worse still is the situation in most Asian countries where many vehicle derivatives transporting many passengers are often fitted with only a motorcycle engine (Faiz 1996, VWS, 1991). This overloading varies depending on local characteristics and factors such as direction of travel and time of the day. To cater for these heavier loading, correction ranging from 1.0 to 1.5 depending on local situations and vehicle types is used.

3. DATA COLLECTION AND CLASSIFICATION OF VEHICLES IN KENYA

3.1 Data Collection

The aim of the data collection was to be able to gather information which can be used to classify vehicles in different technological layers and to assess the modification factors associated with maintenance

conditions, ageing and travel mileage and finally loading. This data could be classified into:
Vehicle characteristics: country of origin, make, type, fuel used, age, mileage and usage
Maintenance history: frequency and type of repair, nature of garage

In addition, fuel consumption data was collected and fuel consumption test conducted on some chosen vehicles in order to asses lead emissions in Kenya. This had to be done separately as the available data from industrialised nations do not include lead emissions are the use of leaded fuel is being faced out. Details of these are given in section 3.5.

Data collection involved interviews using questionnaires. Vehicles were sampled randomly at normal parking places in towns and at shopping centres all over Nairobi and also at special designated parking for passenger transport vehicles. Age data was later confirmed for each vehicle from official records with the licensing authority.

3.1.1 Sampling

Overall population was taken as motor vehicles in current use in Kenya at the time of data collection and its size was to be indicated by the number of licensed vehicles. Reliable data on the number of licensed vehicles was not available; most data that could be used to calculate it are incomplete. Based on estimates of sold licences this number is estimated at 350,000 to 400,000 vehicles. Sampling was done in Nairobi only but available data show that up to 83% of all vehicles in Kenya are registered for use in Nairobi. This therefore means that a sample taken in Nairobi would also be representative for the whole country.

A simplified stratified sampling method was used. In order to minimise variations for estimates of proportions a sample of size of at least 1000 vehicles was targeted. The vehicles were divided into homogenous strata according to their types. Due to lack of reliable data on the overall population, the priori used was estimated from traffic counts at various roads in the city. Random sampling was then done to ensure that the number of vehicles interviewed in each stratum corresponded to pre-determined rates. This led to interviews of about 1200 drivers.

3.1.2 Quality of Data

Sampling error was estimated to be up to 4% for the central measures of mean and standard deviation. Systematic errors or those arising from sampling bias were expected to be negligible basically because in most instances, each class of vehicle was treated separately.

Comparison of the basic characteristics like proportion of makes and fuel used for the sample against those for the whole population showed minimal variations. As is already mentioned, comprehensive statistical data on the overall population was not available. However, comparisons were conducted on the basis of data from Motor Vehicle Registry (MVR) and Central Bureau of Statistics (CBS). It should be noted that the MVR and CBS data, which represent newly motor vehicles registered in the past 30 and 15 years respectively, do not exactly correspond to the overall population of interest (i.e. vehicles with current licences) but closely describe it.

Table 2 shows classification of vehicles according to fuel usage based on results of the interview and on MVR data. It can be seen that the results for all vehicles (80%: 20%) compare favourably with MVR data (78%: 22%). Similarly figure 1 shows the distribution of vehicles according to their make and these also compare reasonably well with CBS data. The highest difference was in the make shown as others and the reason for this is that the CBS data contained even old vehicles which are no longer in use at the time of data collection.

3.2 Establishment of Technological Layers

The vehicle fleet in Kenya is primarily composed of Japanese vehicles and European vehicles having a share of 78% and 22% respectively. These vehicles are either directly imported mostly as used vehicles

Table 2: Type of fuel used by different vehicle types. Data from Motor Vehicle Registry (MVR) is for about 350,000 vehicles.

Fuel Used	From Interviews					MVR Data
	Vehicle Types					
	Cars Pick-up	Vans	Mini bus L. Trucks	Buses H. Trucks	All Types	All Types
Petrol	94	86	11	0	80	78
Diesel	6	14	89	100	20	22
Total	100	100	100	100	100	100

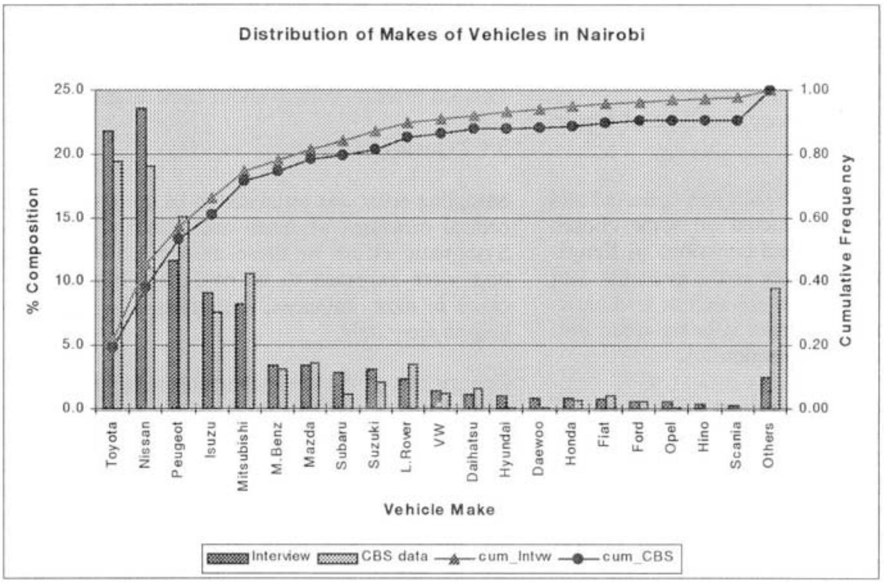

Figure1: Distribution of makes of vehicles obtained from the interviews and from Central Bureau of Statistics (CBS). CBS data for about 200,000 vehicles.

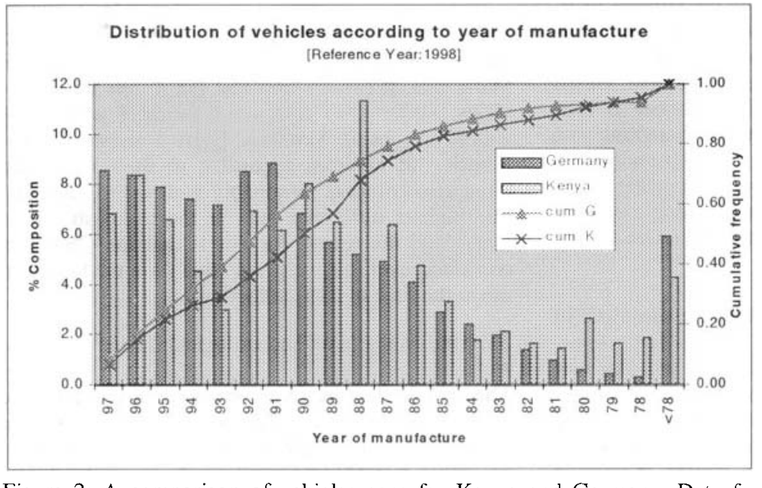

Figure 2: A comparison of vehicles ages for Kenya and Germany. Data for Kenya was from interviews and confirmed from official record. Average age in Kenya 8.08 years and in Germany 6.75 years.

or as completely knocked down (CKD) units and assembled within the country. From the interviews imported vehicles constitute about 45% whereas those assembled in the country about 55%. Imported vehicles in Kenya can therefore be easily divided into different European or Japanese technological layers.

Those assembled in the country cannot be classified that easily however, due to lack of candid data from the manufacturers. They are therefore subjected to technological transfer lag, to allow for the time lag before the production according to the newly stipulated standards to commence in the host country. This is assumed to last five years from the time that the standard became effective in the home country.

(In many cases however, there are others like the regulated three-way catalyst that take longer before adoption in the country).

Figure 2 gives the basis of classification in different technological layers. On the basis of the year and place manufacture and the emissions control technology, vehicles are separated into various layers. As can be seen in the figure, the modal years are in the range 1991 to 1987. This is because a lot of vehicles registered in Kenya are imported as used vehicles and the majority is 4 to 8 years old.

3.3 Assessment of Maintenance Condition

A quantitative measurement for maintenance does not exist, and without mechanical inspection or an emissions test on a vehicle, it is not easy to classify its maintenance condition. Information about its condition can only be inferred through secondary data particularly its maintenance history and other relevant data, all of which can be obtained relatively easily. These include:

1. Type of repairs;
2. Frequency of repairs;
3. Intensity of usage of the vehicle; and
4. Nature of garage where vehicle is usually repaired.

Type of Repair

Repairs influencing emissions are those which involve tuning, adjustments of dwell and air fuel/ratios and spark timing. Vehicle servicing (change of filters, sparks plugs, oil etc) also influence emissions to a large extent as these have also a bearing on quality air and fuel intake and consequently their mixture. From the above figure, it can be therefore concluded that more than 90% of all reported repairs would influence emissions. Frequency at which a vehicle is repaired depends on its intensity of usage. During the interviews, drivers were asked on how much mileage they cover monthly or yearly but most of them were not certain of this. Consequently the data they gave was unreliable.

In general terms however, the intensity of use can also be inferred from the type of use the vehicle is subjected to. Vehicles used in public transport generally travel the most followed by those for goods transport whereas private vehicles travel the least.

Table 3: Categorisation of vehicle condition with respect to their repair frequency and type of use. *OK*: Expected behaviour, *NS*: Unexpected behaviour.

Usage of Vehicle	Frequency of repair in months			
	1	2 to 5	6 – 12	>12
Private use	NS	**OK**	**OK**	NS
Goods transport	**OK**	**OK**	NS	NS
Passenger transport	**OK**	NS	NS	NS

A criterion that could help in estimating the vehicle condition is to compare its repair frequency against its usage. It would be expected that vehicles that travel more should also have a higher repair frequency and that those which travel less conversely also have a lower repair frequency. Consequently it could be an abnormal behaviour to have lower repair frequencies where the travel is higher and conversely, higher repair frequencies with lower travel intensity. An intermediate classification of vehicle conditions according to this criterion is given in table 3.

A private vehicle, which is taken for repair every month, is likely to be in an unsatisfactory maintenance condition just as one taken only once or less in year. On the other hand it is expected that vehicles for passenger and goods transport are taken for repair more frequently since they travel more. Those that are taken after longer periods of time are also likely to be in poorer state.

Nature of Repair Garage

The garage at which a vehicle is repaired may in itself not affect emissions, but the nature of the workmanship does. Proper tuning and adjustments can only be achieved in well-equipped garages with properly qualified technical staff. Street mechanics as well as most non-dealer garages neither possess the necessary equipment nor the technical know-how to be able to tune vehicles accurately. The distribution of vehicles according to their usual repair place is given in figure 3. As already mentioned defective adjustment results in higher pollutant emissions.

A final classification of maintenance condition of vehicles can be achieved by further combining nature of garage and the behaviour classification from table 3. Four conditions are utilised as good, medium to good, bad to medium and finally bad, and these are derived as given in Table 4. Figure 4 indicates the distribution of different vehicle types in Kenya into the various maintenance classes. The group private cars has the highest proportion of vehicles in good condition whereas light vehicles the least. The adjustment factor associated with each maintenance class is expected to vary between the two extremes.

A special layer for used gasoline vehicles imported from Japan has been set up separately for the Kenyan situation. These vehicles can be considered as tampered with because although they were manufactured for use in Japan where only leaded fuel has been in use since 1977, they are powered by leaded gasoline in Kenya. Most vehicles in Japan are fitted with three way catalysts although that is not a man-

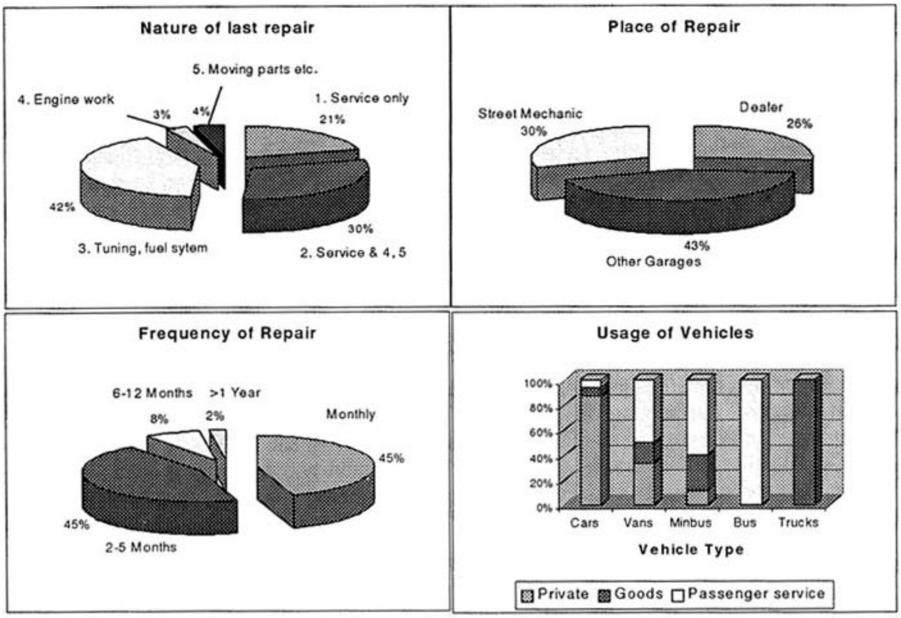

Figure 3: Repair characteristics and usage of vehicles in Kenya

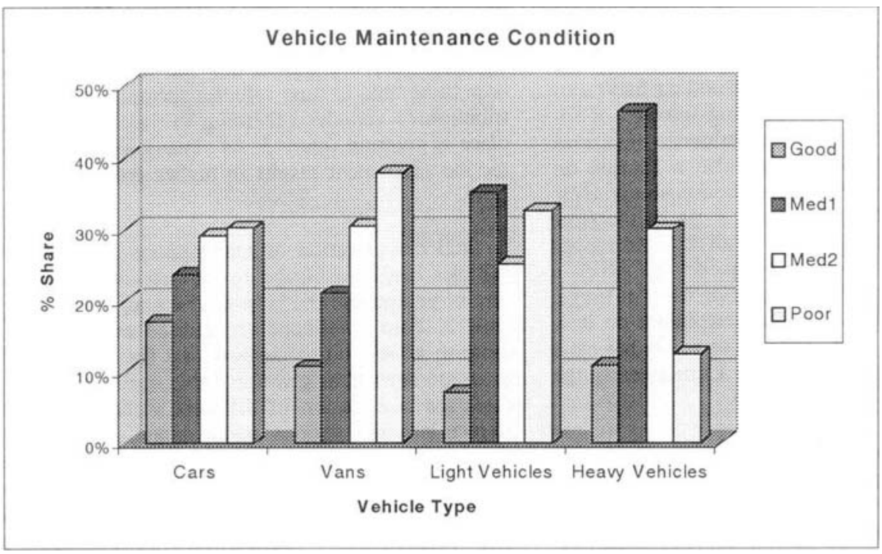

Figure 4: Division of vehicle types into classes of maintenance condition

datory requirement (JAMA 1998). To allow for use in Kenya, some adjustments have to be made which in most cases involves the removal of the whole equipment. Consequently the emissions from these vehicles are expected to be much higher and consequently require a higher adjustment factor. Among the European countries, Britain is the predominant exporter of used vehicles to Kenya. In comparison to other European countries, Britain still has a large proportion of vehicles powered with leaded gasoline [CONCAWE 1995]. The proportion of vehicles from Europe requiring similar treatment is therefore still negligible.

Table 4: Final Classification of Maintenance Condition of Vehicles

Type of Garage	Repair behaviour classification	
	OK: Expected	NS: Unexpected
Dealer	Good, G	Lower medium, M2
Other non-dealer garages	Upper medium, M1	Bad
Street mechanics	Lower medium, M2	Bad

Table 5: Fuel consumption rates for selected gasoline vehicles in Kenya and Germany. Average speed of about 26 km/h.

Type	Capacity ['000cc]	Fuel consumption for vehicles in Kenya. Data for 100 vehicles			Fuel consumption in Germany [g/km]
		Ages	Mileage ['000 km]	Consumption rate [g/km]	
Car	<1.4	3-14	20-166	90	61
Car	1.4 - 2.0	1-9	50-124	95	74
Car	>2.0	1-18	47-272	156	94
All Cars	All	1-18	20-272	101	71
Vans	>2.0	4-8	69-129	113	94

3.4 Assessment of Age, Mileage and Loading

Vehicles in Kenya have an average age of 8 years (Fig1) with a mileage of 163,000 km whereas in Japan the average service life is just above 9 years (JAMA 1998), thus working out to an average age of about 5 years with correspondingly lower mileage. In Germany, the average age of vehicles is about 81 months or 6.75 years (KBA, 1998). Adjustment factors for age would therefore tend towards the lower values for the European vehicles and somewhat higher for the Japanese vehicles.

In Kenya for example, most vehicles for passenger and for goods transport are usually overloaded. However, private vehicles are rarely overloaded and therefore may not require any adjustment for loading.

3.5 Fuel Consumption and Lead Emissions

Lead is used as an additive to gasoline fuel to improve its volatility. However owing to environmental concerns, the use of lead has been steadily reducing especially in industrialised countries like in EC which has a ceiling lead content set a limit of 0.15g/l. The use of unleaded petrol exceeds 50% in OECD countries but most developing countries still use only leaded gasoline predominantly. Many of those countries have a lead content ranging from 0.15 to 1.5 grams per litre of petrol. Kenya uses a maximum of 0.6g/l of leaded in petrol.

Lead emissions are directly proportional to lead content in petrol since it is not consumed up during the engine combustion process. For every quantity of fuel consumed, the amount of lead emitted may be slightly less than actual lead content due to loses and retainment in the engine. A value of 75% for this amount is frequently used and it was on the same basis that lead emissions were calculated for the Kenyan situation.

Fuel consumption data for various vehicle types was collected from various organisations with large fleets of vehicles including the official public transport company. In addition, tests were carried out on twenty private cars and vans in order to determine accurate consumption rates for validation of the collected data and to estimate the travel speeds associated with those fuel consumption values. The test results was in good agreement with collected data and the average urban travel speed was found to be about 26 km per hour.

The obtained fuel consumption rates are shown in Table 6. When compared with the German data for urban driving cycles of the same average speeds, the data shows that fuel consumption in Kenya is significantly higher, in some cases up to 60% higher. Similarly they are also higher than those in Singapore which yielded an average of 61g/l for cars with a mean engine capacity of 1.3 litres driven at similar average speed in urban area (Fwa, 1992). These findings can be attributed mainly to differences cited above.

3.6 Adjustment Factors

The overall ranges and limits of proposed adjustment factors for base emission rates are given in Table 6. These ranges have been set based on the foregoing literature. Three scenarios were consequently built up for the Kenyan situation. The present scenario assumes the adjustment factors that were assessed using the available data. The best scenario assumes that the emission characteristics of vehicles in different technologcal in Kenya are the same as those of corresponding vehicles in the source countries. Minor adjustments to age differences are applied. The worst scenario is built up assuming that the situation in Kenya warrants the use of the highest values of the adjustment factors.

From the foregoing literature, variations of 400% or more have been reported as result of incorrect tuning of vehicles alone (Potter and Savage 1986). Combined with other factors, the emissions could be much higher. The maximum values of these factors have been set based on available information in published literature. In assigning these limiting values, it was assumed that when these factors act together, the final deviation of emission rates would generally be within the ranges ever observed. In extreme cases, damaged catalytic converters or malfunctioning fuel injection system can increase emissions by up to 20 times (Faiz 1996). To be realistic, the maximum factors were chosen to yield emissions which can be up to 7.5 times more for the worst case. It must be stressed here that prior assessment of the traffic situation in any locality is necessary in order to assign values of the adjustment factors.

4. ESTIMATED EMISSION COEFFICIENTS AND COMPARISONS

Table 7 gives a summary of estimated emission coefficients for Kenyan situation under the different emission scenarios for a driving speed range of about 25 km/h. Emissions for other speed classes were also determined in the same way. Lead emissions were calculated from fuel consumption data and are not subjected to scenario analysis. Emissions at scenario 2, which is expected to best represent the Kenyan situation, are two to three times those of the best scenario. The best scenario corresponds with data from Japan and Europe and can be seen to be in

Table 6: Proposed adjustment factors to be applied to base rates for CO, HC and NOx emissions for vehicles in developing countries. Scenarios apply to the Kenyan situation only.

Type of Adjustment	ADJUSTMENT FACTOR				
	Classification	Range of possible values	Scenario 1 Best	Scenario 2 Present	Scenario 3 Worst
Maintenance Condition	Good	1.0 – 2.5	1.00	1.10	1.20
	Medium1		1.20	1.40	1.60
	Medium2		1.60	1.80	2.00
	Bad		2.00	2.25	2.50
Age and Mileage	0-10 years	1.0 – 2.0	1.00	1.10	1.20
	More than10 years		1.20	1.60	2.00
Loading	Private cars	1.0 – 1.5	1.00	1.05	1.10
	Passenger vehicles		1.10	1.30	1.50
	Goods vehicles		1.10	1.30	1.50

Table 7: Estimated emission coefficients for Kenyan situation under the different emission scenarios.

Emissions [g/km]	Private cars Gasoline	Private cars diesel	Vans Gasoline	Vans diesel	Light Vehicles Gasoline	Light Vehicles Diesel	Heavy Vehicles diesel	Motor cycles Gasoline
Scenario 2 (most representative)								
CO	**17.05**	**1.36**	**19.35**	**1.57**	**23.97**	**2.17**	**10.72**	**33.24**
HC	**2.31**	**0.28**	**2.63**	**0.33**	**3.31**	**0.17**	**5.62**	**8.18**
NOx	**1.76**	**1.65**	**2.00**	**1.90**	**3.20**	**3.80**	**20.53**	**0.09**
Lead	**0.06**	**0.00**	**0.07**	**0.00**	**0.08**	**0.00**	**0.00**	**0.02**
Scenario 1 (best case)								
CO	5.91	0.65	5.91	0.65	9.89	0.90	4.88	25.18
HC	0.85	0.13	0.86	0.13	1.37	0.29	2.56	6.20
NOx	0.63	0.79	0.63	0.79	1.32	1.57	9.37	0.07
Scenario 3 (worst case)								
CO	21.29	2.33	26.61	2.91	44.49	4.03	21.95	75.54
HC	3.10	0.49	3.88	0.61	6.15	1.31	11.51	18.60
NOx	2.26	2.85	2.82	3.57	5.94	7.05	42.03	0.21

Table 8: Reported emission coefficients for other developing countries [Indonesia: VWS 1991/1992, India: Goyal 1998]

Emissions [g/km]	Private cars		Vans		Light Vehicles		Heavy	Motor cycles
	Gasoline	diesel	Gasoline	diesel	Gasoline	diesel	Vehicles diesel	Gasoline
Germany 1998								
CO	3.57	0.61	3.57	0.61	6.93	0.90	10.72	20.95
HC	0.47	0.10	0.47	0.10	1.14	0.19	5.62	3.27
NOx	0.47	0.65	0.47	0.65	1.05	1.06	20.53	0.14
Japan 1998								
CO	2.58	0.58	2.58	0.58	12.42	0.49	4.50	
HC	0.27	0.11	0.27	0.11	1.50	0.31	2.60	
NOx	0.28	0.44	0.28	0.44	0.60	1.50	7.50	
Indonesia 1991								
CO	23.50	5.15	23.50	5.15	41.40	5.32	2.57	19.20
HC	2.23	0.49	2.23	0.49	9.14	0.51	1.58	3.99
NOx	6.87	1.26	6.87	1.26	3.93	1.48	10.40	0.13
India 1998								
Nox	3.20	0.99	3.20	0.99	-	-	21.00	0.07

the same order of magnitude as the actual data from the two countries (Table 8.)

On comparison of the estimates of scenario 2 with those for other developing countries (Table 8), it can be seen that the estimates are generally in the same order of magnitude. NOx emissions India compare well with the estimates above. However the data for Indonesia has generally higher individual values and this could be attributed to the fact that it is for the year 1991 and is expected to be higher than what is presently in Kenya. It should also be noted that the information availed in the references from those other countries was not adequate to judge the accuracy of the provided emission rates.

As is already noted, actual values for fuel consumption are much higher in Kenya than in Germany and this is expected to arise because of the factors already discussed (i.e. maintenance, age/mileage and loading). They at least give direct insight that actual emissions in Kenya are also likely to be higher than in Germany by at least the same order.

Although this method can best be described as approximate, it yields plausible results which can be used where no emissions data exists. Of important to its success is the correct division of vehicles into layers and the choice of the adjustment factors for maintenance, age and mileage and loading. With basic data the various layers can be identified and assessment done to assign the factors logically.

CONCLUSION

A methodology of how emissions data from industrialised countries can be used in developing countries was presented and exemplified for the Kenyan situation. Factors for adjustment of those emissions rates were assigned for maintenance condition, age and mileage as well as loading characteristics of vehicles. For each vehicle category, emissions for CO, HC and NOx were estimated to be two to three times higher those of industrialised countries.

The estimated emissions compare reasonably well with those reported from some developing countries. In addition, fuel consumption rates for specific vehicle classes were found to be 40% to 60% higher in Kenya than in Germany. It can be concluded that the proposed method indeed yields plausible results when applied with due consideration to the traffic and vehicle characteristics existing in a particular country.

It should be noted however that actual measurements of tail pipe emissions still need to be carried out in order to establish actual and accurate data of the emissions characteristics of vehicles in any country. The methods proposed here are meant to be stop gap measures that can be used to before actual measurements can be conducted.

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Urban public transport and environmental economics – Evolving a model: A tale of two Indian cities, Pune and Banglore

A. Khan & P. Udayakumar
Central Institute of Road Transport, Pune, India

ABSTRACT : The 1991 census, explained that at present there are 23 metropolitan cities in India and it is likely to increase by 30, by the turn of the century. The rate of urbanization will increase from 23 % to 30 % which means one-third of Indian population will live in metropolitan cities. On the other hand, the rate of vehicular population growth in metropolitan cities in India increase between 15 % and 200 % each year. Out of which major share has been taken by personalised vehicles i. e. , two-wheelers and cars. From this statistics one can find out the increase in the levels of pollution from metropolitan cities.

The situation has been worsen due to lack of policy where the personalised modes is getting the priority than promotion of public transport. With this given background, the paper will attempt to analyse the following objectives :

1. To analyse the polluant levels from different modes of vehicles (two-wheelers, three-wheelers, cars, jeep) and estimate the future contribution in the light of present policy level (Promoting public transport).
2. Comparative analisys of the public transport (Bus) and Personalised modes in the context of fuel consumption, fuel cost, congestion, emission and total cost.
3. Critical analisys of policies and programmes for promoting public transport in the context of Indian Cities.
4. Evolving a model for promoting public transport in the context of Environmental Economics.

An analisys of the impact of environmental pollution in urban public transport in India can, at best, be speculative. This is because inadequate information on different data regarding the pollution aspect is available for different periods. This has been responsible for several scholars and policy makers trying to achieve a feasible solution on environmental pollution in India cities. On the other hand, this has aslo let many of the protagonists and environmental economists to suggest that the critics must wait for reliable data to become available from national data gathering agencies and until then the government should go ahead with the present situation. However, given the limitation of the existing data base and the urgency of understanding the implication of the changes in the macro parameters, environmental economics and pollution, there is no option but together available secondary data and assess the impact of environmental economics in a somewhat unsatisfactory manner. Within this given background the paper attempts to built up an analytical framework for the study based on the trend of vehicle population growth, pollution aspect, urban public transport etc. in the following section.

Section I : analysed the present trend of urbanisation process and the growth of vehicle population in metropolitan cities in general and estimated future contribution of pollution in the light of the policy changes.

Section II : attempted to analyse environmental pollution of the public transport and non public mode in the context of fuel consumption, fuel cost, congestion, emission and total cost for Banglore and Pune city.

Section III : tried to evolve a holistic model for promoting urban environmental management system in the context of environmental management system in the context of environmental economics.

Section I: Urbanisation and Urban Transport

It is expected that by 2011 A.D. two thirds of India's population will live in urban areas. Urbanisation in India is part of the demographic and economic change, that is inexorably and speedily spreading across the developing countries. Every third person in the world is a city dweller, and 30 years from now, there will be more people in the cities than villages, and of the 400 million plus cities, 264 will be in the developing countries, including 40 in India. The urban population of India has grown nearly four times since 1951, from 62 million in that year to 217 million in 1991 or about 27 per cent the total population spread over 4689 urban agglomerations. (Padam, 1999).

The levels of urbanisation vary across the states. Of the total urban population, 62.5 per cent is concentrated in 320 cities with a population of over 1, 00, 000 and 35 per cent in the 23 metropolitan cities. Contrary to the popular impression, upto 60 per cent of the growth of cities is on account of natural increase and extension of city limits, and the role of migration is diminishing. In the context of economic reform, it is important to note that the process of urbanisation has been accompanied by major economic and structural changes. The share of the urban sector in the Gross Domestic Product (GDP) has risen from 29 per cent in 1951 to 47 per cent in 1981 and it was 60 per cent in 1991. The urban - rural per capita GDP ratio, has increased from 1.97 in 1951 to 3.62 in 1991, according to estimates made by the Planning Commission, Governmental of India. During the period 1965-89, the contribution of industry to GDP went up from 22 per cent to 29 per cent , and that of services from 34 per cent to 41 per cent. The percentage share of urban areas in the Net domestic product (NDP) generated in different non-agricultural sectors like manufacturing, transport, trade and other services, ranges from 57 per cent to 77 per cent.

According to Motor Transport Statistics, the annual rate of growth of motor vehicles in India is 10 per cent. In 1985 there were 9 million vehicles. After 11 years 10 1996, this number increased by $3^{1/2}$ times to be 41.1 million (Table I). The basic problem is not the number of vehicles in the country, but their over concentration in a few selected cities. If one compares the population per passenger car in different countries, it will be revealing to note that in 1989 in USA every two persons owned a car, in Japan every 10 people had a car while this figure for India was 353.

A majority of motor vehicles in India, are concentrated in urban centres and it will be alarming to note that 49 per cent of these vehicles are plying on the roads of just three mega-cities - Delhi (30 per cent), Mumbai (11 per cent) and Chennai (8 per cent). This fact also reveals that 30 per cent of the total vehicles in India are registered in just one city - Delhi.

Traffic composition in India is of a mixed nature. There is a variety of about a dozen types of both slow moving and fast moving vehicles. Stray cattles also move freely on major roads of many large cities including Delhi. A modal split indicates that in 1986, about 61 per cent of total vehicles were 2-wheeler which increased to 68.75 per cent by 1996. With multinationals entering the Indian market, the share of 2-wheelers is likely to increase to about 75 per cent in the next ten years.

Most of the cities in India do not have an efficient and reliable mass transport system. Mass rapid transport system, which is the backbone of a metro-city, is only available in 5 out to 23 such cities. Delhi, the national capital, has yet to have the facility. Manufacturing of 2-wheeler vehicles has gone up by 20 per cent per year while that of buses in only one per cent. As a result, the percentage of cars and 2-wheeler scooters, out of the total number of vehicles is 91 in Kanpur, 88 in Hyderabad and 86 in Nagpur whereas buses in these cities constitute 0.5, 0.52 and 0.37 per cent respectively. It will be alarming to note that the percentage of buses in India as a whole has decreased 11.5 per cent in 1961-62 to 1.9 per cent in 1998-99.

The area occupied by roads and streets in Class-I cities in India in only 16.1 per cent of the total developed area while the corresponding figure for USA us 28.19 per cent. The road space in India cities, is therefore, grossly insufficient. To make the bad situation worst, most of the major roads and junctions in Indian cities are heavily encroached upon by road side shop keepers, pavement dwellers and persons engaged in informal commercial activities. Provision of street furniture causes obstruction to free flow of pedestrians forcing them to move on carriageway.

Section II : Environmental Economics - A tale of Two Cities

There is a direct relationship between transport system and health and safety in a city. Emissions from motor vehicles pollutes the air which, in turn, affects the health of people and makes cities unsafe for living and working. Large volume of vehicles, mixed nature of traffic composition and less area of road space, inter alia, reduce speed, cause delays, traffics jams and idle fuel consumption. All of these add to air pollution, accidents, physicalstress, mental tension, respiratory diseases and a fear psychosis.

The average peak hour speed in Pune is about 7 km per hour (kmph) when the permissible speed limit ranges from 30 to 60 kmph. As per Centre for Science & Environment (CSE), the quantity of all the three pollutants of air namely, CO, hydrocarbons and nitrogen oxides, drastically increases in slow speeds. For example at 75 kmph, emission of CO is 6.40 gm/km/vehicle which at 10 kmph increases by five times to 33.02 gm/km/vehicle. Similarly emission of hydrocarbons, at the same speeds, increases by 4.8 times from 0.93 to 4.47 gm/km/vehicle.

The ambient air pollution, in terms of suspended particulate matter (SPM), in all metropolitan cities exceeds the limits set by World Health Organisation (WHO). In Pune and Bangalore the average annual emission of SPM is 543 micrograms per cubic meter while WHO standard is only 150. In case of Cacutta and Mumbai, the corresponding figures are 394 and 226, respectively. According to one study, the air pollution due to vehicles in Pune will rise from 59 per cent in 1991 to 78 per cent in 2010. The study also shows that 98 per cent tempos and trucks, 94 per cent buses, 82 per cent taxies, 66 per cent 2-wheelers and 52 per cent cars are found to have emission above the permissible limit. A Random check of 1092 new vehicles in Pune, found 43.6 per cent that failed to meet the standards, in case of Bangalore it is 42 per cent. In case of old vehicles, it was found 52 and 51 per cent failing the emission test in Pune and Bangalore, respectively. It is surprising the even the new vehicles are adding to the air pollution in the city. On the official record of the Transport Authority, however, a different picture is seen where more than 80 per cent of all vehicles in both the cities have pollution under control. If no action is taken, the projected air quality of these two cities in India is likely to deteriorate by a factor of the next 10 to 15 years

Vehicle emission pollutes the air, which in turn affects the human health and quality of life in a city. Polluants from vehicular emission, depending upon their effect on human body, can be divided into the following three types :

- those which exert inflammatory effect on the respiratory organs ;
- Those which produce toxic systematic effects ; and
- Those which produce carcinogenic substances.

Bangalore city

Currently, automobiles in Bangalore contribute majority of the air pollution. In 1996, Bangalore total vehicle population is 9 lakhs, which stands second among the major metropolitan cities vehicular population. (delhi stands first with vehicle population of 26.30 lakhs) as seen from table 1.

TABLE 1:
VEHICULAR POPULATION IN MAJOR CITIES
AS ON 31ST MARCH 1996

(In thousands)

City	1991	1992	1993	1994	1995	1996
Bangalore	577	605	654	716	798	900
Chennai	544	604	641	689	768	812
Mumbai	629	647	646	608	667	724
Delhi	1813	1963	2097	2239	2432	2630
Calcutta	475	497	517	545	561	561
Pune	280	296	313	331	358	412

Source. Transport Statistics in India, 1997 by MOST

The city has been experiencing a rapid growth in motorised vehicles : an average annual growth rate of 9.3 per cent between 1991 and 1996.

In terms of vehicular composition, the personalised vehicles (like cars, jeeps, two-wheelers) in Bangalore constitute about 88 % (9.27 lakhs vehicles) of total vehicles (about 10.44 lakhs in 1998), with the share of two-wheelers and cars/jeeps about 74 % and 14 % respectively. The share of buses, three-wheelers and trucks are about 1 %, 5 % and 3 % respectively ; In the recent past, diesel driven personal cars have been increasing.

Table 1 shows the growth of motor vehicles in Bangalore between 1991 and 1996. Among the personal vehicles, ownership of two-wheelers have increased more than one and a half times between 1991 and 1998 as seen from Table 2.

TABLE 2 : NO.OF VEHICLES REGISTERED AND KEPT FOR THE USE IN BANGALORE FROM 1990-91 TO 1997-98

	Category	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98
1	Two wheelers	458860	500613	525317	517171	574578	641298	723626	778640
2	Three wheelers	17379	23096	25478	29755	33238	37876	46164	48606
3	Cars	82205	90939	89879	91690	105115	117101	133096	142921
4	Jeeps	6376	6807	6474	4204	4690	5650	5790	6020
5	Omni buses	2532	2663	3182	4032	3853	4376	5487	7114
6	KSRTC buses	2483	2661	2892	3796	3925	4118	4483	531
7	BMTC buses	1614	1664	1702	1796	1819	1926	1924	2088
8	Pvt Buses	419	489	534	321	710	954	1054	1081
9	Trucks	19149	21345	21353	26049	24455	27469	28775	30017
10	Tractors	1993	2190	1690	1480	2098	2349	2481	2677
11	Trailers	1723	1903	1595	1360	2033	2270	2159	2359
12	Maxicabs	2511	2773	2862	2847	568	3119	3985	4260
13	Others	3815	4197	3699	5019	10352	11201	13351	18167
	Total	601059	661352	686657	689522	767434	859707	972375	1044481

Air polluants emitted from petrol vehicles include carbon monoxide (CO) arising from the combustion of fossil fuel, hydrocarbons (HC) resulting from incomplete combustion, and nitrogen oxides (Nox) generated at high combustion temperatures. Air pollutants emitted from diesel vehicles are CO, HC (but at rates lower than petrol vehicles because of better combustion efficiences). Nox at a rate higher than petrol vehicles because of lower combustion temperatures. Diesel vehicles emit fine suspended particulate matter (SPM) and higher levels of sulphurdioxide 5So2). Given the rate at which the cities are growing and the quality of life of many urban residents will continue to deteriorate.

The increasing penetration rate of the two-wheelers is of real concern. Of the two-wheelers, about 95 per cent are powered by two-stroke engines, where as the rest 5 per cent have 4 stroke engines. The problems regarding the existing design of two-stroke engines is that 25 per cent to 40 per cent of the fuel supplied is discharged without being combusted which result in very high emissions of unburned hydrocarbons (much higher than four-stroke engines). Thus, in case of two-wheelers, replacing a two-stroke engine with a four-stroke one would improve fuel efficiency and emission discharge substantially. Production of two-wheelers powered by four stroke engines have been initiated by different manufactures like Bajaj, Herohonda etc. , but its penetration rate in Bangalore has been very slow.

Air quality monitoring for Bangalore city is done Karnataka Pollution control board (KPCB) in different locations in the city (like Anand rao circle, Whitefield road, Mysore road). The levels of polluants like SPM, Nox and SO2 is measured through monitoring equipment, starting from the year 1984 to 1997 as seen from figures 1 to 3. In the commercial area (Anand Rao circle) the concentration of SPM during the last four years exceeds the world health organisations limits of 230 micrograms/m3. SPM concentrations in the other two locations during the same period ranges from 113 to 208 micrograms/m3 which is below the limits of world health organisation guidelines.

Similarly, the levels of sulphurdioxide(SO2) measured at different locations during the last four years ranges from 23 to 46 micrograms/m3 and 16 to 42 micrograms/m3 respectively.

Pune city

Pune is a classic example of strong environmental deterioration. For the sake of illustrating a point it would be essential to mention certain statistics. In 1960 the total number of vehicles in Pune was 6, 200 approximately. In 1990 it became 3, 12, 000 (includes the total vehicle registered in Pune Metropolitan Region) and at the end of 1998 it stood at 9, 33, 000. This incidentally is more than a figure of total vehicular population in Mumbai. Albeit we have more two wheelers which, apart from problems of movements, create more pollution. The density of vehicular population in Pune is the highest. The human population compared to 1960 has multiplied by about 5 times, available road surface by 7 times and the vehicular population by more than 150 times.

The city of Pune has had its environment endangered by the rise in the levels of air pollution. The main cause of the air pollution in Pune city is to the increase in the number of automobiles, particularly the six seaters, the two-wheelers and three wheelers. With the proliferation of such polluting vehicles, Pune's already polluted air would be thick poison together with rising sound levels. A study of pollution levels according to various categories of vehicles was conducted by Department of Environment, University of Pune for PMC, in January 1997. Refer Table. A cursory glance at the growth in the number of vehicles indicates that the vehicular population has increased by 10, 000 per cent while the human population has increased by 1235 per cent over the last 30 years.

Table 3 : Growth in the number of vehicles

Year	2 wheelers	3 wheelers	Cars / Jeeps	Buses / Heavy vehicles
1960	1313	207	2658	2245
1997	462021	39914	70617	44306

Source : Regional Transport Office, Pune

Table 4 : Pollution levels on account of various categories of vehicles

Categories of vehicles	Number approx	Average Kms Per day	SPM Conc in ton	SO 2 Conc in ton	NO 2 Conc in ton	CO Conc in ton	HC Conc in ton
1. Diesel 6 seaters	2000	100	0.1	0.08	0.2	0.22	0.04
2 Petrol 3 seaters	35000	100	11.12	0.28	10.96	137.2	20.54
3 Two wheelers	500000	15	2.28	0.55	22.17	277.21	41.58
4 Four wheelers	68000	20	0.44	0.11	4.31	53.83	8.07
5 Heavy vehicles	45000	100	1.62	1.31	46.52	28.12	4.64
Total	6.5 lakhs	335	15.56	6.33	84.16	516.40	74.87

Source: Dept. of Environment, University of Pune

Thus the daily weight of pollutants which drown Pune city everyday is around 720 tons of poison.

The comparative study mentioned in Table 4 regarding petrol and diesel pollution revealed the following results. The emissions from diesel vehicles are nitrogen oxide, carbon monoxide, hydrocarbons, formaldehyde, solids and carbon particles. Out of these carbon particles are most dangerous and quick in their impact. Even though diesel and petrol vehicles cause pollution, petrol vehicles generate carbon monoxide which cause green house effect on a global scale where as the effects of diesel vehicle pollution remains localised, thus causing immediate adverse impact on the local populace. The diesel vehicles produce carbon particles, 100 times more than petrol vehicles. The study shows that not only the status of ambient air quality in Pune is deteriorated but also the city has crossed the safety limits regarding the pollution levels. Pune requires urgent protection from the continuous load of ultra fine carbon particles coming out of diesel exhaust PM 10 particles. Human population is very sensitive to PM 10 even a marginal rise of 1, 00, 000 particles per cubic meter of air can result into 2-3 % increase in incidences of cardio-vascular deaths. The excess presence of PM 10 particles in the air lead to a rise in death rate approximately 1 %, death on account of heart problems by 1.4 %, death due to impairment by 3.4 % and asthmatic occurance by 3 %.

Ambient air quality monitoring was carried out in the months of September and October 1998 at the two sites, Shimla Office chwk and University circle in Pune. Table 5 shows that the levels of NO_x in

September have increased and are slightly above permissible limits as compared to those in October at the Shimla Office chowk. The levels of SO_2 are within permissible limits for both the months and are relatively lower in the month of October. The respirable particulate matter at the University Circle has increased considerably as compared to month of August. The levels of SPM and PM 10 are above permissible limits for both the stations for September and October. The variation in the magnitude of the particulate matter is shown in Fig.

Table 5 : Ambient Air Quality in Pune

Shimla office chowk	SO_2	NO_x	PM10	SPM	TSPM
	μg/m3	μg/m3	μg/m3	μg/m3	μg/m3
Aug. 98	59.12	51.84	194.01	514.5	708.51
Sept. 98	42.81	81.87	147.77	253.08	400.85
Oct. 98	22.08	57.87	121.15	115.82	236.97
University Gate	SO_2	NO_x	PM10	SPM	TSPM
	μg/m3	μg/m3	μg/m3	μg/m3	μg/m3
Aug. 98	57.53	56.47	36.61	156.36	192.97
Sept. 98	19.32	70.2	137.8	141.29	279.09
Oct. 98	18.49	27.62	107.05	100.78	208.28

Permissible limits average permissible limits for 24 hours
SO_2 80μg/m^3, PM10 100μg/m^3; SPM 200μg/m^3

Section III : Evolving a Modal

The analysis of Section - II explained that the main cause of pollution in general and air pollution in particular in both the cities. This is due to the increase in the number of automobiles. A comparative analysis of environmental implication of public transport and non-public motorised transport has brought out a few facts and raised many issues in these two cities. Those are :

- Per passenger kilometer, a non-public motorised transport consumes 5 times the energy used by a public transport.
- The fuel cost in a non-public motorised transport is 11.8 times of a public transport.
- A non-public motorised transport occupies 38 times more road than a public transport vehicle.
- Emissions are 5-7 times more in a non-public motorised transport than in a public than in a public transport.

This suggests that mass transportation is vastly superior to personal and intermediate vehicles (taxi, three-wheelers and two wheelers). The desirable cost-effective solution, to more people with fewer vehicles using less energy and less polluants could be achieved by increasing the share of mass transport based on buses. It is estimated that an increase in share of buses in road transport from 66 per cent to 80 per cent, would lead to a saving of 0.35 per cent million tonnes of fuel.

The other advantages that ensure are over 50 per cent reduction in total vehicles on the road, significant reduction in road congestion, and reduced air pollution However, diesel requirements will increase by about 8 per cent (from 0.74 to 0.80 million kl). This too, can be overcome to a sizeable extent by improving the fuel efficiency of buses and improved traffic management measures with preference to buses, for example the provision of exclusive bus lanes. A system of road pricing which has proved to be effective in some countries in the concept of area licensing, where by low occupancy vehicles pay a charge for entering a congested area during the rush hours. The system encourages greater use of public transport and shared private cars or taxis, and discourages avoidable journeys.

There is potential scope for increasing traffic speed from the present average figure of 20 kilometer per hour (Km/h) to the optimum level of 45/44 (Km/h). Simple measures such as separation of fast and slow traffic, better signalling, policing of traffic flow and well designed and maintained sidewalks and pedestrian crossing need to be implemented. As a medium term strategy, programmes to improve and widen road surfaces need to be initiated. The advantages of road improvements needs to be augmented, not only in saving fuel and reducing emissions, but also in improving the life of the engine, tyres, and other components of vehicle.

A comprehensive policy framework needs to be evolved to combat pollution in following ways.

- Establish a comprehensive database
- Prepare an action plan including the contribution of all sector
- Draw up a regulatory framework covering all sectors.

Conclusion :

Managing critical urban environmental problems involves not only the transport section but also numerous public and private sectors and a range of strategically targetted preventive and curative actions. In addressing the underlying causes of environmental degradation, there are four principal action areas. Strengthening governance's, involves mobilising public support and participation to create a constituency for sustained environmental problems and establishing clearly defined institutional arrangements for urban environmental management.

Improving policies should include more comprehensive, efficient and effective regulatory, economic and environmental services and establishing public/private partnerships. Lastly, improving information and understanding involves the collection of environment data and use of analytical frameworks to understand problems, prioritise them, and design environmental programmes to resolve them.

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Forecasting pollutant emissions by automobiles in three large metropolitan areas: São Paulo, Montreal and Paris

Prévoir les émissions de polluants par les automobiles dans trois grandes régions métropolitaines: São Paulo, Montréal et Paris

Previsión de la contaminación ambiental por los automoviles en tres grandes regione metropolitanas: São Paulo, Montréal y Paris

Jean-Loup Madre, Jean-Paul Hubert & Jimmy Armoogum – *INRETS-DEST, Arcueil, France*

Orlando Strambi – *Universidade de São Paulo, Brazil*

Yves Bussière – *Institut National de Recherche Scientifique, University of Quebec, Montreal, Que., Canada*

ABSTRACT: The paper compares the impact of the private car on atmospheric pollution in Sao Paulo,. Paris and Montreal, cities which contrast by their size, their level of economic development, their rate of growth and their urban form. In the three case studies the same methodology is applied to estimate the evolution of the car fleet and of traffic. The data used come from O-D surveys realized between 1973 and 1997 and the projections at the horizon 2020 are made with a demographic based model. The results show that the traffic grows slighlty more than the car fleet in Sao Paulo and Paris, and much more rapidly in Montreal. Thus, in spite of important differences in population size, the absolute growth in vehicules-km is similar in the three urban regions. However, while this growth is generated mainly by the inhabitants of the the outer suburbs in the two urban regions of the North, in the case of Sao Paulo it is comes from the central city. The technical characteristics of the fleet differ (gasohol in Brazil, diesel in France, gasoline in Montreal) but these differences will tend to disappear with the introduction of anti-pollution legislations. The three case studies share common trends, but the local effects of traffic on air quality appear more severe in Sao Paulo due to its concentration in the central city.

RÉSUMÉ: L'article compare l'effet de l'automobile sur la pollution atmosphérique à São Paulo, Montréal et Paris, villes qui diffèrent par la taille, le développement économique, le rythme de croissance et la structure urbaine. Une méthode identique permet d'estimer l'évolution du parc automobile et de la circulation. Les observations proviennent d'enquêtes origine-destination réalisées entre 1973 et 1997 et les projections à l'horizon 2020 sont réalisées par un modèle à base démographique. Les résultats montrent que le trafic progresse légèrement plus que le parc à São Paulo et Paris et beaucoup plus à Montréal. Ainsi, malgré la différence de taille, l'augmentation absolue du trafic en véhicules-km est du même ordre de grandeur dans les trois régions urbaines. Ce sont les habitants de la périphérie qui engendrent l'essentiel de cette croissance dans les villes du Nord, alors qu'à São Paulo, ce sont les habitants de la ville centrale. Les caractéristiques techniques du parc sont spécifiques dans chaque ville (*gasool* à São Paulo, diesel à Paris, essence à Montréal) mais tendront à s'homogénéiser avec les normes anti-pollution. Malgré certains points communs aux trois cas étudiés, les effets locaux de la circulation sur la qualité de l'air sont rendus bien plus graves à Sao Paulo par la concentration du trafic dans la ville centrale.

RESUMEN: Él articulo compara el impacto del automóvil sobre la contaminación ambiental en Sao Paulo, Montreal y París, ciudades que difieren por el tamaño, el desarrollo económico, el ritmo de crecimiento y la estructura urbana. Aplicamos un método idéntico para estimar la evolución del parque automóvil y la circulación. Las observaciones provienen de encuestas origen-destino realizadas entre 1973 y 1997 y las proyecciones al horizonte 2020 están realizadas por un modelo demográfico. Los resultados muestran que el trafico progresa ligeramente más que el parque en Sao Paulo y París y mucho más a Montreal. Así, pese a la diferencia de tamango, el aumento absoluto del trafico en vehículos - kmts. es del mismo orden de tamango en las tres regiones urbanas. Este crecimiento se produce esencialmente en la periferia de los dos países desarrollados, pero se realiza mayoritariamente en el centro de Sao Paulo. Las características técnicas de los vehículos difieren (gasool en São Paulo, diesel en Paris, gasolina en Montreal) pero tienden a homogeneizarse. Los casos estudiados tienen puntos comunes pero los impactos locales de la circulación sobre la calidad del aire son mucho más grave en Sao Paulo a causa de la concentración del trafico.

INTRODUCTION

Detailed analyses of pollutant emissions have been conducted in many metropolitan areas. A basic distinction is made between fixed sources (industries and domestic heating mainly) and mobile sources. The density of population and the urban - particularly suburban - way of life make personal mobility responsible for a main part of pollution emitted by mobile sources. As coal is being replaced by oil or electricity, and industrial plants are leaving the more economically advanced metropolitan areas, the evolution of air quality for the future depends more and more on the mastering of pollution due to personal mobility, but without hampering people's freedom nor social and economic activities.

This article focuses on the private car which is the main transportation mode responsible for pollution. Roughly speaking, the question of growth in emissions by private cars can be divided into two aspects:

- a socio-economic or socio-demographic one, which is the growth of car traffic,
- a technological one, which reflects changes in the efficiency of engines, not only for new vehicles but for the whole car fleet.

We consider car traffic at different points in the past as well as in the future by means of projections of motorization and circulation. This gives us a common basis to discuss on the possible evolutions of pollution by car in the three large cities that we have studied: São Paulo (16 million inhabitants), Paris (11 million) and Montreal (3.5 million).

For both dimensions of car traffic growth and automobile technologies, the situation of urban areas in developed or emerging countries is different. In developed countries, the level of motorization seems to be approaching saturation levels. However, the greater functional complexity of sprawling urban areas increases car mileage. In less developed countries, expected growth of the car fleet is still very high. Yet, industry still plays a great role on the structuration of space and trips are more compartmentalized.

Our main results concern forecasts of urban car fleets and traffics in different zones with a uniform demographic approach (section 1). As the results for car traffic are not yet available for São Paulo, we examine its relation to its main determinant: the growth of the total number of vehicles (section 2). For the assessment of technical progress in car engines, we have collected separate results on the three urban areas to set some elements for a future discussion (section 3).

1 A DEMOGRAPHIC MODELING APPROACH FOR ESTIMATING URBAN CAR FLEETS

1.1 *An age-cohort-period model*

The limits of traditional forecasting models [Gallez 1994, Strambi et al. 2000] have led some authors to propose a new model, based on longitudinal analysis of behavior. The approach adopted here follows that proposed by [Madre 1990 and Gallez 1994]. Similar ideas appear in the work of other researchers [Kitamura et al. 1987, Jansson 1990].

The longitudinal approach highlights the complex impact of age on car ownership which, in a dated temporal context, consists of the combination of three linked dimensions:

- the moment in the life cycle, which indicates the importance of age on car buying decisions and on mobility paterns;
- the generation (or cohort), which identifies the behavior of individuals born during the same period, and therefore sharing a common life experience; and
- the period, which indicates the impact of the global socio-economic context.

The analysis of the life cycle effects generates a characteristic curve (the *standard life cycle profile*) representing the evolution of motorization and of car use related to age, which is hypothesized to constitute a stabilized pattern of behavior. The introduction of the generation effects permits to place this curve in a historical perspective, highlighting the influence of the life styles, institutional constraints and consumer needs on the diffusion of the automobile. Finally, the introduction of the period effects permits the measurement of the influence of factors affecting all the individuals or households simultaneously; these factors can be related to the economic context (like the disposable incomes or the price levels) or to characteristics of the supply (like infrastructure or level of service changes).

1.2 *How to implement the model for motorization and mobility?*

The main idea in our approach is to outline the variables of age (with its components of life cycle, generation and period mentioned above) and of spatial distribution to explain the dynamics of motorization, mobility, and modal choice. The trips are largely conditioned by the supply of travel modes, especially the availability of a car. The rate of motorization thus appears as a key variable of mobility behavior. Therefore, we will start by studying motorization: first, at the level of the household, namely to project the number of automobiles, then at the level of the individual to be able to study mobility patterns. This latter analysis which develops measures in terms of number of trips as well as in terms of distances travelled will be done globally and by travel modes.

We consider that the household remains the unit of decision for motorization even though multi-vehicle acquisition tends to individualize the choices. The generations are defined by the date of birth of the head of household. Motorization is characterized by the proportion of equiped households on the one hand, and by the proportion of multi-car households among equiped households on the other hand. The total number of cars is estimated by taking the product of the number of households by the weighted sum of the two rates calculated above.

A longitudinal analysis of motorization behavior based on French national data [Gallez and Madre 1992] shows the importance of generation lags in behavior and the remarkable stability of the curves in relation to the life cycle. Once the age and generation effects have been taken into account, the period effect (economic or political context) appeared to be residual and thus justified the age-cohort approach.

2. THE FUTURE OF CAR TRAFFIC AND OF CAR FLEET

2.1 *The Metropolitan Areas*

The age-cohort model has been estimated for *Région Ile-de-France*, or Paris region (IDF) in France, *Grande région de Montréal* (GRM) in Canada, and *Grande São Paulo* (GSP) in Brazil. In each metropolitan region, three concentric, or approximately concentric, zones are distinguished to take into account the phases in the urban growth processes. The zones were drawn considering their different density and population growth patterns. Tables 1, 2 and 3 present the distribution of population, population density and households motorization in the different zones: Centre (C), Inner Suburbs (IS) and Outer Suburbs (OS).

Surfaces are those of administrative territories. Densely urbanized areas are somewhat different. In 1999 in IDF, 90% of the population is concentrated within 2,500 km² (20% of the total surface), and 80% in 1,500 km². In 1996 in GSP, the figures are: 90% of the population within 2,500 km² (45% of the surface) and 80% in 1,850 km². In 1996 in GRM, only 55% of the population is concentrated in 500 km² (15% of the total surface).

Motorization (as well as multi-motorization, see section 2) increases when households live further from the centre in GRM and IDF, while the reverse is true for GSP, a poorer city. The increase in car ownership rates in the suburbs of cities in richer countries has been associated with land use patterns leading to a dependence on the use of cars, and also to a higher proportion of households with children. In GSP (and other cities of developing countries) suburbs are poorer than the central city. This result is confirmed by cross tables between the level of income and motorization for the different age groups. In 1991, households of the highest quartile of income possessed more than 50% of the private cars in the GSP (data IBGE), and multimotorization occured almost exclusively in this category of households.

We may find differences between the region and the country as a whole. GRM is slightly less motorized than Canada. Since the late 1970s, IDF has been the less motorized region of France. In 1990, household motorization was 8 points under the national average. In 1991, motorization in GSP was some 10% above the average of the southern part of Brazil. São Paulo is the most motorized city in Brazil. However, 1991 census shows that some nine secondary urban areas had a higher level of household motorization (more than 41%), among them Jundiai and Campinas which are very closely linked with São Paulo.

2.2 *The Patterns of Motorization*

Age-cohort models are estimated on data from three successive transportation surveys for each area, over periods of approximately 15 years, in IDF and GRM, and 20 years in GSP, from the late seventies to the early or late nineties. The standard life cycle profiles and generation lags graphs draw parallel portraits of motorization according to age bands and generations in the three metropolitan regions [Strambi et al. 2000]

In IDF and GRM access to the first automobile is rapid, while this movement is slower in GSP (fig.1). The maximum rate of motorization occurs under the age of 30 in GRM and around 30 in IDF; maximum motorization in GSP occurs notably later, when the head of the household is about 50.

The access to a second car is more gradual in all regions. Multi-motorization reaches its maximum when the age of the household head is around 50 (not represented on these graphs, see [Strambi et al., 2000]). These maximum rates are very much differentiated by the zones.

The most motorized generation (figure 2) was born in the thirties for the whole of GRM, in the fifties in IDF

Table 1. Distribution of population

region	census year	population total ('000)	distribution (%) C	IS	OS
IDF	1990	10,644	20.2	37.4	42.4
	1999	10,942	19.4	36.9	43.7
GRM	1991	3,127	30.9	25.9	43.2
	1996	3,326	31.8	21.5	46.7
GSP	1991	15,210	33.9	32.5	33.6
	1996	16,400	30.2	32.1	37.7

sources: Insee, Statistique Canada, IBGE.

Table 2. Density of population

region year	area density	total	C	IS	OS
IDF	km²	12,010	105	660	11,250
1999	inhab.Ha	9.1	204.0	61.2	4.3
GRM	km²	3,450	140	350	2960
1996	inhab.Ha	9.6	75.5	20.4	5.2
GSP	km²	5,440	490	1,700	3,260
1996	inhab.Ha	30.1	101.1	31.0	19.0

sources: Insee, Statistique Canada, IBGE.

Table 3 Motorized households

region	Total	C	IS	OS
IDF (1990)	67.5%	48.2%	68.9%	83.7%
GRM (1987)	74.0%	56.4%	76.3%	89.0%
GSP (1997)	49.1%	56.4%	54.8%	42.6%

sources: Insee, Statistique Canada, Metrô SP.

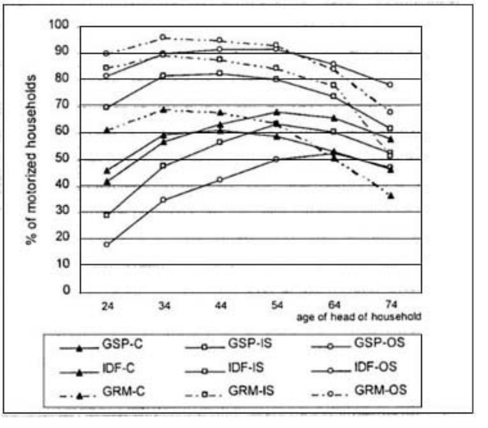

Figure 1. Standard life cycle profiles for the generations 1946-1950 (IDF,GRM) and 1942-1951 (GSP)

(somewhat later in the inner and outer suburbs). In GSP there is a gap: the most motorized generation was born and in the forties in the central zone and in the sixties in the suburbs. Motorization decreases for the latest generations in IDF and GRM. This movement is accented in the centre and in the inner suburbs of Montréal. It suggests a situation of saturation or a change of attitudes towards the automobile among the young, or possibly a sign of their impoverishment. In GSP, a more continuous increase in the rate of motorization can be observed as generations follows, especially in the suburbs.

Multi-motorization grows continually and reaches around 50% for the younger motorized households living in the outer suburbs of IDFs and over 60% in GRM. The multi-motorization pattern is much less clear in GSP, most of the obtained results for generation gaps being statistically not significant.

Another interesting contrast is associated with spatial location. While differences in motorization rates among zones are getting larger for the younger generations in IDF and GRM, in GSP these differences are vanishing. This result suggests that a transition may occur in the poorer suburbs where automobile is about to take an important role as in suburbs of richer metropoles.

2-3 *Forecasting car ownership and car use*

With help of demographic projections, standard life cycle profiles and generation lags give estimation of motorization and multi-motorization for the households to come, as well as an estimation of the distances travelled by the households' cars.

Tables 4, 5, and 6 show the relation between the increase of the number of cars and the growth of daily car traffic as given by the origin-destination surveys. The evolutions are parallel in the different zones of IDF. The number of cars appears here as the major determinant of circulation in terms of vehicule.km. As a matter of fact, the number of trips by car per household has stayed almost constant (2.6, 2.6 and 2.7 in 1977, 1984 and 1992). Observations in GRM reveal that in the last 20 years the traffic grew much faster than the fleet. Because of high multi-motorization, the number of trips by car per household increased regularly, (1.7, 1.9, 2.2, and 2.6 in 1976, 1981, 1986, and 1991). In GSP, the circulation followed closely the evolution of the fleet in the period 1977-1987, but grew faster than the fleet between 1987 and 1997. This was due to longer trips because the number of trips by

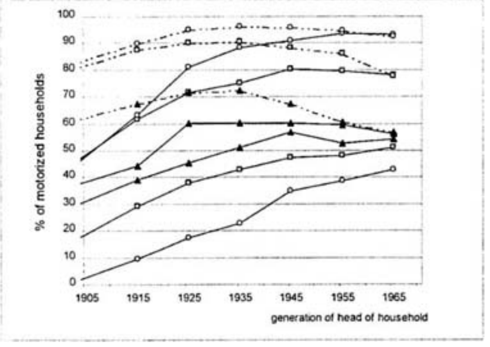

Figure 2. Differences between generations for age group 35-39 years (IDF,GRM) and 29-38 years (GSP)

Table 4. Observations on fleet and traffic in IDF

cars (' 000)	C	IS	OS	IDF
1977	560	1,110	1,180	2,850
1984	580	1,320	1,550	3,450
1992	605	1,480	1,960	4,050
average annual growth rate				
1977-1992	0.5%	2.0%	3.4%	2.4%
distance (' 000 veh.km per day)				
1977	5,870	15,080	23,190	44,060
1984	6,590	18,100	29,270	54,020
1992	6,520	20,940	41,660	69,120
average annual growth rate				
1977-1992	0.7%	2.2%	4.0%	3.0%

sources: Dreif EGT

Table 5. Observations on fleet and traffic in GRM

cars (' 000)	C	IS	OS	GRM
1974	385	325	410	1,120
1978	360	330	490	1,180
1982	350	340	560	1,250
1987	380	345	670	1,395
1993	400	370	820	1,590
average annual growth rate				
1974-1993	0.1%	0.5%	3.5%	1.7%
distance (' 000 veh.km per day)				
1974	5,770	5,790	9,220	20,750
1978	6,610	7,320	12,750	26,650
1982	6,640	8,020	14,740	29,380
1987	7,350	9,220	19,270	35,800
1993	6,660	9,160	24,120	39,930
average annual growth rate				
1974-1993	0.8%	2.5%	5.2%	3.5%

sources: STCUM

Table 6. Observations on fleet and traffic in GSP

cars (' 000)	C	IS	OS	GSP
1977	810	370	140	1,310
1987	930	590	360	1,890
1997	1,070	980	800	2,850
average annual growth rate				
1977-1987	1.4%	5.0%	9.9%	3.7%
1977-1997	1.4%	5.0%	9.1%	3.9%
distance (' 000 veh.km per day)				
1977	11,580	7,090	2,970	21,700
1987	14,325	9,750	6,090	30,490
1997	nd	nd	nd	49,650
average annual growth rate				
1977-1987	2.2%	3.3%	7.5%	3.5%
1977-1997	nd	nd	nd	5.0%

sources OD Metrô SP

car per households diminished through that period (2.5, 2.7, 2.3 in 1977,1987 and 1997).

The forecasts of car fleet and car traffic in IDF and GRM (tables 7 and 8) show how this relation is projected by the model. In IDF, the link between numbers of cars and mileages remains stable for the whole region, but in the denser parts, the fleet grows more rapidly than circulation. In GRM, circulation growth slows down and becomes similar to that of the fleet. In GSP (table 9), the data only permitted to make projections of the fleet. From the two other examples, we can assume that circulation in the next 15 or 20 years should grow at least like the fleet, *i.e.* +2% per year, which would be more than IDF and less than GRM.

Table 7. Projections 1990-2020 IDF

cars (' 000)	C	IS	OS	IDF
2000	635	1,550	2,490	4,670
2010	660	1,680	3,110	5,450
2020	690	1,830	3,990	6,520
average annual growth rate				
2000-2020	-0.3%	0.6%	1.6%	1.1%
distance ('000 veh.km per day)				
2000	6,820	23,430	54,240	84,490
2010	6,530	23,770	66,970	97,340
2020	6,130	23,230	80,390	109,650
average annual growth rate				
1990-2020	-0.4%	-0.3%	1.3%	0.9%

demographic projection Insee, motorization proj. Inrets

Table 8. Projections 1990-2020 GRM

cars (' 000)	C	IS	OS	GRM
1996	400	380	880	1,660
2006	440	440	1,170	2,050
2016	470	480	1,420	2,370
average annual growth rate				
1996-2016	0.8%	1.2%	2.5%	1.7%
distance ('000 veh.km per day)				
1996	8,080	10,140	31,430	49,610
2006	9,050	12,060	41,370	62,430
2016	10,010	13,620	48,890	72,580
average annual growth rate				
1996-2016	1.1%	1.5%	2.2%	1.9%

demographic proj. Stat.Canada , motorization proj. Inrs

Table 9. Projections 1990-2020 GSP

cars (' 000)	C	IS	OS	GSP
2000	1,120	1,050	900	3,080
2010	1,170	1,230	1,330	3,730
rdrs2020	1,300	1,445	1,790	4,530
average annual growth rate				
2000-2020	0.7%	1.6%	3.5%	2.0%

demographic proj. Seade, motorization proj. Inrets/USP

This growth rate for GSP in 2000/2020 could be considered as a low scenario since we are projecting the low motorization rates of the poor suburbs on the most dynamic zones from the demographical viewpoint. This projection is the result of two separate tendencies: a saturation of motorization in the centre due to demographical decline, and a certain delay in the taking off of motorization in the outer suburbs. Such progression of the number of cars in GSP would nevertheless lead to a 50% increase of the private car fleet from 1997 to 2020 and a subsequent increase of circulation, in a context where traffic congestion and quality of air in São Paulo are already two major problems. Our estimation of the car fleet is much smaller than what is commonly estimated on the basis of registers of *Departamento do Trânsito*, the State institution in charge of traffic administration. These registers count 5.6 millions of vehicles in 1996, 80% of which are cars [Reis & Di Palma, 1999]; *i.e.* 4.5 millions in 1996 - our estimation for 2020! We feel however that the robustness of our statistic basis is confirmed by crossings between Metrô SP data and IBGE census data.

Table 10. Spatial distribution of additional cars

cars (' 000)	annual average	distribution C	IS	OS
IDF (1976-91)	+79.9	4%	31%	65%
GRM (1974-93)	+23.1	2%	8%	86%
GSP (1977-87)	+57.5	22%	40%	39%
GSP (1977-97)	+76.9	17%	40%	43%
projections				
IDF (2000-20)	+92.7	3%	15%	81%
GRM (2000-20)	+33.5	10%	15%	82%
GSP (2000-20)	+72.9	12%	27%	61%

sources Dreif, STCUM, Metrô SP, projections Insee, Stat. Canada, Seade, Inrets, Inrs, USP.

Table 11. Spatial distribution of additional traffic

veh.km/day (' 000)	annual average	distribution C	IS	OS
IDF (1976-91)	+1,670	3%	23%	74%
GRM (1974-93)	+1,010	5%	18%	78%
GSP (1977-87)	+878	32%	31%	37%
GSP (1977-97)	+1,400	nd	nd	nd
projections				
IDF (2000-20)	+1,260	-3%	-1%	104%
GRM (2000-20)	+1,150	8%	15%	76%

74sources Dreif, STCUM, Metrô SP, projections Insee, Stat. Canada, Seade, Inrets, Inrs, USP.

Table 12: Contribution of the automobile in total transport pollution in GRM

pollutant	auto/ total transport 1994	evol 90-94	transport/ total pollution
COV	70%	+1%	43%
CO	74%	+1%	78%
Nox	41%	+4%	85%
CO_2	45%	+3%	50%
PP	55%	+3%	30%

source: RMQA 1998

Table13: average emission of a car in GRM

emissions (g/km)	1990	1994	2010
COV	2.13	1.45	1.04
CO	18.44	13.9	10.59
Nox	1.42	1.12	0.78
CO_2	198	-	155
PP	0.37	-	0.12

source: RMQA 1998

From the observations of the surveys we notice that in the recent past, IDF and GSP received approximately the same amount of supplemental cars (1.2 million in 15 years and 1.5 million in 20 years), and vehicle.km per day (25 million in 15 years and 28 million in 20 years). In 19 years, the metropolitan area of Montréal received a number of cars in proportion to its population (0.4 million cars) but almost as much traffic (19 million vehicle.km per day). The projections for the next 20 years add similar quantities of cars and traffic as in the previous period: +1.5 million cars in GSP, +1.8 and +0.67 million car, and +25 and +23 million veh.km/day in IDF and GRM respectively.

There is a major difference however that only spatial decomposition reveals: in IDF and GRM, both for cars and traffic, the major part of the growth comes from the low density outer suburbs. In GSP, it is the opposite.

3. EVOLUTION OF THE EMISSIONS OF POLLUTANTS

3.1. *The case of GRM*

In the GRM most of the car fleet runs with gasoline. Its average as well as median age is of approximately 6 years. RMQA [1998] gives estimations of the contribution of pollution by the private car in total transportation pollution and that of transportation in total atmospheric pollution for 1994, as shown in table 12. Modeling the emissions for an average car in 1990, 1994 and 2010 by projecting the actual rates of renewal of the fleet gives the results shown in table 13.

The evolution of technology and the renewal of the fleet of table 13, combined with our traffic growth projection suggest a stabilization of COV and CO emitted by cars in the centre, and a significant increase in the suburbs. NOx emissions would be reduced everywhere. It may be noticed that RMQA makes the asumption that traffic will grow of +25% from 1994 to 2010, and for this reason, its conclusion is more optimistic on the evolution of automobile emissions in GRM.

Buses in the GRM are mostly diesel powered, their number in 1994 was around 6,400 (3,500 public buses and 2,900 scholar) [RMQA, 1998].

3.2. *The case of IDF*

The quality of air has improved in Paris since the 1980s. Concerns remain for NOx in the dense areas and O_3 in the periphery [Hivert, Morcheoine 1998]. Gallez [1995] shows that from 1976 to 1991, mainly because of growing car ownership and urban sprawl, the total energy consumption due to mobility (all modes) has increased by 58%. One quarter of the automobile is diesel powered and another quarter is equiped with catalytic converters [Servant 1997]. This high proportion of diesel powered cars is a French peculiarity. As a consequence, particles emissions are larger. In 1996 in IDF, the average age of the fleet was superior to 6 years with 54% of the vehicles less than 5 years old.

Specific data on average emission rates for IDF fleet is lacking. We know, however, that despite a traffic and consumption increase of about 15% during the next ten years the self limitation agreement of car builders could lead to zero increase in CO_2 emissions, and European regulations (EURO I to IV) should give a considerable decrease for local pollutants (for instance, dividing CO by four). Perspectives are more uncertain for NOx and COV.

In addition to the automobile, IDF bus fleet is almost exclusively diesel powered; 4,000 RATP buses circulate in the centre and inner suburbs, and their average age was 7.75 years old in 1996; 3,000 buses, two years younger in average, operate in the periphery [Servant, 1997].

3.3. *The case of São Paulo*

The quality of air is a major concern in São Paulo and concentrations of the different pollutants rarely stay long under the acceptable norms, especially in winter time. Cetesb [1999] shows significant reduction of concentrations of SO_2 since 1981, and a reduction for CO and NOx as well, but since 1990 only. However O_3 concentration have increased since 1990, tropical summer favours its production. Both for pollution and traffic concerns, the State of São Paulo (from 1995 to 1998 in winter months) and the Municipality (every day at peak hours in the centre except in school holydays) imposed an interdiction of circulation one day per week based on the registration plate.

Brazil is known to have developed the utilisation of ethanol as fuel and to produce a specific fuel, the *gasool* (composed of gasoline and 24% ethanol since the legislation of august 98). Such fuels have very low emission rates of CO and make lead unuseful [Faiz et al. 1995].

Vehicules using exclusively alcohol have been produced between 1980 and 1990. They represented 50% of the car fleet of GSP in 1989 but only 23% in 1998 (this number is probably overestimated, since the private fleet running on alcohol is much older than the *gasool* fleet - 11.15 years vs 7.2 years - for Brazil as a whole; sources: Detran and Geipot). The perspectives which could be induced by the new norms in Brazil are similar to those which we find in european or north-american countries. The national

Table 14: Contribution of the automobile in total transport pollution in IDF

pollutant	auto/ total daily mobility*	auto/ total road transp¤	transport/¤ total pollution
COV	82%	46.5	55%
CO	99%	-	-
Nox	90%	58.9	67.3%
CO_2	93%	-	-
PP	78%	-	-

* source: Inrets [Gallez 1995], ¤ source: Citepa [DRIRE 1999]

Table 15: Contribution of the automobile in total transport pollution in GSP

pollutant	car/ total road transport	road transport/ total pollution
HC	80%	97%
CO	86%	98%
Nox	27%	96%
MP_{10}	25%	40%
SOx	35%	57%

source: Cetesb 1999

Table 16: estimation of average pollutant rates in GSP

pollutant (g/km)	alcool	gasool (22%)
HC	1.9+1.5*	1.6+2*
CO	16.9	15.8
Nox	1.2	0.9
MP_{10}	-	0.08
SOx	-	0.16

* = exhaust + evaporation; source: Cetesb 1999

programme PROCONVE had for effet to reduce progressively the maximum rates of emissions authorized for the new vehicules, from 24 g/km of CO in 1990 to 12 g/km in 1994 and to 2 g/km in 1997.

Our projections suggest an inversion in the dynamics of the growth of the fleet. Inhabitants of the periphery should be responsible for most of the additional cars in the future, but the growth of traffic in the central zones might stay significant for the next years to come. It is therefore most important that the renewal of the fleet should be quick. Such objective may be helped by the competition among car builders (source CCFA), recently stimulated by enormous investments made by Brazilian traditional main car builders (VW, Ford) or newcomers in the country (Renault, Peugeot). This should accelerate the introduction of new models, particularly in rich metropolitan areas where motorization is much higher than in the rest of the country [Droulers & Costa-Gomez, 1999]. Therefore the rural areas could be a spillway for older cars while fleets of richest towns could regenerate rather rapidly.

Another part of the problem of pollution is the emissions made by diesel powered vehicles. GSP has one the greatest diesel powered bus fleet in the world, extremely concentrated in the centre. In São Paulo municipality (9.8 million people in 1996, 59% of the GSP) the municipal bus fleet was over 11,500 in 1992 until 1997 [Brasileiro, Henry et al 1999]. Other fleets of the GSP set the total number at around 25,000 buses in the RMSP in 1995, (data E. Henry OnibuCad). In São Paulo and Rio de Janeiro more and more buses powered by gas have been introduced.

CONCLUSION

The contribution of car traffic on pollution in the three cities studied was analyzed with a single method that has highlighted the differences of development, life patterns, and urban structure.

Observations from recent OD surveys have shown that the standards of living of IDF and GRM have induced high rates of motorization and also a strong growth of the fleet because of multi-motorization. However, central zones, when they are very densely populated did not leave more space for the car to expand. The fleet has grown more in low densities of sprawling urban areas. In such instances, the use of the car, *i.e.* circulation, grew more rapidly than its possession. This may explain why for the last twenty years, the absolute variation of circulation in vehicle.km has been surprisingly similar in GRM and IDF despite a population three times larger in IDF. But most of this traffic was generated in the peripheries of these regions.

A lower level of economic development explains why, despite of its huge size and a strong demand for cars, GSP has gained roughly the same amount of additional cars as IDF in the past twenty years. Of course, starting from a lower stage, the fleet grew more rapidly. The income factor also explains why, upper classes being concentrated in the centre, the growth of the fleet and of traffic has been concentrated there as well. Congestion and bad quality of air were obvious consequences of it.

On a prospective point of view, this method made it possible to continue the comparison for the years 2000-2020 with a demographic based model. It appears that if the strong economic and social differences remain between the urban zones of GSP, the fleet might continue to grow less, in number, in GSP than in IDF, so that household motorization would stay much lower in GSP than in IDF and GRM. The continuation of the urban sprawl in GRM and, to a lesser extent, in IDF would result in another absolute increase of circulation of +23 million veh.km in GRM, +25 million in IDF, localized in the periphery for the most part. In GSP, we can extrapolate from the fleet projection an increase of +25 million veh.km (low scenario of +2% growth per year) or +30 million (+2.5% per year). The increase would concentrate now in the periphery of GSP, which might make it possible for technology to slow down emissions of pollution in the centre.

Spatial distribution of estimations brings useful information on the possible impact of traffic on pollution. Studies on mobility are important for a better anticipation of urban pollution, and, especially for cities of emerging countries, this studies might be extended by two general questions. What role will play in the future the size of connurbation, population density and the history of car ownership? Will emerging metropolitan areas follow the same evolutions as those observed in developed countries?

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Modelling urban traffic noise in Delhi and abatement measures

S.S.Jain & M.Parida
Department of Civil Engineering, University of Roorkee, India

ABSTRACT : In the present study noise level models have been developed taking traffic volume, average speed of traffic stream, distance from pavement edge as independent variables. Separate models were developed for each of the landuse category. The effect of abatement wall in noise reduction has also been discussed.

1.0 INTRODUCTION

Phenomenal growth of vehicular population in cities has resulted in increase of noise level within residential colonies and silence zones. Besides vehicular emission road traffic noise another major environmental polluants in Delhi city , the capital of India. Road traffic noise is responsible for 55 percent of total noise. A detailed noise and traffic study was undertaken at 27 different locations in various land use zones in Delhi. The information has been used to develop noise prediction models. An attempt has also been made to study the effectiveness of noise abatement wall.

2.0 FIELD STUDY AND DATA COLLECTION

The above locations identified for noise study match with the locations (1) chosen by Central Pollution Control Board, New Delhi during June, 1989. Table 1 shows the details of Identified locations. These standard noise monitoring stations were chosen for data collection in different land uses. Noise level, traffic volume and spot speed measurements (2) were carried out at each of the locations.

2.1 Novel Level

To record the traffic flow generated noise levels, noise level meter no NL 2100 B Manufactured by Components and Control Systems (CCS), Roorkee has been used. It was placed at a specified distance from the pavement edge and at a height of 1.2 m from the ground level.

2.2 Traffic Volume

The traffic volume data has been collected through manual counts. At all the twenty seven locations one hour classified, directional traffic volume data during peak hour were recorded, in a predesigned, hourly traffic volume proforma which was subdivided in 5 minutes time intervals.

Table 1 : Noise parameters for selected locations in Delhi city of India.

Type of Land Use	Location Name	Noise Parameters in dB(A) L10	L50	L90	Leq
Silence Zone	A I I M S	88	81	76	83.57
	Safdarjung Hospital	88	79	71	83.02
	R M L Hospital	82	76	70	78.57
	J P N Hospital	85	79	72	82.02
	Kalawati saran Hospital	79	72	65	75.5
	D. P S. Mathura Road	89	82	78	84.16
Residential Zone	Ashok Vihar	82	77	73	78.45
	New Friends Colony	77	73	66	75.16
	Greater Kailash	82	75	66	79.57
	Timarpur	84	75	67	80.16
	Ashram Chowk	91	82	72	88.45
	Sarita Vihar	81	76	71	77.79
Commercial Zone	Karol Bagh	86	77	70	81.57
	Nehru Place	81	74	67	77.50
	Connaught Place	88	82	78	84.57
	Chandni Chowk	89	83	77	85.57
	Shahadara	85	79	75	80.79
Industrial Zone	Anand Parbat	83	75	68	79.02
	Wazirpur	82	76	71	78.18
	Kirti Nagar	84	78	74	79.79
	Naraina Industrial Area	84	77	71	80.02
Heavy Traffic Zone	I T O	88	79	73	82.02
	Kashmere Gate	88	80	70	85.79
	Kingsway Camp	84	76	70	79.50
	India Gate	84	79	73	81.18
	Mulchand	87	82	75	84.57
	Hauz Khas	87	77	68	83.45

2.3 Spot Speed Measurements

A Doppler Radar speedomotor was used for measuring the spot speeds in Kmph. Speeds for all the categories of the vehicles were recorded in a predesigned preforma for hourly duration, which was subdivided in 5 minutes interval columns. To facilitate the computations, the first step in the analysis of the observed speed data of whole traffic stream was grouped into speed - class intervals and a frequency distribution table was prepared for every hourly observed spot speed data, at all the study locations.

3.0 Data Analysis

Data analysis has been done using MS EXCEL-97. Various parameters i.e. Passenger Car Noise Equivalence (PCNE), Weightged Flow (Qw), average Speed of Traffic Stream (V) and Equivalent Noise Level (Leq) were calculated for the use in the development of mathematical models. Leq has been calculated as follows and Leq. Values for different locations along with L_{10}, L_{50} & L_{90} are given in Table 1.

$$Leq = L_{50} + \frac{(L_{10} - L_{90})^2}{56} \quad \ldots\ldots\ldots\ldots\ldots (1)$$

3.1 Determination of PCNE

The intensity I of sound corresponding to noise level L dB (A) is

$$I = 10^{l/10} X I_0 \quad \ldots\ldots\ldots (2)$$

Where I_0 = reference intensity

Now corresponding to Lc dB (A) of sound level produced by car intensity is given by

$$I_C = 10^{Lc/10} x I_0 \quad \ldots\ldots\ldots (3)$$

Corresponding to L_T dB(A) of sound level produced by a particular vehicle intensity

$$I_T = n x I_c \quad \ldots\ldots\ldots (4)$$

Considering total intensity due 'n' cars is equal to intensity due to one particular vehicle,

$$I_T = 10^{LT/10} xI_0 = nx\ ^{10Lc/10} xI_0 \quad \ldots\ldots\ldots (5)$$

where n = PCNE of any particular type of vehicle whose noise Level is L_T dB (A)

To determine PCNE factor of different types of vehicle whose noise Level data of individual vehicles have been collected and cumulative noise frequency table has been made. Fifty percentile noise level has been calculated. Further from this, PCNE value for different categories of vehicles have been calculated.

Vehicles Type	Bus	Truck	Two wheeler	Three wheeler	Cycle Rickshaw
PCNE	7.08	2.00	1.28	7.08	0.08

Qw the weighted flow was computed using the following equation.

Qw the weighted flow was computed using the following equation.

$Qw = n_c + 7.08\ n_b + 2n_t + 1.28\ n_{2w} + 7.08\ n_{3w} + 0.08\ n_{cr}$ ....(6)

n_c, n_b, n_t, n_{2w}, n_{3w}, and n_{cr} are PCNE values for car, bus, truck, two wheeler, three wheeler and cycle rickshaw respectively.

4.0 FORMULATIONS OF MATHEMATICAL MODEL

The following steps have been adopted for model formulation.

(i) Identify and list the various possible variables which could be considered for developing the predictive models, and

(ii) Establish the independent and dependent variables.

Though, there are a number of independent variables (3) which may affect the traffic noise parameter. In the present study the important parameters like hourly traffic volume (Qw in EPCNE/hr), average traffic flow speed (V in KMPH), distance of the observer from the elge of the pavement (d in meter) were taken as the independent variables and Leq as the dependent variable. The following relationship has been established between independent and dependent parameter :

$Y = a_0 + a_1 X_1 + a_2X_2 + a_3X_3$ ....(7).

Where,

Y is a traffic noise parameter i.e. Leq (Equivalent Sound Energy Level in dBA)

a_0 is a constant,

X_1 represent the traffic volume (Q_w in EPCNE/hr)

X_2 represent the average speed (V in kmph)

X_3 represent the observer's distance (d in meters) and

a_1, a_2 and a_3 are the coefficients to be determined.

5.0 NOISE LEVEL Leq Prediction Model

Regression analysis was carried out amongst the various parameters for different land uses i.e. Silence Zone, Residential Zone, Commercial Zone, Industrial Zone and Heavy Traffic Zone and the values of co-efficients are presented in Table 2.

TABLE 2: REGRESSION ANALYSIS FOR PREDICTION OF L_{eq}

Sl. No.	Land use Type	"X" Parameters	Constant	'X' Co-efficients
1.	Silence Zone	Log (Q_w),d	47.45	8.58,-0.14
2.	Residential Zone	Q_w, V,d	49.44	0.00366, 0.023,-0.19
3.	Commercial Zone	Log(Q_w), V,d	59.96	7.84,-0.25, -0.55
4.	Industrial Zone	Q_w, V,d	74.82	0.00047, 0.075,-0.58
5.	Heavy Traffic Zone	Q_w, d	74.20	0.00076, -0.21

6.0 Effect of Noise Abatement Wall

To control noise level in silence zone and residential areas construction of noise abatement wall has been considered as one of the effective solution. This measure has been adopted in the New Friends Colony in Delhi in the form if brick masonry wall. To study the effect of this wall in the present condition, noise data has been collected on both side of road at 9m distance from pavement edge. So that one side of it is behind the abatement wall and otherside without abatement is on only one side. The data has been collected for ten minute interval for ten minute interval for both side at same time. Noise parameters calculated for both conditions has been given in Table 3.

Table 3 : Effect of Abatement Wall

Noise Parameters	Without Abatement Wall dB (A)	With Abatement Wall dB (A)
L_{10}	77	70
L_{50}	73	47
L_{90}	66	36
Leq	75,42	70,12

CONCLUSION

To check the validity of the developed models, data collected under a University Grants Commission (UGC) sponsored research project (4) has been used. With the help of these data, comparison of Leq observed and Leq predicted has been made. Due to limitation of space the details of comparison, it is clear that Leq calculated through various models are approximately near to real observed Leq. This comparison shows the adequacy of developed models. The models developed in this study shall be useful in predicting future traffic noise using the inputs of traffic stream parameters i.e. traffic volume and traffic speed. The model can quantify the impacts of transport development and can be used as a part of the development of Environmental Impacts of transport development and can be used as a part of the development of Environmental Impact Assessment.

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Some observations on gaps between aims and reality in implementing environmental policy in the urban transport sector in Southern Africa

Considérations sur la coupure qui existe entre les objectifs et la réalité au niveau de la mise en oeuvre d'une politique environnementale dans le secteur des transports urbains en Afrique du Sud

Algunas observaciones sobre las diferencias entre los objetivos y las realidades existentes para implementar una política consciente del medio ambiente en el sector del transporte público sudafricano

P.N.W. Freeman
CSIR, Transportek, Pretoria, South Africa

ABSTRACT: There have been many changes in Southern Africa since 1994 when a democratic government was elected in South Africa. Prior to this date the neighboring "Front-Line States" were in confrontation with the beleaguered Apartheid-Government and environmental issues, for example, were often seen to be of lesser importance. The eventual resolution of the "South African Question", however, paved the way for a variety of reforms in many sectors and the expansion of the Southern African Development Community (SADC) soon followed. This has lead to some interesting changes in policy approaches and this paper will look closely at the way environmental issues are being regarded in the region. Essentially there are a number of agendas evident, some of which are quite dissimilar. These include the aims of the donor agencies, the different governments, the implementing authorities, the lobby groups and the communities affected. It is argued that there is a substantial gap in many cases between aims and reality, but that although there is still a considerable amount of "lip service" there is also a growing awareness of the importance of environmental issues. This paper, focusing on the urban transport sector, examines which strategies appear to be most successful in the developing country context and where policies can have the best impact in a climate of scarce resources.

RÉSUMÉ: De nombreux changements sont intervenus en Afrique du Sud depuis 1994, date à laquelle un gouvernement démocratique a été élu pour diriger le pays. Avant cette date, les pays de la « ligne de front » étaient en conflit avec le gouvernement assiégé du pays de l'apartheid. Les questions environnementales, par conséquent, étaient souvent considérées comme de moindre importance. Finalement, la solution du « problème sud-africain » a permis de mettre en œuvre diverses réformes dans un grand nombre de secteurs, et le développement de la Communauté pour le Développement de l'Afrique Australe (*Southern African Development Community*, ou SADC) a bientôt suivi. Des changements intéressants se sont alors produits au niveau des démarches et des politiques ; cet article se propose par conséquent d'examiner de près la manière dont les questions environnementales sont considérées dans la région. Nous sommes essentiellement en présence d'un grand nombre d'ordres du jour évidents – dont certains sont contradictoires – parmi lesquels on peut mentionner les objectifs respectifs des organismes donateurs, des divers gouvernements, des autorités chargées de la mise en œuvre, des groupes de pression et des communautés concernées. Nous tenterons de démontrer qu'il existe une coupure considérable, dans bien des cas, entre les objectifs et la réalité mais que, malgré les nombreux « vœux pieux », on assiste à un développement croissant de la conscientisation aux questions environnementales. Cet article, en se concentrant sur le secteur des transports urbains, se propose d'examiner les stratégies qui semblent réussir dans un contexte de pays en développement, et les lieux où les politiques environnementales peuvent avoir le meilleur impact dans un climat de ressources restreintes

RESUMEN: La elección de un gobierno democrático en 1994 en la República de Sudáfrica, originó grandes cambios en Africa Austral. Antes de esa fecha, existían confrontaciones entre los países vecinos de la "Línea del Frente" y el sitiado Gobierno del Apartheid y, por ejemplo, los asuntos referentes al medio ambiente, normalmente eran considerados de menor importancia. Sin embargo, la eventual solución del "Problema Sudafricano" allanó el camino para efectuar reformas en varios sectores que a su vez fomentaron la expansión de la Comunidad para el Desarrollo de Africa Austral (SADC). Esto ha llevado a varios e interesantes cambios en el enfoque de las diversas políticas y este papel analiza en forma detallada cómo se enfocan los temas relacionados al medio ambiente regional. Esencialmente, existen muchas y variadas agendas. Estas agendas incluyen los objetivos de las agencias donantes, los de los distintos gobiernos, los de las autoridades que los implementan, los de los grupos activistas y los de las comunidades afectadas. Se argumenta la gran diferencia entre los objetivos y la realidad, pero a pesar de que todavía existe una gran cantidad de "charlatanería" también existe una conscientización general de la importancia que tienen los problemas del medio ambiente. Este papel, que trata el sector del transporte urbano, examina cuáles son las estrategias más exitosas en el contexto de los países en desarrollo y cómo pueden producir mayor impacto las políticas cuando se las aplica en un clima de pocos recursos

1 INTRODUCTION

Since the mid eighties, and particularly with the ending of the East-West cold war increasing attention has been paid to the potential for non-military, human-centered threats such as environmental issues to affect the existing global order. The potential for environmental harm has escalated with a burgeoning world population, the rapid consumption of scarce resources and skewed income distributions especially between developed and developing countries. Phenomena such as global warming and acid rain are widely debated and there is little doubt about the seriousness of their effects. However, there are growing concerns that not enough is being done to mitigate negative global impacts and the debates around the moral issues of responsibility and affordability are generally avoided in political circles.

Experts estimate that North Americans may have to triple the price of petroleum fuel to meet world goals set in terms of the 1997 Kyoto Protocol for the reduction of vehicle pollution. This protocol commits signatories to reduce emissions of carbon dioxide and other greenhouse gases to 1990 levels over the next 10 to 12 years. To get to a 20 percent emission reduction from cars for example would require tripling the price of petroleum in Canada, according to Prof. Soberman of the University of Toronto. Just doubling the fuel price would reduce driving by only about 4 percent in cities and close to 15 percent in suburbs for an overall reduction of about 10 percent in emissions. People not living near public transport routes would simply have to bear the additional costs. A study for the Canadian Federal Agency Ministry on "full-cost pricing" estimated that automobile users may pay as little as half of the true costs of driving.

In developing countries the prospects for introducing environmental taxes are far worse. Affordability levels are much lower and the environmental lobby has to contend with competing demands for more expenditure on schools, hospitals, water and sanitation schemes and other basic services. There is also a common perception that the extent of environmental damage has been spearheaded by the first world economies and that these countries have a moral obligation to assist the developing world in this regard.

Southern Africa is a microcosm of this debate and this paper examines the issues more closely in the urban transport sector in the region. The realities effecting Southern Africa, however, are equally applicable in many other developing countries.

2 ENVIRONMENTAL ISSUES AND POLICIES IN SOUTHERN AFRICA

Southern Africa is endowed with an interesting range of natural resources and an impressive diversity of wild animals and plants, which, to a certain extent, are still found in their natural habitats. However, because of the rapidly growing population the fear is that without decisive action the rate of degradation could double over the next 30 years.

The official policy adopted by SADC is prefaced by a statement that there should be an urgent and radical transition towards environmentally sustainable development. SADC policy and strategy provides the basis for implementing Agenda 21, the global action plan for environment and development, adopted at the 1992 Earth Summit, (set in the Southern African context). Its primary aim is to address poverty, which is considered to be the main underlying factor causing environmental degradation in the SADC area.

The goals of the SADC Environment and Land Management Sector, as articulated in the SADC Policy and Strategy for Environment and Sustainable Development, are:

- To protect and improve the health, environment and livelihoods of the people in Southern Africa, particularly the poor.
- To preserve the natural heritage, biodiversity and life-supporting ecosystems in Southern Africa; and
- To support regional economic development on an equitable a sustainable basis for the benefit of present and future generations.

Environment management is instrumental in achieving sustainable utilization of the region's resources. It is also crucial to the socio-economic integration process.

The Environmental Information Systems (EIS) Programme, the Environmental Education Programme and the Environmental Information Exchange Networking Programme are already ongoing programmes.

Initiatives, which are at the design stage, include:

- Integrating Environmental, Economic and Equity Impact Assessment into Decision-Making;
- Formulating a strategy and programme for the 'brown environment' (environmental issues arising from, for instance, urbanisation and industrialisation); and
- Developing programmes to address other priority environmental issues, such as biodiversity.

It can be seen that for Southern Africa as a whole urban transport issues do not feature strongly. The focus is more on land management, education and preservation of natural resources.

Many of the programmes are still in their infancy or design stage and concern has been expressed in some quarters that there is slow progress due the complex bureaucratic structure of the SADC administration coupled with lack of resources and, in some countries, instability.

The largest economy in the region is South Africa and this country has the only truly metropolitan areas i.e. Johannesburg-Pretoria, Durban and Cape Town. South Africa is preparing a national state-of-the environment report. In this report the reliance of the country of coal and oil or its products for energy purposes is the reason for the extent of $C0^2$ and $S0^2$ emissions. The transport sector contributes 44 per cent of the total national nitric oxide emissions and 45 per cent of the total national volatile organic carbon emissions (VOC). VOC combines with nitric oxide and carbon monoxide, in the presence of sunlight, to form photochemical smog, which is particularly bad in the large urban areas. Concentrations of carbon dioxide as measured at Cape Point show a steady overall increase of approximately 0.6 per cent per year.

Troposphere methane has increased steadily from 1983 to 1998 (total increase of 8.3 per cent over the time period). In general, the worst air quality in South Africa occurs when wood, dung or coal is used as fuel inside poorly ventilated dwellings in informal urban settlements and rural villages.

On the other hand there has been a decrease especially in urban areas in ambient lead concentrations over the past few years, which can be ascribed to the decrease in, lead concentrations in petrol. On average, the temperature stations in South Africa have shown an increase of 0.2°C during the nineties, but this is not yet a cause for alarm.

The development of several new environmental policies, the inclusion of environmental rights in the Constitution, and the increased funding for environmental issues are positive changes in the South African political scene. These changes have arisen from both national and international pressures, and in turn, are having national and international impacts, such as the redirection of funding within the country, and a marked increase in the availability of donor funding.

3. ENERGY USE AND ENVIRONMENTAL IMPACTS IN URBAN TRANSPORT IN SOUTH AFRICA

One such donor-funded project is a World Wild Life sponsored project focused on sustainable development in Southern Africa. At the time of preparation of this paper only data for South Africa were available, however.

The rate of growth of motor vehicle population has exceeded the rate of the human population growth since 1970. Between 1980 and 1990, for example, the car population grew at an annual rate of 3.9 per cent, while the human population increased at 2.5 per cent. The number of cars in 1996 stood at 3.8 million and is projected to grow to 6.4 million by 2020. This process is speeded up by increasing urbanization coupled with a gradual reduction in average household income disparities. At the same time, however the average age of the vehicle fleet is increasing due to pressures at the lower end of the income scale.

The public transport system, normally offered as an alternative to private car transport, is largely a commuter system with traditionally low levels of service. An operator-based bus subsidy system with all incentives geared to the operator to keep costs to an absolute minimum has translated into the slow retirement of buses. Operating conditions in the minibus taxi industry, on the other hand, have also resulted in poor levels of capital investment in the minibus fleets. The average age of minibus taxis is estimated to be approximately 9 years old, while that of buses is estimated at more than 11 years, with obvious implications in terms of energy consumption and emission levels.

Transport ranks as the third most important user of energy in South Africa in Tetra joules (TJ), accounting for 24.9 per cent of the total (2.4 billion TJ), after industry (35.4 per cent) and residential consumption (24.9 per cent). Over 90 per cent of transport energy is derived from liquid fuels. The remainder is mostly provided by electricity.

The modal use of energy by the South African transport sector in 1996 is summarized in Table 1

Table 1. Energy consumption by the South African Transport sector, 1996

Mode	Coal (Tons)	Electricity (GWh)	Petrol (kl)
Road	-	7 539	10 467 734
Rail	23 402	3 446 195	-
International air	-	-	-
Domestic air	-	12 890	-
Pipeline	-	59 092	-
Other	-	748 618	3 161
Total		4 274 334	10 470 895

	Diesel (kl)	Avgas (kl)	Jet fuel (kl)
Road	3 315 331	-	-
Rail	196 375	-	-
International air	-	-	855 173
Domestic air	-	25 157	745 293
Pipeline	-	-	-
Other	3 153	-	-
Total	3 514 879	25 157	1 601 006

(Source: Department of minerals & energy, Digest of South African Energy Statistics, 1998)

Price elasticity's of demand for the main petroleum fuel types used in land transport have been calculated for South Africa for the period 1996 to 1998. The results of the exercise are contained in Table 2

Table 2. Fuel price elasticities of demand for SA

Fuel Type	Elasticity
Petrol – 93 Octane	0.124
Petrol – 91 Octane	1.248
Diesel	0.427

The results in Table 2 indicate that the demand for leaded petrol (93 octane) and diesel are relatively price inelastic. The results for unleaded petrol (91 octane) indicate that demand is relatively price elastic. This must be seen in context of the (albeit slow) take-up of unleaded petrol, with leaded petrol still enjoying over 90% of the market share. It would appear that a greater price differential between leaded and unleaded fuel (currently 4c/ℓ) is needed to give unleaded petrol greater penetration into the market.

In 1998 the South African National Department of Transport put forward a draft discussion document based on its strategy project "Moving South Africa". (MSA) This was followed a few months later with " An Action Agenda". MSA research concluded that if earnings rise above R30 000 (US Dollars 5 000) the car starts to dominate as the preferred mode of transport.

MSA segmented the urban passenger transport market according to various criteria as summarize in Table 3.

In terms of future transport energy requirements, Table 3 indicates a significant growth in the number of people that prefer to use motorized transport by 2020. The use of fossil fuels and the amount of vehicle emissions emitted are primarily a function of number of vehicles in use and vehicle kilometers driven, given the characteristics of the vehicle fleet and operating conditions.

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Table 3. South African Urban passenger transport

Segment	Criteria	% of Urban pop	Number (1996) M	% Growth to 2020
Strider	Cost	23	5.4	28
Stranded	Cost	12	2.8	28
Survival	Cost Speed	17	4.1	24
Sensitive	Speed, cost Choice	9	2.1	25
Selective	Speed, choice Convenience	19	4.1	39
Stubborn	Speed Convenience	19	3.0	88
Total urban population			21.4	38% (1.4%pa)

Increasing private car ownership and usage is widely expected in South Africa over the next 20 years, with the "stubborn" category of the population (3m) projected to grow by 88%. Likewise, the "selective" element is set to grow by 39%. The car fleet is projected to grow by 64% between 1996 and 2020. This even more concerning when measured against the provision of an alternative to the private car in the form of reasonable public transport system. The dependency on car usage arises in part due to the lack of an attractive alternative to the car, as well as incentives such as company cars and car allowances, which make the use of a car a relatively cheap and attractive option. The issue is not only how to get the "stubborn" out of their cars, but how to keep a substantial portion of the "selectives" (2.6m in 1996) on public transport.

The apartheid system's legacy of dormitory townships on the urban periphery with long travel distances from work centers is being exacerbated by current land use planning in South Africa which locates new low cost housing on the cheapest land and away from the urban centers In parallel, current development practices of locating commercial development out of the CBD and in the suburbs creates urban sprawl and renders the service of these areas by public transport non-viable. Due to these considerations, average commuter trip distances are 17km for private cars and 20km for public transport, compared with 10km in European and Latin American cities.

A further issue has been the need to value and eventually price externality costs of transport. Such costs represent the external costs that transport usage imposes on the rest of society, primarily in the form of congestion, air pollution, noise, accidents, global warming and infrastructure. The quantification of externalities is a very complex task and the current lack of reliable South African data has led to serious questioning of the practice of making inferences from European and North American studies. Current estimates in the order of R27 billion Rands (US $ 4.5 billion) are put forward for the likely magnitude of externality costs in South Africa and only about half of this amount is currently met by fuel levies. A study is now in progress to address this lack of information. Obviously, societal costs are a highly political issue. City structures are based on *inter alia* historical transport costs and to move to a new price level overnight, which includes externality costs, would be highly unpopular and probably politically suicidal. There also needs to be a reasonable public transport alternative.

South Africa seeks to average future urban development along "transport corridors" which would encourage densification of the population and make public transport more viable. The government wants to replace the 126 000 16-seater taxis with an estimated 85 000 18-seater taxis and 35-seater mini-buses powered by diesel engines. The fitting of diesel engines is expected to increase South African diesel consumption by 67 per cent and make a dent in the current large diesel over-supply. Taxi operators are also expected to receive a price incentive at the retail pumps. Through these means the number of vehicles will be reduced and the overall condition of the fleet improved.

4. ENVIRONMENTAL POLICIES IN SOUTHERN AFRICA : QUO VADIS?

Southern African policy in general exemplifies a willingness to at least address the key issues related to the environment, although in cities urban sprawl and lack of resources make the task of limiting motor vehicles extremely difficult. However, the mitigating factor as yet is that the absolute number of vehicles is not as bad as in many other more urbanized parts of the world, whether developed or developing.

Nevertheless environmental issues will tend to be secondary when the majority of the population is unemployed and lacks basic services and amenities. Not surprisingly the first "Green" candidate in the 1999 South African General Election did not gather sufficient votes (40 000 needed in a proportional representation system) to secure a seat in parliament.

The current status is one of uncertainty, as many policies are new and the impacts of their implementation are not yet evident. Furthermore, implementation depends on adequate capacity amongst government officials. In many cases this is lacking, as is the capacity for policing and enforcement. The system of environmental change is dynamic, responding to ever changing and developing international and national priorities and pressures. As our understanding and awareness of driving forces and their impacts grows results will improve. However, the state of the environment is gradually becoming a global issue and the developed countries will in the end have to take a more proactive stance to bring about meaningful change in some developing countries, which simply do not have the resources to do what is needed to prevent permanent environmental damage.

Southern Africa's biodiversity and climate are ideal for the promotion of tourism, but this will have to be underpinned by translating policy into action. Current efforts to support the region in developing the capacity to do this are at least a step in the right direction.

It has become obvious that public transport is a basic element of "liveable" cities which means a balance between private cars and public transport must be sought using public transport incentives and private car disincentives. This implies extensive education of the public and political leaders about the relationship between policies, types of transportation and character of the cities. In Southern Africa, with its new democracies and huge educational deficiencies, this is a formidable challenge.

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Urban ecology, a comprehensive approach of the environmental issues related to transportation: The RATP case, Paris

L'écologie urbaine, une approche globale des liens entre transports urbains et environnement: le cas de la RATP

La ecologia urbana, un enfoque de los lazos entre transportes urbanos y medio ambiente: El caso de la RATP

Françoise Duchezeau
RATP, Paris, France

Affiliation Elsewhere

ABSTRACT RATP has been more and more involved as an urban actor, far beyond its role as a transporter. Urban ecology is a strategic aim for RATP, as public transport will constitute a major asset in the sustainable development of the cities of the future. RATP's comprehensive urban ecology policy revolves around four main themes: more ecological mobility, improved public transport, citizenship and an exemplary environmental record. RATP is committed to setting up a management system that takes into account the environmental considerations of projects, along with the performance of lines and industrial sites. The ecological reflex must be there in everything our staff do and in every decision the company makes. Finally, this is a long-term approach that will bring to the fore certain economic and fiscal issues involved in the choice of transport policies and the way operators manage networks.

RÉSUMÉ: La RATP s'est de plus en plus investie au-delà de son métier de transporteur, comme acteur de la ville. L'écologie urbaine est un axe stratégique, les transports publics constituant un atout majeur pour le développement durable des mégapoles : mobilité plus écologique, attractivité renforcée des transports publics, citoyenneté et exemplarité environnementale sont les quatre volets d'une politique globale d'écologie urbaine. La RATP est engagée dans la mise en place d'un système de management touchant aussi bien la prise en compte des aspects environnementaux dans les projets que les performances des lignes et sites industriels. Le réflexe écologique doit être présent dans tous les actes du personnel et les décisions de l'entreprise. Enfin, ce type d'approche s'inscrit dans le long terme et fait progresser la dimension économique et fiscale dans les choix de politiques des transports et la gestion des opérateurs.

RESUMEN: La RATP se ha venido implicando más y más allá de su actividad de transportista, como actor de la ciudad. La ecología urbana es un eje estratégico ya que los transportes públicos constituyen una ventaja principal para el desarrollo duradero de las megápolis : movilidad más ecológica, atractivo reforzado de los transportes públicos, ciudadanía y ejemplaridad medioambiental son los cuatro sectores de una política global de ecología urbana. La RATP se ha comprometido en la implementación de un sistema de management que se relaciona tanto con la toma en cuenta de los aspectos medioambientales en los proyectos como con las buenas prestaciones de las líneas y sitios industriales. El reflejo ecológico debe estar presente en todos los actos del personal y las decisiones de la empresa. Por último, este tipo de enfoque se sitúa a largo plazo y hace progresar la dimensión económica y fiscal en las opciones de políticas de transportes y la gestión de los operadores.

1 UNE PREOCCUPATION MONDIALE

Le phénomène de l'urbanisation est mondial. Il se caractérise, à l'aube du troisième millénaire, par la poursuite de la concentration des populations urbaines dans les agglomérations millionnaires, qui devraient accueillir plus de 40% de la population mondiale vivant en ville en 2010. Aujourd'hui déjà, 15 agglomérations comptent plus de 10 millions d'habitants.

Le devenir des villes est directement liée à la possibilité de s'y déplacer dans des conditions correctes de temps et de sécurité, et supportables pour la santé et la qualité de vie des populations.

En effet, le constat actuel est inquiétant : beaucoup de villes sont paralysées par la circulation et asphyxiées par la pollution de l'air. Des quartiers entiers peuvent être exclus de l'accès aux activités et il s'y développe, sur fond de chômage, violence et délinquance. Les coûts de telles situations sont considérables pour les collectivités.

A ces enjeux régionaux s'ajoute la prise de conscience des risques de la concentration de gaz à effet de serre, principalement le gaz carbonique, sur les changements climatiques. Or, il est produit pour un tiers par le secteur des transports, essentiellement les transports routiers.

Les instances internationales s'accordent pour reconnaître que la viabilité des agglomérations et leur développement durable passent par une accessibilité organisée en étroite relation avec l'urbanisme, favorisant l'équité et la cohésion sociale, et par un transfert massif de trafic routier vers des transports collectifs efficaces, compétitifs et peu polluants.

Les pays riches ont une responsabilité importante dans l'évolution attendue et ils doivent montrer le chemin. Ils ont pris des engagements quantifiés de réduction de leurs émissions de gaz à effet de serre d'ici 2010. Leurs opinions publiques sont devenues très sensibles aux risques de santé publique liés à la pollution atmosphérique. Elles sont maintenant acquises à l'idée que le « tout voiture » tue la ville.

L'Union européenne met l'accent, dans ses politiques, sur la prise en compte systématique de la protection de l'environnement dans les décisions et les programmes de recherche. Désormais, la priorité aux transports collectifs est reconnue et affirmée dans le développement urbain et la politique des transports.

2 POURQUOI LA RATP S'EST ENGAGEE EN FAVEUR DE L'ECOLOGIE URBAINE

Les transports publics ont tous les atouts pour répondre aux trois composantes qui permettront un développement durable des villes : ils contribuent aux développement économique, ils ont un avantage environnemental incomparable et leur rôle social est majeur.

Le cas de la RATP est illustratif dans la région capitale française.

2.1. *Une fonction indispensable au développement*

La RATP transporte chaque jour 9 millions de personnes. Dans Paris-même, la RATP est un acteur majeur de la capitale : elle assure 60% des déplacements quotidiens et réalise jusqu'à 75% des déplacements aux heures de pointe.

Avec son réseau multimodal de 14 lignes de métro, 2 lignes de RER (réseau régional rapide), 2 lignes de tramway et 240 lignes de bus, la RATP réalise 80% du trafic des transports collectifs dans la région capitale française.

La facilité d'accès est vitale pour le dynamisme des villes. La présence de transports rapides et fiables favorise l'implantation des activités, des grands équipements, des logements. La réussite de la ligne A du RER – qui a anticipé l'urbanisation et transporte aujourd'hui un million de personnes par jour - témoigne de cette attractivité.

Les investissements pour la réalisation d'un métro souterrain favorisent l'industrie et l'emploi au moment de sa construction, puis constituent un patrimoine actif dont la rentabilité socio-économique à long terme.

2.2. *Un avantage environnemental incomparable*

En milieu urbain, les transports collectifs provoquent beaucoup moins de nuisances que la circulation automobile. Dans la région de Paris, 80% de la pollution de l'air est due à la circulation, dont seulement 4% aux autobus.

Tous les modes collectifs consomment moins d'énergie au passager transporté que la voiture : leur efficacité énergétique à Paris est de 2 à 2,5 fois supérieure à celle de la voiture, y compris pour les bus.

Les modes ferroviaires sont particulièrement peu polluants : pas d'émissions de gaz à effet de serre localement, pas de pollution de l'air. Lorsqu'ils sont souterrains, comme le métro, ils consomment très peu d'espace urbain. Globalement, ils génèrent moins de bruit que le trafic routier. Enfin, ils sont plus sécuritaires. La valorisation des impacts externes des modes montre la part écrasante du coût des nuisances de la voiture : 33 fois celui des nuisances des transports publics dans la région parisienne.

2.3. *Un rôle social majeur*

Les transports publics sont un lieu de brassage de la population. Ils jouent un rôle crucial : accès de tous à bas prix au transport, désenclavement des quartiers défavorisés, emploi.

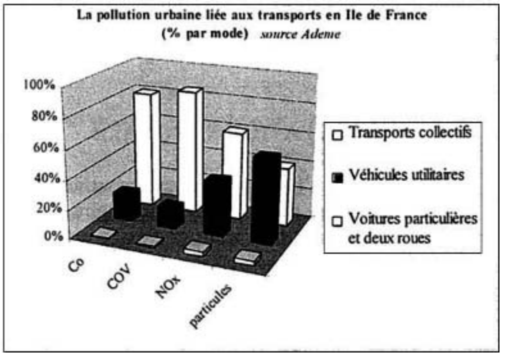

Figure 1. Polluants par mode (Source :Ademe)

Pour combattre l'insécurité sur ses propres réseaux, la RATP s'est impliquée fortement dans des actions de prévention, d'éducation des jeunes et d'assistance aux populations défavorisées, en partenariat avec les municipalités, les écoles, la poste, etc. Par ailleurs, elle valorise ses anciens sites d'ateliers et de dépôts de bus par des opérations d'aménagement urbain et des logements sociaux.

2.4 *Une responsabilité qui dépasse le métier de transporteur*

Pour la RATP, le choix de l'écologie urbaine comme axe stratégique de son Plan d'entreprise 1998-2000 résulte de cette implication, confortée par les attentes formulées par la population et les élus pour améliorer la qualité de vie dans leur ville.

Les enquêtes réalisées montrent que les transports publics ont le meilleur score de satisfaction (note de 7 sur 10 en zone dense) et sont fortement réclamés là où ils sont peu implantés.

Pour les habitants, la notion d'écologie urbaine évoque la qualité de vie, c'est-à-dire la recherche d'un bien être à la fois individuel et collectif. Cette qualité de vie recouvre

- la lutte contre les nuisances, la propreté
- la possibilité d'accès aux activités par des transports collectifs efficaces
- un cadre de vie de qualité : espaces verts, architecture, paysages
- des relations humaines plus conviviales, une société plus harmonieuse.

Les personnes enquêtées accordent à la RATP une légitimité forte pour s'engager dans l'écologie urbaine et dépasser son métier traditionnel de transporteur : 63% souhaitent qu'elle s'implique plus encore dans leur qualité de vie. 80% attendent qu'elle soit un acteur de leur cité.

Ces attentes envers la RATP sont confortées par celles des élus, des associations de défense de l'environnement et des experts de l'urbanisme et du transport : innover et multiplier les expériences de

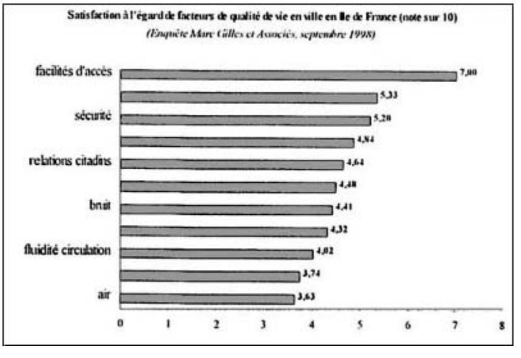

Figure 2. Taux de satisfaction de la population

services nouveaux, faire progresser les bilans écologiques des différents modes de transport et les outils d'aide à la décision, jouer un rôle pédagogique auprès de la population pour développer des comportements plus respectueux de l'environnement.

Enfin, à l'intérieur de l'entreprise, les enquêtes montrent un fort consensus du personnel en faveur de cette orientation ; il est prêt à s'engager dans son travail quotidien.

3 UNE POLITIQUE GLOBALE

De nombreuses actions étaient déjà menées avec succès dans l'entreprise lorsque fut décidé l'engagement dans l'écologie urbaine. Cette expérience a permis d'aller plus loin.

Un facteur déterminant d'une telle démarche réside dans l'implication de la hiérarchie de l'entreprise : le Président de la RATP, Jean-Paul BAILLY, également Président de l'Union Internationale des Transports Publics (UITP), s'est personnellement engagé dans ce choix.

Une Délégation générale à l'Ecologie urbaine et au Développement durable rattachée à la Direction générale a été créée en 1998 pour fédérer dans une stratégie globale toutes les initiatives et les plans d'action, et mettre en place et animer le système de management et la culture du développement durable.

Les principes d'action ont été arrêtés par le Comité exécutif de l'entreprise :

- un niveau d'exigence accru dans le souci de la RATP pour la protection de l'environnement et sa contribution à la qualité de la ville
- une responsabilisation individuelle et collective visant à créer le « réflexe écologie urbaine » dans toutes les prises de décision, processus, comportements quotidiens et management des projets, à l'instar du réflexe sécurité présent dans toute l'activité de la RATP
- l'exemplarité environnementale, gage de crédibilité des transports publics comme alternative aux modes individuels polluants
- deux valeurs essentielles pour l'entreprise : le respect (du client, du riverain, du personnel, de la santé, de l'environnement) et le souci d'économie et de bon usage des ressources.

La démarche concerne tous les agents dans toutes les fonctions de l'entreprise. Pour cela, une première étape a consisté à intégrer dans les contrats d'objectifs annuels des départements et des unités des objectifs et plans d'action concourant à l'écologie urbaine.

Elle inclut aussi la gestion préventive des risques connus et le développement d'une approche de précaution dans les domaines d'impact sensible et

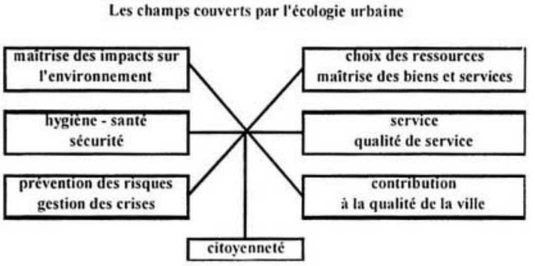

Figure 3. Les 7 champs de l'écologie urbaine

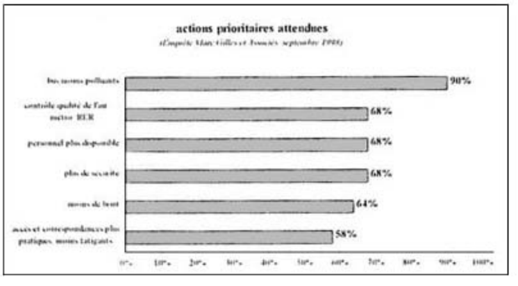

Figure 4. Actions prioritaires attendues de la RATP

encore incertain sur la santé (par exemple la pollution du diesel).

Enfin, elle promeut un comportement d'écoute et de dialogue envers les riverains, les associations et les élus locaux, par une concertation systématique et plus en amont sur les projets ou modifications de service les concernant.

4 LES PLANS D'ACTION PRIORITAIRES

Ils répondent :

- d'une part à la demande sociale, exprimée par la population et les responsables politiques
- d'autre part au diagnostic interne, qui a mis en évidence les points forts et faibles de l'entreprise.

Ainsi, la politique s'articule autour de quatre volets :

- le développement d'une mobilité écologique
- la qualité du service et le cadre de vie dans le transport
- la protection de l'environnement
- la citoyenneté et le lien social.

L'écologie urbaine est dissociée de la sécurité, au plan des responsabilités, car la sécurité en soi fait appel à un plan d'action complet, incluant la prévention de la délinquance, le volet répressif, les partenariats avec les autorités.

4.1. *Développer l'accès au transport*

Le Plan de déplacements urbains institué par la Loi sur l'air en 1996 a pour objectif de transférer une part significative de déplacements de la voiture vers les modes collectifs et non polluants. Son objectif est d'offrir à 7 millions d'habitants un maillage de desserte qui se rapproche de celui offert aux 2 millions de Parisiens.

Les principaux projets se développent autour du concept Mobicité :

- constitution d'un réseau de 50 lignes de bus ayant des amplitudes et des fréquences proches de celles du métro, séparées de la circulation normale, équipées de systèmes de régulation et information en temps réel, dotées de véhicules non polluants et accessibles aux personnes en fauteuil roulant.

La première ligne ainsi transformée est la ligne de rocade périphérique de Paris, qui transporte 130 000 voyageurs par jour.

- organisation de 60 pôles d'échanges multimodaux régionaux, véritables lieux d'animation des quartiers, favorisant l'accès par vélos, la dépose-minute et le rabattement en voiture,.

Parallèlement, la RATP propose de nouvelles infrastructures dans le cadre du Contrat de plan Etat-Région 2000-2006 : construction d'un anneau de tramway de près de 80 km pour relier les banlieues autour de Paris, en correspondance avec les lignes de métro et de RER

4.2. *Accroître l'attractivité de l'offre*

Pour fidéliser les clients actuels et attirer des utilisateurs de la voiture, la RATP agit sur tous les aspects du service en apportant un soin particulier

- à la qualité de l'accueil et à la relation de service
- à la garantie du service offert en s'engageant dans la certification des lignes
- à l'embellissement du cadre du transport : le programme "renouveau du métro" concerne 200 stations, à l'éclairage renforcé et au décor amélioré d'ici 2001, et une dizaine de stations thématiques réalisées pour le centenaire du métro
- à la différenciation des services en fonction des clientèles : contrats de services pour les entreprises, accompagnement des personnes ayant des difficultés à se déplacer, services de gardiennage et location de vélos,..
- à la facilitation de l'accès au réseau, grâce à la télébillettique et à la généralisation de l'information en temps réel.

4.3. *Promouvoir un comportement exemplaire en faveur de l'environnement*

Les transports collectifs doivent être irréprochables. Cette dimension a une valeur hautement symbolique dans la défense de la priorité aux transports publics.

La RATP a hiérarchisé ses actions en fonction des attentes de la population et avec un objectif d'anticipation sur les normes et les exigences externes :

- en premier, la qualité de l'air.

Son plan englobe tous les aspects où l'entreprise est concernée, avec une priorité à l'exemplarité de sa flotte de 4000 bus.

D'ici 2001, 2500 bus seront mis à la future norme européenne en vigueur en 2000, grâce à l'achat de 220 bus au GPL et au GNV, de 20 bus électriques et surtout l'équipement de 2300 bus diesel avec des filtres à particules catalytiques associés à un gazole désulfuré ; leurs performances environnementales sont équivalentes à celles du gaz.

- ensuite, la lutte contre le bruit.

Le bruit des transports est, après la pollution atmosphérique, le second sujet d'inquiétude de la population parisienne. Or, le métro de Paris est le plus sinueux du monde et les problèmes de bruits et vibrations sont complexes. Aujourd'hui, l'entreprise développe une politique préventive de traitement des voies par semelles antivibratoires, de protections phoniques des voies aériennes du RER et d'insonorisation des roues de 200 rames de métro sujettes à des crissements en courbes.

- les paysages .

Dans les grandes villes, la nature est rare. Les abords des lignes ferroviaires constituent des couloirs protecteurs de la biodiversité , que la RATP a décidé de valoriser par un traitement naturel et une gestion durable de la végétation. Elle apporte également un grand soin à l'insertion de ses nouvelles infrastructures, afin d'en limiter l'effet de coupure et de favoriser simultanément une requalification urbaine des quartiers traversés.

- le traitement des déchets .

. Chaque jour, sont collectées environ 20 tonnes de déchets émanant des stations de métro et de RER, sans compter les déchets industriels des sites d'entretien des bus et des trains. L'entreprise élabore une politique globale visant à la fois à réduire la production de déchets en amont et à organiser leur traitement en aval pour les valoriser et augmenter progressivement la part recyclable.

- la préservation de la ressource eau

L'eau est présente en grandes quantités dans les tunnels, par infiltration, et mérite un traitement de plus en plus écologique. L'entreprise doit aussi garantir la qualité des eaux industrielles de ses établissements.

- l'élimination des produits toxiques.

Elle concerne principalement l'éradication de l'amiante et le traitement des pyralènes des postes de redressement, qui font l'objet de programmes importants.

- la protection contre les crues de la Seine.

Un plan de protection du réseau contre une crue centenaire, comme celle qui envahit le métro en 1910, est en cours de réalisation.

4.4. *Introduire un système de management de l'écologie*

Les interpellations externes sont de bons aiguillons pour faire bouger les comportements. Ainsi, lors de la première application du plan d'alerte pollution en Ile de France, en 1997, qui limitait l'usage de la voiture en zone dense, chacun a pu mesurer la mutation dans les attitudes : un million d'automobilistes se sont reportés vers le réseau de la RATP, 40% l'ont fait dans un esprit civique et 75% ont été satisfaits de leur voyage. De tels moments sont mobilisateurs pour les agents du transport public comme pour les décideurs politiques.

La recherche et les innovations technologiques favorisent également de nouveaux comportements.

Introduire des démarches de développement durable et faire pénétrer le réflexe écologie dans les comportements suppose cependant méthode et sensibilisation. L'effort de la RATP porte sur :

- la démarche de certification ISO 14001 des ateliers et centres de maintenance, ainsi que de lignes de métro
- une approche intégrée des aspects environne mentaux et des méthodes d'éco-conception des projets (design for environment), des équipements, du matériel roulant
- la prise en compte de tous les maillons de la chaîne des acteurs, incluant les sous-traitants et fournisseurs
- l'intégration des règles et principes d'action dans les cursus de formation par métier.

Le futur système de management de l'écologie s'appuie sur la décentralisation des responsabilités et une forte cohérence globale, à travers des indicateurs communs traduisant les performances d'entreprise.

Dès 1999, la RATP a publié son premier rapport Ecologie urbaine.

4.5. *S'ouvrir à la démocratie locale*

Les projets de transports doivent faire l'objet d'un consensus des populations qu'ils concernent. La vie des lignes et des sites industriels n'est pas sans poser des problèmes de nuisances. Il convient donc de développer le dialogue avec les riverains et de progresser vers des solutions élaborées en commun. Pour autant, l'exercice de la démocratie locale est difficile.

Pour progresser, la RATP s'attache à soutenir les initiatives locales menées par les unités décentralisées auprès de leurs clients et riverains. C'est ainsi que les agents du RER rencontrent régulièrement leurs clients pour mieux cerner leurs attentes et leur satisfaction. De même, une grande campagne sur le thème du respect a été menée à l'initiative de conducteurs de bus, pour tenter de résoudre les problèmes relationnels avec les jeunes.

5. LEVIERS ET FREINS

5.1. *Une opportunité historique*

Incontestablement, les transports publics bénéficient d'un courant porteur avec la prise de conscience des risques écologiques qui pèsent sur la planète et des risques spécifiques des grandes métropoles : problèmes de pollution, de congestion, accès au transport de populations massives dans les banlieues.

Dans l'entreprise, il existe un réel consensus du personnel en faveur de la démarche écologique. Ainsi, il est bien admis qu'il faut éviter les gaspillages de matières, d'énergie, d'eau, pour économiser des ressources qui ne sont pas inépuisables et penser ainsi aux générations futures et aux autres peuples qui souhaitent se développer.

5.2. *L'importance des partenariats publics et privés*

Les politiques à mener ne se conçoivent pas sans une forte impulsion des Pouvoirs publics, collectivités territoriales et autorités organisatrices des transports urbains.

Le contexte européen et français présente une opportunité que les opérateurs doivent saisir, pour apporter leur force de proposition dans les plans de déplacements urbains et montrer leur capacité à rendre les transports collectifs plus compétitifs..

Ainsi, la RATP a-t-elle pu bénéficier d'un soutien total de la Région et de la Ville de Paris dans son programme de technologies propres pour ses bus, car elle a un effet d'entraînement sur les comportements des autres gestionnaires de flottes.

Pour les industriels, les références offertes par des réseaux de grandes villes restent un tremplin au lancement de nouvelles technologies et à la compétitivité de leurs produits..

5.3. *Les aléas de domaines encore neufs*

La RATP a fait l'expérience de l'introduction de filières pour lesquelles la réglementation n'existait pas encore. Elle a mené toutes les expérimentations et initialisé la phase d'industrialisation. Les aléas sont nombreux et expliquent les délais nécessaires.

Le manque de recul soit sur les effets de la pollution sur la santé, soit dans les technologies propres, conduit de nombreux lobbies à défendre des technologies sur des performances dont toutes ne sont pas validées ou ne correspondent pas aux conditions réelles d'exploitation de réseaux urbains.

Dans le domaine des systèmes de management, il reste aussi du chemin à parcourir pour adapter les méthodes éprouvées pour les sites industriels aux lignes de métro, par exemple.

En outre, passer du management de l'environnement au management du développement durable ou de la contribution écologique d'une entreprise pose des problèmes d'outils de mesure et de pilotage nouveaux.

5.4. *Importance de la dimension économique*

Elle se joue à plusieurs niveaux :

- potentiel de productivité et de réduction des coûts par la lutte contre les gaspillages et l'optimisation de l'utilisation des ressources
- économies sur la taxation des activités polluantes, les filières de traitement des déchets, par optimisation des politiques environnementales
- coût d'introduction des technologies nouvelles, l'amortissement des frais de développement devant souvent être porté par l'opérateur qui introduit le premier ces technologies
- développement de l'approche économique des performances écologiques : dans l'évaluation des projets et des politiques de déplacements, la comparaison des modes et la prise en compte de leurs externalités dans les politiques de prix
- fiscalité écologique appliquée aux transports : débat largement ouvert en Europe et en France, auquel il convient que la profession et les élus s'intéressent, car la fiscalité doit avoir un rôle incitatif en faveur des modes et technologies les moins polluants, internaliser une part des coûts externes des modes et donner des signaux clairs sur les priorités dans les politiques
- traduction économique des accords internationaux sur les émissions de gaz à effet de serre, faisant jouer les mécanismes de permis d'émission et aussi des mécanismes de développement propre pour les pays en développement.

CONCLUSION

L'engagement dans une politique volontariste de développement durable s'inscrit dans le long terme, a fortiori dans le domaine des transports, qui font appel à des politiques d'aménagement urbain et d'infrastructures lourdes. Cet engagement répond à une préoccupation devenue majeure sur le plan local, national, international. Dans un monde de plus en plus urbanisé, les transports collectifs ont un rôle naturel à jouer en faveur de la qualité de vie des habitants, car ils répondent à leurs aspirations et aux besoins de la communauté.

L'écologie urbaine, concept déjà ancien mais peu popularisé, et le développement durable, concept neuf, mais très présent chez les décideurs, sont donc une chance pour les villes et un levier de développement stratégique pour les transports publics.

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Urban transport and air pollution: Lessons from the Indian experience

Madhav Badami
India

ABSTRACT : This paper presents a picture of motorization and urban air pollution in India, with Delhi as the focus, and discusses implementation issues related to current and proposed transport emission prevention and control policies. Based on this discussion, it makes suggestions for effective policy analysis and implementation with regard to this issue in the Indian and less-industrialized country (LIC) contexts.

MOTORIZATION IN DELHI AND OTHER INDIAN CITIES

Motorization is occuring at a rapid pace in Delhi and other Indian cities. Delhi's motor vehicule fleet grew at an average annual rate of 20 % in the 1970's and 1980's, as against a population increase of 5-6 % per annum. While motor vehicle numbers appear not to be increasing at the same frenetic pace in this decade, they are still growing at around 8 % per annum. In 1996, around 2.6 million motor vehicles were reportedly registred in the city. Of these, there were as many as 1.7 million motorized two-wheeled (M2W) vehicles, 624, 000 cars and jeeps, and 27, 600 buses. It is also estimated that 70,000 motor vehicles from neighbouring states ply in Delhi daily (AIAM 1994 and 1995 ; CPCB 1997 . Mohan et al 1997 ; WHO/UNEP 1992).

Delhi is by far India's most motorized city, accounting for 8.1 % of all motor vehicles, 7.8 % of all M2W vehicles, and 16.6 % of all cars registred nation-wide, with only a little over 1 % of India's total population. But motorization has been at least as rapid in other Indian cities. Between 1971 and 1995, motor vehicule numbers increased at 28, 25, and 39 % per annum Ahmedabad, Bangalore and Chennai. Chennai increased its fleet from only 120, 000 to 768, 000 in that period. Nation-wide, motor vehicle numbers increased from a mere 665, 000 in 1961, and 5.4 millions as late as 1981, to over 27 millions in 1994. At 8 % growth annually, this number could touch 43 millions by 2000. M2W vehicles are growing most rapidly (44 % pa in the 1980's).

Their numbers increased from only 88, 000 and 2.6 millions in 1961 and 1981, to 18.3 millions in 1994. They now represent nearly 80 % of all motor vehicles produced and sold, and 67 % of those registered, nationally. And where as M2W vehicles form 67 % of Delhi's motor vehicle fleet, they represent 70-80 % of the fleet in Ahmedabad, Bangalore, Chennai, Hyderabad, and Pune. Only Calcutta and

Mumbai have a low percentage (43 %) in this respect (AIAM 1994 and 1995 ; ASTRU/CIRT 1997 ; RITES/ORG 1994 ; TERI 1997).

The predominance of M2W vehicles in India and other Asian LICs is in part due to low incomes in these regions. As incomes increase, the poor majority purchase bicycles, and those who own bicycles graduate to M2W vehicles. Also, buses are often the only affordable motorized modes, but their availability routinely falls short of demand, despite expanded services (Brown and Jacobson 1987 ; Mohan and Tiwari 1997 ; Pendakur 1987 ; Sathaye et al 1994). Finally, as in Delhi, many low-income persons are forced to live far away from their places of work, in aeras poorly served by public transit. Thus, for large numbers of the not-so-poor, for whom cars are out of reach, and public transit increasingly inconvenient and time-consuming, M2W vehicules (and for-hire paratransit vehicules) offer excellent mobility at a not unreasonable price, and thus easy access to employment centres and other services essential to a better life.

URBAN AIR QUALITY AND HEALTH EFFECTS, AND THE ROLE OF TRANSPORT

Air quality in many Indian cities is poor, and is worsening rapidly. Delhi's annual averge carbon monoxide (CO), sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) levels appear to be acceptable.However, SO_2 levels exceed WHO (Worl Health Organization) standards at some, including residential, sites. Airborne lead levels appear to be declining generally, likely due to lowered lead levels appear to be declining generally, likely due to lowered lead levels in gasoline and the introduction of unleaded gasoline. Most importantly, annual average levels of suspended particulate matter (SPM), which is strongly correlated with respiratory and cardiovascular diseases, have been routinely exceeding the WHO limit by as much as five times, since the early 1980's. Worse, they are as high as 9-10 times the WHO standard at specific (including residential) sites. While annual average SO_2 and NO_2 levels are acceptable , daily average levels exceed WHO standards on several days of the year, at several sites. As for SPM, daily levels exceed WHO limits nearly every day of the year. Based on a limited study, ozone appears to be a major problem, especially in winter, exceeding 8-hour and 1-hour WHO limits at several sites (CPCB 1992, 1995 and 1996 ; CSE 1996 ; WHO/UNEP 1992). The city almost certainly has a fairly serious photochemical smog problem, because of vehicular and other emissions, weather conditions and thermal inversions.

Air pollution is taking an increasingly heavy toll. Five of Delhi's 13 millions, and 40 % of its children, reportedly suffer from respiratory diseases. In a recent study of 10, 000 5/16 year-old school children in the city, 12 % were found to be asthmatic. Including those who showed symptoms in the past, the figure was closer to 17 %.

But Delhi is by no means unique. Air pollution, and per capita air pollution effects are significantly higher in many secondary Indian cities. PM levels exceed the WHO standard in over 90 % of monitoring stations nationwide, and equal or exceed Delhi's levels in several cities. At least every tenth Indian reportedly suffers from asthma, and most contract it as children (Agrewal 1997 ; Basu 1997 ;

Brandon and Hommann 1995 ; Chhabra 1997 ; CPCB 1996 ; Priti Kumar 1997 ; Roy Chowdhury 1997).

The majority of M2W vehicles, which form the bulk of India's motor vehicle fleet, and motorized three-wheeled (M3W.) vehicles, are powered by highly polluting two-stroke engines. Most buses and goods vehicles (predominantly diesel-oprated), are of old vintage and poorly maintained, and are gross polluters, particularly in terms of particulates. Though emission standards have been progressively tightened in the 1990's, and those relating to M2W vehicles for 2000 are the strictest in the world, except for Taiwan, many in-use M2W and M3W vehicles, and also cars, particulary those manufactured prior to 1991, pollute heavily. There are discrepancies in emissions inventories (Faiz et al 1992 ; CPCB in CSE 1996), but in Delhi, for example, motor vehicles appear to play a prominent rôle in terms of CO, HC and NOx. Their contribution, even in respect of SPM and SO_2 is not insignificant, and is becoming more important with time.

Because of their very high emissions per vehicle-kilometre, and their accounting for as much as 60 % of total passenger motor vehicle-kilometres in Delhi, M2W vehicles alone contribute to approximately 30, 51 and 30 % of total exhaust CO, HC and PM emissions respectively from all motor vehicle activity in the city. Their contribution is marginal only in terms of NOx and SO_2, for which buses (and other diesel vehicles) are primarily responsible. Further, while buses account for only around 10 % of vehicle kilometres, but as much as 71 % of passenger-kilometres, M2W vehicles account for only 16 % of passenger-kilometres, in motorized passenger vehicles in Delhi. Thus, M2W vehicles represent the most serious problem in terms of emissions per passenger-kilometre ; on this basis, these vehicles produce roughly 33, 50 and 7 times the amount of CO, HC, and PM, and one-fourth the SOx, from buses (calculations based on ASTRU/CIRT 1997 ; Bose 1996 ; CPCB 1997 . GoI/ESCAP 1991 ; IIP 1994 ; Shalh et al 1997).

Fuel (and lubricating oil) quality also contribute significantly to air pollution. Lead content was as high as 0.56 g/L in 87 octane (and 0.8 g/L in 93 octane) gasoline until 1995. While unleaded gasoline (0.013 g/L lead) was introduced then for new four-wheeled gasoline-powered vehicles with catalytic converters in Delhi and the three other major metropolitan centres, and in all other state capitals and major cities in 1998, the fuel for all other gasoline-powered vehicles contains 0.15 g/L lead. Benzene, a known carcinogen, is presently not controlled. Gasoline sulphur is as high as 0.2 % by weight. Diesel sulphur, an important contributor to particulates, was as high as 1 % until recently, and was brought down to 0.25 % in 1996, but only in Delhi and its neighbourhood (BIS 1995a ; BIS 1995b).

Fuel and lubricating oil adulteration is also an important factor. M3W vehicle operators, who typically do not own their vehicles, commonly adulterate their gasoline with as much as 30 % kerozene, which retailed, in Delhi in 1995, at nearly one-seventh the price of gasoline. And to guard against the wear and tear due to this, they mix excessive amounts -- as much as 10 % -- of lubricating oil, the principal source of particulate emissions in two-strokes. Diesel is adulterated with kerosene as well, tough the diesel-kerozene price differential is considerably lower than that for gasoline-kérozene. Lubricating oil, sold loose mainly for use in M2W and M3W vehicles, is also adulterated. As can be imagined, fuel and oil adulteration have a significant impact on emissions (not to mention fuel economy and engine life). Finally, gasoline evaporative emissions from vehicle fuel and fuel distribution systems, which contribute to ground-level ozone formation, are an important issue in the Indian context, given the high ambient temperatures. (Chandini 1997 ; CSE 1996 ; Faiz et al 1992 ; Iyer and Balaraman 1997 ; Raje and Malhotra 1997).

POLICIES AND IMPLENTATION ISSUES

Severel emission control policies have been instituted or are contemplated (CSE 1996 ; CSE 1997 ; MoST 1996 ; BIS 1995a ; BIS 1995b ; Chandini 1997 ; Iyer and Balaraman 1997 ; NCTD 1997a, b and c ; Gol-MoEF 1997). A few of these are discussed, along with some related implementation issues, with reference to M2W vehicles particulary.

To maintain octane rating to compensate for lead removal and benzene reduction in 2000, MTBE (methly tertiary butyl ether) will be added to gasoline. In vehicles xithout catalityc converters, this can actually cause increased reactive HCs, nitrogen oxides and formaldheyde (a possible carcinogen), thus aggravating the ozone problem (Humberto Bravo et al 1991 ; Faiz et al 1992 ; Gordon 1991). Also, corrosion of fuel system components due to this would have to be taken into account.

As indicated, emission standards have been progressively tightened since 1991 for all motor vehicles types. All new cars registered after April 1995 in Delhi and the other major cities were required to be fitted with catalityc converters. Converter performance, reliability and durability, and thus long-term effectiveness, are an important concern, particulary until 2000, on account of the likelihood of mis-fueling because of the lack of widespread of unleaded fuel outside the cities. In this regard, it is instructive to note that tests in Delhi in 1995 showed that some car models fitted with converters did not even meet in-use CO standards for cars without converters (CSE 1996). Finally, effective converter functioning depends on, among other things, precise air-fuel ratio control, which in turn can be delivered only by electronic fuel injection (EFI). This technology has run into problems of clogged injectors, because of poor quality fuel.

Achieving the stringent M2W vehicle emission norms for 2000 will require four-stroke engines or two-strokes with catalytic converters, both of which will increase vehicle costs. In the case of four-stroke engines, fuel economy would be considerably better than with two-strokes with catalytic converters, but the engine would need to be bigger. Scooters, rather than motorcycles, are preferred by users with families, and form the bulk of M2W vehicle production. Many such users interviewed by the author stated that they would never consider purchasing motorcycles, because they have little luggage carrying capacity, they cannot carry more than two persons easily, users feel more exposed to road hazards on them, and they are concerned that their wives' saris could get entangled in the wheel spokes. And yet, four-stroke engines are available only on motorcycles, not on scooters. The reason is that scooters, which have an enclosed body, require major design and tooling changes involving massive investments to accommodate the much larger and more complex four-stroke engine, which would be reflected in a higher vehicle price. Since 2000 standards might require a four-stroke, though, the industry is gearing up for it, and four-stroke scooters are entering the market.

Two-strokes with catalytic converters will require phosphorus-free lubricating oil in addition to unleaded fuel (see Footnote 5). Even so, catalyst durability, and thus long-term effectiveness, would be an issue. Catalytic converters require stable spark ignition, but spark plugs are highly susceptible to malfunctioning in M2W vehicles in the Indian Context, because of dirty operating conditions. Additionally, M2W vehicle converters have to withstand a high degree of vibration. Frequent replacement of the catalyst would be expensive and burdensome. Dealers are concerned about who would pay for replacement in case of failure in service. Another concern is how to police the secondary market likely in spurious relacements that is likely to spring up.

In terms of vehicle user perspectives, initial vehicle price is important, but so are fuel economy, trouble-free and low-cost operation,easy and inexpensive serviceability, long service life, and resale value. Users would find costly emission control technologies acceptable only if these did not compromise any of the foregoing features. Most M2W vehicle users service their vehicles on an 'SOS' basis (that is, only when it is needed). Many use authorized dealers, but also road-side mechanics. This has important implications for the effectiveness of new technology vehicles, and sales taxes on spare parts.

Properly implemented, centralized, loaded dynamometer inspection and maintenance (I/M) testing, though expensive, would be extremely beneficial in ensuring long term effectiveness of advanced emission control technologies. Currently, however, enforcement of in-use emissions standards in India is by means of a decentrelized no-load pollution check, on the basis of which a « pollution Under Control » sticker is issued. The system is burdensome without being effective, open to corruption by staff, and full of loopholes (it is common for people to purchase stickers in bulk).

Mopeds, which are small, low-power, inexpensive vehicles catering for low-income people, present a real challenge in meeting the 2000 norms. Fitting four-stroke engines is problematic, because either much higher engine speeds and/or increased engine size would be required for the same veihcle performance . There are severe space constraints in a moped ; aslo, the cost would increase considerably. In view of this, a catalytic converter appears to be the only option. However, there would still be a cost increase (though not as much as with four-strokes), and there would still be the issue of catalyst durability. Also, catalityc converters, which can run very hot, would pose a safety hazard on mopeds.

Old vehicles are proposed to be scrapped in a phased manner in Delhi. It remains to be seen if this policy will actually be implemented, how effective implementation will be, and what loopholes users may find to get around the rule, especially in the absence of viable options to personal motorized vehicles. Many users interviewed by the author said they expected to keep their vehicles for a long time, and hope to get a reasonable re-sale value when they do dispose of their vehicles.

The possibility of operating M3W vehicles on propane is being considered. It is doubtful if this will bring significant benefits, considering that these vehicles do not constitute a substantial proportion of the overall motor vehicular pollution load. More importantly, reliable and widespread availability of the fuel, serviceability, and safety are important concerns. Recently, all government vehicles in Delhi were converted to run on CNG (compressed natural gas). This quickly became a fiasco, because of a lack of commitment on the part of the vehicle drivers. Most of these vehicles have been converted back to gasoline.

Retro-fitting emission control equipment is being considered. In the case of in-use M2W vehicles, catalyst durability would be even more of a problem than in 2000-model vehicles, because the high HC levels would burn very hot in the converter, damaging it quickly. Catalityc particulate traps are being considered for retro-fitment on in-use heavy-duty diesel vehicles. Precious metal catalytic traps would reduce total PM substantially, as also HCs and CO, but, if low sulphur fuel were not used, they would oxidize SO_2 to harmeful particulate sulphur fuel were not used, they would oxidize SO_2 to harmful particulate sulphates (Faiz et al 1992).

We have discussed only e few examples here, but hopefully, they will serve to demonstrate the complexity of the problem, and the interdependancies, trade-offs and conflicts that will need to be considered in policy analysis and implementation.

RECOMMENDATIONS FOR POLICY ANALYSIS AND IMPLENTATION

Transport emissions, already significant in terms of the rapidly worsening urban air pollution, will likely become even more so. And because, unlike in the West, motorization and other energy-intensive activities in the LICs are typically concentrated in few megacities, in which the majority are in marginal health, and have poor nutrition and health care, very large exposures and impacts related to dangerously high air pollution levels ensue. While air pollution is perhaps the most widely felt impact of rapid motorization, it is by no means its only impact – it has been argued that it gets the most attention, because it is a great leveller, and it is impossible for the well-off to insulate themselves from it. There are several others, and transport emissions are inextricably linked with them. These include road accidents, congestion, access and mobility losses, noise, and rising energy demand.

India's road safety record, already one of the world's worst, is deteriorating. Road accidents killed 60, 595 people in 1993, far more than in North America , and with a fraction of its motor vehicle activity. Petroleum product consumption increased three times between 1970 and 1990, and is rising rapidly. Net oil imports currently consum over a third of net export eanings .

The future is worrisome. Transport energy demand could increase three times in as many decades. India is vulnerable to world oil prices and crises, and domestic oil reserves will likely last only around 25 years at current production levels. (AIAM 1995 ; ASRTU/CIRT 1997 ; GoI/ESCAP 1991 ; Stackhouse 1995 ; TERI 1997). .

One shudders at the thought of the implications of massive motorization in terms of all of the above impacts in India and similar countries, particularly given their meagre ressources to deal with it. If Delhi's current 8.6 % motor vehicle growth rate is maintained, it will be adding nearly 600 motor vehicles daily, and its motor vehicle fleet will double in less than nine years to around 5.2 millions by the years 2005. And as many as 3.4 millions of the projected 5.2 million motor vehicles will likely be M2W vehicles. Finally, the poor are typically the most exposed to and affected by impacts such as polluted air, accidents and loss of access and mobility, and the least able to cope with them when they occur. They enjoy few if any of the benefits of motorization, while bearing the brunt of its impacts. For example, while car occupants accounted for only 12 % of Delhi's road accident fatalities in 1994, pedestrians, cyclists and M2W vehicle users accounted for 42, 14 and 27 % (Mohan and Tiwari 1997 ; Mohan, Tiwari and Kanungo 1997).

Addressing motorization and its air pollution and other impacts, and more generally, transport-energy-environment linkages in India and other LICs is vitally important, in terms of local well-being as well as regional and global issues such as energy security, acidification and climate change. Also, transport is arguably the most complex sector in terms of human dimensions.

Systematic Thinking reflecting Complexity of the Problem. Policy analysis and implementation should be based on systematic thinking that fully reflects the complexity of the problem. Thus, in terms of transport emissions, since the policy objective is not emissions prevention and control per se, but the minimization of health and welfare effects due to emissions, a systematic analysis of which of these effects are the most important, which polluants are responsible for these effects, which modes and factors contribute to these polluants, and so forth, is necessary. Emissions of critical polluants from the transport system as a whole should be targeted, rather than merely exhaust emissions. More generally, since urban transport is not the only air pollution source, particularly in the case of harmul PM and SO_2 an emissions inventory that is as reliable and comprehensive as possible, and evaluation of sectoral contributions in terms of exposure to critical pollutants, are essential for effective control. It should not be the case that, after expensive measures are taken to control vehicular emissions, there is no substantial reduction of air pollution health and welfare effects.

Policy Analysis and Implementation for Long-term Effectiveness with Justice. Just as motorization unevenly distributes costs and benefits between different groups, so do policies to address its impacts. Policy analysis and implementation should therefore aim to minimize air pollution health and welfare effects at low cost to vehicle users, government and industry, while compromising as little as possible access and mobility for the public, the vast majority of whom are poor.

Polluters should no doubt be made to pay, but the application of « the polluter must pay » principle should be tempered by an understanding of how and why people pollute. Low-income persons forced to live far away from their places of work, in aeras poorly served by public transit, have no choice but to use inexpensive, polluting M2W vehicles. We should be concerned about how policies that would increase vehicles purchase, operation and maintenance costs will affect them. With specific reference to M2W vehicles, public policy should address their impacts. While not adversly compromising the considerable beneficits these vehicles affords many. If we wish to wean users away from these vehicles, we must attempt to preserve these benefits by other means. Thus, restricting their ownership and use without providing viable options, such as accessible, frequent, convenient and affordable public transit, would be to put them to considerable hardship.

The transport air pollution problem is complex and multi-dimensional, and requires concerted action by a range of agencies. However, the Indian and LIC contexts are characterized by the inability to provide adequate transport infrastructure, public transit and transport system management, manufacture clean vehicles and fuels, and maintain vehicles satisfactorily. More fundamentally, the institutional setting for policy making and implementation with regard to transport air pollution -- as is the case with many other environmental issues -- is characterized by a multitude of actors and jurisdictions with fragmented, overlapping, and conflicting roles and responsabilities and interests, and who lack the financial, technical, political, legal and administrative resources for reliable information generation and policy analysis, and effective inplementation, co-ordination, monitoring, and enforcement (Brandon and Ramankutty 1993 ; Faiz et al 1992 ; Faiz et al 1996 ; Shalizi and Carbojo 1994). Thus, the institutional setting is severely mis-matched with the complexity of the problem, even in terms of transport air pollution, let alone transport impacts generally.

Rather than cosidering policies as if they will be implemented in a friction-free world, they should be evaluated with reference to the realities of the context. In-use emissions under real-life conditions, rather thean only new vehicle emissions, should be targeted. For long-term cost-effectiveness, and to avoid unintended consequences that so often characterize policy efforts and typically tend to show up only over the long-term, policy impacts should be evaluated over the long term. Analysis and decision-making should consider implementation issues up-front, as an integral part of the policy-analytic process itself. These include the institutional barriers and constraints and policy interdependencies, trade-offs and conflicts discussed above, and last but not least, vehicle user and industry perspectives as to how they would be impacted by, and would respond to, various policy alternatives.

Policies should be selected that, as far as possible, deliver results rapidly, while also being cost-effective over the long term (there are no easy, quick-fire, inexpensive solutions, though). In this connection, it is worth pointing out the importance of fuel quality improvements, such as reduced volatility for reactive HC emissions reduction. These might not be as effective as vehicle technology improvements in reducing per-vehicle emissions, but can start reducing emissions from all vehicles in-use (and the fuel distribution system) as soon as they are introduced.

Many emissions and fuel economy improvements can involve increased complexity sensitive to quality of maintenance and spare parts, increased costs, and unintented consequences. In the interests of long-term effectiveness, such measures should be thought throught and designed carefully before being put in place. The vehicle servicing industry should be adequately prepared to handle them well in advance of introduction, and widespread availability of moderately priced quality spares should be ensured to encourage good maintenance. This has important implications for, among other things, spare parts taxation.

Because transport air pollution (and its causes) transcend political and sectoral boundaries, and involve multiple disciplines, the institutional framework must take a regional, if not a national, and a cross-sectoral, interdisciplinary, perspective. It is important to ensure close co-ordination between technological, regulatory and economic policies. And since these are determined by, or affect multiple actors – governments at the national, regional, and municipal levels, the vehicle, fuel, and servicing industries, vehicle and fuel retailers, and vehicle users – all of these actors should ideally be involved in policy development and implementation. Additionally, agencies responsible for public health, land use, transport planning, roads, transport system management, traffic control, air quality and emissions monitoring, and vehicle registration, inspection and maintenance, should be involved, right from setting vehicle emission and fuel standards to intitutional mechanisms for smooth implementation and long term cost-effectiveness.

Prevention rather than Cure. Motor vehicles undoubtedly have an important role to play, and so do technical measures to address air pollution and other impacts. But technical measures can be quite quickly rendered useless unless measures are also taken to reduce overall motorized vehicle-kilometres and vehicle-trips. Worse, in some instances, they can actually aggravate the problem they were meant to address.

Transport emissions should not be targeted in isolation. Policies targeted at transport air pollution should consider interdependencies between transportation impacts, and between policies to address those impacts. As far as possible, they should be designed to achieve synergies, and fulfill other transport and urban livability objectives (such as improved road safety, fuel economy, equitable access, neighbourhood quality) in addition to improving air quality. Ideally, all transport impacts should be addressed in an integrated fashion, with the overall aim of achieving an urban access and mobility system that is reource conserving, environmentally benign, safe, and socially just.

Given this goal, and also given that providing for motorization and mitigating its impacts can involve considerable resources, in a context of already severe financial constraints and a multiplicity of urgent demands, and that the vast majority of city dwellers poor and benefit little from motorization (many cannot even afford subsidized public transport), the last thing urban transport policy in India and similar countries should do is accommodate motorization. We should accord primacy to reducing the need to use personal motorized modes. In addition to providing public transit that is extensive, reliable and convenient, we should plan pro-actively for walking and cycling. This is not only because of their environmental benefits, but also because these modes account for an overwhelming majority of trips among low-income users.

Institutional Capacity Building : Finally, and perhaps most importantly, institutional capacity needs to be built for reliable information generation, policy analysis, long-range planning, standards setting, and effective implementation, monitoring and enforcement. Political commitment is essential for effective environmental action, but so is strong informed public pressure. This in turn will require action by, for example, adequately funded NGO' S and local agencies, to build public awareness not only of problems and their seriousness, but also of the complexities, barriers and trade-offs involved in resolving them. Ultimately, effective resolution of urban air pollution, transport and other environmental problems depend on representative, commited, competent, and financially independent local governments that are keenly aware of local priorities, resources, constraints and possibilities (Brandon and Ramankutty 1993).

As a process, policy analysis and implementation should enable decision makers and affected groups to become aware of the complexities and trade-offs, and help identify key issues over which they can carry on an informed debate leading to a mutually beneficial consensus that will ensure long-term policy effectiveness (rather than merely mandating standards and technologies without any thought to implementation). It should be self-reflective, enabling constant re-examination and refinement of analytic and implementationproaches in the light of experience, adaptive learning and « learning to learn ».

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Intégration des infrastructures, notamment routières, dans l'environnement: le cas du Bénin

The integration urban transport of infrastructures in environment: The case of Benin

Intégración de las infraestructuras del transporte al medio urbano: El caso de Benin

M.A.da Matha Sant'Anna
Département de Géographie et d'Aménagement du Territoire, Université Nationale du Bénin, Abomey Calavi, Benin

RESUME : Au Bénin comme dans nombre de pays sous développés, la progression urbaine évolue à un rythme accéléré et nécessite la mise en place d'infrastructures routières devant insérer les populations des villes dans un processus de développement humain durable. Pour ce faire l'État recourt à une politique d'établissement d'infrastructures respectueuses de l'environnement dans ses dimensions biophysiques, économiques, techniques et socio-culturelles.

ABSTRACT : In Benin as in many underdeveloped countries, urban in development is becoming very rapid and must take in account the environment . This means that road construction in all beninese towns must be founded on biophysical, social cultural and economic elements.

RESUMEN : En la República de Benin el desarrollo urbano es rápido y necesita una política de transporte urbano que se funda en la noción de medio ambiente que debe ser entendida en un sentido integrando los diferentes factores naturales, técnicos, sociales, políticos y económicos que influyen un desarrollo humano sustentable.

1- INTRODUCTION

Au Bénin comme dans nombre de pays sous-développés la progression urbaine évolue à un rythme accéléré. En 1960 par exemple le rapport ville/campagne était de 1/10, c'est à dire un citadin pour 10 ruraux. Actuellement ce rapport est passé à 1/3 et l'Institut National de la Statistique et de l'Analyse Economique prévoit qu'il sera de 1/1,4 vers l'an 2025. Cette évolution démographique indique clairement que les programmes de développement urbain doivent offrir un cadre sain à cette concentration humaine afin de l'aider à ne pas enclencher contre elle-même un processus de nuisance irréversible lié à la dégradation de son environnement.

Un des moyens dont dispose le Bénin pour affronter cette adéquation entre les besoins sans cesse croissants de cette population et l'espace urbain relativement limité, est la mise en place d'une politique de déplacement urbain fondée sur l'intégration des infrastructures à l'environnement biophysique, socio-culturel économique et technique dans lequel évolue chaque ville du pays.

Ces infrastructures assurent donc le transport d'un nombre de plus en plus élevé de personnes et un volume toujours important de marchandises.

2- TRANSPORT DE PERSONNES ET DE MARCHANDISES

2.1 Le transport de personnes

Deux modes relevant exclusivement du secteur privé coexistent.Ce sont les taxis autos et les taxis motos. Les taxis autos sont, soit collectifs, soit individuels.

La composante individuelle de l'offre de transport concerne les voitures particulières et les deux roues couramment appelés "Zémidjan" dont l'avènement remonte à la seconde moitié des années 80 caractérisées par une crise économique sans précédent obligeant chacun à se démerder pour se procurer quelque revenu que ce soit. Plusieurs sociétés privées de transport, récemment constituées telles "Les Rapides de l'Albatros", "La Régie Autonome des Transports du Bénin", "La Coopérative de Transport" participent au déplacement des populations urbaines.

2.2 Le transport des marchandises

Il est surtout assuré par des moyens et gros porteurs qui encombrent les voies étouffant le déplacement des piétons, cyclistes et petites voitures. Pour cette raison l'État procède à une réglementation des heures de circulation de ces gros porteurs qui doivent garer durant les heures de pointe. Ce faisant, il contribue à décongestionner la circulation et à réduire

l'émission des gaz nocifs par les moteurs surtout quand ils tournent au ralenti lors des encombrements avec déplacement pare-chocs contre pare-chocs.
Depuis 1990, le trafic des marchandises transportées à travers la ville de Cotonou à partir du port de cette dernière enregistre régulièrement une hausse moyenne de 5,03% l'an et a atteint 2.219.813 tonnes en 1996.
Face à cet enjeu lié à l'adéquation des besoins de transport à la protection de l'environnement, l'État incite les opérateurs économiques intervenant dans le transport à renouveler ou contrôler techniquement leurs véhicules pour offrir les conditions minimales de sécurité aux usagers. Lui-même s'efforce de mobiliser les ressources nécessaires pour l'entretien, la réfection et la construction des infrastructures de transport dont une bonne partie est vétuste.

3- INFRASTRUCTURES ET ENVIRONNEMENT

A travers cette édification des infrastructures l'État veut aider les urbains à évoluer dans un cadre de vie sain favorable à la lutte contre la pauvreté urbaine. En effet le caractère défectueux des infrastructures de transport fragilise davantage les écosystèmes des grandes villes par la pollution due à l'émission des gaz et poussières toxiques des véhicules à moteurs.
Pour réaliser l'adéquation entre l'édification d'infrastructures routières efficaces pour un développement urbain maîtrisé et la vie des populations dans un environnement sain l'État s'appuie alors sur une politique nationale des transports aux objectifs suivants :

- respecter le milieu biophysique,
- tenir compte des facettes topographiques,
- sauvegarder les bases socio-économiques et culturelles,
- promouvoir l'agro-foresterie urbaine.

3.1Le respect de l'environnement biophysique

L'État évite d'implanter des voies, sauf raison majeure, dans les secteurs fragiles ou topographiquement bas, de peur de gêner les fonctions purificatrices naturelles des bas-fonds humides marécageux qui jouent le rôle de collecteurs et de digesteurs des déchets solides et liquides transportés par les eaux pluviales ruisselantes des sommets et des versants des plateaux urbanisés. La fonction chlorophyllienne de leurs végétaux comme Juncatus spp, Eichornea spp, purifie l'air de leur parage et contribue au bien être des riverains . Autant de raisons qui justifient leur sauvegarde.
Cas des villes de Porto-Novo, Cotonou et Parakou par exemple. Dans ces villes comme dans la plupart des autres du Bénin, la collecte des ordures et déchets ménagers naguère assurée par la voirie relève désormais de structures privées qui n'arrivent pas à couvrir les besoins d'une population urbaine sans cesse croissante et en pleine expansion spatiale. Ainsi les points de collecte s'organisent à peine en un réseau efficace. D'où la prolifération des tas d'ordure anarchiques livrées aux eaux ruisselantes lors des grandes pluies.

3-2 Les facettes topographiques et l'édification des voies

L'Etat exige des architectes et ingénieurs en génie civile de réaliser des voies dont les tracés et fondations tiennent compte des facettes topographiques pour ne pas entraver l'écoulement des eaux pluviales vers les bas-fonds et provoquer la constitution de plans d'eau stagnante favorable aux insectes et germes pathogènes nuisibles à la santé des populations.
Par ailleurs il encourage l'implantation des voies selon les pentes des versants pour une meilleure canalisation et drainage des eaux de ruissellement de l'amont à l'aval, avec recourt à des dispositifs en maçonnerie ou en enrochement ou en végétaux pour stabiliser ces versants, comme sur le plateau de Porto-Novo et les flancs de la montagne de l'Atacora , flancs abritant une partie de la ville de Natitingou. Le même constat est fait sur les collines de Savalou, de Dassa et de Savè.

Le cas de Natitingou est particulièrement intéressant car il s'agit d'une ville linéaire enserrée entre deux façades rocheuses à l'ouest et à l'est. Sur les flancs de cette chaine, quand les pentes ne sont pas trop fortes se développent des quartiers où stagnent à peine les eaux de pluie. L'essentiel ici est de pouvoir les canaliser vers les bas-fonds tout en réduisant leur vitesse abrasive et érosive et les empêcher de déchausser les fondations des habitations et surtout des infrastructures routières.
Dans les secteurs presque plats au niveau des plaines ou sur les sommets des plateaux les fondations des infrastructures bénéficient de remblais entrecoupés de ponceaux pour faciliter l'écoulement. Ce dernier étant renforcé par des canalisations souterraines qui drainent ces eaux vers les marécages ou les lacs et lagunes.
Pour faciliter l'infiltration des eaux , des infrastructures sont réalisées avec des pavés dont les mini espacements interstitiels sont très indiqués à cette fonction.

3.3 La sauvegarde des bases socio-économiques et culturelles.

Sur le plan socio-économique par exemple la réalisation des infrastructures routières urbaines avec l'utilisation généralisée des pavés (Fig.1) fabriqués sur place à partir du ciment et des matériaux locaux, réduit sensiblement leur coût.

Aussi fournit-elle du travail à une importante partie de la main d'œuvre sans emploi des villes.

Ceci s'inscrit dans la politique des travaux à haute intensité de main-d'œuvre favorable non seulement à la création d'emplois urbains mais également à la mobilité des personnes et des biens dans des conditions satisfaisantes.

Pour mener à bien cette opération, l'Etat s'appuie sur les associations de développement, les collectivités locales et les usagers. Il les responsabilise pour l'entretien des voies ainsi construites surtout que le long de celles-ci sont installés les dispositifs de télécommunication, d'électrification et d'adduction d'eau pour le bien-être des ménages.

Cette conception des infrastructures qui prend en compte les aspirations socio-économiques et culturelles des populations est basée sur un effort d'insertion de celles-ci dans la prise des décisions et de leur exécution tant au niveau de la conception des plans d'urbanisme que de leur mise en application.

Ainsi se définit une nouvelle approche pour le développement des agglomérations urbaines. L'ambition est de créer des cités qui ne seront plus l'expression évidente du dénuement et de la pauvreté, mais des cités assainies où les individus pourront disposer d'un certain minimum vital favorisé par des infrastructures de circulation adéquates conçues et mises en œuvre avec le concours des citadins dans une approche participative et démocratique.

Cette préoccupation explique le fait que l'Etat valorise lors de l'élaboration des plans de circulation urbaine les lieux traditionnels d'échanges commerciaux que sont les places des marchés locaux. Il accorde une importance à ces voies qu'on évite de supprimer mais qu'on contourne le plus souvent. De plus à leur niveau les voies s'élargissent avec création pour les véhicules de gares et de parcs harmonieusement incorporés à l'architecture d'ensemble. Cas des voies déservant les marchés de Dantokpa (Cotonou), de Porto-Novo au sud , de Parakou et de Djougou au nord du pays.

Sur le plan culturel, les lieudits chargés d'histoires et de traditions ancestrales sont sauvegardées.

Ainsi les vieux quartiers et leurs constructions caractéristiques qui ont traversé plusieurs siècles de même que les vieilles résidences royales ou de personnalités historiques sont ménagées. Il en est de même des sites sacrés liés aux religions locales ou étrangères.

Quand il arrive que les tracés des voies tombent contre toute attente sur des sites jugés historiques ou archéologiques, l'Etat demande alors aux entrepreneurs routiers de les éviter. Cas d'un ancien village souterrain découvert près de Bohicon en 1998 lors des travaux routiers et qui a dû occasionner une déviation de la voie.

Outre ces préoccupations culturelles, l'Etat protège les sites naturels rattrapés par l'extension urbaine telles les forêts sacrées ou non comme à Ouidah à Parakou et à Djougou. Il en fait de même pour les collines et flancs de montagne. Les citadins et les touristes y trouvent détente, agrément et un air encore sain.

Toutes ces actions favorisent le développement du tourisme dans les villes et incitent les opérateurs économiques à investir dans les crénaux porteurs tels les établissements hôteliers, l'organisation des foires et expositions nationales et inter-nationale

Par ailleurs, conformément à son souci de réduire les pollutions liées aux moteurs quand ils tournent au ralenti et de réduire le temps consacré par les citadins à leur déplacement sur route, l'Etat démultiplie le nombre des voies rapides soit par le classement de certaines en voies prioritaires, soit par le dédoublement d'autres.

3.4- L'essor de l'agro-foresterie urbaine.

Pour offrir un cadre toujours plus sain et plaisant aux populations des villes l'Etat procède sur de larges bandes à l'implantation le long des voies d'arbres utilitaires et d'agrément. Le choix de ces essences est fortement conditionné par leur enracinement profond et la résistance aux vents violents de leurs branches. Autant de dispositifs naturels qui les protègent du chablis.

Le refus d'implanter des essences à système racinaire latéral trop développé est justifié par la crainte que ce dernier ne déstabilise les fondations des infrastructures.

Comme arbres d'agrément s'observent : Dolonis spp, spatogea spp, Phoenix spp, et parmi les essences à buts multiples plantées le long des rues et dans les habitations se retrouvent entre autres fruitiers : Manguifera indica, Sapotas spp, Persea spp , et Citrus spp, surtout pour leurs fruits comestibles. A celles-ci s'ajoutent d'autres appréciées pour leurs feuilles utilisées dans la pharmacopée cas d'Eucalyptus spp.

A leur ombre sont construites des banquettes en maçonnerie pour la détente des

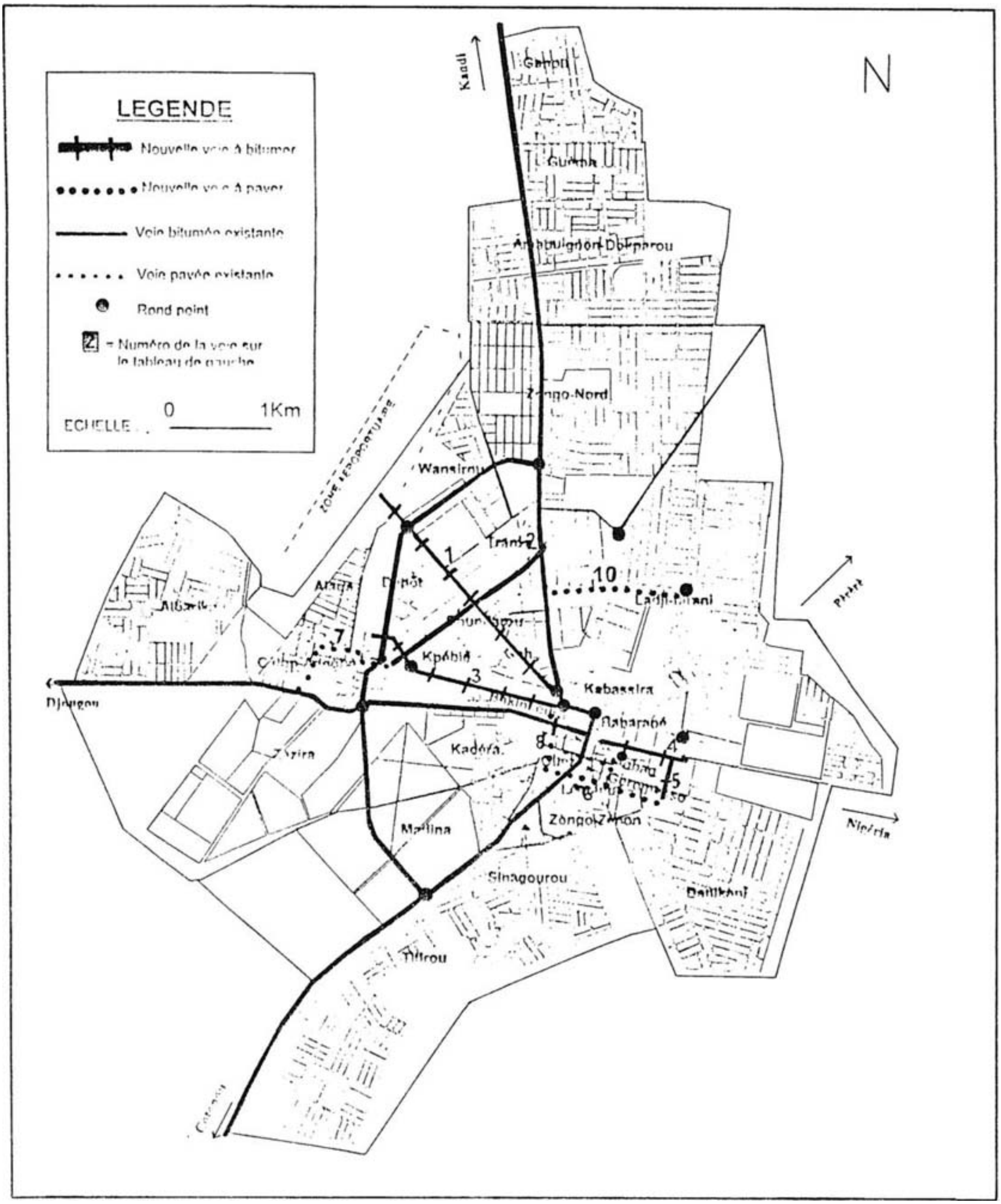

Figure 1 VILLE DE PARAKOU :
Programme d'aménagement de voies urbaines sur financement conjoint Commune Urbaine de Parakou (CUP)-Union Européenne

urbains. De plus ces arbres offrent d'appréciables bois de services et d'œuvre, tout en contribuant à purifier l'air à qui ils retirent d'importantes quantités de gaz carbonique tout en lui restituant de l'oxygène à travers leur fonction chlorophylienne.

Parfois sur les terres-pleins centraux de certaines grandes voies s'entretiennent des pelouses parsemées d'arbrissots aux feuillages multicolores ou souvent en fleurs comme Acacia floribunda.

4- MOYENS D' ACTION

4-1. Le Budget national et la coopération internationale.

Pour réussir la mise en application de cette conception des infrastructures routières urbaines respectueuses de l'environnement, l'Etat s'efforce d'apporter les moyens tant par ses programmes budgétaires que par ses relations avec les partenaires au développement. Il incite également les populations à nouer des relations favorables aux jumelages de leurs villes avec celles d'autres pays. Un cas particulièrement illustratif à cet effet est le développement de la ville de Parakou qui bénéficie non seulement de l'appui de la CEE pour la construction de ses voies mais aussi des apports de la ville française d'Orléans depuis 1993.

4-2- Les actions d'information et de responsabilisation.

Pour éviter de créer des situations conflictuelles entre lui et les habitants à propos de l'espace foncier devant recevoir les infrastructures, l'Etat s'arrange pour faire comprendre aux populations l'intérêt économique et social qu'elles ont quand ces voies passent devant leurs habitations selon des dimensions réglementaires.

Ce faisant il amène les propriétaires terriens concernés à lui céder les bandes de terre nécessaires. Certains s'exécutent librement en implantant leurs mûrs à distances légales. D'autres non. Mais au début l'Etat ne recours pas à la force et continue à rappeler la nécessité de respecter les largeurs des voies. Par la suite quand les personnes réticentes se rendent compte de l'importance du trafic que connaissent lesdites infrastructures elles acceptent plus ou moins volontiers leur élargissement. Mais dans certaines circonstances l'Etat est obligé de procéder à des déguerpissements forcés des abords pour normaliser les routes.

Dans le contexte démocratique actuel basé sur la participation des populations à l'exercice du pouvoir et à la gestion de la cité, l'Etat recourt à une méthodologie de communication populaire appropriée pour aider les citoyens à élever leur niveau de connaissance de formation et d'information pour contribuer à l'édification, à l'entretien et à l'utilisation durable de ces outils de développement urbain.

5- CONCLUSION

Somme toute, le Bénin comme nombre de pays sous développés reconnaît de plus en plus la nécessité de mettre en place des infrastructures de transports urbains respectueuses de l'environnement dans ses dimensions non seulement technologiques et économiques mais aussi et surtout sociales, biophysiques et culturelles. L'Etat se fonde alors sur une approche politique participative et démocratique. Ainsi il met en palace un programme spécifique pour préparer le rôle des collectivités locales dans la gestion urbaine. Ce rôle est conçu comme celui d'un organisateur et d'un mobilisateur des énergies locales. Les collectivités verront s'améliorer leurs capacités à faire et a fait faire. Ceci passe par une délégation des services publics et une mise à disposition de fonds au profit desdites collectivités.

Cette approche est appréciée par les citadins qui se sentent de plus en plus cogestionnaires et responsables de ces infrastructures qui rendent agréable leur existence dans un cadre sain et assaini : gage de leur insertion dans la politique de développement humain durable mise en œuvre par l'Etat dans son Plan d'orientation 1998-2002.

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Transport-related pollution and investments required to minimize it in Dar-es-Salaam City, Tanzania

Francos Halla
UCLAS, Dar-es-Salaam, Tanzania

ABSTRACT : Transportation in Dar-es-Salaam, the only primate city in Tanzania, is more efficient in 1990s than in 1970s and 1980s: The improvement can be attributed to the liberalization of the transport industry in the late 1980s. The efficiency level would be higher if the liberal policy were supported by expansionist transport investments for the city. However, the efficiency is in operational terms only as environmental pollution has increased. With the liberal transport policy, increased volume of motor vehicles for passenger travel, personal transport and freight haulage has augmented air pollution in the city. The reason is use of leaded fuel coupled with excessive exhausts from aged motor vehicles that ply along congested roads.

Pollution minimization would, therefore, require substantial investment to change to the lead-free fuel culture on the one hand, and to expand the city's road-network on the other. Since the move is substantially costly, the attained operational efficiency in city transportation will continue at the expense of the city's environmental quality. Hence, the subject of the paper is that inconsistency in transport policies and investments leads to environmental deterioration. The purpose of the paper is to analyze and expose such inconsistency with a view to devising workable strategies that can upkeep the city's environment while maximising operational efficiency of the city transportation.

INTRODUCTION

Dar-es-Saalam City Region occupies about 1,400 square kilometres of land, of which less than one-third is built-up, while the rest is forestry or agricultural land that is sparsely populated. The City is estimated to have a population of three million, which is about 10 percent of that of the Country, of which 80 percent live in rural areas (i.e. human settlements of less than 10, 000 people each). It is the Country's primate city and has been so since its inception, a century ago. Currently, the City's population is five to seven times larger than that of the second largest city, Mwanza. The Country occupies an area of 945, 000 square kilometres and its population is approaching 30 million, of which more than one-fifth live in urban centres. In Tanzania, levels of locational accessibility and traffic mobility are quite low in both urban centre and rural settlements. This is due to the low road density and poor road quality on the one hand, and limited human activity on the other. In both urban and rural settlements traffic mobility is highest at the local level by using non-motorised means of the transport (NMT), along the well-maintained major roads in urban centres, along the national trunk roads, and along railways, sea/lake/river routes, and air routes. But for the major parts of the urban and rural settlements that are not traversed by such standard roads and the other routes locational accessibility and traffic mobility are highly constrained. Government efforts to increase the levels of locationel accessibility and traffic mobility at the settlements and country levels have tented to focus on infrastructure provision, technological innovations and policy guidance.

Movement corridors traverse only a small proportion of the areas of urban and rural settlements in the country. The rest of the areas suffer from locational inaccessibility and the subsequent limitations in traffic mobility. In such inaccessible areas, traffic mobility is only possible at high vehicle operating costs and low-quality transport services. At this time when the government sector is focussing on provision of transport infrastructure, the business sector (formal and informal) is increasingly assuming the transport operation role in all modes except railways. For example, most road freight and passenger operators own small fleets of vehicles ranging from one to three trucks of one to fifteen tonnes or one to three buses of ten to sixty-five seats. The main reasen for the locational inaccessibility of a greater part of the country has been limited government funds for transport infrastrusture provision in terms of networks expansion, maintenance and reconstruction. Where as the average road density for the country is 0.09 km/km^2 that for the City is 0.83 km/km^2 (Baruti et Al, 1992).

THE TRANSPORT - RELATED CITY'S ENVIRONMENTAL PROBLEMS

As such, traffic circulation in the city is greatly hampered by the high levels of locational inaccessibility simply because there are inadequate roads and other transport modes. The city has a radial road pattern that is constituted by only five arterial roads. The radial arterial roads are linked by only two circumferential roads at intervals of a kilometres and 10 kilometres from the city centre. Since the City's built-up area spreads out to between 30 kilometres and 50 kilometres along such radial roads, there are large parts of the city, lying between these roads, that are inaccessible by motor traffic. The situation has necessitated high levels of radial road congestion for motor traffic as each motorist has to go past the city centre or the inner city in order to join a radial road from another. The situation has led to unnecessary environmental pollution in the form of particulate matter (excessive dust) from the erosion of the numerous earth/gravel roads. Another form of pollution is the burning of large amounts of leaded fuel as the numerous old and reconditioned motor vehicles are always stuck in traffic jams. Another form of pollution is the widespread visual intrusion caused by endless queues of slow-moving motor vehicles for very long road stretches. Another form of pollution is the abandoned defective motor vehicles found along the radial roads due to high vehicle operating costs that related to long journey times, traffic jams and the friction with the earth/gravel roads.

MANAGING THE TRANSPORT - RELATED ENVIRONMENTAL POLLUTION

Key stakeholders represented in managing this environmental issue have included representations from the following sectors and levels of the City's community :

- Central Government ministries and departments of Transport and Communications, Works, Home Affairs, Lands and Human Settlements Development, Water, Health, City Regional Engineer's Office, and the City Council/Commission :
- Parastatal Organizations like Dar-es-Saalam Motor Transport Company (UDA), Tanzania Bureau of Statistics, Muhimbili Medical Centre and National Environmental Management Council.
- Institutions of Higher Learning including University of Dar-es-Saalam, University College of Lands and Architectural Studies (UCLAS) and National Institute of Transport.
- Association of Daladala (Public Bus) Operators (MUWADA), Tanzania Association of Non-Governmental Organizations (TANGO), Non-Governmental Organizations (NGOs) and Community-Based Organizations ;
- the Business communauty.

To address this issue the stakeholder representations focussed on the following sub-issues : radial road congestion and the subsequent traffic congestion, road networking and storm water drainage, city centre parking, public transport, non-motorised transport, and air pollution. The outputs of the working sessions of the issues stakeholders focussed on modifying some policy issues that pertain to transport infrastructure provision and air pollution. Their recommendations have included the following strategies :

- Importation of old and smoking vehicles should de banned.
- Unsuitable vehicles for public transportation should not be allowed to operate.
- Stakeholder participation and partnerships need to be harnessed in the provision of transport infrastructure like road-network expansion, maintenance and operation.
- Self-enforcing traffic management measures to be executed in order to reduce radial road congestion and traffic jams along city-centre streets.
- Banning heavy duty vehicles, service delivery vehicles and solid waste collection trucks from entering the city centre during the peak hours of the day ?
- Construction and privatisation of « parking garages » as well as privatisation of the on-street parking lots.
- Allowing the sea vessels that are plying between Dar-es-Saalam and Zanzibar to offer public transport services (while they are idle) along the coast of the city.
- Introduction of solar powered trams especially in the peri-urban areas.
- Privatization of road/pavement cleaning which is already being implemented in the city.

During the course of tackling the sub-issue of transport-related air pollution, a special opportunity arose whereby the City was admitted as a participating city in the Global Environmental Monitoring system (GEMS) Air Programme. Through this programme, the relevant working group received technical assistance from various institutions. They included World Health

Organisation (WHO) Geneva that offered air pollution scientists. Also through WHO assistance, the group was able to receive technical assistance from the Norwegian Institute for Air Research (NILU).

Moreover, through the GEMS/Air Programme the city was able receive a set of documentation pertaining to air pollution and three SPM (Hi-Vol) monitors. The provision of the monitors was facilitated through what is known as « Twinning Project ». In this project, cities in developed countries do provide citites in developing countries with air pollution monitoring equipment that is no longer used in those cities but are still in good condition to be used in the cities in the developing countries. Dar-es-Saalam City received such equipment from The Air and Radiation Management Administration of the Maryland Department of Environment, USA.

As such simple air monitoring methods have been instituted in the City including the use of simple passive air samplers. For instance, some ten such samplers have so far been used by the City to measure two types of polluants : sulphur dioxide and nitrogen dioxide. The samplers were located in ten stations in the City. After the test period the samplers were analyzed, results verified, and prompt actions taken by the City stakeholders.

To accomplish the task of tackling this environmental issue the respective City stakeholders were supported by some limited external support that included the following :

- Technical assistance and expertise from Habitat, WHO, Norwegian Institute of Air Research (NILU), and local consultants from institutions of higher learning.
- Financial assistance from LIFE/UNDP.
- Equipment for monitoring of air pollution from Maryland, USA through GEMS/Air Twinning Project.

This support was extended to the project over different periods of time. The external support was very useful especially in the area of air pollution where, without it, it would have not been possible to get the monitoring equipment because such equipment are very expensive.

CONCLUDING REMARKS

However, if the urban transportation and air pollution issue was to be addressed today would include a lot of case studies and lessons of experience from elsewhere in the world so as to improve the preparation of strategies to be in more practical way and implementable by the City stakeholders. The current status of the traffic mobility and services is not conducive to increased productivity at both local and national levels. Traffic mobility services are so far not sustainable. The production process cycle of traffic mobility services in both rural and urban settlements cannot be sustained by the government sector alone. The business sector and local communities as well as the local and international donor communities need also to continue to contribute resources so as to sustain the current traffic mobility services. Such Strategic transportation planning needs to be both technical at the problem-solving level and involving stakeholder participation and partnerships at the resource-mobilisation level.

In order that the government can spearhead successfully the provision of a sustainable framework and basic conditions for traffic mobility in the country, Lyatuu (1997) poses the following policy issues that have to be addressed promptly by mobility stakeholders :

- Stabilise conditions of trunk and rural road-networks at levels that can be sustainably maintained.
- Give priority initially to rehabilitation of key trunk road corridors and to rural roads essential for agricultural production and then to be expanded to all economically productive areas including trunk roads to landlocked countries and between regional centres.
- Devise a workable self-enforcing mechanism of resource mobilization for sustainable provision of traffic services from all sectors and levels of society.
- Learn from outside the country how others have responded to the 2000 mobility challenges.
- Devise workable efficient institutional arrangements to manage the above policy statements.
- Implement transport investments that are environment friendly.

Short of efforts to address these issues, the country stands to lose in the traffic battle as manifest in its 2000 mobility challenges for the lack of mobility sustainability.

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Process of environmental licensing as transport planning instrument

Le processus d'autorisation environnementale en tant qu'instrument du planification du transport

El proceso de licenciamento ambiental como instrumento de la planificación de transporte

Eliana Bonfim Thomé Berti Barone & Angela Bebber
Companhia do Metropolitano de São Paulo, METRÔ, Brazil

Klara Anna Maria Kaiser Mori
Faculdade de Arquitetura e Urbanismo, Universidade de São Paulo, Brazil

ABSTRACT : This work presents the Environmental Licensing routine, the interpretation provided by Metro-SP to the legal requirements and its reflections on Transport Planning.

RÉSUMÉ : Le présent travail présente la routine de l'Autorisation Environnementale, l'interprétation donnée par le Métro-SP aux exigences légales et ses réflexes dans la Planification.

RESUMEN : El presente trabajo presenta la rutina del Licenciamento Ambiental, la interpretación dada por el Metropolitano-SP a las exigencias legales y su reflejos en la Planificación de Transporte.

1 INTRODUCTION

An analysis of CMSP, since its foundation in 1968, reveals a wide experience in environmental management. The core of the environmental and social actuation of CMSP is comprised of its contributions to the urbanization of the São Paulo Metropolitan Region - RMSP, through development of the transport infrastructure. In proposing changes to the accessibility standards of the several portions of the urban space, the transport plans and projects comprise important instruments of urban planning.

The practice of CMSP, in such sense, is evidenced through studies such as the conception of its first Metro Network (in 1968) where, besides the concrete propositions of trasnformation of the RMSP urban space, the particular economic-social conditions at that time and the technical attitude before such conjuncture pictures are explained. Another important reference of such practice is the Metro Impacts Analysis Program - PAIM, drawn-up in 1975, which proposes to assess and measure the Metro effects on the environment, the resident population, the urban economy, the transport system and the metropolitan area institutions, thus representing a comprehensive project of production and systematization of knowledge and reflection of CMSP on its actuation in the city.

As an innovative activity, the construction of metro lines presents both in scope of projects development and in implantation, operation and maintenance stages of each metro line, the need of formulating procedures and fixing them through standards and norms.

In the progress of implantation of each new work, the wide variety of involved technical procedures tends to be put together in combined sets of procedures. Such procedures, submitted to a critical opinion, result in new propositions wich, upon being tested, incorporated to the routine and successively standardized, characterize the integrated process of the CMSP work.

However, with the economic recession arising from the second half of the 70's, bringing the radical changes of the urban public transport financing policy, the metro mode became more and more identified as if it were an *item de luxe* for the country. From the Metro Network, comprised of 5 lines with length of 65 km, to be implanted within 10 years from 1968, and foreseeing their increase for 200 km up to the 90's resulted, to the middle of the 80's, the drawing of a Basic Network of approximately 50 km and the effective implantation of about 30 km.

It is into such context that, as a component of a process aimed at the articulation of an environmental policy for the country and as one of the few instruments of the State acting on the in progress transformations of the space, the Environmental Impact Assessments arise as mandatory. Such mandatory practice which, among others, is olso regarded to metro enterprises.

The introduction of environmental feasibility as a condition for the approval of Brazilian enterprises is recent. Initially, Law No. 6803/80, of July 02, 1980, required environmental impact assessments, in order to authorize the implantation of industrial use zones.

From the "National Environment Policy, its Purposes and Formulation and Application Mechanisms", EIA became required in others Brazilian enterprises. (Law n° 6938/81)

On July 01,1983, Decree n° 88351 regulates the aforementioned law, providing the National Environment Council - Conama with competence to "settle the basic criteria in accordance with which the environmental impact studies will be required for licensing purposes, with the institution of obligatory elaboration and presentation of Environmental Impact Assessments - EIAs, and their respective Environmental Impact Statements - RIMAs, being its first instrument of legal control, for the licensing of activities considered as environment changers (Resolution No. 001, of 01/23/86).

In the following chapter, the Environmental Licensing Process will be presented according to the current law.

2 ENVIRONMENTAL LICENSING PROCESS

The State Environment Council - Consema and the State Environment Secretariat - SMA, the competent organisms in the State of São Paulo to treat the environment issues in the Metropolitan scope, with the purpose of making their processes more dynamic, instituted two instruments before EIA and RIMA: the Preliminary Environmental Report - RAP and the Reference Term - TR (SMA Resolution 42, of 12/21/94).

RAP is the first document for environmental licensing. Its function is to provide grounds for the decision of either requirement or release of both EIA and RIMA.

In case the RAP is considered as sufficient regarding the justification of the enterprise the identification and treatment of impacts, the process continues: three licenses are issued by SMA as the enterprise stages are concluded, in the planning, implantation and operation stages, corresponding respectively, to the Previous License (LP), Installation License (LI) and Operation License (LO).

In case of being required the elaboration of EIA/RIMA, the Reference Term, agreed between the Entrepreneur and SMA, guides as to the required contents as a complementation of RAP.

The first license, the Previous License - LP, which is bound to the satisfactory conclusion of RAP and/or of EIA/RIMA, and ensures the enterprise feasibility, establishes the basic requirements and conditions to be complied with in the next stages of its implementation.

Installation License - LI authorizes the start of the works, in accordance with the compliance with programs that include the environmental control measures and other conditions, presented in an Environmental Action Plan. Such Plan must be detailed after the executive project conclusion, it being a previous requirement for the beginning of works.

Operation License - LO is issued upon the verification, by SMA, of the implemented environmental control measures and, also, of other conditions determined for operation.

All licenses are granted with variable validity terms, set forth in Conama Resolution No. 237, of 12/19/97. LP and LI may have their validity terms extended, provided that, as a whole, they do not exceed 5 and 6 years, respectively. The validity term for LO will be of at least 4 and at most 10 years.

2.1 *Preliminary Environmental Report*

RAP and/or EIA shall comprise all aspects regarded as necessary to the enterprise understanding, in all its relevant dimensions.

It must explain the licensing object and the importance of its insertion into the metropolis, regarding the displacement conditions of such urban agglomeration.

It must also define the set of the enterprise project characteristics, in order to serve as basis for identification of its negative external points, and allow its equationing through mitigating measures.

Complementing such set of information and propositions, the recommendations and conclusions must contain the institutional actions required to ensure the enterprise effectuation and the full compliance with its main functions.

2.2 *Environmental Action Plan*

The set of actions intended to control, reduce or eliminate the negative external points of the enterprise must be object of several programs, organized around an Environmental Action Plan.

Such programs must formulate and organize the actions required to settle the listed aspects, establishing their monitoring processes and related corrective actions; may comprise aspects ranging from information production and publishing to formulation of mechanisms in order to materialize the project technical specifications, being developed as a previous requirement for the enterprise Installation License.

It should be reminded that new programs may be required in the extent of the environmental licensing process development, whether appointed by SMA or resulting from specific circumstances, both of implantation and of operation.

3 REFLECTIONS ON SMA's ADVICE

Conceptual difficulties inherent to the methodology proposed by SMA to elaborate Environmental Impact Assessments, particularly in urban environments, caused discussions in the scope of the CMSP transport planning, whose contents will be briefly presented, as follows:

The basic concept related to those studies is that related to its objective, the Environment. Pursuant to the law, such objective is defined as follows:

"Environment: the set of conditions, laws, influences and interactions of physical, chemical and biological character, which allows, shelters and governs life in all its forms".

Although it may be undertaken that, without further appeal, the life of any being may be governed as such, the attempt for application of such concept to the social life immediately shows its limiting character.

This is because, in the societies' life, such set of factors is always comprised in the surroundings of the social organization, so as that it is always and necessarily in accordance with the specific values, parameters, possibilities and limitations of a certain society that said set of laws, interactions and influences actuates. To reduce the life of men to the nature state, as it means in the definition above, therefore, would eliminate its main characteristic: the social organization that provides them with support.

The importance of such question is, for the purposes of making EIAs, its consequences in relation to what may be considered as Environmental Impact. The document that guides the elaboration and presentation of those studies, adopting the definition of the Environment National Board, is as follows:

Environmental Impact: any change in the physical, chemical and biological properties of the Environment, caused by any kind of matter or energy resulting from human activities that, either directly or indirectly, affect:

I - The population health, safety and welfare;
II - Social and economic activities;
III - Biota;
IV - The esthetic and sanitary conditions of the environment;
V - The quality of the environmental resources.

Thus, such as by the omission of the society's role in the Environment determination, the conditions in force of health, safety, etc., may not be attributed to anyone. In the definition above, not even is society treated as responsible for the transformation of those conditions.

From the theoretical dissociation, operated by means of those joint concepts of Environment and Environmental Impact arises, in the practice of EIA development, a similar dissociation, where the "human activities" (those potentially aggressive to the Environment) are corresponding to the project of the enterprise set forth herein; in contrast to an essentially static and balanced background of the environmental picture. And so this is true that the obligatory performance of the EIA is explicitly applied to Environment modifying activities. Which ones would not be?

Specifically concerning the CMSP activities, it must be emphasized that the implementation of a transport system has as inherent dimension the urban environment transformation. And it could not be different, since the change of the absolute and relative standards of accessibility to the several urban segments provided by Metro change the general production conditions of the city, leading, on its turn, to the space re-distribution movement of the activities – transforming the ground uses and occupation. That is, according to the concept base set forth hereinabove the purpose of the Metro enterprises would be confounded with their own impacts.

It could be clearly seen, on the other hand, that in view of the virtual non-existence of an urban policy, and before the increasingly absence of planning in the conduction of the Brazilian urban process, the programmatic exercise of the State control on the space transformations - by means of SMA, would have the highest importance. Therefore, it would be required to search for overcoming the conceptual and methodological difficulties inherent to the Environmental Impact Assessments.

The systematic reflection on the issues above allowed the overcoming of the difficulty, as well as of the risk of the impact assessments of the CMSP, wich incorporating the environmental issue in each of its stages, passes on proposing the necessary transformations in order to re-qualify the urban space where it is inserted, searching for solutions of implementation that minimase or even eliminate the resulting negative impacts, enterprises being reduced to a mere rendering of accounts and inventory of tasks before SMA. They started acting as a lever of the planning process in CMSP, with significant potential consequences, both in its internal procedures and regarding the city urban and transport planning.

4 TRANSPORT PLANNING PRACTICE

In an attempt to make an approach of such theme in a didactic way, some examples have been organized around three fundamental stages: Planning and Project, Implantation, Operation and Maintenance.

As previously pointed out, since the beginning of its establishment, the CMSP has always incorporated environmental issues in its several work fronts.

The changes in the country's historical process, in leading its urban policy to abandonment, with consequent stoppage of investments in the sector, have been directly reflected in the Company, which because of the lack of a consistent Planning, starts developing its activities in an isolated way, generally restricted to its several actuation areas, then missing the notion of set.

Due to the fact the Standards and Procedures, constructed mainly on first years of implantation, have guaranteed keeping of quality of the rendered services. The attitude adopted by CMSP, in view of the obligatory legal compliance, served mainly to replace the need for effective exercise of the planning activity, with significant gains, in each of its stages.

4.1 *Planning and Project*

A basic analysis is made in the Planning phase, under three aspects: metropolitan, regional and local.

The reference of the metropolitan scope is the São Paulo Metropolitan Region - RMSP. In such context, the general standard of the performed displacements and the characteristics of the already implanted network must be analyzed, comparing them with the demographic and social-economic evolution: population estimates and projections, income profile, supply of employment and their geographic distribution.

Knowing the accessibility and mobility levels in the city, it is possible to propose a proper integration policy among the high, medium and low capacity systems, searching for the highest usage of each system and of the transports network as a whole.

The regional scope, more specific, is related to the urban space, where the transformations caused by the enterprise are more intense. There, a better insertion of the line is tried, respecting the ground use and occupation law in force. It is possible, however, that localized changes are proposed to the law, so as to warrant that the urban transformations arising from the enterprise insertion in the metropolis are effectuated.

The institutional interactions are indispensable, in order to overcome the sector view of specific interests, strengthening the transformations caused by the enterprise. This is the case of the projects that complement each other, or of those superposing to each other, all of them with major urbanistic meaning and which require mutual adjustment.

In the local scope, the studies are focused on a more restricted insertion of the enterprise. The reflection on the environmental issues, concurrently to the project conception and detailing, allows the impacts to be minimized or even eliminated.

The possibility of use of several construction methods and the adoption of bold station designs, employing technological innovations, lead to a better usage of spaces, reducing expropriations.

At the same time, opportunity is opened to the formulation of policies that warrant minimum discomfort to the expropriated, preserving the main purposes set forth in the project guidelines.

Another impact which may be even eliminated is related to the noise and vibrations caused by the wheel-rail contact. Regarding this, once there is possibility of happening, the solution is provided by the adoption of shock absorption systems, currently with fully developed technology.

4.2 *Work Installation*

The Environmental Action Plan, as required by SMA, obligatorily fully made before the work installation, has purposes which warrant that the transport planning activities may be perpetuated, as follows:

- To serve as control instrument in the several enterprise aspects;
- To feed a data base for development of new projects;
- To allow a systematic verification of the programs effectiveness and their continuous compatibility with the urban quality standards set forth by the company;
- To generate and systematize information for the several public organisms involved in the metropolitan planning;
- To allow the definition and improvement of the indexes extracted from the developed programs.

4.3 *Commercial Operation and Maintenance*

From the beginning of the Commercial Operation, and maintenance the right and wrong actions arising from the planning, project and implantation stages, are shown.

The systematic registration of all detected events and of the solutions found are a significant basis that, in being incorporated to the planning, allows the continuous improvement of process.

5 CONCLUSION

The State presence is fundamental to warrant the continuity and higher effectiveness of the transport planning process.

In such sense, the law that provides for the making of Environmental Impact Assessments, becomes a valuable instrument that must be emphasized. In requiring a logic and detailed approach of several and different items, they promote and even impose the notion of integrated space, which is the base for the Transport Planning practice.

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Population relocation plan and economic activities affected by works of São Paulo Metro

Plan de replacement des populations et activités economiques atteintes par les ouvrages du Métro de São Paulo

Plan de reubicación de población y actividades económicas afectadas por obras del Metropolitano de São Paulo

Tania Olga Solitrenick & Adalberto Santos Capelo
Companhia do Metropolitano de São Paulo, METRÔ, Brazil

ABSTRACT : This assignment deals with the relocation process of the population and economic activities affected by the expropriation due to both the São Paulo Metro expansion works and mainly, the mitigating measures promoted by the Company, which intend to relief their impacts.

RÉSUMÉ : Ce travail traite du processus de replacement de la population et des activités économiques atteintes par l'expropriation en raison des ouvrages d'expansion du Métro de São Paulo et principalement des mesures de compensation réalisées par la Compagnie dans le but d'atténuer leur impact.

RESUMEN : Este trabajo se trata del proceso de la reubicación de la población y actividades económicas afectadas por la expropiación en razón de las obras de expansión del Metropolitano de San Pablo y, principalmente, de las medidas mitigadoras promovidas por la Compañía, que tienen por fin atenuar sus impactos

1 INTRODUCTION

A large work such as a metro line represents not only a large economic investment, which will have deep repercussions in the social and environmental level of a metropolis like São Paulo, but means, equally, a change in the environment that will certainly affect the daily life of the majority of its inhabitants. In that sense, before properly entering the theme, a few and brief considerations are required.

Normally, when there's the need of either installing or extending a metro line, it is because the metropolis presents difficulties to make the circulation of people and goods on its higway network by the conventional transport modes (buses and cars) and, therefore, evidences saturation signals, which may even jeopardize it as "locus" of large economic pole and everything else arising from it, such as, for example, the life quality of its inhabitants.

Before such observation, a metro work is presented as an essential need to the survival of the metropolis, even with all impacts and problems caused along its entire implantation process. The arising benefits will always be much bigger than the imposed restrictions, and it is under a particular problem-situation that we will develop our theme, in order to present the several measures taken in order to try to mitigate it as most as possible. For such purpose, we will take as example the RELOCATION ACTIONS PLAN - PAR, involving populations and companies affected by the expropriation process, located in the axis of the future LINE 4 - YELLOW - MORUMBI/LUZ, elaborated by Companhia do Metropolitano de São Paulo.

This assignment will submit the steps taken to the elaboration of that Action Plan.

2 STEPS FOR ELABORATION OF A RELOCATION PLAN

A plan for relocation of owners and inhabitants of real estates to be expropriated because of works which have as purpose the expansion of metro lines, requires from the company some basic preliminary procedures aiming at the success of the enterprise.

2.1 *First Step*

The first step is the survey of all real estates to be expropriated, which will determine the several types of forms to be used to research the population to be expropriated.

2.2 *Second Step*

The second step treats of the elaboration of data collection instruments, according to the following examples:

a) For the families to be displaced, a form is applied before the heads of families, where the following indicators are raised:

- Real estate occupation condition, that is, to check if it is owned by him/herself, leased or assigned (lent).
- Demographic characteristics, which may be verified as follows: family type, if it is nuclear, expanded (parents, children, grandchildren, etc.), or if the person lives alone, as well as the gender and the age of its inhabitants.
- Fixing in the region determined by the following items:
  - ✓ Place of birth of the heads of family, that is, if they are born in the same Municipality, in the State of São Paulo or are from other regions of the country and from other countries;
  - ✓ Time living in the Municipality, which has as purpose to perceive the adaptability degree to the metropolis;
  - ✓ Time living in the real estate, whose purpose is to perceive his/her friendship relations and social integration to the neighborhood, through its neighborhood relationships, because the longer time in the house, the higher the probability of being inserted in a larger frame of social relations and to present higher resistance for changes.
- Work, Employment - in this item, the intention is to detect the occupational situation of the inhabitants and of their respective heads of family, checking those who are either working or unemployed or retired. For those working, it is tried to know his/her insertion in the productive structure (employees, owners, self-employed, etc.), as well as the number of years exercising such activity and its location, also surveying how their inhabitants go to their work places, if by private mode, public mode or walking.
- Life Standard - the purpose of this item is try to perceive through some social-economic variables, such as income, education degree, the social levels composing the population affected by the expropriation process.

b) For those owning real estates with economic activities, the collected data are gotten before the entity's owners or managers. The indicators surveyed within such item are the following:

- Dominion Status, which considers the number of real estates occupied by the entity and their occupational situation (own, leased or assigned).
- Line of activity and specification of developed activity.
- Size of the company classified according to the point of view of the interviewed himself, that is, each owner dimensions the size of his/her enterprise (micro, small, medium, large) and, at the same time, inform the quantity of employees and/or persons employed in the company.
- Company's situation, where it is intended to check if the entities to be expropriated are single companies, parent companies or branches.
- Fixing Degree in the Region, where it is checked for how long the companies are occupying the real estates to be expropriated, and how long ago they have been created. In such item, it is also tried to know the types of consumers served by those companies, that is, if such consumers are in the end of the process or if they are other private companies or even public entities.

2.3 *Third Step*

The third step is the analysis of the collected data in order to direct the elaboration of the Action Plan.

2.4 *Fourth Step*

The fourth step is the elaboration of the Action Plan. In order to such plan may be feasible, some basic premises must be observed:

- To release, timely, areas required to the enterprise implementation.
- To warrant the fair indemnity of the expropriated real estate.
- To provide access of the expropriated families and businessmen to facilitating mechanisms both of the replacement of the expropriated asset as well as of re-installation of economic activities.

In order to reach such objectives, it is required to comply with some guidelines, such as:

- Equality of treatment, understanding that all owners and/or occupants of the affected real estates are the target public of the mitigating measures.
- Plurality of options, focusing on offering diversified compensation alternatives, so as to contemplate the dominion heterogeneity and the social-economic singularities of the affected population.
- Participation and social negotiation, towards a dialog between Companhia do Metrô and the affected population, avoiding judicial expropriations as most as possible.
- Guarantee of resources in order to avoid interruption in the indemnity process or the incentive

to the use of judicial measures as a way to handle with lack of liquidity to perform the expropriations.

- Socially fair indemnities, understood as such when the value attributed to the expropriated real estate allows the purchase of a similar real estate.
- Institutional articulation, which provides a joint actuation with other government levels, always when required.

The Relocation Plan is structured into five programs, arranged as follows.

Area Acquisition and Release Program

Area Acquisition and Release Program, which has as purpose the acquisition of the real estates inserted in the area required to the enterprise implantation and the change of occupants sufficiently before the start of works, avoiding that the people to be displaced are subject to undesirable transition periods which may come about in the short time period between the expropriation and the search for a new real estate.The main actions related to the plan are concentrated in the following items: (a) Publishing of the Public Utility Decree; (b) Approval of Budget Law by the Legislative Assembly; (c) Physical enrollment of the real estate; (d) Real estates appraisal; (e) Documentary survey with the purpose of identifying, in advance, real estates with documentary problems, with the purpose of accelerating the regularization; (f) Approval of the values by the company's Board of Directors; (g) Negotiation: presentation of the values attributed to the real estates to the owners; (h) Payment of indemnity; (i) Change of the families; (j) Writ of ejectment of real estates, incorporating them to the company's equity; (k) Demolishing of real estates, cleaning of area and start of works.

Support Program

Support Program to Residential Relocation and Economic Activities: its purpose is to proceed the reinsertion in the area of houses of the families taken-off from their domiciles and re-installation of the economic activities affected by expropriation. Its main actions are the following:

- To create conditions which facilitate the acquisition of new real estates and re-installation of affected economic activities. In such sense, the expropriated one would count on the following mechanisms:
  - ✓ Financing Line for acquisition of real estates, which consists of the organization, before Public and/or Private Banks of facilitators, for access of the expropriated people to the credit facilities for real estate acquisition, in a context where the shortage of resources for habitation financing is the opposite of the continuous expansion of demand for such. Basically, the mechanism feasibility requires the actions below. In the expropriation preparation phase: (a) actions from the company before the bank system, with the purpose of examining availability of financing lines or possibility of their activation, studying actions in order to facilitate the access of the expropriated people to financing; (b) to make surveys before the future expropriated people, in order to examine the adherence of such mechanism to its interests and in the perspective of dimensioning the quantity of potential requests that may be made to the financial system; (c) entering into agreements (between the company and the bank system), for compliance with financing applications of people expropriated for implantation of Line 4; (d) formation of Real Estates Exchange through agreement with entities acting in the real estate market. In the plan execution phase, the central actions of said program are: (a) campaign of information with the expropriated people with the purpose of forming their knowledge about requirements, mechanisms facilitating the real estate replacement and the company re-installation; (b) formalization of adhesion of the inhabitants who wish so, to the replacement facilitating mechanisms; (c) to use Real Estates Exchange.
  - ✓ Credit system for small and medium companies, which consists in organizing facilitators for obtaining credit for re-installation of the displaced economic activities and/or for their re-organization, acquisition of new technologies, power rationalization, environmental control and managerial capacity, having as purpose the development and modernization of affected micro and small companies, subject to such kind of compensation. Operationally, such support is made through actions of the company before the financial system, having as purpose to enter into agreements facilitating the insertion of the expropriated people into credit facilities.
  - ✓ Technical and managerial support for displaced companies, which consists of the facilitation of use of companies' technical and managerial support programs, offered by specialized institutions. Operationally, the role of

the company is to deal with institutions, enter into agreements to accelerate the use of its programs by part of the affected businessmen.

- ✓ Permanence in the real estate, that allows its occupant to stay for a given time in the real estate, after receiving the indemnity money. The facilitating character of such mechanism arises from the following understanding: (a) the leasees, released from the rental payment are able to use its corresponding value as savings to face a new lease; (b) residing owners, holding the indemnity value, may have a larger term to search, locate and make effective the transaction of new real estate.

Social Communication and Interaction Program,

It has the following purposes:

- To align dialog actions among the company, affected families and businessmen, in order to provide the latter with all information on the expropriation process and on the utilization of the mechanisms facilitating the real estate replacement and company's re-installation.
- To order information campaigns to the society, publishing the enterprise, its time schedule and the progress of works.
- During the phase of works, to warrant to the inhabitants and users of their surrounding areas, information on changes in the traffic and main work events.
- Such program will be developed through the following mechanisms:
- Installation of Information Stations along the Line route, decentralizing the information with the purpose of facilitating the access to the interested people.
- Meetings with the population and companies affected by expropriation, submitting the Line design; time schedule; expropriation system with emphasis in the real estates appraisal model; mechanisms conceived in order to minimize the expropriation adverse effects.
- Enterprise publishing campaigns, made by actions of the Company's Press Advisory through the communication media.

Monitoring Program

Monitoring is understood as the continuous follow-up of the actions defined to achieve the objectives of a Plan, The objectives of such program are the following:

- To systematically record the progress of the actions of the Areas Release and Acquisition Program, Program of Support to the home re-insertion and business re-installation and of the Social Communication program and Interaction with the Community, with periodical measurements of their progress, detecting obstacles and indicating the required paths for their overcoming.
- To watch for the programs and their respective actions to be implanted within the basic provisions of the Plan, expressed in its guidelines.
- To form a Data Bank that makes possible to take advantage of the knowledge of the situation of families and companies before the expropriation event.
- To examine the interest of the expropriated people regarding the re-insertion facilitating mechanisms, providing the Company with resources for effectuation of the studied agreements.
- Registration of the works phase effects in the dynamics of the economic activities (flow interruption).
- Follow-up of the real estates documentary situation and of the foreseen actions of documentary regularization, with the purpose of reducing, as most as possible, obstacles to an amicable indemnity.
- Systematized follow-up of the Negotiation actions (presentation of the real estates' values to the owners; adhesion to the mechanisms facilitating the house re-insertion and business re-installation, presenting adjustment alternatives when applicable).
- Follow-up of the real estate release (moving of families and companies).
- Follow-up of the expropriated families and companies re-insertion path in the period from the moving from the expropriated real estate up to one year after insertion in the new real estate.

The related objectives are subject to:

- Political-Institutional Factors, such as: (a) environmental licensing; (b) effectuation of taking of loans before international organisms; (c) effectuation of the Budget Law through which expropriation/indemnity resources are guaranteed; (d) expiry and publishing of public utility decrees; (e) the Line concession process.
- Legal Factors: it is understood that the Plan may have its progress affected by the real estates' documentary situation. This is because Companhia do Metrô is subject to the specific law that provides for the documentary requirements in order to accelerate indemnities. Therefore, to anticipate the diagnosis of the real estates presenting documentary problems, as well as to previ-

ously provide the owners with guidance for regularization, is a base action for a successful Plan.

- Economic-Financial Factors: the value attributed to the expropriated real estates is another critical point of the population and companies Relocation Plan. That is because the owner's agreement with the offered price is the starting point to accelerate an amicable indemnity, one of the Plan precepts. The theme monitoring passes by the follow-up of the following aspects: (a) examination of the attributed values, comparing them with market values at the time when the re-insertion mechanisms are carried out; (b) registration of the values presentation and negotiation ritual with the owners, as well as its final result, recording circumstances of different points of view among the parties; (c) performance of external agents (financial system), which will make the mechanisms feasible for house re-insertion and re-installation of economic activities.
- Social-Cultural Factors: as no analysis of adhesion interest has been performed with the community affected by expropriation, there is no evidence that the house re-insertion and business re-installation facilitating measures are of interest of the affected population.

Further, the Plan monitoring foresees follow-up of the real estates prices dynamics inserted around the future Line. Although the price evolution has no direct relationship with the relocation plan, but with the enterprise, the theme monitoring is justified by the need of warranting resources to the appraisal of the plan, which will be performed after the monitoring. At the appraisal moment, the data related to the real estates price evolution around the future Line will be an important base for discussions concerning the fair indemnity concept. On the other hand, the data on the theme will be largely valid in order to examine some principles related to the effects from the implantation of enterprises such as Line 4, over the real estate market. The achieved resources may also be used to compare the attributed values with the real estates and the trend of valuation (or not) around the future Line. Finally, the plan monitoring comprises a direct follow-up of a sample of families and companies in their house and business re-insertion process, in order to get real knowledge of the process, until today analyzed basically through indirect information.

Appraisal Program

The Plan appraisal will have "ex-post" character, and must start one year after the leaving of the expropriated people from the real estates. Its general purpose is to identify, measure and analyze the relocation effects in the population life conditions and in the companies' re-establishing and operation.The proposed appraisal model is that with control group, which offers highest chances of isolating the expropriation effects from those produced regardless of it, because of social-economic context conditions.

2.5 *Fifth Step*

The fifth step treats of the Plan Management: the Plan implantation involves a series of activities, of different natures, implying in mobilization of several Company's areas.

As the Plan implementation involves actions under the responsibility of several areas, it is important to define the coordination mechanisms and timely mobilization of those organizational units.The planning of the Relocation Plan needs, therefore, to be together with its organizational structure. In other words: whenever the planning is related to new mechanisms and actions, there must be an operationalization compensation in the organizational structure.

The Plan coordinator area will develop permanent interaction with the technicians and managers of the following areas: legal planning, engineering, real estate property, finance, institutional marketing and special projects.

Such area will centralize the set of documents, records, cartography, among other elements currently spread by several areas of the company, required to the management of the Relocation Plan.

The process coordinator area will have authority to perform the actions required to the Plan implementation.

The first management duty will be to formulate a detailed work plan, appointing activities to be performed, terms and technical resources required to the Relocation Plan implementation. The first management duty will be to formulate a detailed work plan, appointing activities to be performed, terms and technical resources required to the Relocation Plan implementation.

3 CONCLUSION

In order to be successful, any relocation plan should be based on the socio-economic reality of the affected population.

It should provide favourable conditions to acquisition of new real estates replacing the expropriated ones, hence leading to a smooth reinsertion of the families in other houses, as well as the reorganization of the economic activities affected by the expropriation process.

Last but not least, it should court on a continuous follow-up of the proposed actions and an evaluation for assessing the effects of relocation as well.

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Transport-related pollution perspectives of the use of three-wheelers mode of public transportation in the Lagos metropolis

Kayode Oyesiku
Centre for Transport Studies, Ogun State University, Ago Iwoye, Nigeria

ABSTRACT : Perhaps the most apparent transportation planning and urban development problems that have over the years received attention of, and yet continue to pose challenges to policy makers, are the need to provide sustainable public transport system and revitalisation of distorted socio-economic policies. The pressure created by rapid population growth of Lagos on transport infrastructure and services in the city is indeed great that decline in quality and quantity of services are inevitable and uncertain. The persistent trials and errors in the urban public transportation policy resulted to the introduction of the three wheeler vehicular mode of public transportation in the metropolis of about 11 million people.

Since the vehicles hit the streets of Lagos about two years ago, many under-employed graduates were put in business, many un-educated citizens incapacitated by poverty-stricken background got something to do, while short-distanced commuters, who hitherto had made their trip on foot or motorcycle had relief. These gains were, however, over shadowed by the relatively small size of the vehicle (officially three passengers full capacity) that made it uncomfortable for many passengers, its fragile nature inability to withstand the restlessness and aggressive nature of Lagos commuters, emissions from within and other vehicles, engine noise from within and other vehicles continuously give passengers persistent discomfort. More importantly, the adoption of the mode for public transport with its attendant limited occupancy restraint design put many passengers at risk and made the mode unsafe at any speed.

This paper examines the policy background of the introduction of this mode of public transportation in the most populated city in the African continent and discusses in details the transport-related pollution implications of its use on the environment and the urban passengers and population. The overall concern of the government driven and dominant control of public transportation systems in rapidly growing Nigerian cities is highlighted and the some policy suggestion advanced towards ensuring a more effectively sustained public transport systems and urban environment.

INTRODUCTION

Cities of the developing countries are now faced with a peculiar phenomenon called urbanisation, it is as a result of changes in socio-economic, political, and geographical factors of the communities therein ; It has such features as rapid population growth, increasing spatial differentiation and a highly diversified need to commute between and within the settlement that abounds in the area. However, the frequent mismanagement of scarce resources coupded with the absence of an effective planning and implementation policy in these countries have weakened the capacity to provide basic social amenities and infrastructural facilities that can match the demands of urbanisation.

The urban public transport system in many cities of Nigeria is an epitome of the situation highlighted above. The public sector participation in the road transport system is chiefly in the construction of roads, bridges, terminal and so on, and its effort at providing municipal bus services (conventional buses) have not been successful. Consequently, the provision of urban public transportation services has been conceded to the private sector. In essence, intermediate modes predominate in the cities and the urban centres in Nigeria. The inherent mobility crisis that result from this practice is what has characterised the urban road passenger transport in Nigeria.

The Urban road passenger transport services are provided in a variety of modes in Nigeria. Each city has its particular modal choice alternatives. Lagos is the most populated city and its undergoing rapid urbanisation process, experiencing great mobility crisis. It is based on this background that the introduction of motor cycles (« Okada ») into the urban passenger transport system has been made in the early part of this decade by private transport operators in most Nigerian cities. Recently, the state government introduced the supply of « 3-wheeler autorickshaw » as another alternative urban passenger transport mode. Its introduction is bag of mixed feelings according to recent study in Nigeria. Although not conclusive, the study results elucidate on some transport related pollution perspectives on its use on the environment. The study looked at the possible impact of the use or readership of the mode of public transport on the commuters and the environment. The researcher was also asking about how cheap, time reducing, safe and environmental friendly the mode is. The study used questionnaire, asking 980 regular commuters of the mode of transport on various aspects of transport related pollution and environmental issues while in the vehicles. The analysed result of the study is the focus of this paper. Also discussed in general are the issues in urban public transportation services in Nigeria.

ISSUES IN URBAN PUBLIC TRANSPORT IN NIGERIAN METROPOLIS.

There are different types of urban passenger transport modes operating in Nigerian cities due to the diversity of travel patterns, user preferences, ridership, densities, variety of land uses and the affordability and availability of private and public transport (Adeniji and Ogu, 1998). However, the prevailing condition of mobility and accessibility has not been satisfactory, as they exist in crisis situation with transport problems growing in scale and complexity.

This situation has been the subject of many studies and researches by indigenous and foreign researchers, consultants and World Bank Agencies. These studies reveal numerous transport problems and those relevant to this study will be summarise as follow :

1. Acute shortage of transport supplies relative to transport and traffic demand. Car ownership level, 4.30 per 1000 population, is comparatively lower than that of most countries (UNCHS, 1996). The number of public owned bus services have reduced drastically, while the rate of operation of paratransits have been reducing over the years with passenger transport traffic demand continually on the increase (World Bank, 1996 ; Oyesiku and Obadimeji, 1998).

2. Usage of over-crowded and unsafe vehicles for public transport. Vehicles used for public transport in most cities include adapted vehicles such as « molue », mini-buses, taxis, private cars, and recently motorcycles. The vehicles are in deteriorating conditions as a result of bad road conditions, unavailability of spare parts, national economic downturn, leading to importation and use of old vehicles for public transportation. In an effort to break-even by operators and also due to shortage of available services, the vehicles usually operate at excessive carrying capacities making it uncomfortable and unsafe.

3. Road congestion, parking problems, accidents and environmental pollution among others. Studies have revealed the extensive use of narrow and unsuitable tertiary roads for urban transport in Lagos State instead of wider secondary roads leading into primary roads (Dar Al-handasah consultants, 1992). The comparative study of road kilometres per thousand population for Lagos and seven other cities in Africa , show a value of 0.47 for Lagos (the lowest) with the effect of a low operational efficiency of its road network. Also, the World Bank policy study on urban transportation noted that in Lagos, the average vehicles travels at about half the speed of its counterpart in London and Frankfurt, indicating that a large amount of time and energy are often wasted.

4. Increased immobility of the urban poor in the face of escalating public transport fare. A number of studies and researches show that intermediate or paratransit modes (private sector owned in the informal sector) predominate urban transport system in Nigeria. The commuters are left at the mercy of the private operators, whose fare structure levels fluctuates and increases at will, especially during peak and fuel scarcity period. A way of reducing exploitation by private operators is for the Government's efforts of providing three-wheelers autorickshaw.

5. Lack of system co-ordination, which has resulted in non-integrated mobility. As noted, there are in existence different types of urban passenger modes, but their impact has been very low, thus requiring adequate co-ordination of the system. A critical appraisal of each mode available to the commuters becomes useful in achieving the desired system co-ordination, since the relative success of each sub-unit of a system will bring overall success to the whole unit called the system.

6. Perhaps the most fundamental of transportation problem in densely populated cities of Nigeria, including Lagos, is difficulties for the people to get to and from work daily. Reducing travelling time and cost are major consideration for transportation planners

in growing megacity such as Lagos (Auclair, 1999. P.26). For instance, travels time to and from work is the longest in Africa compare to other parts of the world. Lagos, Nigeria has travel time of 85 minutes with car ownership of 4.30 per 1000 population.

It is against this background that, the existing public transport mode in Lagos cannot reduce travel time, reduce accident, and lower travel cost to individual commuters. Early in the decade, motor bicycle involved as dominant mode of public transportation in metropolitan cities in Nigeria. Many writers attributed this to poverty and decreasing number of para-transit mode of public transport and lower car ownership (Ikya 1993). Thus, the evolution of motorcycle was to fill an important economic gap, and to an extent, alleviate public transport problem of certain categories of commuters. The decline in per capital expenditure of greater proportion of commuters by mid of 1990s, further necessitated an in-road of three-wheelers-cycle as another mode of public transportation in Lagos.

Moreover, as it used in many densely populated developing countries, such as India, and Indonesia, it is hope that the three-wheeler cycle will perform better than motorcycle, particular in terms of safety, durability, easy-maintenance, accessibility and environmental friendliness. However, as this study revealed, the expected gains from the use of the three-wheeler cycle has been over shadow by its fragile nature and some basic transport related pollution problem, such as emissions from other vehicles, engine noise, and persistence discomfort. It is basis of this that the elaborate study on transport related pollution perspective of the use of three-wheeler cycle mode of transport is carried out .

USE OF THREE WHEELER BYCLE AND CITY GOVERNMENT

The 3 - wheeler autorickshaw is a tried and tested produce having been developed more than twenty (20) years ago in Italy as a derivative of the well known Vespa scooter. The autorickshaw can carry three (3) adult passengers plus the driver and also a small child and some hand luggage. It uses a modified « Vespa » type engine. It therefore offers more than three - (3) time the revenue of a normal « OKADA » motorcycle, and yet has almost the same operating costs.

The 3 - wheeler cycle was identified to satisfy the commuters changing tastes and preferences since the taxes are now beyond the reach of many commuters, and the buses do not ultimately provide mobility into and from the emerging settlements within in the metropolis. The use of motorcycle is a product of necessity. The high cost of taxi fares had driven some people into patronising the cyclists, though the level of safety and comfort leaves a lot to be desired. The introduction of the 3 - wheeler is expected to meet the aspirations of Lagos commuters in terms of comfort, variety and safety.

The first phase of the Lagos metropolis autorickshaw project covers the deployment of five hundred unit' (500) of autorickshaw within Lagos to individual operators on a deferred payment basis. It is geared not only to ameliorate the transport problems of people of city, but to also generate gainful employment for five hundred to one thousand individuals directly as operators (an autoricshaw can have up to two (2) shift of drivers it each day) and over five thousand (5, 000) others indirectly as mechanics, support staff, and so on. The project has been well planned and integrated by the government of Lagos State. The project is self supporting in that the money spent in procuring the first 500 units will revolve to continuously inject more autorickshaw into the project as repayments from operators come in monthly.

The Lagos State government is subsiding the registration and licensing fees, as well as the hackney permit to assists the operators. This study shows that each operator was able to realise a net revenue of at lease double the amount which the will repay each month to the scheme. The surplus is earning to support self and family.

A well-equipped and well-staffed main workshop had been established at the project site and has been catering for any major repairs of the 3 - wheelers. Advanced overseas training of some senior technicians was also been planned at the manufacturer's plant in India. Each 3 - wheeler operator was also supplied with large quantities of adequate spare part for eighteen (18) to twenty (20) months of operation free and at no extra cost for the basic preventive maintenance. Any operator is expected to replace this parts with his own hands as at when required or go on to any one of the two hundred (200) or so mechanic trained and spread throughout Lagos. Where for some serious problems the vehicle is brought into the main project workshop, then all problems are attended to free of any labour costs by the project engineers/mechanics on site. In addition , all further requirement or spares are sold at subsidised prices to all bonafide operators. These prices were at least twenty-five (25) present lower than the normal local retails prices for the same replacement spare.

TRANSPORT RELATED POLLUTION PERSPECTIVES : MAJOR FINDINGS

The analysis of the study showed that over 75 percent of commuters interviewed expressed acceptability of the mode of transport. Moreover, 92 percent of them opined that the mode has considerable cheaper, while most commuters were of the view that the most prominent factor that attracted them are safety records, costs, and reduced travel time.

In terms of transport related pollution of the use of mode of transport, 38 percent of commuters indicated the noise from the cycle and other vehicles as the major in the ridership of the mode. This is following by both the noise and air pollution by (25%) and air pollution (0.75%). Furthermore, 30 percent of the respondents indicated that the extent of emission from the 3-wheeler mode is higher than other mode of transport, while the 50 percent consider the extent of emissions very moderate. In terms of severity of the noise from the use of mode of transport, 25 percent considered it very serious, while the 56 percent of the users considered it fairly serious.

Perhaps, one of the most important aspect of the survey is visual intrusion posed by the three-wheeler mode of transport. Under normal weather condition, most interviewed commuters indicated that travelling by the mode is good. However, during the raining season that is between March and October visibility is very poor, therefore, making the use of the mode very uncomfortable. As high as 86 percent of the respondents was of the view that irrespective of weather condition they are often affected by heavy emission from other vehicles which affected their visual intrusions. In the actual fact, based on the field observation, the 3-wheeler cycles could hardly be found on the road whenever it rains. The visual intrusions as a result of emissions from other vehicles. This has further made the use of the mode very uncomfortable particularly during the peak period.

Going by the transport related pollution aspect of the use of the mode of vehicle including severity of noise, extend of air pollution, visibility and visual intrusions, it is undoubtedly clear that commuters are affected to great extent by severe noise and high level of emission. Commuters were also affected by visual intrusion through emission from other vehicles. In the other words, this mode of public transportation is considered very reliable, somewhat safe and affordable to significant proportion of commuters in metropolitan Lagos. However, it use brings a considerable discomfort to commuters in terms of noise, emission and visual intrusions.

We should never lose sight of fact that the period of discomfort to the commuters is short because trips made in this mode of transport is usually for a very short distance and cheap. Nevertheless, it is environment that actual becomes repository of the effect of the pollution, particularly those of the use of cycle.

No doubt, the government of Lagos City has allowed the low-income groups to be part of the participatory urban management programme, thereby enhancing their capacity to manage solution to city development policies by improving public transport system. The autorickshaw project is also 'pro-poor' and is one that has ensured more participatory approach by the government.

These are important aspects of sustainable development. However, the autorickshaw project is yet another case of how urban development has impact on the environment and local ecosystems. It is indeed a difficult situation to reconcile the agendas with city urban public transport policies of the state and improving the environment. Sustainability of the 3-wheeler cycle use as another public transport mode is very much in doubt. The pollution aspect of the use of the mode as it affects the commuters and the environment poses a constraint that limits the usefulness of a good programme target at the poor. Nevertheless, the study still continues to research into several different aspects of the use of the mode within the context of 'sustainable urban development' without masking the real conflict of interest and encouraging the sustaining of an unjust mode of urban public transport alternative.

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The environmental Brazilian law extension over the urban transport

L'application de la législation brésilienne du environnement pour le transport urbain

La aplicación de la legislación brasileña del ambiente al transporte urbano

Mário Jorge Lima
Transport Department, Polytechnic School, Federal University of Bahia, Brazil

ABSTRACT: During the last decades, the care with the environment has grown, in Brazil, intending to reduce the man action harmful impact, over the nature and human life dome, above all, about.the amazon forest. Besides that worries, it has grown too, the regulations destinated to face the urban environment problems. The article analyses the effects of the environmental law, over the urban transport planning and operation.

RÉSUMÉ: Durant les derniéres décades, à Brésil, la attention pour le environment est augmentée, pour diminuer le dommage que l'action du homme cause, sur la nature, la qualité de la vie, et surtout, pour la amazone forêt. À coté, est augmentée aussi, les régles destinée pour les problèmes du environment urbain. Cet article vise demonstrer les effects de les lois bresiliènes du environment pour la opération du transport urbain.

RESUMEN: Durante las ultimas decenas, hay crecido, en Brasil, la atención con el medio ambiente, con el designio de reducirse el efecto dañoso de la acción del hombre sobre la naturaleza y qualidad de la vida, sobretodo, con la floresta amazonica. Al lado, hay crecido también, la regulación hacia el medio ambiente urbano. El artículo trata de la influencia de las leyes brasileñas del ambiente sobre el transporte urbano.

1 – INTRODUCTION

The nucleus of the brazilian law system, organized to protect and rule the environmental inheritance, is found in the Brazilian Federal Constitution, promulgated at 1988.

The appropriated inclusion of that subject on the Constitution, appears accompanying the new cultural guidance, emerged in all the west world, mainly at the developed countries, since the last of the 70's years.

Since that time, the intelligence and scientific elite attended for the unknown impacts over the nature and the life quality, of the man action, always pursuing the economic development, to promote the intended collective welfare.

At the juridical world, the arising and increasing autonomy of the environmental law, rouses a new legal philosophy, maintaining it collective law character, but allowing for the private and then, finishing the exclusive State's responsability for the collective interest defence[1].

Another important innovation is the necessary support for the judges and lawyers, frequently assisted by nature sciences technicians and engineers[2], to produce the practical environmental law, instead of the west Right history, always founded only, over the socials and politicals sciences.

2 – THE BRAZILIAN ENVIRONMENTAL LAW HISTORY

Before the Constitution of 1988, none former brazilian constitutions attended direct the environment subject, but existed, under that constitutions, such anothers countries, several similar laws destined to rule the community interests, as the sanitary, the animal and forest protection laws[3].

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[1] Minahim, M. A Direito Penal Ambiental ... pg. 252.
[2] Machado, P. A. L., Direito Ambiental ..., pg. 158.
[3] Leite, J. L., Dimensão jurídica ... pg. 174 e segs.

That laws were used as the embryo, whereby were developed the actual environmental law in force, although not by the enlarged use, but above all, by the extensions added for them, brought by the new environmental guidance.

Before the Constitution of 1988, the environmental law, below the former constitutions, hold rules extended over the urban transport, as the Decree n. 303/67, criating the Environmental Pollution National Council, bringing the base concepts about the pollution, but the enforce and control was destined only for the States and the Municipalities[4].

The Brazilian Constitution of 1988 devotes a special chapter for the environmental rules, and, reigning as the greatest law of the nation, guides the government action obligation and the complementary law requisitated for the environmental protection.

So, after the emerged constitutional standards and with the ascribed tasks for the Union, the States and the Municipalities, became possible to require the government, to act and legislate about the environment.

3 - THE CONCEPTUAL DIVISION ABOUT THE ENVIRONMENT

The theoretical analysis of the environment subject, enable the division over the contents in accordance with three aspects: the artificial environment, the cultural environment and the natural environment[5].

The artificial environment is limited by the edifications and public constructions components of the urban space.

The cultural environment is the landscape, historical, artistical and tourist inheritance local arrangement, that attributes tradition or originality, although sometimes, producted by the human too.

The natural environment is the ecological nature, composed and balanced with the union of the physical, chemical and biological elements.

The first and the last of that environment kinds are the most sensitive, under the urban tarsnport system operation. The natural environment because of the air and noise pollution produced by the vehicles, and the artificial environment, because of the urban land use, affected by the streets tracing, both altering the urban life quality.

The cultural envinroment can be affected by urban transport system too, brought by the reflexive effects from the natural and artificial environment aggressions, but with less damage.

4 - THE RULES FOR ENVIRONMENT AND URBAN TRANSPORT AT THE BRAZILIAN CONSTITUTION OF 1988

4.1 - The subject arrangement

The brazilian constitution of 1988 holds the chapter devoted for the environmental at the Social Order Section, where are fixed the government obligations to promote the citizens welfare.

Meanwhile, there is no rule in that chapter, guided to protect the environment inheritance, submited to the urban transport impact.

That chapter only orientates generally, the governement actions for the environmental preservation, and among them, will be the legislation and management for the urban transport, as potential aggressive activity for the environment and land use.

Meanwhile, to understand the standard structure for the environment, conected with the urban transport, is necessary to watch on the Constitution too, the Urban Political chapter, classified at the Economic Order Section, and still the public government tasks share, distributed for the three federal entities, the Union, the States and Municipalities.

The rules in the Constitution, about the urban political, establish the orientation for the legislation development, about the land urban use, and compel the Municipalities, with more then 20.000 inhabitants, to maintain a Director Plan.

That Director Plan standardizes about the development and urban expansion, with direct effect over the street tracing and the urban transport system operation.

4.2 - The government competences distribution

The government tasks share can be understood about two aspects: the execution competence, such the administration work to protect the environment; and the legislation competence, such the regulation development.

Following the Constitution, the execution government competence, taking care of the environmental protection, pollution control, and the

[4] Silva, J. A., Direito Ambiental ... , pg. 17.
[5] Idem, pg. 3.

natural and cultural preservation, is a common responsability for all the federal government entities.

The common responsability means the enduring obligation for the gorvenments entities, to compel the law obedience within their territories, about the envinronmental protection, it means, the whole three entities law arrangement.

Besides, the three entities ought to act within cooperative integration, sharing the tasks, to attend that function.

The legislation competence is comissioned by the Constitution for Union and States, charged with the rule production, for the pollution control, forest political, natural preservation and punishment for environment, historical, artistical and landscape inheritance damage.

The legislation competence means, enable the Union and States, to regulate the environment protection within their federation automomy, entrusting the Union about the general rules, over all the country, and charging the States with the regulation about their interests and characteristics.

Although the legislation competence comissioned for the Union and the States, the Municipalities, in fact, are enable to rule about environment protection too, because the Constitution charges them to regulate the locals interests, above all, about the urban welfare[6].

Regarding the political and urbanization planning, the execution and legislation competences are shared among the three federal entities too.

Meanwhile, the execution and legislation competences for urban development guides, are entrusted only for the Union, such the national poltical guides about transit and transport, including the urban transport.

That competences are completed by the municipalities responsability for the local public services regulation, like the urban transport, the land organization, and the development urban planning.

Besides the Federal Constitution of 1988, the States and Municipalities Constitutions, following the greatest law, charge their respectives entities with execution and legislation competence about the environment protection and urban transport organization.

4.3 The constitutionals writs

Besides the constitutionals determinations, about the action and legislation competences, for the federal entities on the enviroment protection and nature preservation, the Constitution of 1988 establishs writs, to require, from that federal entities or others aggressors, the law obedience or punishment charging.

That writs are special judicial initiatives, available to citizens and socials groups, to protect the public and collectives interests. They are the 'popular lawsuit' process and the 'public civil lawsuit' process[7].

The 'popular lawsuit' is a process included among the human civil rights, available for any citizen, to finish or punish any damage over the public, historical, cultural inheritance, or the environment.

The 'public civil lawsuit' is a process also included at the human rights writs, to protect the public and cultural inheritance and the environment, available for the Prosecuting Attorney, or civil associations, preceded by preliminary civil inquiry.

5 - THE ENVIRONMENTAL LAW BELOW THE CONSTITUTION AND IT EXTENSION OVER THE URBAN TRASNPORT

The analysis about brazilians laws, below the Constitution, devoted for environmental protection, and with extension over urban transport, requires some necessary divisions over their subject.

The first division separates the civil laws from the criminal laws, including the administration laws, among the first kind of them.

Regarding the environmental civil laws, within the urban transport view, they may be shared, in accordance with their contents subject, as: general environmental rules, special environmental rules and urbanization rules.

5.1 The general environmental rules

In the scope of the general environmental rules, the widest and most important legal document is the law n. 6.938/81, promulgated under Union competence, organizing the National Political for Environment, and taking the coordination over the rest of the regulations.

This law criated the CONAMA, National Council for Environment, the main advisory and deliberation technician board for environmental subject, only submited to politic council of the

[6] Cunha Jr, D. "A Competência ..., pg. 332.

[7] Leite, J. L., ob. cit., pg. 192.

President, and acting integrated with the IBAMA, Brazilian Institut for Environment and Natural Resources, a executive government institution.

The CONAMA, among it tasks, ought to fix the rules and standards for pollution control for motors vehicles, causing direct influence over the urban transport system operation and private automobiles movement at urban zone.

The law defines juridical concepts for environment, pollution, polluant agent and environmental resources, including, among the last, the atmosphere and the land, both submited to transport operation aggression, above all, at the urban area.

The law equates the transport activity with the industrial activity, when declares the same punishment aggravated, if some pollution action cause risk for the animal, vegetation or human life, provoked by one of that activities.

The law still determines to IBAMA to maintain a National File for Potential Pollution Activities or Environmental Resources Explorers, for compulsory register of the people or companies working that activities.

Among the obliged people to register, are the transport operators for dangerous products with pollution risk.

One of the most important rules of the law, is the called 'objective responsability' charged over the aggressor, when causes environmental damage, compelling him to repair the injury or to compensate the damage, even without guilt.

The repair or compesation will be decided after the analysis about the more effective action to restore the environment injuried, and with a cost valuation, considering the non-monetary aspects about the environmental health[8].

At the end, the law fixs a penalty administration system for her rules, or any other complementary regulations aggressors, to be charged in addition with others administratives or criminals punishments.

5.2 - The urbanization legislation

The importance of the urbanization laws for the environmental subject over the urban transport system is the street trace planning, and that ought to be guided by the urban land use orientation.

The way crossing, about the technical aspect, must to determines standards for alingment, level, circulation, salubrious, safe and easy operation[9].

The plan have to consider the potential damage impact, brought by the urban transport system operation over the community life quality, mainly, by the air and noise pollution, as aggressive agents, over the artificial environment.

The brazilian constitution intends to equate the urban life quality at the several diferents brazilian big cities, and charged the Union, to institute a urban development paln law, with general standards, including the urban transport guidelines.

Meanwhile, in spite of that constutional order, the country still does not have, that general law for the urban development and the urban trasnport systems, to unify the federal entities action in that function.

So, the others federal entities, States and Municipalities, follow planning and acting over the urban development, in accordance with their specific and varied interests, above all, through the municipalities legislation, compelled to maintain the Director Plan, for the cities with more then 20.000 inhabitants.

That director plans, in fact, are the most importants legal documents to plan the development and expansion of the cities, fixing guides for the land use and the street trace, and even, about the environmental protection at their respective urban zone.

Sometimes, the lack of the Union legislation about the urban development, can be partially fulfilled by the urban land allotment federal law, the law n. 6.766/79, fixing standards about the urban land 'sharing' and 'allotment', bringing direct effect over the urban transport system.

That law, in fact, only determines the least standards about the 'sharing' and 'allotment' at urban zone, for private building companies investments, and for municipalities control.

By the law, the 'sharing' is the division of a private big urban land in several parts maintaining the street trace, and the 'allotment' the division of the same kind of land, meanwhile, altering or enlarging the street trace.

So, only for the allotments new projects, that law may practise, in fact, some influence over the urban transport system.

The law is completed by several complementary rules, about the urban land use, added by the states and municipalities legislations, because it is not a law for the public administration obedience.

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[8] Chiquetto, S., A Review on Monetary ..., pg. 63

[9] Meirelles, H. L., Direito Municipal ..., pg. 389.

5.3 - The special environmental rules

The most important special legislation for the urban transport system, is that about the air and noise pollution.

About the air pollution, the most important document is the law n. 8.723/93, devoted to reduce the polluants emissions by motor vehicles.

That law determines for the industrials plants new lower limits for harmful gas emission over the atmosphere, as the carbon monoxide, hidrocarbonets or residuals parts, and fixing finish dates for the industry adaptation.

Besides, the law requires a previous licence from IBAMA, to free trade that vehicles.

The law also establishs rules for the public administration, requiring the quality control for the fuel, sold in the country, intending to reduce it polluant action, and the control over the air quality too, mainly, at the urban area in the big cities.

So, the law exercise direct impact over the collective transport vehicles specifications, the most of them, in Brazil, moved by diesel oil, and over the urban transport system operation, because of the air quality control.

Within that regulation competence, the CONAMA completes the law with the Resolutions n. 18/86, 03/89 and 04/89, fixing standards about air pollution control produced by motors vehicles, and about aldeids and hidrocarbonets emissions, aided by the Instruction n. 100/80, from MINTER, fixing limits for smoke emissions by motors vehicles moved by diesel oil.

About the noise pollution, in spite of the CONAMA's Resolution n. 001/86, recognizing that environmental impact, it does not exist any federal law, uniting the noise production control.

Only the technician standards, the NBR 10.151 and NBR 10.152, regulates the noise valuation at inhabited areas.

The Aerial Code, at the Union legislation, the Decret nº 89.431/84, establishs zone standards too, for urban occupation around the airports and landing tracks.

So, the federal control over the noise pollution is practised only with the Resolution n. 001/90, considering the noise production as public nuisance, and determining the NBR 10.152 limits obedience for any activity.

Out of the Union competence, the States and Municipalities, within their local competences, issue regulations about the noise nuisance, above all, for the community welfare at the urban zone.

5.4 The Criminal legislation

The criminal legislation in Brazil is a private competence for the Union, but, as much as so the federal judge, the state judge, is enabled to order it application.

About the environment, the most important criminal law is the recent law n. 9.608/98, published at 13/02/98, unifying the types and criminals penalties for environmental offences.

Besides the punishment for the people, among the most importants rules, brought by the new law, is the possibility to impose sanctions for the enterprises offences, by action comanded by their board, with extension over their board members too, using the 'disregard of the legal entity doctrine'.

The sanctions enabled for the enterprises, besides the fines, may be: rights restrictions, as the operation stoping or contract forbided with public administration; or community services, as damage repair or environmental programmes support.

The sancitions enabled over the entreprise's directors are the same used for the common man, as the fines, beyond the right restrictions and the jail.

Among the environmental offences listed by the law, the most importants for the urban transport are the environmental pollution offences, including the air pollution.

So, the air pollution, causing damage to human health or forcing the human evacuation, is admited as felony, and punished with prison from 1 to 5 years, besides the fine.

There is also a criminal sanction for offences over the urban ordination or cultural inheritance, punishing the agent with prison from 1 to 3 years, by destruction or deterioration over that buildings protected by law, like the provoked by the smoke or harmful gas emissons from motor vehicles.

Before that law, anothers rules devoted criminal punishments for environmenal offences such the forest code, but, about the air pollution, the most important sanction is the 'misdemeanour law', from 1941, still in force, ordering fine, for smoke or gas emissions, when annoying people.

6 - CONCLUSION

Finishing, is important to report the recent advances last years, mainly with the Constitution of 1988 and the new laws n. 8.723/93 and 9.608/98, but the brazilian environmental law stand deffective.

The regulation about the general environment is produced by the CONAMA administration oficials instructions, and even advancing with details about the environmental protection, are submited to judicial interdiction, because they are not law.

About the urban transport, it is imperative the necessity of the federal law with general rules about urbanization and urban land use, guiding unuform standards for the cities development, including the urban transport system.

The legislation available about the noise pollution is deficient too, and wanted for general uniform standards.

At the end, we conclude observing the most notable advance occurred for the air pollution subject, with the issued legislation about standardized control, and mainly, fixing progressive limits to reduce the air pollution production.

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A extensão da legislação ambiental Brasileira sobre o transporte urbano

Mário Jorge P. de C. Lima
Fundaçao Escola Politécnica da Bahia, Brazil

ABSTRACT : In Brazil, during the last decades, like at the most of the western countries, has grown the care and the law regulation production about environment subject, intending to reduce the man action impact, over the nature and human life dome.
It could not be different, in the country where is the greater part of the amazon forest, the greatest in the world, holding the greatest water flood net too, beyond others nature land sites with similar importance.
Meanwhile,[1] besides that worries about the nature, it has grown too, the regulations destinated to face the urban environment problems, like the urban transport aggression, caused mainly by the urban population concentration, always growing in Brazil, the last decades.
Just about the evolution of the environmental law structure, and the regulation in force, also extended, over the urban transport planning and operation in Brazil, we conduct our exposition.

RESUMO : No Brasil, como na maioria dos países ocidentais, têm crescido nas últimas décadas a atenção e a legislação sobre a proteção ao meio ambiente, no intuito de reduzir o impact negativo da ação humana negativa sobre natureza e a qualidade de vida do homem.
Isso não poderia ser diferente no país onde está situada a maior parte da floresta amazônica, a maior do mundo, contendo ainda a maior rede fluvial do planeta, além de outros sítios naturais de importância similar.
Entretanto, ao lado das preocupações com o ambiente natural, crescem também as regulações destinadas à qualidade de vida urbana, entre elas a proteção contra as agressões causadas pelo sistema de transporte urbano, sempre aumentando no Brasil, nas últimas décadas.
Conduziremos então nosso trabalho, justamente sobre a evolução da estrutura legal sobre meio ambiente no Brasil e a regulamentação em vigência extensiva sobre o planejamento e operação do transporte urbano.

[1] Professor de Transportes, Esc. Politécnica / UFBA, Mestre em Administração / UFBA

I - HISTÓRICO DA LEGISLAÇÃO AMBIENTAL BRASILEIRA

O ponto de partida para a construção de um sistema legislativo dirigido e estruturado para os problemas do meio ambiente no Brasil deve ser localizado na Constituição Federal de 1988.

A inclusão oportuna da matéria no texto daquela Lei Maior, emerge em acompanhamento de uma nova diretriz cultural produzida em termos mundiais, sobretudo nos países desenvolvidos, a partir do final da década de 70.
Naquele período, a elite científica e intelectual despertou para o impacto imprevisível, que a ação humana sobre a natureza, na busca descontrolada do chamado desenvolvimento econômico para promover o bem estar coletivo, poderia exercer sobre os recursos naturais e a qualidade,de vida.

No mundo jurídico, o surgimento e crescente autonomia do chamado direito ambiental também provoca inusitadas inovações filosóficas, quando assume seu caráter de direito coletivo, porém disponível à iniciativa individual privada, ainda que em nome interesse coletivo, retirando a tradicional exclusividade do Estado e do direito público, na defesa jurídica dos interesses sociais[2].
Outra substancial inovação, é a necessidade dos juristas e advogados em buscar permanente apoio em conhecimentos e técnicos das ciências naturais[3], para produzir . o direito ambiental prático objetivo aplicado e aplicável, em contrapartida a toda a história do direito ocidental, onde sempre foi suficiente apenas o apoio nas ciências sociais, filosóficas e políticas.

Antes da Constituição de 1988, nenhuma das Constituições brasileiras havia tratado diretamente do problema, existindo porém, no plano infraconstitucional, como em diversos outros países, variadas leis destinadas a regular aspectos coletivos interesse comunitário, como o saneamento, a proteção florestal e animal[4].

Essas leis constituíram-se no embrião do qual se desenvolveu a legislação ambiental mais atualizada vigente, embora não por força de sua progressiva utilização prática, mas sobretudo pela extensão que a nova diretriz ambiental coletiva acrescentou a suas matérias.

Naquele período anterior à Constituição de 1988, a legislação infraconstitucional, embora de forma não concatenada, já produzia normatizações de alcance sobre o transporte urbano, a exemplo do Decreto-lei nº 303/67, que criou o Conselho Nacional de Poluição Ambiental, contendo conceitos básicos jurídicos sobre poluição, mas que, no entanto, era de controle e aplicação de responsabilidade dos Estados e Municípios[5], retratando a entendimento restrito e acanhado então aplicado a tais matérias.

A importância da introdução de normas referentes ao meio ambiente na Constituição Federal de 1988, que lhe dedica capítulo específico, está na

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[2] Maria Auxiliadora Minahim, "Direito Penal Ambiental - um conflito entre a tutela aos interesses coletivos e o individualismo", pg. 252
[3] Paulo Affonso Leme Machado, Direito Ambiental Brasileiro, pg. 158.
[4] Joaquina Lacerda Leite, "Dimensão Jurídica da Problemática Ambiental Brasileira", pg. 173 e segs.
[5] José Afonso da Silva, Direito Ambiental Constitucional, pg. 17.

situação hierárquica máxima que a Carta Magna assume no sistema normativo como lei fundamental da nação, orientando em definitivo os deveres de atuação governamental e produção legislativa necessários ao atendimento das expectativas dos cidadãos.

Desse modo, a partir da determinação constitucional de normas sobre o meio ambiente e da atribuição de competências aos entes federativos para sua ação nesse campo, pode ser exigido dos governantes a iniciativa na construção de regulamentações e programas de tarefas sobre a proteção e preservação do meio ambiente.

II - A SUBDIVISÃO CONCEITUAL SOBRE O MEIO AMBIENTE

Em termos conceituais, o trato da matéria meio ambiente, importa na subdivisão de sua abrangência segundo três aspectos: o meio ambiente artificial, o meio ambiente cultural e o meio ambiente natural[6].

O meio ambiente artificial se compõe do conjunto de edificações e equipamentos públicos constitutivos do espaço urbano.
O meio ambiente cultural, entendido como o conjunto patrimonial histórico, artístico, paisagístico e turístico, que apesar de também artificial, conta com valor adicional impregnado pela tradição ou peculiaridade local.
O meio ambiente natural é a reunião equilibrada e integrada de elementos físicos, químicos e biológicos, em estado natural não transformado pelo homem.

Nessa subdivisão, os ramos que mais importam para exame, quanto ao impacto produzido pela operação de um sistema coletivo de transporte urbano, são o meio ambiente natural, sensível às poluições atmosféricas e sonora causada pelos veículos, e o meio ambiente artificial, onde o ordenamento do solo urbano e o traçado das vias, produzem efeito direto sobre a qualidade de vida da população.

O meio ambiente cultural também pode ser alcançado, embora em menor escala, pelo funcionamento de um sistema de transporte urbano, em decorrência das ações negativas reflexas da agressão aos ambientes natural e artificial.

III - A REGULAÇÃO DO MEIO AMBIENTE E DO TRANSPORTE URBANO NA CONSTITUIÇÃO DE 1988

III.1 - A distribuição da matéria

A Constituição brasileira atual situa o capítulo destinado a diretrizes sobre o meio ambiente no título da Ordem Social, onde a Lei Maior estabelece os programas norteadores e obrigatórios aos poderes estatais, para a finalidade de produzir o bem estar social dos cidadãos.

No entanto, nenhuma norma pode ser encontrada neste capítulo, que possa ser entendida como diretamente dirigida ao transporte em geral, ou transporte urbano. As disposições do capítulo orientam apenas, de forma genérica, as ações do Poder Público em proteção ao meio ambiente, nas quais devem estar incluídas as ações e legislações destinadas ao segmento de transporte urbano, como atividade ocupante de espaço territorial e potencialmente capaz de produzir degradação ambiental.

[6] José Afonso da Silva, ob.cit., pg.3.

No entanto, para compreender toda a estrutura normativa da Constituição, com disposições referentes ao meio ambiente e relacionadas ao transporte urbano, é necessário examinar também um outro capítulo constitucional, o da Política Urbana, situado nas disposições sobre a Ordem Econômica, e sobretudo, o sistema de repartição de competências de atribuições governamentais entre as três esferas federativas que compõem o Estado brasileiro.

A disposições sobre a política urbana da Constituição, estabelecem a orientação para a produção legislativa sobre a ocupação do espaço territorial urbano, determinando a obrigatoriedade de elaboração, em lei municipal, de um plano diretor, para os Municípios com mais de 20.000 habitantes.
Neste plano diretor deverá estar incluído o planejamento de desenvolvimento e expansão urbana, com efeitos diretos sobre traçado e operação do sistema de transporte em geral e o coletivo.

III.2 - A distribuição de competências

O sistema de repartição de competências pode ser subdividido em competência executiva, quanto ao exercício das funções administrativas para a proteção do meio ambiente, e a competência legislativa, quanto à produção de normas com a mesma finalidade.

A competência executiva administrativa, segundo a Constituição, para a proteção do meio ambiente, combate à poluição e à preservação natural e do patrimônio cultural, é de responsabilidade comum de todos os entes federativos, União, Estados e Municípios.

Essa competência comum significa, que as três esferas autônomas de governo devem exercer, de iniciativa própria, suas atribuições nessa área, respectivas a seus interesses e territórios, no intuito de fazer cumprir as leis destinadas à proteção ambiental.

Além disso, devem buscar atuar de forma integrada com os demais entes federativos, em regime de cooperação equilibrada para com a divisão de tarefas nesta atividade.

A competência legislativa quanto ao meio ambiente é atribuída de forma concorrente para a União e Estados, e também no que diz respeito ao controle da poluição, política florestal e de conservação da natureza e dos recursos naturais.
A responsabilidade por danos ao meio ambiente, e ao patrimônio histórico, artístico ou paisagístico, também está disponível para a normatização concorrente pela União e Estados.

A competência legislativa concorrente significa que ambos os entes governamentais, União e Estados, podem produzir leis, dentro de suas autonomias federativas, destinadas à regulação da proteção ao meio ambiente, com a diferença de que à União caberá a legislação de normas gerias aplicáveis a todo o país, e aos Estados caberá a produção normativa destinada a seus interesses e peculiaridades, respeitadas as normas gerais determinadas pela União.

Apesar do poder normativo sobre direito ambiental estar reservado à União e aos Estados, os Municípios também se tornam autorizados à elaboração de leis sobre proteção ambiental, sobretudo com respeito ao ambiente urbano, em função da sua competência executiva nesta área e ao poder que lhe é delegado pela Carta Magna de legislar sobre os assuntos de interesse local[7].

No aspecto da política e planejamento urbanístico, as competências executiva e legislativa também se distribuem, da mesma forma, aos três entes governamentais.
Merece destaque porém, a competência executiva privativa da União para instituição de diretrizes para o desenvolvimento urbano, incluindo os transportes urbanos, e a competência legislativa, também reservada à União, para regulação normativa de transito e transporte, e para estabelecer as diretrizes da política nacional de transportes.
Essas competências são complementadas pelas responsabilidades municipais para com a regulação dos serviços públicos locais, onde se inclui o transporte urbano, o ordenamento territorial e o desenvolvimento urbano planejado.

Além da Constituição Federal, também as Constituições estaduais e municipais, chamadas estas de Lei Orgânica, em consonância com a Carta Magna federal, atribuem responsabilidades e funções a seus respectivos entes federativos autônomos, para ação e legislação com a finalidade de proteção ao meio ambiente e organização do transporte urbano.

III.3 - As garantias constitucionais

Além das disposições constitucionais programáticas para a atuação dos entes federativos sobre a proteção e preservação do meio ambiente, existem também as garantias fornecidas pela mesma Magna Carta, para exigência daquelas entidades ou de outros infratores, de conduta de obediência às leis ambientais ou de sanção ao descumprimento daquela legislação.

Essas garantias são de natureza processual e se constituem em ações especiais disponíveis aos indivíduos ou grupos sociais, que se destinam à proteção de interesses públicos coletivos. São elas a ação popular e a ação civil pública[8].

A ação popular é uma ação prevista entre os direitos fundamentais constitucionais, e que pode ser iniciada por qualquer cidadão, quando verifique a ocorrência de lesão ao patrimônio público, histórico, cultural ou ao meio ambiente.

A ação civil pública consiste também numa garantia fundamental para tutela do patrimônio público, cultural e do meio ambiente, entre outros, a ser iniciada por associações civis ou pelo Ministério Público na defesa daqueles interesses e após um inquérito civil conduzido pelo Ministério Publico.

IV - A LEGISLAÇÃO AMBIENTAL INFRACONSTITUCIONAL E SUA EXTENSÃO SOBRE O TRANSPORTE

O exame integrados das leis brasileiras, situadas abaixo da Constituição, que estabelecem normatização sobre a proteção ambiental, com reflexos sobre o transporte urbano, exige uma subdivisão sistemática segundo suas matérias.

Assim, a primeira secção necessária consiste na separação das leis de natureza

[7] Dirley da Cunha Jr, "A Competência dos Municípios em Matéria Ambiental", pg. 332.

[8] Joaquina Lacerda Leite, ob. cit., pg. 192.

civil ou penal, incluindo entre as primeiras as de cunho administrativo.

Entre as leis de caráter civil, importa ainda nova ramificação, segundo a matéria tratada na lei, que pode estar destinada ao aspecto ambiental geral, urbanístico ou ambiental específico, no que afeta ao transporte urbano.

IV.1 - A legislação ambiental geral

No âmbito da legislação ambiental geral, o documento legal mais amplo e importante é a lei 6.938/81, com suas alterações, promulgada na esfera federal, que dispõe sobre a Política Nacional do Meio Ambiente, e assume a função de norma geral coordenadora das demais regulamentações.

Essa lei estabelece a criação do CONAMA, Conselho Nacional do Meio Ambiente, como principal órgão técnico deliberativo e consultivo para questões relativas ao meio ambiente, subordinado apenas a um conselho político de governo vinculado ao Presidente da República, e com atuação simultânea como o IBAMA, Instituto Brasileiro do Meio Ambiente e Recursos Naturais, órgão principal de ação executiva e administrativa.

Entre as competências específicas do CONAMA está a fixação, com a participação dos órgãos técnicos competentes, de normas e padrões relativos ao controle da poluição por veículos automotores, com interferência direta sobre a administração dos sistemas de transporte coletivo e circulação de veículos particulares em zona urbana.

A lei em exame define os conceitos jurídicos para meio ambiente, poluição, poluidor e recursos ambientais, incluindo entre estes a atmosfera e o solo, de particular exposição à exploração da atividade de transporte, sobretudo em ambiente urbano.

A lei equipara a atividade de transporte à atividade industrial, quando considera agravante, para feito de punição de ação poluente com risco para a incolumidade humana, animal ou vegetal, a circunstância da mesma ter sido causada por uma daquelas atividades.

A lei em exame obriga ainda a manutenção pelo IBAMA, de um Cadastro Técnico Federal de Atividades Potencialmente Poluidoras ou Utilizadoras de Recursos Ambientais, de registro compulsório para as pessoas físicas ou jurídicas que exerçam tais atividades.
Neste cadastro também devem ser inscritos os operadores de atividade de transporte, com produtos perigosos em potencial.

Entre as mais relevantes determinações dessa lei, está fixação da chamada responsabilidade objetiva do agente infrator que causou lesão ambiental, obrigando-o à indenização e/ou reparação do dano causado, independentemente da existência de culpa.

As medidas de reparação ou indenização deverão ser decididas após uma análise técnica, a respeito da providência necessária mais eficaz para restabelecimento do meio ambiente agredido, e utilizando técnicas estimativas de custos com considerações sobre as variáveis e bens ambientais destruídos ou sob risco, muitos deles com expresso conteúdo não monetário[9].

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[9] Sergio Chiquetto, A Review on Monetary Valuation of the Environmental of Traffic, pg. 62 e segs.

Em seu final, a lei estabelece um sistema de punições administrativas aos infratores de suas disposições, ou de quaisquer outras regulamentações ambientais complementares, que deve ser aplicado em paralelo às penalidades criminais e outras, fixadas em legislação coexistente nas diversas esferas de governo.

IV.2 - A legislação urbanística

A importância da legislação urbanística para o aspecto ambiental de um sistema urbano de transporte, está no planejamento do sistema viário, que deverá obedecer critérios que promovam a qualidade de vida e o conforto da população citadina, e cujas diretrizes, formuladas necessariamente pela administração pública, estarão dispostas em leis sobre o ordenamento do solo.

O traçado viário em termos técnicos deve seguir diretrizes legais quanto ao arruamento, alinhamento, nivelamento, circulação, salubridade, segurança e funcionalidade[10].

Nesta planificação viária urbana, um dos principais efeitos a ser considerado será a contribuição que um sistema de transporte pode exercer negativamente sobre os padrões qualitativos de vida para a comunidade, sobretudo em termos de poluição urbana e sonora, constituindo-se em elemento daquilo que é chamado de meio ambiente artificial.

A Constituição brasileira, atenta à necessidade de equalizar a qualidade de vida dos habitantes das diversas e diferenciadas cidades brasileiras, elevou às atribuições da União, a competência para instituição de diretrizes para o desenvolvimento urbano em geral, e para transportes urbanos em particular.

Não obstante tão claro mandamento constitucional, o país carece até o momento de uma lei de normas gerais sobre o desenvolvimento das cidades e de seus sistemas de transportes, que uniformize a atuação dos entes governamentais neste campo.

A atuação das diversas esferas federativas no planejamento, permanece então sob regulamentação desconcatenada das diversas legislações estaduais necessárias a seus interesses específicos, e sobretudo à legislação municipal, através dos planos diretores, obrigatórios para cidades com mais de 20.000 habitantes, elaborados apenas sob orientação das as peculiaridades e interesses locais.

Os planos diretores, por sua vez, em sua função de planejar a expansão e desenvolvimento dinâmico da cidade, fixam as diretrizes para o ordenamento e ocupação do solo, onde estarão dispostas também determinações sobre o sistema viário, atentas obrigatoriamente à proteção ambiental e à salubridade.

No entanto, o vazio da legislação federal está parcialmente preenchido pela lei federal de parcelamento do solo urbano, lei 6.766/79, que dispõe regras gerais sobre o desmembramento e loteamento do solo urbano, e assim produz efeitos, ainda que preliminares, sobre o sistema de transporte.

Esta lei, em verdade, apenas se destina a estabelecer regras mínimas a serem cumpridas por empreendedores privados, interessados na divisão e comercialização de partes de glebas urbanas, e que devem

[10] Hely Lopes Meirelles, Direito Municipal Brasileiro, pg. 389.

ser fiscalizadas pelas municipalidades, sobretudo quanto aos requisitos mínimos quanto a áreas e equipamentos públicos obrigatórios.

Pela lei, o desmembramento se constitui no parcelamento do solo urbano com aproveitamento do sistema viário existente, e o loteamento é o parcelamento com a abertura de novas vias e/ou alteração das existentes.

Dessa forma, apenas quando existe proposta de loteamento, é que essa lei pode exercer influência sobre a planificação do sistema de transportes urbanos, motivando o estudo do impacto ambiental do projeto.

Não se tratando de lei destinada à orientação da ação executiva da administração pública, a aplicação de suas determinações, na prática, costuma ser largamente complementada pelas exigências e determinações complementares, estabelecidas nas leis estaduais e municipais de uso de solo.

IV.3 - A legislação ambiental específica

A legislação ambiental específica com substancial influência sobre o transporte urbano, é aquela que se refere à poluição atmosférica e sonora.

Quanto à poluição atmosférica, o documento legal mais importante é a lei 8.723/93, destinada á fixação de reduções na emissão de poluentes para os veículos automotores.

A lei se dirige sobretudo para os empreendedores privados, ao estabelecer novos limites para o lançamento de gases nocivos como monóxido de carbono, hidrocarbonetos ou partículas, sobre a atmosfera, fixando prazo para adaptação e obediência dos fabricantes de veículos, e exigindo destes, licenciamento específico pelo IBAMA, para a comercialização dos veículos.

Estabelece obrigações também para a administração pública, quando exige o controle de qualidade dos combustíveis comercializados no país, com a finalidade de garantir a redução da ação poluente, e determina o monitoramento da qualidade do ar atmosférico, sobretudo em áreas urbanas das grandes cidades.

Essa lei exerce impacto direto sobre as especificações técnicas dos veículos de transporte coletivo, no Brasil sempre movidos a óleo diesel, e sobre a influência da operação do sistema de transporte, na qualidade do ar dos grandes centros urbanos.

IV.4 - A legislação penal

A elaboração da legislação penal no Brasil é de competência restrita da União, mas sua aplicação deve ser praticada tanto pela justiça federal como pela justiça dos estados.

No que diz respeito ao meio ambiente, a lei penal ambiental mais importante é a recente lei nº 9.605/98, publicada em 13/02/98, que veio unificar as tipificações e punições aplicáveis no caso de crime ambiental.

Além das punições aplicáveis às pessoas físicas, entre as importantes disposições trazidas pela nova lei, está a possibilidade de imputação de crimes a pessoas jurídicas, por atos praticados por decisão de sua diretoria, com conseqüências extensivas às pessoas destes, por aquelas infrações.

As penas aplicáveis às pessoas jurídicas podem ser: restrição de direitos, como a paralisação das atividades e proibição de contratação com o poder público; a prestação de serviços à comunidade, como a recuperação dos danos e o custeio de programas ambientais, além das multas.

As penas aplicáveis aos administradores são as mesmas destinadas às pessoas físicas em geral, que podem ser de multas, interdição de direitos e privação de liberdade.

Entre os crimes contra o meio ambiente enunciados pela lei, os que mais interessam quanto aos efeitos da atividade de operação de transporte urbano são aqueles que se referem à poluição ambiental, que abrange a poluição atmosférica.

Assim, a prática de poluição atmosférica que cause dano à saúde humana, ou que obrigue a desocupação humana de determinada área, é considerada um crime, sujeito a pena de reclusão de 1 a 5 anos, além de multa.

Há também previsão de punição penal para crimes contra o ordenamento urbano e ao patrimônio cultural, que destina a pena de reclusão por 1 a 3 anos, aos responsáveis, por destruição ou deterioração de bem protegido por lei, como pode acontecer com prédios e monumentos prejudicados pela emissão de fumaça e outros agentes nocivos lançados pelos veículos automotores.

Antes dessa lei, outras leis previam punições penais para crime ambientais como o código florestal, mas no que afeta à poluição atmosférica, o registro mais importante é o da lei de contravenções penais, de 1941, mais ainda vigente, que no seu art. 38, comina a pena de multa, aos que provoquem de forma abusiva a emissão de fumaça ou gás que possa ofender ou molestar alguém.

V - CONCLUSÃO

Concluindo, constatamos que, apesar dos avanços obtidos nos últimos anos, sobretudo com o advento das leis n° 8.723/93 e 9.608/98, ainda é deficiente a legislação brasileira para com o meio ambiente.

A regulação do meio ambiente em geral vem sendo produzida por meio de regulamentações administrativas do CONAMA, que embora avancem em detalhes sobre a proteção ambiental, trazem o defeito de não possuir força de lei, e portanto, sempre passíveis de contestação judicial.

No que diz respeito ao transporte urbano, mostra-se urgente a necessidade da elaboração da lei federal de normas gerais sobre urbanização e uso do solo, que tracem normas uniformes para o desenvolvimento das cidades brasileiras, incluindo seu sistema de transporte.

A legislação disponível para controle da poluição sonora também encontra-se deficitária, e necessitada de regras gerais uniformes.

Por último, constatamos que os avanços mais significativos se materializaram no campo da poluição atmosférica, com a produção de legislação específica de controle padronizado, e pricipalmente com a promoção de metas para redução da produção da poluição sobre o ar.

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1.5 Quality of public transport
Qualité du transport public
Calidad del transporte público

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Strategic logistics management principles in urban transit

Principes de gestion strategique et logistique en moyens de transit urbain

Principios de gestión estratégica y logística para tránsito urbano

W.R. Duff-Riddell

Institute for Transport Technology, Department of Civil Engineering, University of Stellenbosch, South Africa

ABSTRACT: Fragmented planning and operation of transit services are not conducive to the promotion of the use of transit that is sought by so many authorities. The concepts of transit as a product, and strategic logistics management as a planning and operational approach are presented. How these concepts can be used to improve the planning and image of transit is discussed. A decision support system for implementing strategic logistics management approach is described.

RÉSUMÉ: La planification et l'operation fragmentées des services de transit urbain ne sont pas favorables a la promotion de l'utilisation des moyens de transit qui est recherchée par tant d'autorités. Les concepts des moyens de transit comme un produit et la gestion strategique et logistique comme methode de planification et d'operatrion sont presentés. Egalement abordée, est la question de l'utilisation de ces concepts pour ameillorer l'image des services de transit. Un système pour aider les décisions a propos des principes de gestion logistique et strategique presentés est descrit.

RESUMEN: La planificación y la operación fragmentada de los servicios de tránsito urbano no son favorables a la utilisación de los medios de tránsito tal como es aspirada por muchas autoridades. Los conceptos de los medios de tránsito como producto y la gestión estratégica y logística como método de planificación y de operación son presentados. Igualmente descutida, es la cuestión de la utilisación de estos conceptos para mejorar la imágen de los servicios de tránsito. Un sistema para ayudar en decisiones acerca de los princípios de gestión estratégica y logística presentados es descrita.

1 INTRODUCTION

Transit planners and operators sometimes seem to be the worst enemies of transit. Planning is inclined to be a highly departmentalized and fragmented process whilst there is often destructive competition between operators. The promotion of transit requires a more cohesive strategy in which all planners and operators see themselves as working together towards the common goal of providing transit services. The fact that local and regional authorities are normally responsible for the provision and control of transit services, albeit through third party providers, means that implementing some form of holistic planning strategy is both desirable and practical.

One possible approach to holistic planning is known as "strategic logistics management." This management philosophy, extensively employed in industry, is based on the concept of synergy. That is, the belief that if a business is to flourish all participants in the business must attempt to enhance their own position only if it benefits the whole business. The approach does not seek to eliminate the individuals right to a profit, independent innovation or entrepeneurship but to ensure that the actions of one role player do not result in a decrease in the overall success of the industry.

Implementing this management approach has many facets and levels. In the transit environment, these range from community issues through to vehicle maintenance and replacement schemes. At the broadest level however, is the need to provide a marketable transport product. One which simultaneously meets the needs of both users and providers of transit, as closely as possible, whilst taking into account more general community issues such as safety, congestion and pollution.

2 THE TRANSIT PRODUCT

One of the unfortunate perceptions of transit is that it is a second rate form of transport. If the politicians are as serious about sustainable transport as claimed in their white papers, then transit should be seen as the flagship of a region's effort to provide safe, sustainable and efficient mobility and accessibility for its community. This in turn will help to promote tourism, industry and general commerce and community wellbeing.

Under these circumstances, transit becomes the primary concern in transport planning instead of an afterthought. It then reflects the goals and values of the community it serves. With this in mind, branding becomes an important issue. Who has not heard of "London Transport?" On the other hand, who has heard of "Tellings Golden Miller," one of the operators within the London Transport operation?

Concurrent with the development of this sense of identity for the transit industry, a clear identification of the products they wish to sell and the products against which they compete needs to be made. Once the competition is clearly identified, it is easy to recognize that the transit product should provide a safe, cost effective and pleasing alternative to the private motor car. In market-speak, transit must develop and promote its "unique advantages," and it has many, if we would only look.

What constitutes a unique advantage is of course extremely subjective. In some areas, pollution and land use issues may be of great importance. In others, cheap transport with good coverage may be the primary criteria. Usually, several, and often conflicting, measures will apply concurrently. It is a means of achieving the best compromise between these measures, in the transit plan, that is the focus of the decision support system to be discussed later.

Having developed a transit product range, the industry needs to make real efforts to market its produce. This is not a casual matter, but requires careful planning and implementation and the expenditure of significant resources. Poor marketing can result in the failure of even the best product and unfortunately is often a seriously neglected aspect of transit. Marketing should be undertaken by a team of qualified specialists, which should include transport planners, marketing specialists and transport psychologists.

Of course, just as poor marketing can result in failure of a good product, even the best marketing will not sell a poor product. We must thus ensure a good product, which requires careful research of our market, planning of our product and setup of our production system. This brings us to the concepts of strategic logistics management.

3 THE STRATEGIC LOGISTICS MANAGEMENT MODEL

The strategic logistics management approach is primarily a method of managing the movement of goods through a production process from raw materials to customers' hands. This movement of goods involves many role players, each with their own perceptions and goals. Given this diversity, the main tenets of this approach are:

- The business must achieve a prescribed level of customer service in order to remain competitive or increase its market share.
- In adapting to achieve this desired level of service, all components of a business must be seen in their context with all other components of the business.
- Any change made must produce a net benefit to the whole business, although it may produce a localized dis-benefit in some specific aspect of the business.

Formally, strategic logistics management is given the following definition by the Council of Logistics Management. (Lambert & Stock. 1993)

> The process of planning, implementing and controlling the efficient, cost-effective flow and storage of raw materials, in-process inventory, finished goods, and related information from point-of-origin to point-of-consumption for the purpose of conforming to customer requirements.

A version, applicable to the transit environment, could read as follows:

> The process of planning, implementing and controlling the efficient, cost-effective flow of route-seats and related information from point of origin to point of destination for the purpose of conforming to traveller and community requirements.

In order to apply this, we need some form of model structure. The following is adapted from the model presented by Lambert and Stock (1993.)

3.1 *Given the Marketing objective:*

Achieve a target share of the (commuter) travel market.

Allocate resources to the marketing mix to maximize the long-run sustainability of the transport system.

In essence, this means providing the right product at the right place, time and price.

3.2 *Achieve the Logistics objective:*

Minimize total costs given the Customer Service Objective where:

Total costs = Fleet operating costs + Fleet size & composition costs + Vehicle selection & routing costs + Access node & interchange costs + Order processing & information costs

3.2.1 *Customer service objective*

The customer service objective prescribes how closely we are going to attempt to satisfy customer demands. For example, what level of timetable accuracy are we going to aim for? The more rigorous the customer service objectives, the more expensive the product, and price is itself, one of our objectives, and so a trade off is needed. It should be kept in mind that we seek to encourage, rather than force people to use transit. This involves providing a suitable quality of service and changing traveler perceptions.

Since the transit system is operated on behalf of the community, the impact of the transport system on that community needs to be noted. Thus a primary issue in the setting of objectives for transit provision, is that the entire community should be represented, not just the private car user or the transit user or operator. In applying the strategic logistics management model to transit therefore, it is necessary to answer several questions:

1. What are the political and social objectives of the authority responsible for the overseeing of the transit system and how do they propose to support those objectives?
2. What factors influence mode choice locally and how can these factors be modified to maximize transit usage without the imposition of unduly restrictive measures on car use and thus, choice?
3. What resources are available?

The answers to the first two of these questions give rise to the customer service objective that describes the system in terms of performance benchmarks. A few examples are:

- Average walking distance to a transit access point.
- Quality of vehicles. Measured in terms of a set of criteria such as age, seating space per person, on-board amenities, etc.
- Maximum fares.
- Frequency of service.
- Effective travel speed of all travelers.
- Maximum cost of the system to the authority.
- Pollution generation rates per passenger-km by all modes.

Achieving these benchmark values and thus satisfying the customer service objective requires a comprehensive understanding of the costs of producing the product.

3.2.2 *Total costs.*

In achieving the marketing objective, we wish to minimize the total cost of providing the service without forgoing the customer service objective. In the application of the strategic logistics management principles to transit, the concept of total cost should be extended to include community costs and benefits. Examples of this are:

- The tax rates required to ensure adequate levels of transport infrastructure funding.
- The safety of suburban streets for pedestrians.
- The air quality and noise levels within the local environment.

At the same time, the operational costs of transit need to be known so that the efficiency of services can be monitored. Ultimately, the authority should seek to minimize the total cost of transport provision to the community whilst meeting its commitment to social and economic sustainability.

The total costs of providing a transit service may be broken down into several related components, the following being possible cost centers.

3.2.2.1 Fleet operating costs.

The actual operating costs of the fleet based on such factors as fuel, vehicle financing methods, maintenance, driver salaries, management, and any other costs associated specifically with keeping the vehicles on the road or track are important. More universal costs will include non-monetary values such as pollution generation or energy consumption values per passenger kilometer traveled.

3.2.2.2 Fleet size & composition costs.

At the operator level, the lowest life cycle costs may be achieved by meeting the current demand using a single standard vehicle. This may however, result in the lowest return on community investment where the return is measured in terms of goals such as:

- Percentage of total trips made by transit.
- Area coverage of the transit system.
- The energy usage and pollution generation per passenger-kilometer on the transport system.

3.2.2.3 Vehicle selection & routing costs.

The specific type of vehicle assigned to a given route as well as the actual routes chosen on the network can have significant impact on the overall costs of a transit system. Poor vehicle utilization, whether through incorrect vehicle selection or poor route selection is a waste of resources. In addition, certain vehicle types may be more suited to certain local conditions and may provide equal or better service at lower costs than others.

3.2.2.4 Access node and interchange costs.
A transit system is nearly as reliant on access points as it is upon the vehicles. Access nodes, bus stops for example, can take many forms ranging from a single pole, through to a weatherproof construction with electronic information systems. At interchange facilities, where more than one non-walk mode is typically accessed, facilities may range from a pole on a pedestrian island, to something akin to an international airport terminal building.

The different locations and constructions will influence customer satisfaction, (and thus modal choice,) rental income from commercial activities, vehicle operating costs as a result of access and egress difficulties and the like. Customer satisfaction will be perceived in terms of convenience, safety, free movement, speed of access and egress from vehicles, proximity to origin or destination, intermodal co-ordination, and availability of information.

3.2.2.5 Order processing & information costs.
The transit planner, operator, user, and potential user all require information. The amount and manner of gathering and disseminating this information will impact on costs, system performance, user and potential user perceptions, and thus willingness to use the transit system. Cooperative use of modern electronic data interchange will allow planners and operators to readily keep up to date with current information. Similarly, modern ticketing mechanisms may offer a means of gathering information, controlling fare evasion or reducing vehicle access and egress time. The benefits of any of these may quickly offset the cost of the more sophisticated system required.

4 IMPLEMENTATION OF THE MANAGEMENT APPROACH

The implementation of the strategic logistics management principles in the planning and operation of urban transit has two core requirements:

Firstly, there needs to be a central coordinating structure with the power to direct the public and general transport systems. Such control may take the form of contracts and licenses or permission for rights-of-way or facility construction and so on. These powers are typically vested in the local authority. It is not necessary that the authority provides or operates the transit system. It must however, lay down minimum standards and co-ordinate services and monitor performance, providing corrective feedback where necessary, naturally requiring a complete understanding of transit. This coordinating structure must specify the goals to be met by the system as well as the criteria by which it is to be measured. Of course, the authority may also be required to fund services, required by its policies, which are not commercially viable.

Since the provision of basic infrastructure is in any case managed in this way, and more often than not, transit subsidies are paid by the authorities, there is no basis for arguing that this approach would restrict free enterprise. Properly managed, it may very well promote such enterprise by improving the overall image of the industry.

Secondly, a mechanism is required for evaluating the interaction of the various components of the transport and transit systems. In this respect, there is a great deal of very sophisticated software available for the planning and operation of various specific facets of a transport system. Unfortunately, each of these packages tends to be utilized by a specialist in a particular field and all too often, these specialisations are not brought together in a cohesive way. Strategic Logistics Management seeks to link all the specialist fields and thus to:

> Identify an optimal allocation of resources so that all the objectives of all role players are met as closely as possible, according to the priority of the objectives within the system.

Once the regional socio-economic and customer service objectives are established, the goal programming technique can be used as a means of system optimization. In this process, the objective function minimizes the deviation from the desired objectives, solving for each objective or group of objectives in order of priority and weight.

Of course, this is far more easily said than done, but modern computer hardware and software make it perfectly feasible, especially if we make use of existing information and models.

5 APPLYING THE TECHNIQUE TO THE ROUTE DEVELOPMENT AND VEHICLE ASSIGNMENT PROBLEM

Fundamental to the transit business is the need to provide a product, which conforms to customer desires, otherwise they will not buy it, and to produce the product at a profit otherwise nobody will produce it. In other words, we seek to establish a convergence of feasible provision of transit, with the travel desires of users and potential users of transit.

The approach presented here is particularly relevant in the environment of a, multi-modal, multi-operator, multi-vehicle fleet. It provides an optimum compromise between the many conflicting business, socio-economic and technical goals and constraints that will apply in such circumstances.

One of the main problems to be tackled in developing a transit product, is to decide where and when to run transit vehicles and to decide what vehicles to use and their frequency on the route. We will use this problem to demonstrate the application of the strategic logistics management principles.

The first step is to establish an idea of the kind of product that our customers and potential customers will be prepared to buy. This we do by developing a transit desire matrix, in the form of functions of travel time, waiting time, fare and other relevant variables. The use of existing transit demand matrices is of limited value as they only show us what people are doing, not what they would do given alternatives. Ideally, stated preference studies with regular follow-ups are required for the development of these demand functions. This is probably the most difficult and expensive part of the modeling process but is the basic market research that should preface the initiation of any business venture and, for that matter, any comprehensive transport plan.

From this study, the customer service objectives are developed and the data can be used for several aspects of the optimization process, from route establishment to vehicle replacement cycle evaluation.

Once a demand matrix is obtained, we use one of the transport planning models, to perform a free, equilibrium assignment of the transit demand onto the entire potential transit network. The potential transit network includes all possible road, rail or other links that could be used for transit purposes. This means that our model offers some form of modal split or "product choice." In this assignment, the non-transit traffic is simultaneously assigned to the network so that the combined impact of all travel modes on the system is taken into account. In other words, we are evaluating the effect of the transit on non-transit and vice versa.

This free assignment is based on the assumption that only travel time and distance related costs have any impact on the route that a transit user will make. This is the best travel time that any user of transit could hope to achieve, assuming a perfect transit system or use of his or her own motor car.

Since it is quite unlikely to be possible to provide such a perfect transit system, we now discourage transit trips on links with transit demand below the feasible limit. This is done by raising the "cost" of travel on those links in our model, in effect focusing the trips. This is the equivalent of providing a very low frequency of service and thus having long waiting times, or charging very high fare for low vehicle utilization. Some users will be obliged to pay the price, some will change to car, and some trips will not be made any more. This is just the same sort of decision made by any business in respect of which market segment it will attempt to attract. Of course, policy may require that some of these services be operated under subsidy.

The results this process are converted to a set of potential routes. First, express routes, based on origin-destination demands, are extracted. Then, all other routes are extracted from the data using a method which seeks to maximize vehicle utilization over entire routes whilst following the paths that would be chosen by the transit users given free choice in the matter. The results of this route extraction process define routes in terms of route capacity, travel time, node sequence, and distance.

These potential routes are now subjected to a goal programming evaluation process in which the available fleet is assigned to the routes according to local objectives. Factors such as minimum and maximum frequencies, vehicle utilization, maximum allowable fares, vehicle quality requirement on certain routes and so on are taken into account. Usually, but not necessarily, high demand routes are satisfied before low demand routes. In performing this optimization, we are attempting to provide the optimal product choice of the customer, using the best production methods available to the producer.

On the first iteration of this process, it is quite possible that many potential routes cannot be satisfied for lack of resources. At this stage, policy revisions may be required – For example; should coverage be maximized at the expense of individual route capacity? Changes in the policies call for a re-run of the optimization program. If no policy changes are made, we return to the network model where further focusing of the transit trips is undertaken. The process is repeated until subsequent iterations elicit no improvements in the objective function of our goal-programming model.

The final output from the process is a detailed set of routes, which, in addition to the information already mentioned, also specify vehicle type, service frequency, operating cost, stopping points, and other similar information. This set of routes is that which will most closely satisfy the goals of the community in terms of coverage, subsidization, pollution, employment creation and anything else included in the original design objectives. That is, it represents a system optimum for both users and operators within the bounds of the available resources and taking into account the impact of other users of the transport system.

This process fulfills the requirements of strategic logistics management by identifying that transit system that will satisfy the most transit users and potential users and thus maximize the revenue accrued to the transit industry as a whole. It also minimizes the cost of the transit system to the community. Most operators will benefit in as much as that vehicle utilization is maximized by virtue of allocation to certain routes. Of course, it is possible that some operators will not gain contracts in the system, but this should motivate them to examine other aspects of their management such as those described in the following section. Any operator who can create a new market niche should always be free to present his case to the transport authority with a view to a revision of the transit system plan.

6 OTHER OPTIMIZATION AREAS

Many other aspects of the transit system can be optimized within the overall transit plan and management scheme. The following are some of the possibilities:

6.1 *Vehicle replacement cycles.*

In transit, the influence of vehicle age, reliability and general condition, on the demand for transit need to be included in the evaluation of vehicle replacement cycles.

6.2 *Vehicle maintenance schemes.*

Especially where economies of scale can be introduced through cooperation amongst small operators, vehicle maintenance programs can effect significant benefits. Reduced operating costs, improved vehicle reliability, improved safety reputation and appearance and greater attractiveness to potential transit users.

6.3 *Fixed infrastructure.*

Deadheading costs, economies of scale and vehicle and passenger capacities are all major factors in the performance of the system The location and design of interchange facilities, vehicle depots, and maintenance facilities can significantly influence these.

6.4 *Park 'n Ride facilities.*

The location and opportunities surrounding park 'n ride facilities can significantly reduce the mileage of the transit vehicles and generate income by providing other services.

6.5 *Ticketing systems.*

These can have a significant impact on demand and profitability for a number of reasons such as intermodal compatibility, influence on travel time and cash control. The implementation of various alternatives as a system standard need to be evaluated in terms of customer satisfaction as well as technical impact on the service provision.

Other optimization opportunities include financing methods, and fleet diversity amongst others. At all stages however, the impact of changes and ideas need to be seen in terms of their impact on the total transit system and further, in terms of the entire transport system of the region.

Clearly, applying the strategic logistics management approach to the transit system should be the function of the transport authority. Many of the possible applications of the approach are however, applicable at operator level. In a properly managed system therefore, the tools, network data and expertise to perform these evaluations should be provided by the central planning authority as a service to the operators.

7 CONCLUSIONS

Fragmentation of transit planning and provision is a problem and in no way aids the promotion of transit usage. In light of the global interest in promoting transit as a more sustainable mode of transport than the private automobile, two major drives are necessary.

Firstly, the transit industry must develop a unified front against the competition, the private car. This must be supported in the planning of transport systems by local and regional authorities. Together, the planners and the providers must develop competitive transport products. In this paper, we have provided an outline description of a method for developing such products, in a multi-modal environment, using readily available tools and existing skills.

Secondly, having developed these products, the industry, again including the local and regional authorities, must engage in vigorous and properly executed marketing campaigns to sell the product to potential clients, rather than focusing exclusively on captive or existing choice users.

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A mass transit planning model for large cities with public policy implications

Un modèle d'un nouveau système de transport pour les grandes villes avec implication d'intérêt public

Un modelo de planificación para transito masa en ciudades grandes con implicaciones públicas de norma

V. Raman
Chakra Infrastructure Consultants Private Limited, Bangalore, India

K. M. Anantharamaiah
Indian Institute of Management, Bangalore, India

ABSTRACT: New initiatives are possible in evolving environmentally friendly urban rapid transit services in cities of developing countries, with the private sector acting in concert with stakeholders. We draw on two examples of such initiatives in India, which are in different stages of project development and related policy formulation. The paper discusses a model with four integrated modules. These forecast traffic on a new transit facility by computing the quantum of shift from the current modes, based on the transit system fare and savings in travel time; and deal with project technical parameters, financial, environmental and economic analyses. Environmental benefits provide justification for the Government's financial participation and help in evolving a method of raising the State's contribution.

RÉSUMÉ: De nouvelles initiatives sont possible pour un nouveau service de transport urbain rapide et préservant l'environnement dans les villes de pays en voie de développement avec le secteur privé agissant en accord avec les capitaux engagés. Nous avons deux exemples de telles initiaives en Inde lesquels sont à des stades différents dans leurs projets de développement et de formulation de plan. L'article examine un modèle avec quatre modules intégrés. Ceux ci prévoient la circulation sur un nouveau système de transport en calculant les changements du système actuel en fonction des prix du billet du nouveau sytème et l'économie de temps de voyage et s'occupe en même temps des paramètres techniques et des analyses financières, écologiques et économiques des projets. Les bienfaits écologiques en matière d'environnement donnent assez de justification pour une participation financière du gouvernement et son aide en mettant au point une méthode pour augmenter la contribution de l'état.

RESUMEN: Es posible producir servicios de transporte urbanos que son amistosos entorno y rápidos en ciudades de países reveladores, con la cooperación del sector privado con los intereses creados. Utilizamos dos ejemplos de tales iniciativas en India, que está en etapas diferentes desarrollo del proyecto y formulación relacionada de norma, y discute un modelo con cuatro módulos integrados. Éstos pronostican el tráfico en un sistema de transporte nuevo, comparando los ahorros en precios del billete y de tiempo de viaje con sistemas que existen, y discuten los parámetros técnicos del proyecto, estudios financiero, entorno y económico. Beneficios de entorno proporcionan la justificación para la participación financieras del Gobierno y ayudar a evolucionar un método de subir la contribución del Estado.

1 BACKGROUND

The population of large cities, with over one million inhabitants, has been increasing rapidly in developing countries like India. Increasing urbanisation is occurring in developing countries because economic opportunities are relatively higher in urban centres, resulting in migration from rural areas. In the past it was considered the function of the State to provide all the major public infrastructure and services that are essential for an urban agglomeration to function. In India, while delivering these services Governments made very little effort to ensure the finanancial viability of the concerned infrastructure organisations (except in telecommunications where the State run monopoly was profitable). Political compulsions resulted in distorting the management and finances of urban services. As a result in almost every large city in India infrastructure services are of poor quality, inefficiently delivered and unable to keep pace with demand. Further, unsatisfactory infrastructure services have degraded an already strained urban environment.

In the case of urban transportation large cities do not lend themselves easily to environmentally friendly modes of transport such as walking and cycling because trip distances and time considerations militate against the use of these modes. Unless a network of railways exists for historical reasons, road transport is the natural mode of choice, as road infrastructure grows with the development of an urban area. If public transport is unsatisfactory, transport by private modes increases rapidly. Increasing per capita incomes exacerbates this situation. Emissions from road vehicles then become a major contributor to air pollution in cities Air pollution levels in large cities in the developing world exceed those in any city of the industrialised countries (Faiz et al. 1996). Further, air pollution in developing countries accounts for a considerable number of excess deaths, increased medical costs and lost productivity annually.

There is substantial scope for technical policy changes in the road transport sector to increase vehicle fuel efficiencies, reduce pollution, etc. Many of these measures can be effected quickly. Nevertheless, vehicles on the road and average trip distances will continue to increase with the growth of cities in the developing world and this will affect urban pollution loads.

2 PERSONAL VEHICLES AND BUS TRANSPORT IN INDIAN CITIES

Motorised two wheelers amount to nearly 75 per cent of privately owned vehicles in most of urban India. Further, personal vehicle ownership rates are high in the case of Bangalore and Pune, which are Indian cities with current populations of about 5.5 and 3 million people respectively. The absence of satisfactory public transport could be a factor in causing people to buy their own vehicles. Considering these two cities it was observed that 60 per cent of trips longer than a kilometre in Bangalore took place on the public bus system in 1994 and the per capita vehicle ownership was 0.16. In contrast, per capita vehicle ownership was close to 0.25 and bus services only provided 28 per cent of inter-zonal trips in Pune in 1997 (Chakra Infrastructure 1994, 1997a). Most of these vehicles have two stroke engines. These emit more air pollution per vehicle kilometre travelled than equivalent vehicles with four stroke engines. In view of the numbers involved, the economic status of vehicle users and the absence of an inexpensive technological "fix", it will not be simple to find a solution for the air pollution, noise pollution and road safety problems caused by such vehicles in Indian cities.

Except in three metropolises of Mumbai, Chennai and Calcutta, urban public transport in India is bus based. City bus systems are mostly State owned and have a low, subsidised, fare structure owing to historical and political reasons. An argument made for subsidies is that the main users of the public bus transport system are the poor. And it is less energy intensive, more efficient and environmentally friendly than personal vehicles. A rise in prices to remunerative levels may not only be against the public policy of assisting the poor but may also make people shift to privately owned vehicles, which are more energy intensive and environmentally degrading.

Per contra, what drives commuters away from bus services is their poor quality and uncomfortable conditions (100 persons in buses with capacities of 60 people during peak hours). Further, the burgeoning growth of personal vehicles shows that a significant segment of commuters, presently enjoying a fare subsidy, would be willing to pay higher fares for better transport services. In Bangalore 80,000 two wheelers and 20,000 cars are purchased each year. This stock of vehicles implies a willingness to raise capital resources of approximately US $ 150 million annually. Though the motivation to purchase vehicles is not solely a response to poor public transport facilities, these are significant expenditures and, in addition, there are operating costs as well.

3 POLICY ON PRIVATE SECTOR INVOLVEMENT IN TRANSIT

In all cities in India, the Government of the day prevails in a wide range of issues in bus transit, including policies, fares, staff appointments and matters affecting daily operations. Over a period of time inappropriate fares and lack of responsibility manifested in parastatal systems have led to a situation where every city bus corporation is in financial distress. There is insufficient money to modernise them. A related point (Asian Development Bank 1994) is that if public transport tariff structures are not remunerative, it is difficult to attract the private sector to provide additional or competitive transit services in a city.

In 1991 the Government of India enunciated a market friendly and business oriented economic policy framework that aimed to free the private sector from unnecessary controls and regulations. The State would retreat from direct involvement in economic activities and would move gradually towards policy formulation and secondary levers of activity. This would allow it to concentrate on activities that were unlikely to interest the private sector. However, the liberalisation process has not even started in sectors like urban transit for reasons that have been discussed elsewhere (Raman & Ananthara-maiah 1998). Initiatives to involve the private sector in urban transit have been mentioned in over twenty cities in India. However, focussed studies or planning for busways and light rail transit systems (LRTs) with private sector participation have taken place in only three cities – Bangalore, Pune and Hyderabad - and of these, presently only the first is progressing towards a franchise agreement.

Municipal authorities and State Governments have a paucity of resources, making it impossible for them to fund capital-intensive mass rapid transit systems (MRTSs) on their own. It has also been impossible to establish inexpensive schemes such as reserving lanes for buses, owing to high traffic volume to capacity ratios in arterial roads. Private sector consortia of Indian and foreign firms could be interested in providing transport services in Build, Own, Operate and Transfer (BOOT) frameworks provided such schemes have adequate returns, equitable sharing of project risks and strong evidence of the Government's willingness to take decisions quickly. In principle, most of the State Governments in India are willing to make the required administrative and legal changes and follow a process of selecting a BOOT consortium in a transparent manner, duly consulting relevant sections of the local community.

4 MODEL STRUCTURE

A crucial part of evolving a suitable MRTS, rail or bus based, is to develop system and other parameters appropriate to travel demand forecasts. We have developed a methodology that assists in evolving all the major parameters of a new urban transit network in a developing city with a model that has four integrated modules. These modules are traffic forecasts, system parameters and engineering costs, financial analysis and project structuring, environmental and economic analyses.

4.1 *Traffic Forecast Module*

The traffic forecast module involves the conventional method of projecting traffic demand and incorporates each city's characteristic of willingness to pay for travel time savings, based on a survey of households that needs to be conducted. Its principal features are: -

- A land use transport model to estimate travel demand, with and without the proposed MRTS.
- MRTS alignments are identified to pass through high demand areas.
- While doing so, land requirements are minimised, as the legal and judicial process involved in acquiring land is lengthy.
- Integration of the MRTS with para-transit systems and provision for parking personal vehicles.

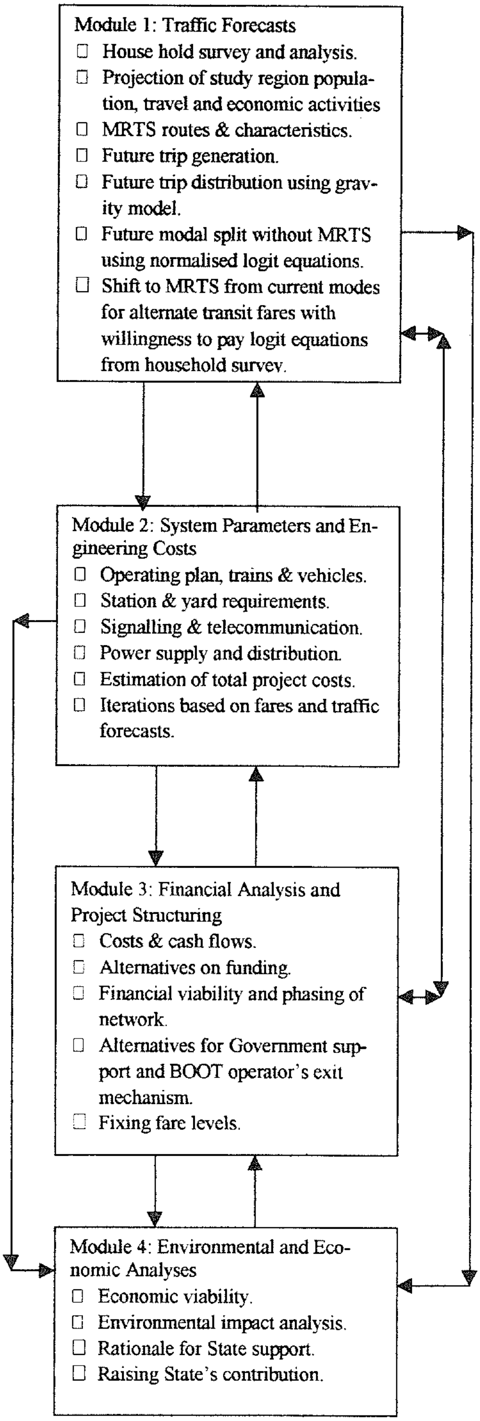

Figure 1: Model Structure

In the Indian context an important innovation has been to incorporate willingness to use the MRTS as a function of travel time savings and fare. A double constraint gravity model using Tanner type deterrent functions generates the total trip distribution matrix. Mathematical expressions of modal use are derived from the household survey as a set of normalised logit equations. The modal split without the MRTS is obtained by applying this set to the total trip distribution matrix. A further set of logit expressions evolved from a sample survey of households are applied to the modal split (without the MRTS) to estimate the shift to the new system. This methodology assists in deciding the general range of fares that should be charged on the MRTS, relative to a unit denominator (such as a stage fare on the public bus service) at constant prices, prevalent in the year of the household survey. The structure of the model has been described earlier by Raman & Anantharamaiah (1996a, b) and in project reports (Chakra Infrastructure 1994, 1995, 1997a, b). The logit expressions for willingness to pay for travel on a new mode are of the form: -

$$p = 100 / (1+A^* (\exp^{By}) * (x^C)) \qquad (1)$$

Where p is the percentage of people who would change to the MRTS from modes they use presently, y is the expected travel time saving as a percentage of the travel time by the mode presently used, x is the multiple of the unit denominator bus fare per km that people are willing to pay and A, B and C are coefficients. Table 1 gives the values of the coefficients for existing modes of travel in the cities of Bangalore and Pune.

4.2 *System Parameters and Engineering Costs Module*

This module uses data from the travel forecast module to ascertain optimal parameters of the transit system that is required to meet the travel demand. It evolves operating plans for horizon years (irrespective of the type of MRTS) from the forecast of daily trips. These need to be translated (in the case of an LRT) into train and vehicle characteristics, station sizes, signalling, telecommunication and power supply and distribution arrangements. By linking these parameters to the traffic forecasts, facilities and costs are planned commensurate with demand, as there is a feedback to the demand forecasting module. Depending on each situation, planning for operations can build in options for flexibility in the future, so that system expansion can be synergetic with residential and work location trends in a city.

Table 1. Values of Coefficients in Willingness to Pay Equations for Bangalore and Pune

Mode	Bangalore			
	A	B	C	R^2
Autorickshaw	25.96	-0.0965	1.3077	0.919
Two wheeler	48.22	-0.0990	1.5129	0.920
Bicycles	107.60	-0.1055	0.7611	0.859
Public Bus	58.95	-0.1006	1.0011	0.921
Car	39.38	-0.1015	1.5194	0.929
Other Modes	4.74	-0.0756	1.6859	0.907

Mode	Pune			
	A	B	C	R^2
Autorickshaw	990.10	-2.507	1.0489	0.974
Two wheeler	2015.8	-2.790	1.1072	0.962
Bicycles	528.36	-2.371	1.1714	0.971
Public Bus	485.26	-2.357	1.0773	0.970
Car	743.59	-2.512	0.9777	0.954
Other Modes	786.18	-2.514	1.2703	0.962

4.3 *Financial and Project Structuring Module*

The module quantifies the support required from the State to achieve financial viability for private sector funds invested in the project. It provides the means to raise the confidence of financial institutions making these investments. It incorporates: -

- Construction costs and cash flows in different years using revenue based on traffic forecasts.
- Alternative sources of funds (domestic, foreign, terms, tenor).
- Assessment of the financial viability of the project under alternative configurations of inflation, interest rates and other investor risks.
- Alternative schemes for the financial role of the Government in the project.
- Appropriate phasing of the network during the project implementation period.

4.4 *Environmental and Economic Analyses Module*

The module identifies environmental benefits. It also provides justification for State participation (if the project is economically viable) and leads to a method for the State to raise its contribution of funds. The main adverse environmental effects of the road transportation sector are deterioration in air quality, noise pollution and decreasing road safety. Congestion in arterial roads exacerbates these. Reducing road traffic by introducing a MRTS improves the environment, not only for users of the system but also for society at large. Our methodology quantifies these environmental benefits, including reduction in the use of resources - in primary energy consumption on account of shifting to a more energy efficient mode.

As an example, the likely environmental benefits from a MRTS in the cities of Bangalore and Pune in the year 2011 are shown in Table 2. The air pollution avoided in Bangalore is less than in Pune because in Bangalore much of the MRTS traffic would be from commuters using public buses, which is less polluting than personal transport.

Table 2. Environmental Benefits from MRTS Projects in the year 2011

Item	Bangalore	Pune
Fuel Saved Kiloliters Per Year	57,500	28,600
Air Pollution Avoided Tonnes Per Year	9,300	13,700
Energy Saved kJ x 10^9 Per Day	3,500	1,550

The economic benefits of MRTS projects are travel time savings of the users of the MRTS and the costs of avoided road accidents. They also include benefits accruing to those who continue to use existing road modes with reduced congestion and improved safety (resulting from the MRTS attracting road traffic). In addition there are the environmental benefits mentioned earlier, to the extent that these can be quantified.

5 PUBLIC POLICIES AND STATE SUPPORT FOR MRTS PROJECTS

It has not been fully appreciated that it is difficult to make the transition from State owned public transit services to involving the private sector without an adequate policy framework. Whether rail based or a busway, an MRTS must supplement and grow with the existing arrangements in the city. Firstly, it is essential that the existing bus services in cities should be made efficient and financially viable. The existing services would remain as the core transit providers for many years to come. Secondly, with the notable exception of Hong Kong, very few urban transit projects are financially remunerative. Most heavy rail urban transit systems cannot produce economic returns (in addition to being financially unviable) unless, among other factors, the city under consideration has 5 million inhabitants with annual per capita incomes exceeding US $ 1,800 at 1990 price levels (Fouracre et al. 1990). Even if the purchasing power parity of the Indian Rupee is considered, the general application of this conclusion holds good in Indian cities. Few direct revenue streams are available other than from the sale of tickets and advertising to finance an urban transit project. The benefits that could accrue from property development are limited. Generally, it is necessary for the State to provide a portion of the capital requirements in order that the balance can be raised from the market and serviced by the project.

However, it is undesirable to provide an annual operating subsidy to a BOOT operator, as that would leave little incentive to be efficient in operations. As a corollary the funds provided by the State need to be in the form of subordinate debt; or a secondary tier of capital that would not attract dividends but would result in the transfer of the entire system back to the State at the end of a franchise period. It is also important to recognise that the State's involvement would provide comfort to lenders. Considering that the greatest risk in urban transit projects with long gestation periods is political uncertainty, particularly regarding fare structures, such financial support from the State would constitute an amelioration of project associated risks. Ensuring carrying capacity requirements in the system's operating franchise agreement can moderate the BOOT operator's objective of maximising revenue. This is a desirable method in comparison to the Government getting involved in approving annual fare increases (Raman & Anantharamaiah 1996b).

The justification for the State providing funds to support a MRTS project in partnership with the private sector must, however, be based on the criterion of economic viability. Provided this is so, the methodology used to analyse environmental benefits in our model provides a way for the State to raise resources to garner its share of funds for such a project. The fare in the new transit system is based on the willingness of users to pay for time savings. Environmental benefits cannot be internalised in the fare structure. Since these benefits accrue to all inhabitants in a city, by imposing a levy on the sale of fuel and other goods, it is possible to get those who benefit from the LRT without using it to partly pay for the development of a system that benefits them. It is, of course, crucial that such a levy should not disappear into the general funds of the State but should be earmarked for the development of the project.

In the case of Bangalore the Government effected these measures in 1995. It has, therefore, been possible for the State to indicate its seriousness regarding the project in a practical fashion to both the private sector and to the community of financial institutions that are likely to participate in it (a similar approach was recommended in the case of Pune but the authorities there have chosen to offer property development in lieu of cash inputs). The quantum of taxes in the case of Bangalore is less than one per cent of the pump price of petrol and diesel with a similar impost on a selective list of goods and services sold in the city.

6 CONCLUSIONS

Governments need to have policies of undertaking MRTS projects in partnership with the private sector. Not only will this introduce market mechanisms in urban infrastructure and services and thus remove inefficiencies in the system; it will also help the Government to concentrate on other priority areas, which are not conducive to private sector participation. Our model allows the main traffic and system parameters of such projects to be developed and quantified in an integrated manner for large developing cities; for an assessment of financial and economic viability to be made; for the positive environmental effects to be identified; and to provide justification for levies to garner the State's contribution to such projects. The authors consider that a further enhancement of their model would be to introduce a module incorporating probabilistic methods of supplementing confidence levels in the project.

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Improving urban bus operations: Recent experience in the United Kingdom

Améliorer les services de bus en milieu urbain: une expérience récente au Royaume-Uni

Mejorar los servicios de autobuses: La experiencia del Reino Unido

N. B. Hounsell
University of Southampton, UK

ABSTRACT: The need for improved bus operations in UK cities is widely recognised by Central and Local Governments in the United Kingdom (UK) as well as by existing and potential bus passengers. Recent UK policy documents have re-emphasised the vital role of the bus in contributing to sustainable urban transport. There have been many initiatives in this respect in recent years, taking advantage of new technologies and Intelligent Transport Systems (ITS). This paper describes these initiatives and selected applications, highlighting their economic and environmental effectiveness. The ITS applications are put in the context of other possible measures to improve bus operations and the potential for their adoption in less developed countries. It is concluded that ITS can provide an important and highly cost-effective contribution to the improvement of urban bus operations, given the existence of appropriate organisational structures and operating conditions.

Le gouvernement et les conseils municipaux, ainsi que les usagers, reconnaissent l'importance d'améliorer les services de bus. La politique britannique en matière de transport a récemment insisté sur le rôle fondamental que le bus doit jouer dans le transport urbain. Dans cet objectif, de nombreuses initiatives ont récemment vu le jour, profitant de technologies nouvelles telles que l'ITS (Systèmes de Transport Intelligents). Ce document décrit ces initiatives, ainsi que certaines applications, soulignant leur impact sur l'économie et l'environnement. Les applications de l'ITS sont comparées à d'autres solutions envisageables afin d'améliorer les services de bus, pour éventuellement les adapter dans des pays sous développés. Ce dossier conclue sur le fait que l'ITS peut produire d'importants bénéfices. Ceux-ci permettront l'amélioration des services de bus, à supposer que l'on puisse s'appuyer sur une gestion et une organisation efficaces.

En el Reino Unido, el Gobierno Central, las Municipalidades y los usuarios de autobuses reconocen la importancia de mejorar los servicios de autobuses. Políticas recientes vuelven a subrayar la contribución central que aporta el autobús al transporte urbano sostenible. En estos últimos años se han visto muchas iniciativas que aprovechan de nuevas tecnologías y Sistemas de Transporte Inteligentes (ITS). Aquí se describen estas iniciativas y unas aplicaciones, destacando sus impactos ambientales y económicos. Las aplicaciones de ITS se comparan con otros medidas para mejorar los servicios de autobuses. Además, la posibilidad de implementarlas en países en desarrollo se examina. Se concluyó que los servicios de autobuses urbanos, con tal que sean bien organizados y que existan circunstancias adecuadas de

1 INTRODUCTION

Travel by bus in the United Kingdom has been declining for almost 50 years, from some 16 billion local bus passenger journeys in 1950 to under 5 billion in 1998 (DETR, 1999). This decline has been against a background of substantial increases in the use of the private car; some 60 billion passenger kilometres were travelled in cars, vans and taxis in 1952, rising to over 600 billion in 1997. However, bus journeys still account for two thirds of all public transport journeys in the UK and represent a vital component of sustainable public transport in cities.

The decline in bus travel in the UK has also been against the background of various changes in the regulatory arrangements for the industry. The most notable was deregulation outside London under the Transport Act 1985. It was hoped that this would encourage greater competition, flexibility and efficiency in bus service provision, and some benefits have been achieved. However, until recently, this also resulted in some instability in services, a lack of strategic planning and timetabling, and some reduction in quality of service to the passenger; deregulation certainly had no impact on reducing the decline in bus use, and has arguably delayed much needed investment in new buses and supporting technologies, including ITS. This investment has occurred only more recently, where mergers and takeovers have gradually consolidated bus operations to one or two major operators in many cities - providing a stability for investment.

The situation in London is quite different. A regulatory framework was maintained here, whereby London Transport Buses have retained the primary function for planning bus services, which are let on a franchise basis to private operators under strict "Quality of Service" requirements. This has maintained stability in bus operations in London, and has stimulated many new initiatives for improving bus services. With this background, bus patronage has been much more steady in London than elsewhere in the UK, although it is difficult to say how much this has been caused by the regulatory conditions rather than the unique transport situation in London.

2 IMPROVING BUS OPERATIONS

Improving bus operations in cities requires particular attention to be paid to a wide range of factors which are important to bus passengers and/or operators. These include the quality of the infrastructure (bus stops, interchanges, terminals etc), the quality of the bus (comfort, cleanliness, easy access etc) and the frequency, speed and reliability of the bus service itself. To maintain passenger patronage, or to attract passengers to buses from other modes, it is essential that all aspects of the journey by bus are addressed - for example, it is no good having perfect punctuality if the quality of the bus is so poor that the private car becomes the preferred mode of transport.

One of the key problems for buses in major cities is undoubtedly the disruption to services and schedules caused by traffic congestion. This problem is increasing in many cities where traffic growth continues apace, particularly in less developed countries. A partial solution to this problem is the segregation of buses from general traffic wherever possible, using bus lanes, central busways or bus-only streets. However, there are very few cities where these opportunities have been realised *before* congestion has occurred - and substantial re-allocation of roadspace to buses after congestion has set in requires a very strong political will which is rarely evident. There is clearly a risk that such re-allocation could increase congestion to an extent that buses are also severely delayed elsewhere in the network, at least in the short term.

The opportunities for roadspace re-allocation in favour of buses are also limited by the overall roadspace available; many historic cities have restricted roadspace and the construction of new roads in cities is often severely constrained, not only by environmental considerations but also by the wish to avoid additional private traffic being generated by the new roads, causing further congestion, pollution, and environmental damage. Indeed, the emphasis in many cities is on reducing private traffic using demand management measures such as parking controls/price, physical restrictions such as central area pedestrianisation, and road user charging.

Against this background the question often set is: "Given our existing infrastructure and traffic conditions, how can we use advanced traffic management and new information technologies to help buses?"

The following sections illustrate five applications where this is being achieved in the UK.

2.1 *Priority for Buses at Traffic Signals*

Traffic signals can be a very efficient and safe form of traffic control for junctions in urban areas. The last decade has seen an increasing use of traffic signals in almost all cities in the world, and significant improvements in Urban Traffic Control (UTC) systems such as SCOOT (Bretherton et al, 1998) and SCATS (Lowrie, 1982). In particular, these traffic-responsive UTC systems use extensive traffic detection and advanced control algorithms to optimise traffic signals in real time. However, optimisation is often dominated by the minimisation of vehicle delays in the network, rather than minimising delays for all road users. This latter consideration leads to the need for bus priority, due to the high passenger-carrying capability of buses. Such bus priority has therefore been developed for a number of UTC and isolated signal systems. In the UK, this is achieved through *selective detection* of buses in mixed traffic as they approach traffic signals and the extension or recall of the green signal to minimise the delay to the bus, subject to any constraints imposed (e.g. satisfying competing pedestrian phases, or limiting the disbenefits to other traffic).

Advanced technologies are often used for detecting buses, although these need not be costly. For example, standard inductive loop traffic detectors can be re-configured in size and location, and tuned to distinguish conventional buses (by their "signature") from other traffic. No on-bus equipment may then be needed. Alternatively, inexpensive microwave, infrared or radio-based tags or transponders can be fitted to buses, which communicate with road surface or roadside detectors which are themselves linked to the traffic signal controller. These may simply register the presence of a bus or may communicate bus-specific data so that bus-specific priority could be provided. For example, some 5000 buses in London are now fitted with transponders, giving priority at over 400 junctions. Automatic Vehicle Location (AVL) technologies, including Global Positioning Systems (GPS) are now being increasingly used for bus location/detection.

Extensive surveys in London and Southampton have indicated average bus delay savings of 3-10 seconds per bus per junction, providing an economic return of typically 6-18 months (Hounsell, 1996). This excludes any modal change which this priority might produce. These levels of benefit are modest but can be achieved at all signalised junctions (e.g. potentially 4000 in London) and at all times of day. Benefits can also be achieved with an insignificant impact on general traffic, provided an appropriate priority strategy is implemented. An interesting policy dilemma arises here, as illustrated in Figure 1. Should we seek to minimise total road user delays, as shown by point A, or seek to maximise benefits to buses (point B), which might produce significant delays to other traffic? The latter option would often produce nett economic and environmental disbenefits in the short term, but would encourage greater modal change to buses which could be better in the medium/long term. In fact, the illustration in Figure 1 is pertinent to all forms of bus priority where general traffic could also be affected.

The dilemma raised in the previous paragraph is drawn into greater focus when considering vehicle emissions. This can be illustrated by the example of the trial of bus priority at traffic signals in Southampton, which formed part of the ENTRANCE project focussing on energy savings in Transport (ref). The bus priority strategies implemented were shown to benefit bus operators and passengers by producing significant reductions in bus delay and fuel consumption. For buses all six major pollutants (carbon monoxide, carbon dioxide, unburnt hydrocarbons, nitrogen oxides, sulfur and particulate matter) were reduced by between 13% and 25%. However, because of the relatively high priority granted to buses,

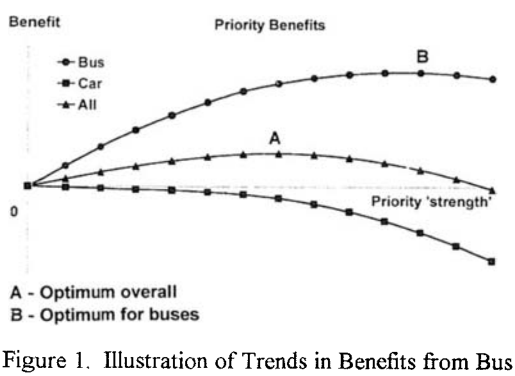

Figure 1. Illustration of Trends in Benefits from Bus Priority with Increasing Strength of Priority

additional delays to car drivers resulted in an overall increase in fuel consumption and emissions of all pollutants except sulphur, oxides of nitrogen and particulates. The net increases were between 3% and 8% for emissions, while fuel consumption increased by 3%. The key point here is that emissions are vehicle-based so that small disbenefits to the dominant vehicle type (usually private traffic) can dominate any short-term energy evaluation.

The bus priority technique described here provides a re-allocation of "spare" green time at a junction to buses, rather than addressing the problem of buses delayed by congestion. In this case, "congestion management" strategies are required, such as the "gating" facility available in SCOOT (Bretherton et al, 1998). Gating allows general traffic queues to be relocated from links where buses suffer from congestion to links where there are no buses, or where buses can be protected (e.g. by a bus lane). This queue relocation is triggered by SCOOT detection of congestion and activated by a reduction in green time on the gated link(s), which might be just upstream of the problem, or many kilometres upstream. Large scale gating schemes in Southampton and London have offered substantial benefits for buses although they do require significant expertise to be set up efficiently.

A local form of congestion management for buses involves pre-signals and bus advance areas. The Shepherd's Bush scheme was the first of some 15 schemes now operating in London, where pre-signals hold back general traffic to allow buses preferential access into a road section where congestion is restricted by the effects of the pre-signal.

2.2 *Automatic Vehicle Location Applications*

Automatic Vehicle Location (AVL) is being increasingly installed in bus fleets throughout the world, often to provide one or more of the following functions:

i) Real-time fleet monitoring for improved fleet management and scheduling
ii) The real-time information needed to predict bus arrival times at bus stops
iii) The location function for bus priority at traffic signals.

The main methods used in the UK for bus-based AVL has been ground/beacon based systems involving the use of bus odometer data relative to the known bus route to calculate its location, with locational accuracy being improved by the use of roadside beacons at set intervals. While this method is still widely used in some cities (e.g. London, Southampton), there is an increasing use of satellite-based systems, particularly differential Global Positioning Systems (dGPS) which can provide a locational accuracy of 5-10 metres. Both methods of AVL then require a communications system from the bus to the infrastructure/control centre to provide the fleet monitoring and other functions mentioned above. Radio communications are often used, with a sequential polling system providing location information for buses typically every 20-30 seconds. A telephone (land-line) communication system can also be used, such as that which is commonly used for centrallised urban traffic control.

Urban bus operations can undoubtedly be enhanced through the improved real-time bus management which AVL can provide. In general, however, there is evidence from discussions with UK operators that these benefits are not being fully realised because of uncertainties as to how best to utilise the AVL data. The passenger information function appears more straightforward, although the economic/financial benefits are more difficult to establish. With a few exceptions, the bus priority function has largely been underutilised to date. However, significant initiatives are under way, such as the trials of selective bus priority in London.

The architecture for the London system is as illustrated in Figure 2. A priority algorithm has been integrated with the AVL data to determine what level of priority each bus needs at traffic signals, according to its time headway to the bus in front. The higher the headway, relative to the schedule, the higher the priority requested. This request is transmitted to each bus at each polling cycle, and it is then communicated to each downstream traffic signal via a roadside beacon. Priority can be locally authorised, or it can be under the control of the UTC system.

The main benefits of selective priority are:

- Improved bus regularity
- Reduced passenger waiting times at downstream bus stops
- Higher priority can be given without affecting other traffic, as fewer buses are given priority
- Buses with higher headways which gain priority tend to have higher passenger loadings.

For the London situation, the benefits of selective priority are expected to be as illustrated in Figure 4, which has been derived from a simulation evaluation. This shows predicted economic benefits of increasing percentages of buses given selective priority, according to their headway. For total journey time savings, benefits increase fairly linearly as more buses gain priority, whereas regularity benefits are maximum when about 40% of buses gain priority. Combined benefits vary little above 40%, so this percentage is a recommended target if regularity improvement is the key objective.

2.3 Camera Enforcement of Bus Priority

Many bus lanes in the UK suffer from violations by general traffic which can reduce their effectiveness for buses. Parking/loading offences can be particularly disruptive where a traffic queue alongside the bus lane hinders buses from pulling out past the offending vehicle, although moving violations can also cause additional bus delays. London has a significant bus lane network and a significant violation problem in some cases. This has prompted the development of camera enforcement systems to attempt to reduce the violation problem and hence improve bus operations.

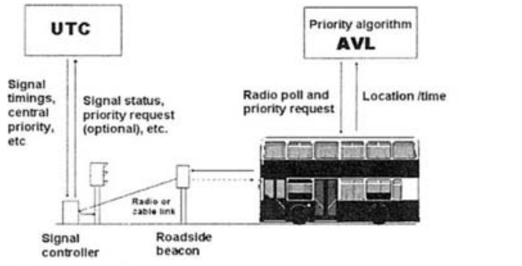

Figure 2. The London AVL Architecture for Selective Bus Priority

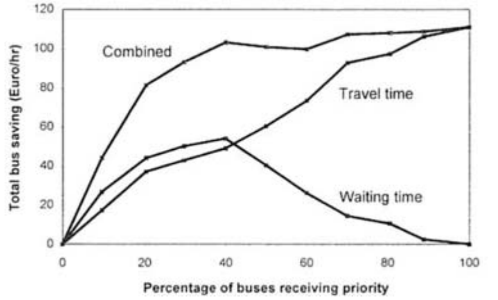

Figure 3. Example of predicted Waiting Time and Travel Time Cost Savings for Selective Bus Priority

Two forms of camera enforcement system are being developed and deployed at present. The first concerns the use of "standard" Closed Circuit Television (CCTV) cameras which are mounted on poles or high buildings for traffic monitoring purposes. These have become widespread throughout London and can be "remotely monitored" so that vehicles violating traffic regulations can be identified (Rogers, 1996). Camera technology is now sufficiently advanced to enable the operator to zoom in on the offending vehicle and record its registration number automatically, together with the surrounding scene and context. The owner/driver of the vehicle may then be prosecuted/fined and, in the case of parking violations in bus lanes, action can be taken to remove the offending vehicle.

The second form of automatic enforcement involves cameras erected on the footway alongside bus lanes and/or cameras fitted to the front of buses, which record bus lane violation information on video tape or digitally (Turner & Monger, 1996). For further efficiency, the Automatic Vehicle Location system fitted to the buses can be used to activate the on-bus camera only when it is within prescribed bus lane sections. Trials of this technology have been concluded successfully in London, and a much wider deployment is now being rolled out.

The operational, economic and environmental benefits of automatic enforcement clearly depend on the extent to which automatic enforcement will reduce the level of bus lane violations, and the impact that this will have on operational efficiency. Initial analyses and comparisons of effectiveness with other enforcement systems are positive, although detailed results are not yet available.

2.4 Automatic Ticketing

Fare transactions carried out between bus drivers and passengers can take considerable time. If boarding times can be speeded up by reducing or, better still, eliminating the time the driver is involved in fares transactions, bus journey times will be reduced, operating costs could be saved, and buses will cause less of an obstruction to other traffic. Some existing ticketing schemes reduce boarding time, including travel cards (which are valid for different amounts of time), pre-paid tickets which the passenger validates either just before the journey or whilst boarding the vehicle (e.g. Sheffield Supertram), and exact fare only buses where the fare is placed in a container and checked by the driver. However, automatic ticketing systems can achieve further reductions in boarding time, and offer additional benefits including:

- reducing fare evasion by instantly detecting
    - i) out of date cards (e.g. monthly passes)
    - ii) attempts to travel in areas where the card is not valid (e.g. travel zones in London)
- greater flexibility in the fares structure, and
- more accurate records about trip origins and the type of fare used.

Reducing the number of transactions can also help, especially where a change of bus is required to complete a journey. Through ticketing has become much harder to implement in the UK since privatisation of public transport has taken place; except in London, there are no powers for the local authorities to make it compulsory for different operators to participate. Automatic ticketing offers the potential to provide a straightforward way of buying a ticket which is valid for various routes run by the same operator and for different operators.

Automatic ticketing systems are now predominantly based on Smartcard technology. Smartcards are the size of a credit card and have a programmable electronic chip which can store and process information. They can be read and updated if placed within a certain distance (usually 10cm) of a reader; this is quicker than systems which require the card to be inserted into the reader. There is no doubt that Smartcard technology is revolutionising many aspects of modern life and that applications of multi-function cards, including automatic ticketing, will continue to expand. The benefits for bus operations have not as yet been widely quantified, but the potential is clearly evident and many large-scale schemes are now under way.

2.5 Variable Message Signing

Variable Message Signing (VMS) in the context of this paper refers to roadside signs providing real-time information to road users or bus passengers. For bus passengers, a rapidly-expanding form of VMS in Europe concerns bus stop displays advising the predicted arrival times of the next few buses at the stop. This application is usually dependent on the installation of AVL into the bus fleet, as described in Section 2.2. The COUNTDOWN system in London is one example of many installed in European cities. Real-time bus arrival information has many benefits for bus passengers in its own right, including a perception of improved bus service even when this does not occur. However, it has a limited impact on bus operations other than secondary effects on bus patronage and, perhaps, improved bus utilisation/boarding times.

The use of VMS for parking guidance and information may also appear not to have a direct impact on bus operations, unless the VMS refers specifically to bus-based "Park and Ride." However, secondary effects can be either positive, through reduced congestion for buses due to reduced parking search time for motorists, or negative if the parking information encourages greater trip-making to central areas by private transport.

VMS is also being used increasingly to provide traffic information to motorists in urban areas, particularly concerning congestion and incidents. For example, London and Southampton each have over 30 signs installed for this purpose. Any improvement which these signs make to traffic circulation in incident conditions clearly has a similar beneficial impact on bus operations. However, there is also potential to use signs such as these to benefit buses more specifically. Opportunities for this include:

i) The use of VMS to encourage general traffic away from congested bus routes. A strategy of this sort has already been implemented successfully in Turin, Italy, as part of their integrated traffic control functions.

ii) Providing positive advice on the real-time status of bus operations and their advantages relative to private traffic.

Exploitation of opportunities such as these requires a high level of integration between highway and public transport authorities and between component parts of the traffic management system. These are challenges yet to be overcome in many cities!

3 CONCLUDING COMMENTS

This paper has illustrated how a range of ITS applications can be deployed to improve urban bus operations. Each of the applications can produce significant benefits in their own right in the correct circumstances. However, circumstances do vary substantially between different cities in terms of their size, public transport provision and regularity framework, level of congestion and quality of traffic management, to list just a few items. The appropriate choice and phasing of ITS implementation is therefore city-specific, but even then decision-making is by no means straightforward. A wide range of products and commercial systems are available for each application, offering different functionality and cost, and the pace of developments in ITS is such that today's chosen option could be tomorrow's redundant system if a wrong decision is taken. This points to the need for much-improved guidance for city authorities in this area - a need which is currently being addressed in the UK in a new research study (Hounsell & Cheney, 1999).

Turning to the transport situation in many cities in less developed countries, problems related to inadequate planning, provision, management and regulation of the transport system are often more acute than in better developed countries. The installation of advanced ITS can then appear to be a very attractive proposition to try and generate an advanced transport system. There will certainly be no shortage of companies keen to sell their products or services. However, there really is a need for city authorities to establish the right basic conditions in their transport operations if ITS is to be truly effective; there is no point, for example, in installing a sophisticated system for bus priority at traffic signals if the underlying dominant problems are congestion, inadequate traffic management and inefficiency in bus operations. ITS has substantial *potential* but it is rarely the solution to basic transport problems.

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Quality, a tool for corporate change

La qualité: outil de transformation de l'entreprise

La calidad: Herramienta de transformación de la empresa

M. Jallageas
Régie Autonome des Transports Parisiens, Paris, France

Z. Dosek
Dopravni Podnik, Prague, Czech Republic

ABSTRACT: The "satisfaction measurement" tool is critical when making decisions about what service aspects need improving. However, the tool does not pass muster to galvanize the staff around service quality. That is why the RATP has developed the CYQ method, serving to define the company's requisite service from the customer's standpoint. Service definition encompasses a reference service standard, a level of achievement and a threshold unacceptable situations. Service is then measured by determining the percentage of customers having benefited from a standard service. This CYQ method has been in effect in the RATP since 1994 and in Prague since 1997. This method has spurred major advances in both transit companies and is now prompting a radical shift toward a customer-focused company.

RÉSUMÉ: L'outil "mesure de la satisfaction" indispensable pour décider des aspects du service à améliorer ne suffit pas pour mobiliser concrètement le personnel sur la qualité de service. C'est pourquoi la RATP a développé la méthode CYQ. Cette méthode consiste à définir le service voulu par l'entreprise, avec le regard du client, sous forme de service de référence, de niveau d'exigence et de situations inacceptables puis à mesurer le service réalisé en % de clients ayant consommé un service conforme. Mise en œuvre à la RATP depuis 1994 et au réseau de Prague depuis 1997, la méthode CYQ a d'abord permis d'importants progrès dans ces deux entreprises et suscite maintenant un changement radical vers l'entreprise centrée sur le client.

RESUMEN : La herramienta "medición de la satisfacción" indispensable para decidir los aspectos del servicio a mejorar no basta para movilizar concretamente al personal en cuanto a la calidad de servicio. Es por ello que la RATP ha desarrollado el método CYQ. Este método consiste en definir el servicio deseado por la empresa, con la visión del cliente, con la forma de servicio de referencia, de nivel de exigencia y de situaciones inaceptables y luego en medir el servicio realizado en porcentaje de clientes que han consumido un servicio conforme. Al haber sido implementado en la RATP desde 1994 y en la red de Praga desde 1997, el método CYQ ha permitido ante todo realizar progresos importantes en estas dos empresas y suscita hoy en día un cambio radical hacia la empresa centrada en torno al cliente.

1 INTRODUCTION

Nous voulons tous améliorer le service offert à nos voyageurs, nous voulons que tous les agents de l'entreprise contribuent à cette amélioration du service, mais au-delà des discours "orientés-client", comment mobiliser concrètement le personnel sur la qualité de service ? Comment en faire une priorité quotidienne de l'entreprise ?

L'évolution vers l'entreprise "centrée-client" passe par la mise au point d'outils mobilisateurs, acceptés par l'entreprise et porteurs de changement. La méthode CYQ (Cycle de la Qualité), développée à la RATP et à Prague est l'un de ces outils qui stimulent le changement dans l'entreprise.

2 UN CONSTAT : LES LIMITES MANAGÉRIALES DES ENQUÊTES DE SATISFACTION

On a coutume de dire qu'il n'y a pas de progrès sans mesure. C'est vrai, mais à condition qu'il existe un lien fort et mobilisateur entre l'action des agents producteurs du service et les résultats de la mesure. Or, ce lien fait souvent défaut dans les enquêtes de satisfaction :

- Le client s'exprime plus sur un vécu global que sur une situation délimitée.

S'agissant de consommations de services très répétitifs, comme l'usage d'une ligne de métro, l'expérience montre que le client a du mal à isoler dans son jugement une expérience singulière, et c'est souvent un jugement global portant sur plusieurs voyages, sur plusieurs lignes qu'il restitue.

♦ La satisfaction sur un critère peut être influencée par des variations d'état sur d'autres critères

C'est l'effet de halo bien connu dans les enquêtes de satisfaction. L'annonce d'une augmentation de tarif conduit à un jugement plus critique sur l'accueil ou la propreté ! Des facteurs non maîtrisés localement viennent modifier l'expression de la satisfaction sur le service rendu.

♦ Les variations de satisfaction expriment aussi les variations du cadre de référence

Dans les grandes agglomérations, par exemple, l'arrivée d'une première ligne de Métro ou de Tramway se traduit par des niveaux de satisfaction exceptionnellement élevés. Ces niveaux ne peuvent que baisser lorsque ces nouveaux modes se banalisent.

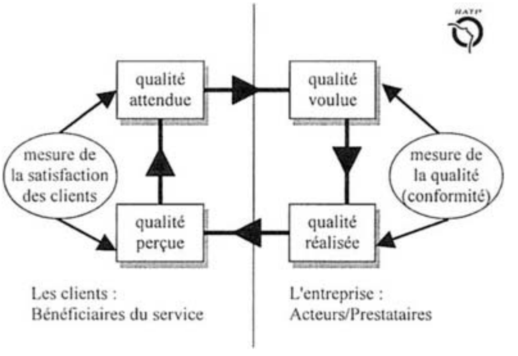
♦ Dans ces conditions, les efforts d'une équipe, leurs actions d'amélioration du service, ne se traduisent pas obligatoirement dans l'expression de la satisfaction du client. Dès lors, comment espérer animer une démarche qualité locale avec une mesure insensible aux actions des agents ?

♦ Au-delà de ces difficultés d'ordre méthodologique, il est un autre problème : nous ne pouvons pas, nous ne voulons pas satisfaire toutes les attentes des clients. Nous ne pouvons donc manager avec pour seul slogan "il faut satisfaire les clients".

Nous ne pouvons pas nous passer de définir et de faire partager à toute l'entreprise le service que nous voulons rendre.

3 UN CADRE THÉORIQUE : LE MODÈLE CYQ

Décrivons rapidement le Cycle de la Qualité, et nous en examinerons rapidement quelques conséquences en matière de management.



Ce schéma positionne les deux univers que sont celui des clients et celui de l'entreprise. Parcourons-le rapidement à partir de la "qualité attendue".

Même lorsque nous croyons connaître les attentes de nos clients, les identifier, les mettre en forme est un exercice qui nous conduit à adopter la logique du client, à voir notre travail, notre service avec le regard du client.Ce changement de "point de vue" n'est pas facile, car il remet en cause notre propre logique d'approche de la situation, celle qui est organisée, structurée par nos problèmes, nos préoccupations quotidiennes, nos responsabilités.

Apprendre a adopter le regard de l'utilisateur sur nos activites est la premiere etape de toute demarche qualite de service.

La deuxième étape-clé de la démarche est la définition de la "qualité voulue". La qualité voulue est définie non seulement en fonction des attentes des clients mais aussi en fonction de ce que l'on peut, de ce que l'on veut faire. Définir la qualité voulue est un acte majeur de la Direction de l'entreprise.

Cette qualité voulue, nous devons apprendre à la définir, la décrire dans la logique du client, en terme de résultat attendu pour le client.

Apprendre a exprimer nos projets, a definir notre service en terme de résultat attendu pour le client, est la deuxieme etape-clé de cette demarche qualité.

Notre performance peut alors se mesurer par l'écart entre la qualité voulue et la qualité réalisée, entre le projet et la réalité.

Quelques exemples, pour illustrer à quel point cette mesure de la "conformité du service client" peut être différente des mesures habituelles de production ou d'exploitation.

Nous avons tous vu un autobus vide suivre un autobus trop plein. Indicateur d'exploitation : taux de charge = 50 %. Et pourtant, ce sont bien 100 % des clients qui sont transportés dans des situations inacceptables ! Le service rendu en terme de charge ne saurait donc se traduire par un taux moyen de charge mais bien par le nombre ou le pourcentage de voyageurs transportés dans des situations conformes.

De même, le taux de disponibilité technique d'un escalier mécanique ne nous renseigne qu'imparfaitement sur le service offert aux voyageurs : une heure de panne à 18 h dans une station centrale ne peut être comptabilisée comme une heure de panne à 23 h dans une station déserte... C'est pourtant ce que l'on fait si l'on ne s'intéresse qu'à la disponibilité technique des appareils.

Apprendre a mesurer le service offert aux voyageurs et non nos performances techniques est le troisieme objectif essentiel de notre demarche qualité.

4 QUELLE MESURE DE LA QUALITÉ ?

Inspirons-nous simplement de ce qui se passe dans le domaine des produits industriels.

Il n'est pas possible de définir la qualité d'un produit indépendamment de l'utilisation qui peut en être faite. Ce n'est que par rapport à une spécification, une "qualité voulue", que l'on pourra mesurer les caractéristiques du produit et savoir s'il est ou non conforme au cahier des charges, et à son usage. Il en va de même pour les services.

Nous ne savons pas mesurer dans l'absolu la qualité d'un service de métro mais si nous avons défini ce que nous appelons un service de référence, nous pouvons savoir si un service particulier est ou n'est pas conforme à ce service de référence.

De même que la qualité de la chaîne de production peut se mesurer par le pourcentage de produits conformes, de même la qualité de la production d'un service peut se mesurer par le pourcentage de services conformes.

Mais, n'oublions jamais qu'un autobus vide, même à l'heure, ne rend aucun service, et qu'un autobus transportant 50 personnes rend 50 services. L'unité statistique de mesure de la conformité du service ne peut donc être l'unité de production du service mais le client bénéficiaire du service.

5 LE "STANDARD DE SERVICE"

L'expérience nous a conduit à définir le service par trois dimensions :

♦ le service de référence, qui caractérise le service nominal que nous voulons rendre. Par exemple : attendre le Métro moins de 3 minutes à l'heure de pointe.

♦ le niveau d'exigence, qui caractérise le degré d'exigence avec lequel nous voulons atteindre le service de référence. Par exemple 97 % des clients attendent le Métro moins de 3 minutes à l'heure de pointe.

♦ un seuil d'inacceptabilité, qui caractérise les situations inadmissibles. Par exemple : attendre le Métro plus de 10 minutes à l'heure de pointe.

6 L'EXPÉRIENCE DE LA RATP : QUELQUES EXEMPLES DE "STANDARDS DE SERVICE"

♦ Accueil au guichet

80 % des "accueils stations" ont une note d'évaluation supérieure à 16/20. Cette note résulte d'une enquête par client mystère qui permet d'évaluer l'accueil tant sur les aspects physiques (guichet repérable, vitres nettes, etc.), que comportementaux (agent disponible et courtois, agent efficace, etc.).

L'accueil est inacceptable si la note est inférieure à 10/20.

♦ Régularité du Métro :

98 % des voyageurs attendent "normalement la rame". L'attente est considérée comme "normale" lorsque les voyageurs attendent moins de 3' aux heures de pointe, moins de 6' en heures creuses et moins de 10' en soirée.

L'attente est considérée comme inacceptable si le voyageur attend le métro plus de 15' (ce seuil est ramené à 10' à l'heure de pointe).

♦ Régularité du RER

96 % des voyageurs arrivent à l'heure ou ont un retard à l'arrivée inférieur à 5'.

Le service est inacceptable si le voyageur a un retard à l'arrivée supérieur à 15'. Ce seuil est porté à 30' après 21 heures.

♦ Fonctionnement des Escaliers Mécaniques

98 % des voyageurs attendent "normalement la rame". L'attente est considérée comme "normale" lorsque les voyageurs attendent moins de 3' aux heures de pointe, moins de 6' en heures creuses et moins de 10' en soirée.

L'attente est considérée comme inacceptable si le voyageur attend le métro plus de 15' (ce seuil est ramené à 10' à l'heure de pointe).

♦ Confort dans le Bus

Dans les situations les plus défavorables, c'est-à-dire à l'heure de pointe et sur l'interstation la plus chargée, 75 % des voyageurs se trouvent dans un bus à charge normale (inférieure ou égale à 4 voyageurs debout au mètre carré).

Le service est inacceptable si plus de 35 % des voyageurs se tassent dans un bus de charge anormale.

Sur l'ensemble des standards de service d'entreprise, la cible à trois ans est définie dans le plan d'entreprise. Chaque département définit les étapes intermédiaires.

Les enquêtes trimestrielles permettent de mesurer l'écart par rapport aux objectifs. Ces résultats, communiqués localement, -par ligne de métro ou de RER, par Centre Bus-, sont présentés trimestriellement dans le tableau de bord de la Direction et du Conseil d'Administration de l'entreprise.

7 L'EXPÉRIENCE DE PRAGUE : QUELQUES EXEMPLES DE STANDARDS DE SERVICE

♦ Information

• L'information aux Stations de Métro, Arrêts Bus et Tram :

90 % des voyageurs attendent dans des stations ou des arrêts dont les informations écrites sont conformes*.

Situation inacceptable : Remise en conformité supérieure à 2 jours après le signalement (ce seuil est porté à 6 jours pour les arrêts de bus qui ne sont pas en correspondance avec le métro).

♦ Information dans les Tram et dans les Bus :

95 % des voyageurs sont transportés dans des véhicules dont les informations sont conformes*.

Situation inacceptable : Remise en conformité supérieure à 2 jours après le signalement.

- Pour être conforme l'information doit être complète, à jour, lisible et en bon état.

♦ Tenue :
95 % des agents en contact avec le public portent une tenue conforme* et ont une présentation générale correcte.

- La tenue conforme est définie dans une charte d'habillement.

Situation inacceptable :
. L'agent est en civil ou combine la tenue avec des vêtements civils.
. Allure débraillée.

♦ Régularité/Ponctualité (Métro, Tram et Bus)
Les voyageurs sont transportés dans des véhicules quittant le terminus et les arrêts ou stations à l'heure*.

* A l'heure =
. 0 + 179 secondes pour les arrêts en station.
. 0 + 59 secondes pour les terminus.

Niveau d'exigence :
. 95 % pour le métro
. 75 % pour les Tram et les Bus

Inacceptabilité :
. Avance supérieure à 2 minutes et retard supérieur à 6 minutes pour les arrêts et stations.
. Avance supérieure à 1 minute et retard supérieur à 3 minutes pour les départs aux terminus.

♦ Accueil dans les stations de métro, aux guichets de vente de titres de transport et dans les centres d'information :
90 % des accueils sont conformes sur les aspects suivants décrits dans la grille de mesure :
. Courtoisie et attitude de service.
. Propreté, rangement et ambiance des lieux.
. Informations précises.

Inacceptabilité :
. Non respect des horaires d'ouverture.
. Expression discourtoise.
. L'agent ignore le client pendant au moins 20 secondes.

8 PERSPECTIVES

Cette approche est l'ossature :

♦ d'une norme expérimentale française sur le transport de voyageurs. Pour que le service ainsi défini puisse faire l'objet d'une certification, la réglementation française impose que le référentiel de service soit défini en partenariat entre : les autorités organisatrices, les associations de consommateurs, et l'entreprise de transport. Ce débat à trois sur la définition du "service voulu" est particulièrement fécond.

♦ d'un projet de norme Européenne sur le transport de voyageurs.

9 CONCLUSIONS

Cette démarche est un puissant levier de changement vers l'entreprise centrée client qui a de multiples impacts managériaux, en particulier :

♦ émergence de partenariats internes : par exemple, exploitants et mainteneurs sont co-acteurs et co-responsables du résultat "pour le client" des escaliers mécaniques ou des distributeurs de billets.

♦ émergence de nouvelles logiques d'exploitation : la pratique de régulation visant à minimiser le nombre de clients "en retard" ne sont plus celles qui avaient pour objectif la remise à l'heure des trains .

♦ évolution de l'organisation : par exemple l'organisation de l'intervention sur les distributeurs automatiques de billets est plus performante en période de vente d'abonnements que le reste du mois, car c'est à ce moment là que le nombre de clients gênés par un dysfonctionnement est plus important.

♦ relations managériales plus adultes : le débat hiérarchique sur la qualité du service ne repose plus sur des impressions ou des a priori mais sur des mesures objectives de résultats.

♦ la formation sur les contenus des métiers peut être plus ciblée sur le service à rendre objectivement défini (par exemple pour l'accueil).

Cette approche redonne tout son sens aux métiers de service en définissant leur contenu en terme de résultat-client.

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Alternatives for promoting public transport integration in the Americas

Alternatives pour la promotion de l'intégration du transport public en Amérique

Alternativas para promover la integración del transporte público en las Américas

Charles Rivasplata
Planning Department, San Francisco, Calif., USA

ABSTRACT: In large cities, where numerous public transport operators provide service to a key sector of the population, the integration of routes, schedules and fare arrangements is essential. This paper reviews past integration efforts in Santiago, Caracas, San Francisco and Vancouver, analyzing their implementation and suggesting new strategies that will improve both operator and passenger satisfaction.

RÉSUMÉ: Dans les grandes villes où de nombreuses entreprises publiques de transport desservent une grande partie de la population, l'intégration des routes, des horaires et des tarifs de transport est indispensable. Ce report revise les efforts passées d'intégration à Santiago, Caracas, San Francisco et Vancouver; il analyse leurs réalisations et suggère des nouvelles stratégies en vue d'améliorer la satisfaction des passagers et opérateurs.

RESUMEN: En las grandes ciudades, donde varios operadores del transporte público prestan servicio a un importante sector de la población, la integración de rutas, horarios y tarifas es esencial. Esta ponencia revisa los esfuerzos que se han hecho para integrar servicios en Santiago, Caracas, San Francisco y Vancouver, analizando su implantación y sugeriendo nuevas estrategias que mejoren la satisfacción de los operadores y usuarios.

1 INTRODUCTION

In cities throughout the world, public transport offers an efficient and economical form of travel. In large cities, where often, numerous public transport operators provide service to a key sector of the population, the integration of routes, schedules and fare arrangements is an essential element of a sustainable urban environment. In order to reduce wasteful duplication of services and provide a viable alternative to the private vehicle, public transport must not only improve reliability, comfort and in-vehicle travel time, but also reduce transfer times and improve ticketing arrangements for the vast number of individuals that rely on more than one transport mode to travel from origin to destination.

While much has recently been written on public transport integration in Europe (Pucher and Kurth 1996) and in the United States (Schumann 1997), few studies have compared integration issues between industrialised and developing countries. In an attempt to identify some of the key factors limiting the integration of public transport services in cities throughout the Americas, this paper reviews past integration efforts in Santiago, Caracas, San Francisco and Vancouver. While these cities have made significant investments in the development of underground rail systems, each has approached the issue of integration differently, based on a diverse set of political, regulatory and structural factors. Research in this area could provide insights into the inherent limitations each system faces with respect to system coordination.

The key objectives of this paper are to identify these approaches, analyze the factors affecting their implementation and suggest new strategies that will improve both operator and passenger satisfaction. It will review the role of public transport integration in the efficient movement of passengers, highlighting different forms of public transport ownership and regulation. Next, it will describe the public transport network in each city, review past integration schemes, and point out the strengths and weaknesses of each approach. Finally, this paper will draw conclusions concerning public transport, and will suggest strategies for improving long-term system integration.

2 AN OVERVIEW OF INTEGRATION

Public transport integration is an important element of any network. While many systems strive to serve trip origins and destinations, it is unrealistic to provide direct service between all points and some interchange is inevitable (London Transport Planning 1997). In order to adequately serve a high volume of passengers passing through a point of interchange, it is important to provide key services, such as close coordination of timetables across modes, and barrierless or "free-body" transfers (Cervero 1998).

Interoperator integration can effectively expand the range of options available to the traveller. The improvement of intermodal connectivity provides for better mobility and economic efficiency. Commuters spend less time traveling, and not only save time and money, but also contribute less to urban congestion and pollution. While time savings is of primary interest to middle and high-income urban residents, cost savings is critical to the survival of low-income residents (since a higher percentage of their wages are spent on transport). Consequently, public transport must be coordinated so that the transferring passenger only pays once; routing and headways facilitate the transfer of passengers; and interchange facilities are kept clean and safe (Rivasplata 1993).

It is important to note that there are different forms of integration between operators, requiring varying levels of operator and/or public investment. Logically, under optimal conditions, the more integrated the system, the greater the potential for significant cost and time savings for the passenger. For example, physical integration, the most common and least expensive form of coordination, involves establishing transition points between systems (Henry 1990). While this contact is essential, without some form of fare integration (e.g., transfer arrangements normally financed by participating operators and/or the government), passengers may be inclined to drive rather than spend time waiting. In addition, informational integration is key to the transport marketing, while institutional integration ensures ongoing planning and investment in interoperator facilities. The greatest benefit to the passenger will occur where all forms of integration are offered.

Service coordination establishes the conditions necessary for two or more operators to develop fare and scheduling arrangements that offer significant cost and time savings to the passenger. In such urban areas as London, Paris and the Rhein-Ruhr, comprehensive transfer systems have been developed for multioperator journeys. In addition, many urban rail systems in Europe and the U.S. now feature the proof-of-payment, or "honour system" (Nash 1988). Nevertheless, it should be noted that the specific organisational and regulatory characteristics of an urban area often inhibit widespread integration.

In a deregulated or privatised environment, regional transportation planning is often not conducted on an ongoing basis, leaving operators to incur many of the costs associated with integration (e.g., ticketing, scheduling). In cities where a majority of the bus market has been privatised, widespread accessibility and system connectivity are jeopardised if fares, routes and schedules are not monitored on an ongoing basis. In contrast, in cities where services are owned and operated by independent districts, transport operators are often called upon by the public to integrate services with other providers.

According to Nash, one of the necessary conditions for establishing an integrated system is the existence of an autonomous, metropolitan authority that can identify and propose a set of integration standards for public transport (Nash 1988). When establishing a set of intermodal transport objectives this authority must balance the interests of the operators with the needs and expectations of the public transport passengers. Indeed, it is essential that regional coordination policy be designed to preserve operator competitiveness and integrity; and to satisfy demand for transfer services.

In the developing world, it is important that comprehensive transport plans propose policies and financial support for public transport coordination, however, it is also important that national authorities recognise the importance of these services, and that service plans incorporate the needs and desires of the passengers, operators and local communities.

3 THE CASE CITIES

Each of the case cities has attempted to develop a comprehensive network of public transport services to facilitate urban mobility and promote land use coordination. All four metropolises are characterized by a dense urban core and a sprawling hinterland. This section briefly describes each metropolitan area, its network of public transport services and past efforts to improve integration in key markets.

3.1 *Santiago*

Santiago, the capital of Chile, is located at the northern end of Chile's Central Valley, 105 kilometres southeast of Valparaiso. Currently, this metropolis of five million accounts for one-third of the nation's population and is the financial, social and political hub of Chile. Greater Santiago comprises an area of more than 500 square kilometers (Sectra 1992).

The average population density of Greater Santiago is approximately 100 persons per hectare (see Table 1), however, densities vary between districts. This pattern of development has resulted in high average trip lengths and long public transport journeys. Disparities in urban density have been compounded by decentralisation, resulting in a rise in auto ownership throughout the region. Despite the predominance of public transport, there has been a marked increase in auto usage, particularly in high-income communities.

Presently, the public transport network consists of privately-operated buses, a heavy rail (metro) system, numerous shared taxi services and a suburban segment of the state railway system. The entire network carries over three million daily passengers, 80 percent by bus and 14 percent by rail. Most services extend out from the downtown to outlying suburban areas.

While public transport integration was initially an objective of the 1968 urban transport report that recommended construction of the Metro (BCEOM-SOFRETU-CADE 1968), once the first line was built, the military regime advocated a policy of transport deregulation that ultimately discouraged coordination among operators. It was the Santiago Metro that first introduced formal integration.

Since 1987, it has operated a Metrobus program that encompasses a series of bilateral agreements between the Santiago Metro and individual private bus operators to provide integrated feeder services at designated Metro stations. While this program has provided cost and time savings to passengers, its scope is somewhat limited and in the early 1990s, it carried less than 3 percent of all intermodal passengers (Cedano and de Freitas 1994). Similarly, the Metro reached an agreement with the Chilean State Railway, to coordinate timetables with regional train service. In addition, limited integration was developed between the Metro and a private trolleybus line in the downtown, however, due to financial difficulties, the trolleybus line closed operations a few years later.

While both democratic governments of the 1990s have re-regulated many services in Greater Santiago, very little has been done to encourage further integration between buses and between modes. Consequently, in most cases, only physical integration has been offered. Thus, government has delayed setting policy on public transport integration; for instance, in its 1995-2010 plan, the regional Transport Infrastructure Planning Commission (Sectra) set fare integration as a goal for 2005, but did not outline an action plan (Sectra 1995).

Table 1. Case Cities: Urban Characteristics, Early 1990s

Indicator	Santiago	Caracas	S.F.	Vncvr.
Population (in millions)	4.6	3.2	6.1	1.8
Density (per ha.)	100	200	25	9
Daily Trips (in millions)	8.4	7.0	18.1	4.0
Work Trips (in millions)	3.0	1.9	4.4	0.8
Mode Split (percent)				
Auto	17	34	81	83
Public Transport	56	50	6	9
Walk	20	16	10	8
Other	7	0	3	4

Sources: Sectra 1992; Morais 1995; MTC 1994; GVRD 1993.

3.2 *Caracas*

Caracas, located in a valley south of the Caribbean Sea, is the capital of Venezuela. Presently, more than 3 million residents live in the Caracas Metropolitan Area, a region surrounded by mountains on all sides. As principal city of a petroleum-exporting country, Caracas concentrates a large proportion of the country's wealth and has attracted many immigrants from other parts of the world (Florez, 1997).

Nearly 7 million daily trips are made in Caracas (Morais 1995), half of them by public transport, a third by private automobile and the remainder on foot (see Table 1). While Caracas has one of the highest auto mode shares in Latin America, the public transport network still carries half of all trips.

The Caracas public transport network consists of four principal modes: a three-line heavy rail metro; "por puestos," privately-run paratransit vehicles of 18 to 32 seats; "jeeps," privately-operated, dual-traction vehicles of up to 12 seats that serve communities in the surrounding hills; and a conventional bus system, consisting of the Metrobus fleet and numerous private operators. CAMetro operates the Metrobus system as a feeder for its Metro operation, extending its catchment area beyond the immediate surroundings of the stations (Rivasplata and Florez 1998). It sells an integrated Metro/Metrobus ticket at a price slightly above the Metro ticket price.

While the Metro and Metrobus offer premium public transport service to middle-income residents, the por puestos and jeeps primarily provide flexible services to low-income groups (Tobia 1990). Due to the success of por puesto associations, the privately-owned, fixed-route bus system has continued to decline in importance. In contrast, the Metrobus system, which covers only 50 percent of its operating costs through fare box revenues, is heavily subsidized by the government (Iriarte and Ocaña 1994).

Despite the integration of Metro and Metrobus services, surveys have shown that more than 80% of all multi-operator trips are through "informal integration," i.e., fare and route integration are not available (Cedano and de Freitas 1994). Most of these informal connections are between por puestos and the Metro, however due to the uncertainty of routing and the competitive approach por puesto operators, institutional integration has been problematic.

Thus, while an integrated Metro/Metrobus system offers reliable services to a key sector of the population, further integration is hindered by the lack of regionwide planning and a legal framework for coordinating services across municipal and state boundaries. In turn, this has resulted in predatory practices on the part of informal operators and fierce competition between the Metro and these modes (Ocaña and Guilarte 1994).

3.3 *San Francisco*

The nine-county San Francisco Bay Area is located on the west coast of California, 550 kilometres northwest of Los Angeles. Currently, it is the fourth largest urban region in the United States, with more than 6 million inhabitants (see Table 1).

While the City of San Francisco continues to be the financial and cultural centre of the Bay Area, the region has witnessed significant growth in the past three decades, primarily in suburban areas, where new centres of economic activity have emerged. This growth has altered regional travel patterns, prompting the expansion of highways and suburban bus systems.

Despite regionwide growth in motorisation, the Bay Area still has a comprehensive public transport network that features bus, cable car, a five-line heavy rail metro (BART), light rail, regional rail and ferry. More than 25 operators serve the Bay Area, collectively transporting 1.5 million daily passengers, 70 percent by bus and 29 percent by rail.

Since the 1970's, the Metropolitan Transportation Commission (MTC), primary regional transport agency for the region, has encouraged interoperator integration. Initially, completion of the BART system and the creation of local public transport agencies prompted MTC to identify rail stations exhibiting a high demand for transfers. However, until recently, the regional agency had few financial resources with which to help operators fund integration projects.

In the past ten years, efforts have focused on financing the establishment of regional interchange facilities; the coordination of schedules between operators; the provision of a single source of public transport information (via telephone and the Internet); and the implementation of a regional fare instrument based on smart card technology (TransLink).

In addition, the California Legislature approved Senate Bill (SB) 1474, supporting the improvement of public transport integration for the purposes of increasing customer satisfaction and achieving a cost-effective network of transport services. This bill directs the MTC and regional operators to consolidate functions that will "enhance service integration in corridors of regional significance." It authorises the MTC to withhold state funding from any operator unwilling to cooperate in regional integration efforts (MTC 1998).

Currently, much of MTC's attention has been directed towards initiating the TransLink Demonstration in October, 2000. This project has generated widespread interest as it introduces a contactless, regional fare card for public transport in the Bay Area. Clearly, it could have positive implications: increased ridership, faster boarding times, broader coverage and shorter travel times. In addition, on-board data will provide planners with current travel data. Current plans call for six operators to participate in the demonstration; if successful, full deployment could be completed by 2003.

3.4 *Vancouver*

The Greater Vancouver Region is located in the extreme southwestern corner of mainland Canada, 3,350 kilometres west of Toronto. Currently, there are almost 2 million residents living in the area, making it the third largest metropolis in Canada (see Table 1).

In the past 30 years, Vancouver has seen a shift in focus from a wood and textile-exporting seaport on the Pacific Coast to a key commercial and financial centre serving the Pacific Rim.

In the 1970s, local residents began to voice their concerns regarding future growth in the region and the potential impacts that a rise in motorisation could have on the quality of life. The Greater Vancouver Regional District (GVRD) worked closely with local authorities and the public to develop a "Livable Region" Plan for directing future growth.

Subsequent revisions to the Plan emphasized the need to preserve the local environment, promote intercultural ties, and improve accessibility through the establishment of transport-oriented subcentres (GVRD 1996). Subsequent documents highlighted the region's dependence upon urban transport for the movement of goods and people, and the need for greater mode choice (GVRD 1993). The GVRD Plan proposes coordinating interchange facilities at the suburban subcentres and the downtown..

Presently, Greater Vancouver's public transport network features four principal modes: bus, light rail, ferry and regional rail. Regional integration has been reinforced by GVRD policies: the regional fare system is fully integrated and a time-based transfer is provided for single journeys. In addition, bus service feeds line haul rail systems.

In contrast to the other cases, Vancouver's public transport system has been operated by a single entity: BC Transit. However, in 1998, the Auditor General of the province found the regional operator to be unresponsive to passenger complaints (e.g., regarding delays and overcrowding), and recommended that it be reorganised. It was recently replaced by the Greater Vancouver Transit Authority (GVTA).

This new agency is responsible for providing public transport and all other transport services (e.g., roads), and has been granted taxing authority by the province to fund needed projects through the use of property taxes and the levying of a petrol tax. It will eventually transition public transport operations to at least four subsidiaries, each in charge of a single mode, in an attempt to effectively tailor services to demand. Once area transit plans have been developed, the GVTA will provide regional integration through the implementation of service agreements.

It appears that the GVTA's major challenge will be to ensure easy access between modes. It is important that regional integration not be compromised by a reorganisation of services, an objective supported by passengers and labour unions.

4 ASSESSING THE IMPACTS OF INTEGRATION

A brief analysis of the four cases shows that each city has had a varying degree of success in the expansion of public transport integration (see Table 2). Where operator coordination has been established, services have been dependable insofar as they have provided physical and economic incentives that outweigh the costs associated with transferring from one vehicle to another. Where integration has not been introduced, significant time, security and comfort penalties have often dissuaded passengers from making interoperator trips. In addition, the poor quality of some road and street networks lengthens journey times, effectively discouraging many from travelling on public transport.

Table 2. Case Cities: Levels of Integration, 1999*

Integration	Santiago	Caracas	S.F.	Vncvr.
Bus-Bus	P: high F: none I: none	P: high F: none I: none	P: med. F: med. I: med.	P: med. F: high I: high
Bus-Rail	P: high F: low I: low	P: high F: med. I: low	P: high F: high I: high	P: high F: high I: high
Bus-Other	P: low F: none I: none	P: low F: none I: none	P: med. F: med. I: high	P: med. F: low I: low
Rail-Rail	P: med. F: high I: high	Non-Existent	P: med. F: med. I: med.	P: med. F: med. I: med.
Rail-Other	P: high F: none I: none	P: med. F: none I: none	P: med. F: low I: low	P: high F: high I: high

* Types of Integration: P=Physical, F=Fare, I=Institutional; Levels of Integration: none, low, medium, high

Sources: Cedano and de Freitas 1994, GVRD 1998.

In the area of fare integration, both Vancouver and San Francisco feature permanent interoperator transfer arrangements that provide significant savings to passengers. In addition, the San Francisco Bay Area is currently developing a smart card that will facilitate regional public transport journeys and reduce boarding times. Santiago and Caracas also feature integrated Metro/Metrobus tickets, but these only reach a small percentage of transferring passengers.

Institutional integration is probably the strongest in Vancouver due to the fact that a single entity has historically made important advances in the provision of intermodal coordination, passenger information and station signage. Similarly, San Francisco has made important advances in the past few decades, but is subject to the limitations of county jurisdictions and SB1474. The Caracas Metro has acquired public subsidies with which to operate its Metrobus service, but there is no regional authority to ensure widespread integration. Finally, Santiago, has not expanded its formal integration to include all operators due to lack of interest on the part of private bus operators, who receive little incentive from government.

Thus, regardless of whether the public transport market is privatised or not, unless some form of cooperation is achieved at the regional level, most operators will continue to allocate time and resources to the improvement (and/or consolidation) of their own services.

5 CONCLUSION

Past experience in public transport planning has shown that it is most cost-effective to satisfy the greatest areas of demand and to encourage some integration. Indeed, many of the world's cities have restructured public transport service to feed rail lines or express buses, and some regional authorities have even established traveller information systems, provided service reliability at interchange facilities and encouraged operators to offer discount ticketing.

In order to improve efficiency and reduce travel times, an autonomous authority should be charged with developing a set of integration objectives (as part of a regional mobility plan). Integration should be promoted as a tool for improving service and a regional needs assessment should be completed.

In its efforts to encourage better provision of public services, secure project funding for integration and improve linkages between interchange facilities and surrounding land uses, the regional authority should explore the following strategies:

1. regulation by a single entity and enforcement of a set of minimum standards for integration;
2. provision of operator incentives encouraging cooperation in regional integration schemes;
3. acquisition of private sponsors to maintain interchange facilities and provide information;
4. introduction of surcharges on private auto registration to fund integration projects;
5. coordination with land use planners, developers on the location of interchange facilities.

This paper concludes that each city must define its long-term transport objectives and establish criteria for developing a network of interchange facilities. At a minimum, integration should facilitate transfers, improve links between the urban core and suburban areas and promote the development of complementary land uses in the surrounding area. In addition, it should provide access and safety to all transferring passengers, and urban amenities to the general public

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Optimal solutions and financing funds for public transport in Bucharest

V. Beldean, V. Ciugudean & E. Coroiu
S.C. Metroul S.A., Bucharest, Romania

ABSTRACT: The paper discusses in brief the natural ambient, the architectural ensemble, the social, political and economical context of Bucharest city, as reference factors in solutioning of the Bucharest transport and its integration in the regional transportation.

1 INTRODUCTION

Bucharest, whose foundation is attested by historical documents to have taken place on 1459, ranked the second biggest city in Southeastern Europe, according to the 1831 survey. After World War I, Bucharest's population grew rapidly, reaching 631,288 inhabitants in 1930.

The fourth decade has meant an expansion in terms of both demography and economy. Architects and contractors' projects were in full swing, the more so as the city had to temporize with the pattern of Western European cities. This was one of the major concerns of town planners throughout Southeastern Europe, as Paris set an ideal example of a modern metropolis.

Bucharest was dubbed '*Little Paris*' being the biggest, most modern and liveable city in Southeastern Europe.

During the communist regime Bucharest experienced the darkest period in his long history. The so-called *Golden Era*'s bulldozers wiped out part of the martyrized capital's historical heritage.

In terms of architecture, Bucharest is characterized by the existence of public bodies and institutions' headquarters located in the city center (Central and Metropolitan Authority, Bucharest University and central services). This area is surrounded by residential areas, alternating with important industrial areas, local subcenters and verdure spots. There are broad tracts of land available for potential development located downtown, within the central road ring, which are currently of little or even no use at all (for instance, the one adjacent to the Parliament Palace).

From a geo-morphological point of view the capital of Romania is situated in the South-Central part of the historical region, known as Walachia, in the morphological unit named the Romanian Plain.

The area of the territory of Bucharest city is included in a circle with a diameter of about 25 km.

The morphology of the area on which the town has developed is plane with a microrelief resulted from erosion and sedimentary processes, which occurred along the two valleys, in the South the valley of Dambovita River and in the North the valley of Colentina River.

The city center developed in the interfluvium area, on an almost plan surface, which presents from NW to SE a 1÷3 ‰ slope with elevations between 87-80 m relative to the Black Sea Level.

From a geological point of view the structural frame specific to the Romanian Plain due to the neotectonical movements, is one of a synclinal with a subsidence character, orientated SW-NE, on which Neogene and Quaternary deposits have accumulated.

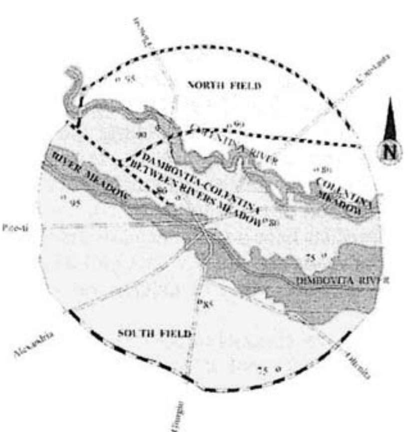

Figure 1. Schematic map of Bucharest

Bucharest is placed in the axial area of the synclinal, where the thickness of the sedimentary deposits is more than 1000 m.

This fact explains the seismic character of the region, due to the lack of a rigid foundation near to the surface made of hard rocks.

The lithological succession in Bucharest up to the Quaternary period is made of alternating lithological complexes that contain either non-cohesive soil such as sands with gravel or only sands, or cohesive clayey layers .

The result of hydrogeological and geotechnical investigations finally lead to conclusion that the lithology along the planned underground network is very non-homogeneous, in both vertical and horizontal plane , with cohesive and non-cohesive discontinuous layers in alternating dispositions. These layers are of relatively recent age and the underground water level is often near the ground surface.

Given the execution conditions and the existing technology , one has decided that the most adequate solution is a shallow and average depth subway.

2 GENERAL DATA REGARDING PUBLIC PASSENGERS TRANSPORTATION AT THE SURFACE AND UNDERGROUND, WITH ACCENTUATION ON THE EXISTING METRO NETWORK AND ITS PERSPECTIVE IN THE NEAR FUTURE .

Two companies provide public transport services in Bucharest, city with a population of approximately 2,350,000 inhabitants, out of which about 50 % are employed.

The first one, RATB, is subordinated to Bucharest City Hall and operates surface modes such as buses, trolley buses and streetcars.

The second one, S.C. METROREX S.A., is directly subordinated to the Ministry of Transport and operates a subway system.

The present road network is a result of Bucharest's historical development combined with major changes arisen over the last decades. The city features a ring-like character determined by the existence of a northeastern half-ring linking the city's former barriers with the southern ones. In some areas the road network forms large loops making possible a classification of roads by their function. The rest of street profiles have a spontaneous aspect.

New district roads are still not enough integrated into the main network, many of them being not yet completed.

The road network consists of 5,340 streets with a total length of 1,820 km out of which the main road network is 600 km-long.

There are 16 passages and 27 flyovers.

Bucharest benefits from the metro network that has about 60 km route in function. There are

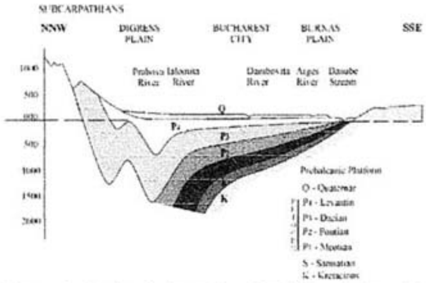

Figure 2. Geological section North-South from Moesic Platform (Romanian Plain)

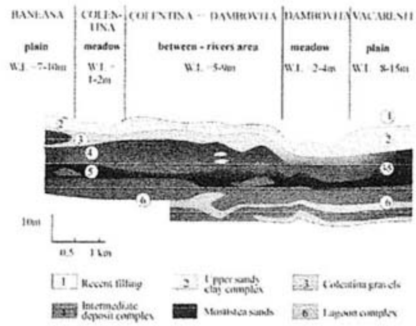

Figure 3. North-South lithological cross section

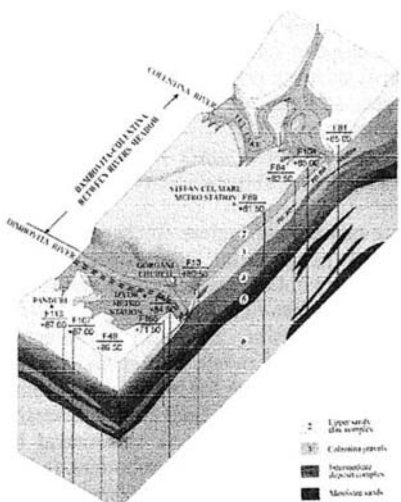

Figure 4. Geological Block Diagram

11.2 km of route that are under construction, of which 4 km will be finished in the year 2000. Due to the lack of the investment funds, around 7 km of already finished underground structures are being pre-served waiting for the moment when the works will start again .

The metro network has a circular and a diagonal course.

The subway represents a high-capacity network, covering only about 8 % of the total public transportation network of the city; however it serves over 20 % of the total passengers.

RATB and METROREX provide together 80 % of the transport demand, namely about 4 million trips/day.

As it has no interaction with the evolution of general traffic and is not subjected to bad weather, it ensures a maximal continuity and rhythmicity of transport, improving the public transport condition.

Because of the economic recession, Bucharest did not enjoy proper expansion and diversification based on demand. The city does not have proper links with its most important areas.

One has currently noticed a rise in the importance of the capital's outlying areas due to changes in the social and economic life, expansion of private agriculture and trade, and a demand for residences outside the urban area.

A possibly suited remedy for the critical condition of Bucharest's public transport is the integration of average and long-distance public transport systems with local and regional transport systems (from the city and its adjacent areas) through extension of present and proposed urban metro lines outside the city (surface railway), as a regional metro system.

The major drawback of the present network, the station density, could be turned into an advantage for a mixed urban-regional network. There is already a pre-feasibility study underway which settles future routes, starting with providing with links the Baneasa and Otopeni airports, than the Snagov area with the rail station (*'Gara de Nord'*) and/or the city center.

The final goal of expanding the public surface and underground transport is to attain a multi-modal system, goal that entails execution of communication nodes represented by interface stations located in the city's most important areas.

3 ECOLOGICAL IMPACT OF THE UNDERGROUND METRO WORKS AND OF THE SURFACE TRAFFIC

The sustained development of the public transport systems and the growing congestion of traffic raises particular problems as far as the environment is concerned.

On the one hand, the surface traffic is alarmingly polluting the environment through fuel leaks, fume discharges, different leaks entailed by car accidents, maintenance waste materials etc, on the other hand,

Figure 5. Bucharest metro network

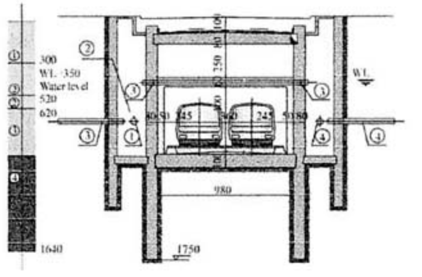

Figure 6. Vertical cross – section of gravity drainage

the underground traffic with its grave effects concerning :

- the dam phenomenon when the underground structures are perpendicular relative to the underground water streams, (this is due to the reduction of the flow section of underground water which leads to higher ground water levels upstream and lower levels on the oposite sides);
- settlements of the land surface, sometimes even until collapse, accompanied by the modification of the compaction degree of the soil, (after making watertight of the tunnels and ground consolidations from the surface by injections applying the injection technologies, there appear the negative effects which are represented by swellings of the ground surface till its break and the appearance of the injection material, or non-achievement of the packed degree foreseen, followed in time by settlements and also by collapse of the soils) deterioration of nearby underground structures, etc.

In order to determine the real effects of the tunnel excavations and to set the technical measures in order to avoid excessive settlement of the ground surface the following elements have been regularly monitored:

- the underground soil lithology in the front shield;
- the volume of seepage measured in the tunnel front;
- the settlement of the nearby buildings and underground water pipes and sewers;
- the quantities of sand extracted from the dewatering wells;
- the correct guidance of the shield;
- the quantity of grouting;
- the degree of loosening of the soil after the tunnel drive;
- the behavior of the nearby buildings.

A special problem was the physical and chemical degradation of the soils .

Deterioration produced to the public utility networks, especially the sewerage system, caussed polluted water exfiltrations, contaminating the phreatic aquifer waters with major impact on the pollution of the environment.

Another aspect was the corrosion effects of the environmental factors over the underground structures .

Some areas in Bucharest are polluted with sulphur dioxide, nitrogen oxide discharged not only by cars, but also by the 5 thermoelectric power stations, over 40 small plants and industrial agents.

However, compared with other European cities, Bucharest is basically less polluted, especially in terms of nitrogen oxide, sulphur dioxide and even carbon dioxide.

On the contrary, Bucharest is basically more polluted than other European cities in terms of deposits of dust, polluting matters containing lead and volatile matters.

4 BUCHAREST METRO MODERNIZATION PROGRAM

Within the program aimed at developing and modernizing Bucharest metro, the following main projects have to be outlined:

Line 4 – consisting of two sections linked with the existing metro network: R1: Nicolae Grigorescu – Belt line, in the city's South-East and R2: Gara de Nord – Laromet, in the city's North-West, with a length of 11.2 km double track line and 10 stations.

Construction works for this line started in 1989, but due to the lack of financing funds most of them have been abandoned.

Line 5 – stage I – which will link the Southwest of the city with the downtown and will be continued during the second stage of the project with a line situated in the Northeast of Bucharest.

The line planned to link the town with Otopeni and Baneasa airports – a project consisting of double track metro line with a total length of 13.7 km and 9 stations.

It is expected that underground works will perform the execution of this project only partially, as a significant part of this metro line is designed as a surface metro line.

The modernization of the existing rolling stock – this project foresee the modernization of 70% of the existing EMUs from the metro fleet.

The project allows the improvement of rolling stock operation standards through the extension of the operation lifetime, passenger safety and comfort increase and maintenance expenses reduction.

It is mandatory to find the necessary funds in order to achieve the programme for Bucharest's metro development and modernization and space out the works to be performed.

The state budgetary resources are bounded and inadequate, so a part of the works already stated was stopped or only partially completed.

5 THE FOUNDING OF EXTENSIONS TO BUCHAREST'S METRO SYSTEM

The financing funds for the metro projects were entirely provided by the budgetary allocation through the Ministry of Transports to which the metro exploitation enterprise - METROREX Bucharest - belongs.

Like in other countries, besides the financing of investments, the government also provides subsidies for operation, 50 percent of the operation being currently financed from government subsidies.

The constraints imposed due to the cash strapped budget, especially during this period of transition, emphasize the necessity of finding alternative investment financing instruments for Bucharest's metro in order to support the metro extension and modernization program.

Long-term investment loans amounting to over Euro 100 million were secured from the European Investment Bank during the last years. These financing funds allowed the carrying on of the projects for metro development and modernization.

The financial resources of the investment projects for the Bucharest Metro may be secured, aside from the state budget, through long-term credit, and especially through implementation of a financing system in the Public Private Partnership (PPP).

This system implies an association, on a contract basis, with private legal persons to take part in the designing, building, financing and exploitation of works.

Its international experience in this field is self-evident.

Examples such as Metropolitan Authority in Washington, the London Underground, Lyon, Madrid prove that a financing system implying a private financing coupled with a public one is extremely viable.

This system, besides the advantage of completing the public financing resources, creates advantages in terms of efficiency, responsibility and risk coefficient, the building period, etc.

The key benefits of the Private Finance Initiative (PFI) are given below:

- Ability to transfer the risk to the private sector
  One of the fundamental principles on which the PFI is based is the achievement of the Value for Money (VFM), which itself is primarily achieved through the transfer of risk. With conventional procurement a substantial amount of the risk is retained by the public sector after the warranty period which is not the case with the PFI procurement. For instance if the service provider takes on the risk under PFI, components will be designed that minimizes the maintenance costs to the service provider on a whole life cost basis.
- Acceleration of passenger benefits
  PFI potentially allows projects to be carried out much earlier than they would be under conventional procurement simply because the constraints on capital funding and consequential delays therefore delaying the delivery of passenger benefits.
- Capital avoidance
  By carrying out the projects under PFI allows capital to be 'theoretically' freed up to fund other project under conventional means.
- Facilitates improved investment planning
  A constraint on investment planning program is the availability of capital to deliver projects. The consequence of reduced government grants have meant a backlog of investment. PFI is a means by which some of this investment backlog can be tackled.
- Public sector retains control
  Under PFI the public sector retains full control through a performance specification along with the achievement of milestones, which drives the payment mechanism. The payment is structured to allow optimum allocation of risks that incentives good performance and penalizes poor performance.

Methods aimed at implementing the PFI range from granting the project execution and exploitation, to conclusion of BOT (Build-Operate-Transfer) or DBFO (Design, Build, Finance and Operate) contracts, or contracting project parts on services contract basis.

The system assimilation and its operation support represent a very important condition.

6 CONCLUSIONS

Applying the Public Private Partnership system on national and/or international level may stimulate the achievement of investment programs in Romania, especially in infrastructure, implying the underground developing and modernization process.

A required legal framework was created in the last years, although it can still be improved in order to comply with the international requirements in the field.

The favorable influence of the PPP system application should not be neglected either in stimulating the activity of material manufacturing, equipment, installation industries and services providers, tax payers that contribute to a better operation of the budget mechanism, that finally undertake the public investments' cost.

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The integration of public transportation system in medium size cities in developing countries: Project of Franca, São Paulo, Brazil

L'intégration du système de transport public dans les villes moyennes des pays du tiers monde: projet de Franca, São Paulo, Brésil

La integración de sistemas de transporte en ciudades de medio porte en países en desarrollo: Proyecto de Franca, São Paulo, Brasil

R. Boareto
DINFRA-GTU, Traffic and Public Transportation Management of Franca, São Paulo, Brazil

ABSTRACT: Franca, a city with 280 thousand inhabitants, has elaborated and is settling a Modernizing Plan for a public transportation System called Transport 2001. The Plan is based on the integration of a bus line system that has been completely reformulated with the adoption of an integrated free-transfer ticket by time control, using electronic ticketing, without the construction of integration terminals. Franca is one of the first cities in Brazil to set up this model successfully. This has enabled the public power to control and plan the city transportation, including service to the disabled.

RESUMÉ: Franca, ville de 280.000 habitants, est en train de mettre en place un programme de modernisation de son système de transport, appellé Transport 2001 et basé sur le compostage electronique et la correspondance des lignes d'autobus par le contrôle de temps, ce qui n'exige pas la construction des terminus fermés de correspondance. Franca est une des premières villes du Brésil où ce modèle existe et le pouvoir public prend la supervision et le développement coordonné des services y compris les handicapés.

RESUMEN: Franca es una ciudad de 280 mil habitantes, está implantando un programa de modernización del sistema de transporte llamado Transporte 2001, basado en el billetaje electrónico y en la integración de las líneas de autobús por control de tiempo, dispensando la construcción de terminales cerrados de integración. Franca es una de las primeras ciudades del Brasil donde este modelo está funcionando. Con este proyecto, el poder público asume la supervisión de la operación y el planeamiento de los servícios, incorporando inclusive los usuários con deficiéncia.

Franca, a city with 280 thousand inhabitants, has set up a program to reorganize its Public Transportation System based on electronic ticketing and the integration of its bus lines by time control. The public power in charge of the System was not structured to handle it adequately. The number of bus lines available was insufficient to meet the many transportation needs of all city bus users. Only a few neighborhoods were directly connected to the main areas of public interest, which caused most users - especially those living on the city outskirts – to pay two fares in order to reach their destinations.

The old System comprised 58 regular diameter bus lines, 53 special lines, and transported an average 1,350,000 passengers monthly. However, due to the inadequate frequency of the buses, whole districts suffered long serviceless periods, especially between rush-hour peaks. The user's access was poorly infrastructured. Of the existing 1,354 bus stops, only 156 were sheltered, and 41 had benches. Three of the existing four small bus terminals were in poor functioning condition and one was still unfinished . The city's current fleet of licensed private vehicles amounts to 90 thousand units and the public transportation fleet is comprised of 95 buses.

Based on these data, we have elaborated – and are now implementing – a nine-project Modernization

Plan of the Transportation System ("Transport 2001") to enable the public power to administer the System and promote its reorganization with a physical and fare integration based on electronic ticketing, thus making the city of Franca one of the first Brazilian cities to apply this kind of system. We have tried to develop a set of actions based on the principles of developing non-motorized means of transportation, prioritizing public transportation, and disciplining the access of private transportation users. This way we will achieve a better organization of the city, making possible the use and occupation of the ground in a more rational manner. The formation and consolidation of urban subcenters has been stimulated within the "Non-Transportation" concept, thus reducing all the negative effects related to the city traffic.

Also, we have tried to analyze and offer solutions to all the problems that users are faced with when obtaining necessary information as they leave home, walk over to a bus stop, use the Transportation, and reach their destinations. With these measures, we intend to both make Public Transportation more pleasant and attractive and stimulate the city's self-sustainable development.

1.THE ELECTRONIC TICKETING SYSTEM AND THE FARE INTEGRATION OF BUS LINES.

The bus lines that serviced the Franca population were implemented throughout the years without planning, as the urban occupation grew. The city had a fleet of 95 small vehicles for 80 passengers each, and 111 different lines. The itineraries were long and the bus frequencies were relatively low, which caused users to be delayed at the bus stops.

The proposed solution was a transportation Network formed by radial and circular lines, integrated through electronic ticketing to avoid the need for building integration terminals, a model used in Brazilian cities.

1.1 The Advantages of Integration through Electronic ticketing.

The main advantages of Electronic Ticketing over integration terminals are (Lapate, 1987)

- It avoids the need for assigning public areas or expropriating any properties for the construction of bus terminals.
- It does not induce a concentration of demand on certain structural corridors, which would precipitate a saturation of the System's capacity and would thus require new vehicle technologies and related infrastructure at increasing marginal costs.
- It requires only a reduced time of implementation, as compared to the construction of bus terminals, as well as a lower cost to be paid by the public power or operating companies.

1.2 The Aims of Electronic Ticketing

- Develop a new fare policy associated with the Integration of the System to minimize the fare levels to cover the same service:
- Technological Innovation of the equipment for operational control and money collection per line to allow the classification of demand by type of user and time. This will provide the managing organ with greater agility and reliability.
- Ensure rationalization of the bus lines.
- Establish a control to quantify the use of ID cards for fare reduction and fare exemption;
- Improve the security of passengers by decreasing the circulation of money in each vehicle and eliminating the use of paper tickets;
- Introduce an Integrated Fare in all of the System through the use of a ticket that will allow a passenger to transfer from one line to another without paying for a second fare, within a pre established period of time.
- The Franca Project has been elaborated to maintain the job of conductor, who will continue receiving payment in money from the passengers who do not have the Magnetic Card. The conductor will also supervise the use of ID cards for fare reduction and fare exemption by the elderly and by students. In addition, the conductor will help the elderly and children with the use of ID cards, and will provide information on the Integration System.

1.3 The New Bus Line System

Franca has a new organization of the integrated bus lines, with the following advantages:

- It meets the new and growing needs of public transportation that arise with the dynamic use and occupation of the urban space;
- Rationalization of the operation;
- It reduces the waiting time by increasing the frequency of buses;
- Shorter trip duration;
- All neighborhoods are connected to each other and to the downtown area in a rational fashion;
- Points of trip attraction are connected to each other;
- It helps to create and /or strengthen urban subcenters;

- Free choice of line connections for reaching the main points of attraction;
- More options of line-transfer points.

The service is given through integrated binary radial and circular lines that provide all the districts with access to all points of interest for the population. The radial lines connect the districts to the downtown area and vice-versa. In the future, such lines will be "binary" for interdistrict connections. The binary circular lines connect the city's different regions to serve the commercial and service poles as well as the industrial and leisure poles. The diameter lines, if necessary, will make the connection between districts at the extreme ends of the city, preferably passing through the central area.

The lines are regular. However, special lines are being planned in case they become necessary after the system has been stabilized. All the necessary adjustments will be made in the operational fleet which will be renewed and will include the right type of vehicle for each type of line. All told, there are 2 circular lines, 25 radial lines and 4 overnight lines known as "corujões" (big owls).

Now that the System, has been implemented, there are new lines that complement each other. For example, the user may take any radial line (district-downtown or vice-versa) that goes across the circular lines. In order to reach any part of the city, all the user has to do – within one hour – is get off the bus at any crossing point and change buses without paying a second fare.

Three types of cards can be used by all user categories. The Common card is for full-fare assengers; the Social card is for students who pay reduced fare; and the Special card is for fare-exempt users (over 65 years of age, disabled, etc). Both Common and Social cards may contain dozens of credits, according to its user's choice.

The System's Operational Data Control makes it easier to plan and implement the necessary changes toward its improvement. The implemented ticketing allows the issue of various types of reports, including a research based on a daily Electronic Origin-Destination Record.

1.4 Characteristics of the Franca Electronic Ticketing

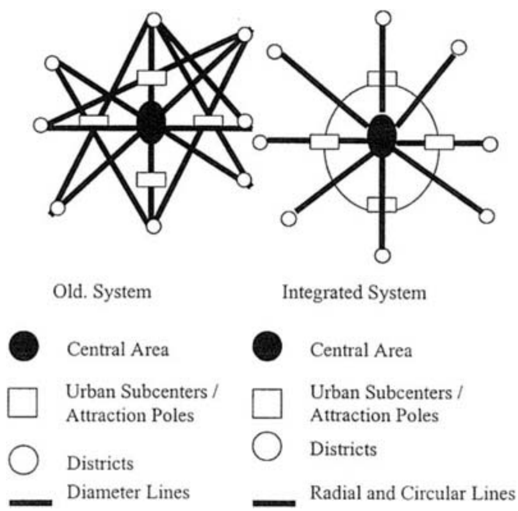
We have analyzed the existing technologies for the implementation of the electronic ticketing. As reference we used a table of analysis produced by Reynaldo Lapate in February 1996, now updated and extended. Through this table we can evaluate the requisite qualifications of the validating equipment (11 qualifications) and of the tickets used (7 qualifications). In September 1998 we started the ticketing operation with fare-exempt users, and in December, 1998 we proceeded to the System's full commercial operation, and on February 16,1999, the lines were completely changed to start the Integration System.

1.4.1 Managing Organ

Defined the technology (ISO format Magnetic Card);

Elaborated the Technical Project:
- Maintained the job of Conductor
- Set up the one hour integration.
- Bid the rental of equipment.
- Is in charge of the Project Implementation and keeps a record of fare-exempt and reduced-fare users.

System of Integrated Lines
Through Eletronic Ticketing (No Terminals)
Plan of Application in the City of Franca, SP, Brazil



1.4.2 Operating Company

Sells electronic credits.
Implements and runs the sales network.
Collects operational data.

1.4.3 Characteristics of the Equipment

Easy installation and maintenance (Plug in).
High MCBF (magnetic head for two million cycles).
Possible Technological Upgrade (Compatible with other technologies).
No need to replace the mechanical turnstile on the buses with electronic ones.

Brazilian-made equipment with open software and adjustments also made in Brazil.

1.4.4 Characteristics of the magnetic Card

ISO format.
High coercitivity magnetic stripe.
Made of polyester, 2 years minimum useful life.
Cost per unit U$ 0,15.
Can be re-validated up to 50 credits.

2. THE IMPLEMENTATION

The Public Transportation System had its lines changed in one day, when 58 regular lines, 53 special lines and about 110 special itineraries were replaced with 25 radial lines and 2 circular lines.

The operational fleet of 95 vehicles used today is the same as that of the previous system and the total number of kilometers driven is reduced by approximately 5%.

The new system, known as "Passe Fácil" Easy Pass has been increasingly approved of by the population despite the initial discomfort and confusion caused by the complete change in the lines. However, there has been an immediate improvement concerning the operational speed.

Of the users who disapproved the new system immediately after its implementation, 65% based their opinion on the fact that the buses were overcrowded.

A second survey, however, showed that this item had dropped to 3.6%, and the first problem pointed out by 36.6% of the users was misinformation about the changes. This fact caused us to accelerate the implementation of a communications program, which was already underway.

2.1. The User Communications System

Included in the "Transport 2001" Program is the project of a new User Communications System. Innovations resulting from this project have already been added to the implementation of the Integration System.

2.1.1. Line Identification for Illiterate Users

Each line is identified by a name, a code made up of a letter followed by a two-digit number, and a specifically colored geometric symbol. This symbol can be recognized by illiterate users or mentally disabled ones to identify the line of their choice.

2.1.2. Stop-request signal book for the blind

Blind users will have a pocket-size book containing all line codes in color along with "captions" in Braille. Thus, at a bus stop for different lines, for example, a blind user will not depend on anyone else to signal a stop. He/she must only keep showing the code for the line of his/her choice. The driver will easily recognize the symbol. This material is new in Brazil.

2.1.3. The Bus Newspaper

The Bus Newspaper will be issued fortnightly. It will be posted on the inside of each bus. In a 45 X66 cm format, it will bring news of the user's interest, such as the changes taking place in the System.

2.1.4 "Bus TV"

The Bus TV is a pioneering project in Brazil. Twenty of the 95 vehicles in the fleet are already equipped with TV and videotape monitors for the broadcast of social-interest programs which include films on Public Transportation, public-interest campaigns, and educational documentaries.

2.1.5 Exhibits

Information billboards are being strategically posted at points of great concentration of bus users. Also, at these points, pamphlets are distributed which contain, in addition to bus line schedules, useful information about the lines and their integration. Specially trained people tell users how to choose the most rational line combinations for access to any destination. As for the locations of greatest public interest, users are given "comic books" showing characters moving around by making use of the system.

2.2 Improvements to the Infrastructure

Even before the "Passe Fácil" was implemented, we started improving both the infrastructures of service-to-the-user and the system operation.

2.2.1. Remodeling and Building of Sheltered Bus Stops and Terminals.

A data bank has been elaborated to include a digitized city plan showing the number and qualifications of bus stops, e.g. existing shelters and benches, the type of pavement and use of stop locations, etc. These data made it possible to develop a new model of sheltered bus stop with benches, garbage containers and information boards with texts in both normal print and Braille. The Braille-printed texts are part of the various improvements to the Transportation Network for Disabled Users, included in the planning of the "Transport 2001" Program.

A 3,000-square-meter bus terminal is under construction in the downtown area for use by an average 40,000 people a day. This terminal features a universal access with ramps, toilets and work points adapted for wheel-chair users, and information boards with normal – and Braille-printed texts.

2.2.2. Tactile-Floored Track for the Blind

The floor of the new bus terminal will feature a one-meter-wide track – lined with a newly tactile flooring material – specially designed to provide the blind with easy and safe access to the platforms, toilets, public phones, and the information desk.

2.2.3. Colored Handrails for the Nearsighted.

Colored handrails, another improvement previously planned, have been installed on each bus. Their color, contrasting with that of the bus interior, adds to the safety of nearsighted passengers.

2.2.4. The City Street Network

To improve the operational performance of the vehicles, the traffic signs on the streets and avenues that form the bus corridors have been adapted so as to allow priority to public transportation vehicles. Also, small works have been planned mainly for a number of streets on the city outskirts to facilitate the bus traffic in those areas.

3. CONCLUSIONS

With the integration of the public transportation system, all the neighborhoods and points of trip attraction are connected to each other and to the downtown area in a rational net. It meets the new and growing needs of public transportation that arise with the dynamic use and occupation of the urban space, including service to the disabled.

The integration through electronic ticketing is time-saving and means lower costs to the public power or operating companies.

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La qualité de service des réseaux de transport urbain

The service quality of urban public transport networks

La calidad de servicio de las redes de los transportes urbanos

F. Kühn & J. Kauv
INRETS, Institut National de Recherche sur les Transports et leur Sécurité, Arcueil, France

RÉSUMÉ : L'alternative à l'usage de la voiture particulière en ville est un transport public de qualité. Les mesures qui tendent à modifier directement le niveau de service des TCU (régularité, vitesse commerciale, fréquence) ont des effets positifs sur leur fréquentation. Différents outils et méthodologies existent à travers le monde pour suivre et améliorer cette qualité. Les autorités doivent avant tout décider de donner ou renforcer la priorité aux TC sur la circulation générale pour résoudre les problèmes urgents de capacité de transport : tout retard dans la décision renforce la place de l'automobile dans la ville.

ABSTRACT : The alternative proposal to use limitations of private car in town is a good quality public transport. The measures which lead to modify directly the service level of UPT (commercial speed, regularity, frequency) have positive effects on their frequentation. Different tools and methodologies exist all around the world to take care of the quality and improve it. Transport Authorities must first of all decide to give or reinforce the UPT priority over the general traffic to solve the instant transport capacity problems : any delay in deciding restores the private car space in the town.

RESUMEN : La alternativa a la restricción del uso de vehículos particulares en la ciudad, es un transporte publico de calidad. Las medidas que tiendan a mejorar directamente el nivel de servicio (regularidad, velocidad comercial, frecuencia), tienen efectos favorables sobre la frecuentación de los TCU. Diferentes metodologías e instrumentos permiten controlar y mejorar esta calidad de servicio. En primer lugar, las autoridades deben acordar a los TC una prioridad sobre la circulación automóvil particular para solucionar los problemas urgentes de capacidad de transporte : la ausencia de una decision en este sentido, refuerza la parte del auto en la circulación urbana.

1 INTRODUCTION

L'amélioration des transports collectifs devient de plus en plus nécessaire dans un contexte de prise de conscience accrue des problèmes d'encombrement et d'environnement liés à une augmentation continue de la circulation automobile urbaine.

2 LA FRÉQUENTATION DES RÉSEAUX DE TRANSPORT COLLECTIF

Les transports collectifs ont un concurrent redoutable, l'automobile qui réagit rapidement à l'évolution des attentes de l'usager et qui offre une image de souplesse, de liberté, de confort, d'adaptabilité à tous types de déplacement.

La qualité de service offerte par les différents modes de transport collectif ou individuel joue un rôle déterminant dans le choix modal des personnes qui désirent se déplacer. Si l'un des facteurs de qualité de service s'avère déficient, c'est l'ensemble de cette qualité qui est compromise car les usagers portent un jugement global sur le mode utilisé.

L'amélioration de la qualité de service a pour objectif d'une part, de fidéliser la clientèle des TC existante, d'autre part de conquérir la clientèle occasionnelle des TC (les multimodaux) qui constitue un nombre important de clients potentiels pour les TCU : mais les facteurs qui déterminent la qualité de service ne sont pas complètement maîtrisés car son amélioration dépend des conditions extérieures et des effets de mesures plus larges. Certaines actions peuvent avoir des répercussions importantes sur la clientèle TC, bien qu'elles ne la visent pas spécifiquement. C'est le cas en particulier des mesures destinées à générer un transfert modal en limitant l'usage de la voirie, telles les limitations de stationnement et les plans de circulation. D'une manière générale, les exploitants des réseaux de transport recueillent les fruits des efforts faits en faveur de la qualité de service, ainsi on observe en France une légère augmentation de la fréquentation des TCU qui est en moyenne de 3% en 1998, les villes ayant des lignes de TCSP (Transport en Commun en Site Propre) s'en sortent mieux en général. Un accroissement de la clientèle suit en général une restructuration du réseau (horaires et itinéraires) ou une meilleure qualité de l'offre obtenue directement ou indirectement, Kauv & Kühn (1999).

En résumé, les mesures qui tendent à modifier directement le niveau de service des TCU ont des effets positifs sur leur fréquentation, surtout lorsqu'elles améliorent leur régularité, leur vitesse commerciale et leur fréquence.

3 LES RÉSEAUX DE TRANSPORT URBAIN EN EUROPE

À partir d'une étude sur la qualité de service mise en oeuvre sur 22 réseaux de transport européens nous avons analysé les conséquences de ces améliorations qui débouchent sur une croissance soutenue du marché de la mobilité avec une première classification selon le taux de voyages par habitant et par an, en trois groupes de réseaux : les réseaux où le taux de voyages par habitant est très élevé (ex. en Suisse), les réseaux de grandes métropoles où l'effet réseau permet d'obtenir un taux de voyage par habitant assez élevé, les réseaux de villes moyennes qui augmente l'offre de transport public mais n'obtiennent qu'un taux de voyage par habitant assez faible.

Ainsi, les réseaux suisses de Zürich, Bâle et Berne ont respectivement une mobilité de 536, 541, et 600 voyages par habitant et par an. Parmi les réseaux visités, ces taux sont les meilleurs, ils reflètent un usage très élevé des transports publics dont les responsables ont dès le début des années 70 pris l'initiative de donner la priorité aux transports collectifs de surface et de dissuader les automobilistes de circuler dans les centres des villes par une politique adaptée de parkings de dissuasion et de plan de circulation. Dernièrement la Loi sur la Protection de l'Environnement (LPE) permet de prendre des mesures encore plus restrictives en Suisse à l'égard de la voiture particulière.

Les réseaux des grandes métropoles comme Paris, Londres, Milan, Münich, Vienne, Stockholm, Amsterdam et Stuttgart ont un ratio de voyages par habitant et par an situé entre 399 (Milan) et 252 (Madrid). Ces réseaux ont très tôt créé une dynamique des déplacements ou un «effet réseau» avec plusieurs modes complémentaires dont le RER, les trains de banlieue ou S-Bahn, avec des stations de correspondances tous modes dans le centre ville comme à Münich dès 1972 et l'intégration tarifaire sur une grande aire de compétence. Le réseau de Linz (235.000 habitants pour le PTU) rivalise du point de vue des déplacements avec les grandes agglomérations ci-dessus, soit 346 voyages par habitant et par an.

Les réseaux d'agglomérations moyennes comme Bruxelles, Cologne, Copenhague, Lyon, Marseille, Oslo, Sheffield, ont leur ratio de déplacements par habitant et par an situé entre 190 (Bruxelles) et 160 (Marseille), ces agglomérations ont pris conscience plus tardivement sans doute de l'enjeu des transports collectifs et les mesures restrictives à l'égard des voitures n'arrivent que plus tard : ainsi un péage urbain a été instauré à Oslo à partir de 1990, ce péage étant plus un instrument de financement que de dissuasion.

La part modale des déplacements en TC en entrée des centre-villes dans les villes européennes reste importante comme le montre le tableau 1 ci-après.

En ce qui concerne les faits marquants sur la qualité de service, nous faisons la distinction entre les trois groupes de villes décrits ci-dessus :

- dans le premier groupe des réseaux suisses, nous constatons que la population a été consultée pour tous les grands investissements de transports collectifs, ce qui a permis aux autorités d'appliquer sans hésiter une politique restrictive à l'égard des automobilistes, et à ne pas envisager de mise en souterrain des tramways par exemple (sauf exception à Zürich pour un faible linéaire) : les transports de surface ont dès le début des années 70 obtenu la priorité aux carrefours à feux et un suivi en temps réel à l'aide de SAE (Système d'Aide à l'Exploitation). Enfin l'intégration tarifaire pour tous les modes de transport public dans le périmètre des transports urbains a été mise en place dès les années 1975-80.
- dans le deuxième groupe concernant les grandes métropoles, la fréquentation est importante compte tenu de la densité de population et de l'offre, le souci des autorités organisatrices et exploitants est d'augmenter la part de marché par la qualité de service : l'intégration tarifaire est en place depuis une vingtaine d'années, la couverture de la desserte est optimisée, des transports de nuit sont organisés, les correspondances multimodales sont en place et l'effort d'amélioration est actuellement porté sur l'information multimodale des voyageurs.
- dans le troisième groupe des agglomérations moyennes, la desserte est encore en cours

Tableau 1 : Part des TC en entrée du centre-ville dans des villes européennes (hors circulation des piétons et des cyclistes).

Villes	TC en %
Stockholm	71
Zürich	65
Glasgow	64
Hanovre	63
Liverpool	58
Vienne	57

Source : Kühn & Hayat (1999) d'après Storstockholms Lokaltrafik, Strategisk plan 1996.

d'extension (notamment après la construction des premières lignes de métro à Lyon et à Marseille) par des lignes de surface, des stations de correspondance multimodale ; un effort particulier est mis sur la qualité de service, enjeu important pour garder et attirer de nouveaux clients, par exemple à Oslo où est proposé la Garantie du voyage en transports urbains, Kühn & Hayat (1999).

4 LES RÉSEAUX DE TRANSPORT URBAIN DANS LES PAYS ÉMERGENTS

La croissance rapide de nombreuses villes des pays émergents a privilégié la quantité de l'offre de transport de leurs systèmes de TC au détriment de l'efficience ou de la qualité de service offerte aux clients. La croissance rapide de la motorisation dans ces pays nous incite à réfléchir car le mode de déplacements en TCU (bus, tramway, métro, etc.) est de plus en plus concurrencé par l'automobile. Les systèmes de TCU de ces pays se distinguent par les conditions dans lesquelles se déroule l'exploitation, la charge des véhicules et des stations, le respect de la séparation des sites utilisés par la circulation générale, la prise en compte ou non des véhicules aux feux, etc., différentes contraintes qui font qu'un système fonctionne bien en Europe avec une charge moyenne et fonctionne mal dans un pays émergent avec une forte charge en atteignant très rapidement ses limites bien en dessous des objectifs théoriques prévus lors de la mise en place des projets de transport. Les nouvelles technologies appliquées en Europe ne sont elles pas applicables progressivement dans ces pays ?

Si nous examinons les problèmes du transport urbain en Amérique Latine multiples et variés, par exemple Peralta (1992), nous constatons :

- au niveau du service de transport, l'absence de services dans certaines zones, la diminution ou la suppression de transport durant des périodes horaires importantes, l'irrégularité du service, la saturation du système de transport à certaines heures et sur certains parcours, des correspondances obligées dans le centre, un manque de complémentarité des différents modes, etc.
- au niveau des usagers, le manque d'offre dans les zones de fortes demandes, l'augmentation des distances absolues et relatives entre les zones d'habitat et de travail, de loisir et d'études, la nécessité d'utiliser plus d'un service de transport et faire de long parcours à pied, etc.
- au niveau des exploitants, il y a la concentration de l'offre dans les aires centrales ; l'augmentation du parc ou éventuellement et conjoncturellement sa diminution ; la diminution des subventions de l'État ou de la municipalité pour améliorer l'offre de service et l'augmentation de la privatisation ; la croissance du transport informel à travers différents moyens (jeeps, camionnettes, vans, etc.) en dehors du contrôle de l'État et libérés des exigences du système formel, etc.
- au niveau de la structure urbaine, il y a la congestion dans des zones déterminées (centrales), sur un système viaire inadapté et insuffisant, des distances excessives pour l'expansion et l'organisation de la ville, l' inaccessibilité de zones déterminées par le mauvais état et le manque de voirie, etc.

Une grande partie de la population vit en zone urbaine, il y a une croissance vertigineuse du parc automobile et l'autobus est le grand transporteur des masses : 80.000 véhicules assurent encore plus de 65 % des TCU de 36 villes d'Amérique du sud, Alouche (1995).

5 LE SERVICE ATTENDU DES TRANSPORTS URBAINS DANS LES PAYS ÉMERGENTS

Dans les pays où le besoin fondamental d'être transporté est accompli d'autres aspirations plus ou moins précises émergent, il importe donc de suivre les attentes des clients-voyageurs : de grandes tendances se retrouvent partout qui traduisent en fait les évolutions de la société et par conséquent les évolutions de la définition de la qualité : besoin de confort (vétusté du parc utilisé et état de l'infrastructure), besoin de climatisation, besoin d'être accueilli dans un monde qui se déshumanise, besoin d'être informé, besoin de continuité par rapport aux services offerts dans la ville, etc.. Le problème de congestion automobile, le bruit, la pollution atmosphérique provenant des émanations des pots d'échappements des automobiles et des véhicules utilitaires deviennent des sujets de préoccupations pour l'État, la Région et les habitants des moyennes et grandes agglomérations en France et ce problème se pose également dans les grandes métropoles du monde (Tokyo, Mexico, Saõ Paulo, Le Caire, Los Angeles, New York, Séoul, Manille, Calcutta, Hong Kong, etc..) comme les moins grandes (Bâle, Zürich, Milan, Francfort, Londres, Athènes, etc..). La population devient de plus en plus sensible aux problèmes d'environnement et de qualité de la vie dans la ville.

Ainsi dans la Région Métropolitaine de São Paulo (RMSP) sur 31 millions de voyages effectués chaque jour 1/3 est effectué à pied, 1/3 en voiture et 1/3 en TCU : sur les 10 millions de voyages effectués en TCU près de 8 millions sont effectués avec plus de 15.000 autobus qui circulent chaque jour. Ajoutés aux 4 millions de voitures qui circulent journellement, ces autobus lorsqu'ils ne circulent pas en site propre participent à la congestion de la circulation qui bloque la population locale une vingtaine de jours par an, Goldschmidt (1996). Cette congestion se traduit par des morts et blessés dans les accidents de la route, 20 % de la population active consacre plus de 3 heures par jour aux transports et 10 % plus de 4 heures. 27 % des trajets nécessitent plusieurs moyens de transport. Afin de réduire l'engorgement croissant de la capitale, plusieurs mesures visant à fluidifier le trafic par une meilleure gestion de la circulation sont envisagées.

Des enquêtes réalisées par l'Association Nationale des Transports Publics du Brésil (ANTP) et l'Institut Gallup au Brésil montrent que les usagers et la population apprécient les services offerts par le métro et par les autobus métropolitains en site propre : la technologie choisie importe assez peu aux usagers, mais ils souhaitent la régularité, la rapidité, le respect des horaires, des conditions de confort et d'accessibilité correctes. Aussi le Secrétariat Municipal des Transports (SMT) de São Paulo a décidé d'augmenter la capacité des lignes de transport par autobus de 6000 passagers par heure et par sens (p/h/s) à 20.000 p/h/s sur les sites propres et donc SPTrans gestionnaire du réseau municipal d'autobus adopte un réseau de système intermédiaire basé sur des véhicules sur pneus de grande capacité, guidé, à traction électrique et exploité à très grande fréquence. Le SPTrans outre le système intermédiaire, applique un nouveau plan, nommé « Programme des Corridors et Terminaux d'Intégration », PCTI qui doit créer un vrai système Intégré dans la ville, à partir de la réalisation de nouveaux corridors et de nouveaux terminaux de correspondance avec des travaux de voirie sur près de 300 km. Les lignes locales qui alimentent les axes lourds sont en correspondance aux terminaux et sont exploitées par des véhicules plus grand c'est à dire des autobus ou des trolleybus articulés. Outre ces axes prioritaires, une partie du réseau de lignes radiales d'autobus a été remis à niveau pour devenir lignes de rabattement ou d'alimentation des axes lourds.

C'est l'annonce d'une priorité absolue aux transports publics, aux systèmes de transports guidés, de haute capacité, à traction électrique et en site propre. Ainsi un programme intégré de transport urbain (PITU) a été proposé par le Secrétariat des Transports Métropolitains (STM) pour améliorer, construire et mettre à disposition de la population de la métropole une nouvelle offre de transport urbain d'une manière intégrée et coordonnée avec l'environnement et l'aménagement du territoire. Outre les extensions du réseau de métro et des trains de banlieue, le PITU prévoit la création d'un réseau radial de couloirs d'autobus de la métropole intégrés avec les sites propres pour autobus de la ville du PCTI : ces couloirs permettent d'accroître la vitesse commerciale et de réduire le nombre d'autobus qui y circulent. Le PITU va se réaliser en fonction des possibilités de financement ce qui va prendre de nombreuses années : aussi c'est l'autobus qui continuera à dominer l'offre de transport public de la région et de la ville de São Paulo pour encore de nombreuses années.

6 LA QUALITÉ DE SERVICE À METTRE EN OEUVRE

Une norme française expérimentale XP X 50-80 « Qualité de service dans les transports - Identification des critères de qualité pour le transport de voyageurs » a été publiée par l'Association Française de Normalisation (AFNOR) en France en Avril 1997 et un projet de norme internationale européenne N 75 « Services de transport - Transport Public de Voyageurs - Définition de la qualité de service, objectifs et mesures » est en cours d'élaboration par le comité technique CEN/TC 320/WG5, Mathieu et al. (1998).

La norme européenne prescrit des exigences permettant de définir des objectifs et de mesurer la qualité de service dans le domaine du transport public de voyageurs et fournit des lignes directrices pour le choix des méthodes de mesures correspondantes. Son utilisation permet de traduire les attentes des clients et leur perception de la qualité en termes de paramètres de qualité viables, mesurables et gérables.

Le prestataire de service doit s'assurer que les exigences concernant le management de la qualité, la définition de la qualité de service et les mesures de cette qualité sont satisfaites.

En ce qui concerne le management de la qualité, un système doit être mis en oeuvre pour s'assurer que les étapes et points suivants soient pris en compte :

- Les attentes explicites et implicites des clients sont identifiées,
- Les contraintes légales, politiques, financières sont prises en compte,
- Les niveaux de qualité existants et les domaines d'amélioration potentiels sont identifiés,
- Des objectifs sont établis en prenant en compte les éléments ci-dessus, ce qui implique la traduction des données en critères de qualité mesurables,
- Les performances sont mesurées,
- Des actions correctives sont prises,
- La perception par le client de la qualité réalisée est évaluée.

Des plans d'action appropriés sont élaborés et mis en oeuvre pour réduire les écarts entre :

- la qualité réalisée et la qualité perçue
- la qualité attendue et la qualité perçue.

La qualité globale du transport public de voyageurs est constituée d'un grand nombre de critères (8 catégories). Ces critères représentent le point de vue du client sur le service fourni :

1. Offre de service
2. Accessibilité
3. Information
4. Temps
5. Attention apportée au client
6. Confort
7. Sécurité
8. Impact environnemental.

Les trois premières catégories décrivent l'offre de transport en général, les catégories 4 à 7 détaillent la réalisation du service, la catégorie 8 décrit l'impact environnemental sur la collectivité.

Dans le livre vert « Un réseau pour les citoyens », la Commission Européenne rappellait en 1996 que : « Des systèmes efficaces de transport de passagers sont essentiels pour les économies et la qualité de vie des citoyens. Il importe que les systèmes de transport soient conçus pour rencontrer les besoins des citoyens et qu'ils soient suffisamment souples pour suivre l'évolution de leurs exigences, y compris le développement de la demande de transports. L'utilisation intense de la voiture particulière qui effectue 75 % des trajets en Europe contribue largement à l'offre de transport : cette utilisation a aussi décuplé les embouteillages, la pollution et les accidents, facteurs qui affectent les automobilistes et les autres usagers de la route. Il convient donc de privilégier le développement de transport public de passagers ». Le livre vert indiquait ainsi que les européens doivent s'intéresser au transport collectif parce que les nuisances de l'automobile affectent de plus en plus les usagers de la route, le cadre de vie des citoyens et parce que 40 % des ménages ne possèdent pas de voitures particulières. Au Brésil ce taux croît à 75 % et dans d'autres pays d'Amérique Latine, d'Afrique et d'Asie ce taux approche les 100 %. Il est donc primordial pour ces derniers pays de s'intéresser à la qualité de service des transports de voyageur pour stimuler, développer, organiser les transports urbains de telle manière que la répartition modale reste équilibrée entre automobiles et transports collectifs, favorisant avant tout les transports urbains dans les métropoles.

Tous les grands réseaux de transport urbain dans le monde s'intéresse à l'application de méthodes de suivi en vue d'améliorer la qualité de service, ce suivi étant plus ou moins avancé selon les priorités de l'entreprise et son potentiel en ressources humaines, Viegas & Macàrio (1999). Ainsi, l'ANTP au Brésil dans un ouvrage « Transporte Humano - cidades com qualidade de vida » en 1997 a développé différents thèmes du transport public dont les systèmes de qualité. Dans le domaine de la qualité de service, l'ANTP décrit l'autoévaluation de la qualité par l'exploitant lui permettant de recueillir des informations pour vérifier le niveau de la qualité offerte et son amélioration éventuelle. Le Prix ANTP de la Qualité a été institué en 1995, c'est un programme d'encouragement à l'auto-évaluation des exploitants : l'objectif de ce prix est d'inciter les corporations impliquées dans le transport urbain à améliorer l'efficacité des services rendus au moyen d'une bonne gestion, en distinguant les meilleures d'entre elles. De la même façon la municipalité de São Paulo a institué un programme de qualité des Transports Urbains par décret municipal et le gestionnaire des autobus municipaux SPTrans a créé un Prix de la Qualité. Ce réseau d'autobus est organisé en 64 lots, exploité par 47 entreprises, chaque lot comprend un nombre variable de lignes, la gestion et la programmation se fait sous la responsabilité de SPTrans. Le programme de qualité de la municipalité détermine le niveau de qualité et son évolution tout au long de l'avancement du concours, trois aspects ayant chacun la même valeur pour l'obtention du Prix sont retenus :

- l'offre programmée en véhicule-km effectivement réalisée ;
- l'état de la gestion de la qualité réalisée par l'exploitant, selon les critères du Prix National de la Qualité ;
- la satisfaction des usagers.

Il y a de grandes variations entre les différents lots quant au niveau de satisfaction, l'identification des points critiques est fondamentale pour améliorer en priorité le service de ces lignes. Le Prix contribue à un environnement de compétitivité inexistant antérieurement, qui a pour conséquence une amélioration de la gestion et des services offerts à la population de la ville de São Paulo.

Des mesures d'amélioration de la qualité de service qui font leur preuve dans les pays du Nord pourraient être mises en oeuvre en priorité dans les pays émergents comme la complémentarité physique entre les modes de transport :

- concevoir des infrastructures nouvelles de transport collectif en site propre et les restructurations de réseaux qui en découlent, dans le sens d'un maillage général du territoire à desservir, minimisant les temps de déplacement pour l'ensemble des voyageurs ;
- dans le cas de réseaux en site propre déjà réalisés, remédier aux maillons manquants en minimisant les ruptures de charge ;
- en zones périphériques, systématiser l'organisation de rabattement sur les gares de chemins de fer et les lignes interurbaines ou urbaines : c'est sans doute là que devrait être organisé le transport alternatif par minibus, vans, combis, etc.

D'autres actions comme la qualité des points d'échange, l'harmonisation des horaires, les tarifications intégrées mais aussi des véhicules bien adaptés et confortables et des infrastructures entretenues sont tout aussi prioritaires de façon a réagir devant l'envahissement de l'automobile.

7 CONCLUSION

La limitation de l'usage de la voiture particulière en ville au nord comme au sud devient une nécessité incontournable. L'alternative est un transport public de qualité. Ainsi, si le niveau de performance des principaux critères que sont la disponibilité, l'accessibilité, l'intermodalité, le confort, la régularité et la sécurité, reste élevé, la qualité de service devrait satisfaire les clients. Les mesures tendant à modifier directement le niveau de service des TC ont des effets positifs sur leur fréquentation, surtout lorsqu'elles améliorent leur régularité, leur vitesse commerciale et leur fréquence. En Suisse où la population a été consultée pour tous les grands investissements de TC, les autorités ont appliqué sans hésiter une politique restrictive à l'égard des automobilistes et se sont données les moyens d'offrir des transports de surface de qualité dès le début des années 70 avec la priorité aux carrefours à feux, un suivi en temps réel à l'aide de SAE et l'intégration tarifaire pour tous les modes de transport public dans le périmètre des transports urbains ou la région.

Les systèmes de TCU des pays émergents se distinguent des systèmes de transport des pays développés par les conditions dans lesquelles se déroule l'exploitation, la charge des véhicules et des stations, le respect ou non de la séparation des sites utilisés par la circulation générale et le système de transport, la prise en compte ou non des véhicules aux feux, etc. Ces systèmes demandent à avoir un suivi de la qualité du service offert. Différents outils et méthodologies existent à travers le monde pour suivre et améliorer cette qualité. Les autorités doivent avant tout décider de donner ou renforcer la priorité aux TC sur la circulation générale et financer des infrastructures en site propre pour résoudre les problèmes urgents de capacité de transport. Tout retard dans l'obtention de ces financements favorise la place de l'automobile dans la ville. La complémentarité physique entre les modes de transport, la qualité des points d'échange, l'harmonisation des horaires, les tarifications intégrées se règleront normalement ensuite entre gestionnaires et exploitants des transports publics car ces partenaires ont des intérêts convergents.

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The challenges of public transport systems in an automotive era

Les défis des systèmes de transport public à l'ère de l'automobile

Los retos de los sistemas de transporte público en la era del automóvil

F. Kühn
INRETS, Institut National de Recherche sur les Transports et leur Sécurité, Arcueil, France

L. A. Lindau
UFRGS, Université Fédérale de Rio Grande du Sud, Porto Alegre, Brazil

ABSTRACT : We present some possible improvements of Urban Public Transport (UPT) about congestion management, UPT priority, traffic calming, using of new intermediate system technology, use of park and ride, information given before, during and after journeys, integration of public transport services, promotion and marketing of UPT and generally service quality. The objective being pursued of course being to satisfy and retain the existing clientele as well as attracting non-users who would opt for UPT, thus becoming a serious alternative to the use of private car in town.

RÉSUMÉ : Nous présentons quelques améliorations possible des Transports Collectifs Urbains (TCU) relatives à la gestion des encombrements, la priorité aux TCU, la modération de la circulation, l'utilisation de la nouvelle technologie des systèmes intermédiaires, l'usage des parkings de dissuasion, l'information avant, pendant et après les voyages, l'intégration des services de TCU, la promotion et le marketing des TCU et en général la qualité de service. L'objectif poursuivi bien sûr est de satisfaire et de retenir la clientèle actuelle et aussi attirer d'autres utilisateurs qui choisiraient les TCU, devenant ainsi une alternative sérieuse à l'usage de l'automobile en ville.

RESUMEN : Presentamos algunas mejoras posibles de los Transportes Urbanos (TU) relativos a la gestión de la congestión, la prioridad a los TU, la moderación de la circulación, la utilización de la nueva tecnología de los sistemas intermediarios, el uso del estacionamento disuasivo, la información antes, durante y después de los viajes, la integración de los servicios de TU, la promoción y el marketing de TU y en general la calidad del servicio. El objetivo buscado es la satisfacción y atracción de la clientela actual y también atraer nuevos usuarios al TU, convirtiéndose así en una alternativa al uso del automóvil en la ciudad.

1 INTRODUCTION

« Nous ne pouvons plus nous permettre de laisser entrer de plus en plus d'automobiles dans les centre-villes (...). Nous devons accepter de larges interdictions de la voiture particulière dans les centre-villes. » Ainsi s'exprimait il y a 10 ans le Président de Volvo dans une interview au magazine Der Spiegel, Quidort (1991). Les constructeurs d'automobiles ont bien compris que l'usage inconsidéré de celles-ci crée plus d'inconvénients que d'avantages. Pourtant de nombreux schémas et actions vis à vis de la circulation urbaine ont été conçus et adoptés pour réagir contre la congestion de la circulation urbaine depuis les années 1960.

Après une période de construction de grandes infrastructures qui a permis d'accroître la possession et l'utilisation des automobiles, il semble maintenant qu'il y ait un consensus pour lutter contre la congestion en définissant et en mettant en oeuvre des politiques générales de déplacement : 84% des citoyens interviewés dans 13 pays d'Europe estiment que la préférence devrait être donnée aux transports publics plutôt qu'à l'automobile dans les espaces encombrés. En Allemagne et en Suisse par exemple, l'accroissement du PNB et du parc automobile n'ont pas entraîné le déclin du transport public mais ont au contraire favorisé son développement en parallèle avec l'utilisation d'autres modes de transport, Laconte (1996).

Les transports collectifs urbains (TCU) ont bénéficié d' innovations technologiques considérables ces vingt dernières années. Les réseaux se sont développés et modernisés, de nouvelles gammes de matériels et de systèmes sont aujourd'hui en service.

La qualité et l' attractivité du service public se sont renforcées. Les conditions d' exploitation se sont transformées. Davantage de sécurité, de souplesse et d' adaptation aux besoins sont assurées grâce aux possibilités offertes par l'automatisation.
L' évolution des TCU a été marquée par l'apparition de systèmes dits "intermédiaires" entre d'une part les systèmes "lourds" de type métro conventionnel ou

régional et d'autre part, les réseaux d'autobus ou de trolleybus circulant au sol en site plus ou moins protégé, Kühn (1997).

La qualité de vie des citadins peut aujourd'hui être améliorée grâce à de nouveaux concepts et de nouvelles technologies offrant plus d'information, de souplesse, de confort, de fiabilité, de sécurité et de vitesse, etc. Les nouvelles technologies d'exploitation permettent au transport public de satisfaire les attentes de la population et par conséquent d'augmenter le nombre d'usagers.

Les récents progrès réalisés dans l'information en temps réel des passagers (horaires et disponibilité) permettent un meilleur équilibre entre l'utilisation des différents modes de transport et facilitent l'intermodalité. Ainsi à Karlsruhe, des véhicules roulant sur les voies du tramway et du chemin de fer ont été mis en service : ce système tram-train évite les ruptures dans la continuité des trajets et les problèmes qui en résultent, ce qui a quadruplé la demande.

2 L'ESPACE PUBLIC

2.1 Le partage inégal de l'espace public

L'environnement de l'homme en ce début de XXI[ième] siècle est surtout urbain : l'organisation des déplacements est un des enjeux essentiels pour la qualité de la vie et le développement économique. L'automobile s'est appropriée la plus grande partie de l'espace viaire. Les systèmes de TCU sont beaucoup mieux adaptés que l'automobile pour assurer la majeure partie des déplacements urbains, en particulier ceux à destination des centres villes car ils n'utilisent qu'un espace au sol très réduit pour le stationnement et rentabilisent au mieux la capacité d'écoulement des voies de circulation : la consommation d'espace et les nuisances diminuent.

Après avoir défini le rôle et le statut de l'espace, il est nécessaire de réaffecter une part plus importante de cet espace à l'usage du transport urbain ; non seulement les TCU ont besoin de sites propres pour concurrencer valablement l'automobile, mais en outre cette appropriation d'espace urbain s'avère parfaitement légitime au regard de l'efficacité relative des modes de déplacement par rapport à leur consommation d'espace. Ainsi, l'autobus assure à Paris et l'Île de France 30 % des déplacements en TC malgré une vitesse commerciale peu attractive, n'occupant qu'environ 3 % de la voirie.

2.2 Les déséquilibres centre - périphérie

Au modèle simple de liaisons quasi-exclusives entre centre et banlieues, il faut aujourd'hui substituer un schéma multi-directionnel, où s'interpénètrent le monde rural et le monde urbain. Ainsi en Île de France la mobilité (en terme de migrations alternantes selon l'horaire de pointe) en TCU décroît au fur et à mesure que l'on s'éloigne du centre de Paris : les déplacements en automobile de banlieue-banlieue ont augmenté d'années en années depuis 1970 représentant en 1991-92 68,9 % de la part modale en Île de France. Ces trajets périphériques en TCU représentent 24,4 % de part modale alors que pour les liaisons Paris-banlieue et Paris-Paris cette part représente respectivement 70,2 % et 75,4 % des déplacements en 1991-92, Merlin (1997). Les analyses de la demande et de l'offre de transport montrent que seuls les TCU peuvent assurer les trafics les plus intenses dans le centre de l'agglomération et sur les axes radiaux aux heures de pointe. L'automobile assure l'essentiel des trajets banlieue-banlieue et pour tous motifs atteind 65,6 % de part modale, tandis que les TCU atteignent 28,1% de la part modale. La politique de transports selon P.Merlin ne peut être en Île de France « qu'une recherche de la meilleure complémentarité possible entre l'automobile et les transports en commun. C'est la voie choisie par le Schéma Directeur de la Région Île de France (SDRIF)».

2.3 Une politique globale des déplacements

Le service qu'attend le voyageur est de pouvoir aller aisément d'un point à un autre quelque soit le mode ou l'opérateur concerné. Les plans de circulation et de stationnement sont insuffisants pour traiter avec pertinence des problèmes de déplacements.

Le déplacement est un concept plus global qui part des besoins de l'usager puis essaie de structurer l'organisation des différents modes y compris la marche à pied et des différents services, en tentant de tirer profit des potentialités de chacun tout en prenant en compte l'intérêt général. Le choix de l'usager doit pouvoir s'exercer dans un cadre mieux défini : le plan de déplacement urbain (PDU) qui est le lieu d'analyse et d'organisation des flux, un outil de planification. Dans ce PDU tous les modes et toutes les techniques doivent être cernées : l'automobile, les TCU, les taxis, les deux-roues, les transports de marchandises, etc.

2.4 La gestion de la circulation

Cette gestion peut s'améliorer en réduisant si possible le nombre de véhicules en circulation, en supprimant la circulation de transfert par le centre-ville, en mettant des voiries périphériques à disposition et un plan de circulation dissuasif, en limitant les places de parkings au centre et les reportant à la périphérie à proximité d'un système de TCU. La limitation de la circulation peut aussi se faire par des programmes de gestion du trafic par « cellules de circulation » instituées dans plusieurs zones du centre d'Athènes par exemple, en créant des sas où sont retenus les véhicules aux heures de pointe afin de les dissuader de s'approcher du centre (système Gertrude à Bordeaux). La restriction d'accès au centre historique de villes italiennes validée par référendum municipal s'impose dans 45 villes : seuls les véhicules de services autorisés munis de vignette pénètrent dans la zone centrale. Les véhicules du système TCU circulant mieux attirent naturellement les automobilistes ce qui doit aussi alléger la congestion de la circulation.

2.5 Le péage urbain

Le péage urbain adopté en Norvège (Oslo, Bergen et Trondheim) permet aux municipalités de dégager des ressources pour investir dans les TCU et la voirie : on constate aussi une réduction sensible de la circulation. Ce système est aussi à l'étude dans d'autres villes européennes et à travers le monde, Kühn & Hayat (1999). Plusieurs études ont montré que le transfert de l'automobile vers les TCU n'augmenterait que si les services d'autobus et chemins de fer sont améliorés et leurs tarifs réduits en même temps que le péage urbain est appliqué.

3. L'EXPLOITATION DES TRANSPORTS COLLECTIFS

3.1 La priorité aux transports publics

Dégagés des aléas de la circulation, les TCU sont théoriquement susceptibles d'assurer une vitesse commerciale supérieure à 20 km/h et une régularité convenable : les seules perturbations proviennent des échanges en station et de la gêne mutuelle des véhicules. L'aménagement de sites propres au sol procède donc d'une volonté d'améliorer l'efficacité de la voirie existante en accordant aux TCU un domaine réservé et une certaine priorité au franchissement des carrefours.

Le niveau de service offert aux voyageurs et la capacité maximale de transport des systèmes de Transport en Commun en Site Propre (TCSP) au sol varient considérablement selon le véhicule utilisé et selon que le site propre est implanté hors voirie, sur autoroute ou sur voirie urbaine et, dans ce dernier cas, selon le niveau de protection, nécessairement imparfait dans les centres des villes.

L'amélioration de la priorité aux TCU peut être effective lorsque il y a une redistribution des emprises routières disponibles pour accorder plus d'espace aux TCU et aux piétons : parallèlement un espace moindre est concédé aux véhicules à usage privé. Ainsi le concept du « modèle de Zürich » s'applique au réseau routier de la cité historique de Zürich et définit l'aptitude de cette ville à intégrer un système de TCU à la fois moderne, rapide et fiable : L'un de ses principaux objectifs vise à garantir la commodité d'accès du centre-ville en recourant à un système de TC attrayant et peu coûteux, Joos (1990). Par ailleurs la priorité de passage aux TCU s'effectue avec la maîtrise parallèle des conditions de circulation et de stationnement des automobiles : les axes utiles pour les TCU sont dégagés de tout obstacle engendré par la présence d'automobiles et de véhicules de livraison à l'arrêt. Ainsi, les sites protégés par de la signalisation mais non séparés par des clôtures ou ilôts sont respectés en Suisse mais ne le sont pas nécessairement ailleurs.

3.2 Les systèmes de priorité

La mise en oeuvre de mesures de priorité pour les TCU n'est pas un concept nouveau ni révolutionnaire. Elle varie de mesures simples, comme les feux alternés aux intersections critiques, à l'implantation de voies aériennes en site séparé pour autobus. De nouvelles dimensions ont été réunies à la notion de priorité pour les TCU sur pneus : le concept adopté n'est plus limité aux mesures physiques et d'exploitation locale pour favoriser le mouvement de véhicules individuels ou en convois. Ainsi, autrefois la décision de prolonger la durée de temps de vert des feux pour un autobus était prise individuellement par le détecteur le plus proche des feux, les systèmes ITS (Intelligent Transport System) permettent maintenant au poste central de contrôle de gérer la circulation de la ville en tenant compte du retard de chaque autobus qui s'approchent d'une intersection, avec d'éventuels préjudices à la progression des véhicules non prioritaires. La notion de priorité aux TCU s'est élargie à un ensemble de mesures physiques et d'exploitation locales et globales qui offrent des réductions de coûts généralisés aux usagers des TCU et qui contribue à la réduction des externalités négatives engendrées par la circulation sur la voirie urbaine, Lindau & Kühn (1999).

3.3 La modération de la circulation

Des mesures de modération de la circulation (traffic calming) ont été introduites avec succès dans un certain nombre de villes du Danemark, des Pays Bas et d'Allemagne où elles sont le plus largement appliquées ; ces mesures ont pour objectif de réduire les vitesses et le nombre de victimes et de rendre les quartiers plus plaisants et mieux adaptés aux besoins des piétons et des cyclistes. Ces mesures ne sont véritablement efficaces que si elles sont appliquées sur l'ensemble d'une zone ou même d'une ville avec des priorités clairement définies en matière de transport. Ces mesures sont complémentaires de celles qui donnent la priorité aux TCU.

3.4 L'organisation des transports urbains

L'organisation du transport aérien et du transport de marchandises a traversé une phase de rupture avec l'introduction du principe de « hub and spokes » ou plaque tournante d'aéroport et lignes aériennes. Ainsi ce type d'organisation est utilisé dans la messagerie express où les colis expédiés de toutes les villes des USA sont regroupés par avion dans la nuit sur un aéroport localisé au centre du pays, Niérat (1998). La prise en compte du déplacement global du passager et souvent des consommations en amont et en aval avec des numéros de vols uniques pour un déplacement faisant appel à plusieurs appareils successifs et une maîtrise complète des correspondances est régulièrement effectuée par les compagnies aériennes.

Pour relever le défi des TCU avec succès ne pourrait on pas examiner ce que ce type d'organisation pourrait apporter à l'amélioration de l'efficacité et donc de la fréquentation des TCU ?

L'automobile a des contraintes comme les embarras de la circulation, les feux, des plans de circulation dissuasifs, etc. mais elle roule directement vers son but final. Les véhicules de TCU sont omnibus, ces systèmes perdent leur attractivité dans les zones de faible densité et en dehors des heures de pointe, la voiture circulant alors aisément.

Le schéma traditionnel de déplacement marche à pied - liaison TC - marche à pied pourrait être amélioré par un schéma automobile/deux-roues - liaison TC - marche à pied et/ou véhicule en self service, ce dernier schéma s'inspirant du réseau « hub and spokes », le hub étant la station d'échange TC/automobile à côté de laquelle on trouve un parking de dissuasion pour automobiles, un parking à vélos, une gare routière où arrivent d'autres lignes de TC en rabattement. La liaison continue TC (spoke) pourrait être exploitée selon le site géographique, selon l'histoire des transports de la ville, selon la demande à court et moyen terme, par les chemins de fer (RER, train de banlieue), le tramway/métro léger, le métro/Val, des systèmes intermédiaires tels que tramways sur pneus, trolleybus ou bus articulés en site propre, Lauer (1994). Cette liaison doit être prolongée jusqu'au centre car d'importantes augmentations de fréquentation ont été constatées partout où les lignes suburbaines ont été prolongées jusqu'au centre-villes (RER à Paris, S-Bahn à Münich, liaisons Cologne-Bonn, etc.). À Berne, sur le réseau RBS entre 1973 et 1975 il y a eu 35 % d'augmentation de la fréquentation, à Bâle 20 % sur le réseau BLT entre 1985 et 1987.

3.5 Les nouvelles technologies au service de l'exploitation

De nouveaux équipements tels que les systèmes d'aide à l'exploitation (SAE) ont été mis en place sur les réseaux de TCU (autobus, tramways, métros) pour augmenter d'abord leur productivité. Ces systèmes de régulation informatisés permettent de décaler les départs pour respecter les intervalles et de donner aux conducteurs les indications nécessaires pour régler leur allure par rapport à une marche-type. Le PCC ayant une vision de la position des rames par rapport à la position théorique communique un ordre d'accélérer ou de ralentir, il agit de plus sur le fonctionnement des feux de circulation en accordant à la rame une priorité proportionnelle au retard. Les SAE facilitent une meilleure adaptation de l'offre de transport aux conditions de circulation. Ils sont de véritables outils de régulation du trafic et sont utilisés comme support d'information du public. Les données transmises par le SAE permettent d'alimenter un système d'information dynamique des voyageurs qui transmet sur les quais et dans les zones d'accès toutes les informations en temps réel sur les services. Grâce aux informations communiquées, le voyageur est en mesure d'adapter son comportement en conséquence et de mettre à profit le temps d'attente.

De la même façon, l'application de l'automatisme intégral de conduite aux nouveaux systèmes de transport a permis d'obtenir des performances techniques (vitesses élevées, réduction des intervalles entre rames, accroissement de la sécurité) que la conduite humaine ne permettait pas d'obtenir. En effet aux heures de pointe sur le réseau de métro urbain de Paris et d'autres réseaux à travers le monde, la plupart des lignes fonctionnent depuis une vingtaine d'années déjà en automatique au moins aux heures de pointe, c'est à dire à celles où la conduite doit être la plus performante et où l'attention des conducteurs risquerait d'être sollicitée au-delà de ce qui est humainement possible. L'automatisation intégrale et la haute fréquence de passage permet une réduction de la capacité unitaire des véhicules (la productivité de l'exploitation n'est alors pas mise en cause par l'accroissement du nombre de véhicules automatiques en circulation). La réduction de la taille des véhicules permet d'alléger le système de roulement, on peut adopter par exemple l'essieu de camion à la place du boogie à deux essieux, l'insertion de petit véhicule est plus facile dans les tracés sinueux, outre les dimensions, le poids global est diminué ce qui permet de réduire les dimensions des ouvrages de génie civil et la voie.

L'essor très rapide des technologies liées à l'électronique et à l'informatique annonce des gains de productivité accrus imposant aux réseaux de transport collectif une évolution croissante vers l'automatisation.

3.6 Les systèmes intermédiaires

Le système de transport intermédiaire en surface permet d'exploiter un plus grand nombre de lignes y compris en banlieue dans des zones de densité moyenne. D'où l'idée du maillage qui est aussi le moyen d'adapter la structure traditionnelle radioconcentrique du réseau à l'évolution de la demande en instaurant des lignes de rocade connectées aux axes radiaux. Un des atouts du système intermédiaire est sa souplesse qui lui permet de quitter le site propre pour aller sur la route en site banal desservir la banlieue, par exemple. Mais cette souplesse peut être aussi un inconvénient c'est à dire que le maître d'ouvrage ne réalise pas le site propre là où c'est le plus contraignant et donc là où il est le plus nécessaire. La desserte fine des zones à faibles densités ne doit pas augmenter les coûts d'exploitation du tramway sur pneus, son taux de remplissage devenant trop faible, Kühn (1998). Le trolleybus guidé ou le tramway sur pneus, le tramway léger et le tramway hybride ce dernier utilisant à la fois les chemins de fer existants et de nouvelles infrastructures dans des centres urbains, sont les véhicules adaptés aux systèmes de transport urbain intermédiaires.

3.7 Les parkings de dissuasion

Faciliter l'utilisation des parcs de stationnement en périphérie, inciter les automobilistes à se rabattre sur les axes lourds en amont des zones encombrées conduit à une tarification intégrée offrant pour un titre unique le stationnement et l'accès aux TC. Accroître l'utilisation de parkings de dissuasion conduit à améliorer la part modale des TC si la correspondance est optimisée du point de vue confort et temps de déplacement.

3.8 De nouvelles liaisons

La ville n'est plus le seul lieu d'habitation, les citadins s'étendent de plus en plus loin en périphérie. Le réseau de TC seul ne peut plus répondre à tous les besoins, il faut établir ou renforcer de nouvelles liaisons directes et efficaces entre la ville et sa région.

Au centre, l'accès et la desserte des zones piétonnières, la desserte des centres commerciaux et d'activités continuent à être effectués par les TC.

En périphérie, le rabattement de chemins piétonniers, de voirie secondaire s'effectuent sur les axes de TC, des parcs de stationnement pour les voitures et les deux-roues sont installés à proximité des gares ou des stations de TC.

Les lignes principales d'autobus doivent être renforcées pour réduire le temps de déplacement. Pour des raisons de coût d'exploitation les exploitants utilisent de plus en plus sur les lignes principales des autobus de grande capacité articulés ou bi-articulés (Bordeaux, Curitiba) qui circulent à intervalles assez courts en heure de pointe puis plus longs aux heures creuses dissuadant ainsi les clients potentiels. On peut imaginer l'introduction de bus express aux heures de pointe, de minibus (coletivos de Buenos aires qui concurrence le métro) ou midibus en Angleterre qui exploité avec une bonne fréquence à Leeds, Swansea, Newbury ont amélioré la fréquentation des TC passant à court intervalle tout au long du jour avec un taux de remplissage maximum, Watts & al. (1990). De nouvelles lignes de TC desservant des zones universitaires comme à Lausanne et à Amsterdam ont vu leur demande en augmentation significative.

3.9 L'information

L'accès à une information intermodale permet au voyageur de choisir avant son départ voire, à terme, en temps réel la meilleure combinaison de modes pour atteindre sa destination. Les informations délivrées avant le déplacement (à la maison, aux arrêts), pendant (à bord des véhicules) et après le déplacement peuvent s'améliorer par l'utilisation des moyens modernes de distribution de l'information - télétexte TV, Internet, Minitel -, etc, de sorte que l'information puisse être obtenue facilement. Fournir ces renseignements à l'arrêt ou à la gare est souvent trop tard car une partie des clients potentiels a déjà choisi l'automobile. La technologie GPS (Global Positioning System), est de plus en plus utilisée pour fournir la position précise du véhicule. Le transfert de données mobiles va permettre de transmettre l'information à d'autres systèmes et enfin à l'usager chez lui qui connaîtra ainsi l'heure à laquelle le véhicule passe à l'arrêt situé à proximité, d'où une réduction du temps d'attente et de l'incertitude d'obtenir un véhicule de TCU : le transport public devient ainsi plus attrayant et la solution de facilité qui était seulement réservée à l'automobile s'élargit aux TCU.

3.10 La qualité du service

Les TCU urbains assurent en France en moyenne autour de 20 % des déplacements. À São Paulo, par exemple, les TCU assurent un tiers des déplacements de la Région Métropolitaine de São Paulo. Il est vraisemblable que l'automobile conservera encore une part modale importante dans les déplacements des grandes agglomérations à travers le monde. Pour que les différents systèmes de TCU soient préférés à l'automobile, il faut que chacun de ces systèmes apportent des gains sur les temps de déplacements, sur le confort, sur la sécurité, sur l'accueil et l'information : il est donc primordial d'améliorer leur qualité de service.

Dans le domaine des temps de déplacements c'est la priorité aux TCU qui fait ses preuves : de véritables sites propres doivent être mis en place pour assurer le gain de temps sur les parcours en centre-ville à l'heure de pointe par rapport à l'automobile, Lefèvre & Offner (1990).

L'amélioration du confort de l'usager passe par l'accessibilité du système et des véhicules et une meilleure information : sur le temps réel d'attente à l'arrêt, la connaissance continue de la situation du trafic, l'intégration des services, l'exploitation, les tableaux horaires, la capacité d'offre, la billeterie, les fonctionnalités des arrêts et des stations d'échange, les conditions d'attente et le confort des véhicules, etc.

La billeterie doit être simple, le prix et la facilité d'accès au système de TCU sont deux des facteurs essentiels déterminants pour le choix entre l'automobile ou les TCU. Des technologies récentes offrent une vaste gamme de moyens de paiement ainsi que des politiques de tarification individuelles : des réseaux de TCU à travers le monde ont introduit des systèmes de perception pour lesquels les voyageurs doivent présenter leur billet à l'entrée et à la sortie ce qui permet de calculer le prix du trajet sur la base de la distance réellement parcourue. L'utilisation de la carte Smartcard sans contact comme titre de transport va faire disparaître les temps d'attente aux barrières d'entrée-sortie des systèmes de TCU, cette technologie va s'étendre à l'ensemble des systèmes de transport de l'autobus aux métros ainsi qu'à d'autres services comme le téléphone, parking, etc. Les réseaux d'autobus de Séoul (8.700 bus équipés en 1996) et de São Paulo début 2000 (12.000 bus) sont actuellement les deux plus grands réseaux du monde à être équipés en valideurs sans contact.

L'usager est sensible à une haute fréquence de passage qu'apporte l'automatisme intégral, en supprimant toute longue attente en station. Cette qualité redonne de l'attrait au transport public. De plus, cette haute fréquence peut être aussi obtenue en heures creuses en fractionnant les rames entre heures de pointe et heures creuses ce qui apporte une souplesse supplémentaire d'exploitation.

4. CONCLUSION

La circulation automobile excessive, particulièrement dans le centre des agglomérations, est un facteur de détérioration de la qualité de la vie urbaine. L'expérience de certaines villes nouvelles montre que la circulation automobile peut être maîtrisée. Le développement des zones piétonnes parfois couplées avec la circulation exclusive des autobus/tramways (par exemple, la Fußgänger Zone de la Bahnhofstraße à Zürich) dans de nombreuses agglomérations européennes indique des solutions possibles. L'augmentation de la mobilité urbaine liée aux mutations de l'environnement économique et social appelle une croissance nouvelle des TCU.

La nouvelle génération de TCU basée sur les techniques numériques apporte des améliorations importantes au transport urbain à des coûts raisonnables. Cette nouvelle génération de TCU se traduit par exemple, par le passe sans contact ou le péage de l'an 2000 à Paris, São Paulo et Séoul, la radiolocalisation des mobiles qui permet une gestion centralisée de la sécurité des autobus et fournit aux arrêts les temps d'attente des deux prochains bus et à bord les temps de trajet, une information intégrée et performante sur l'offre de transport et les rames de métro à grande fréquence. Les citadins souhaitent de plus en plus de mobilité avec facilité, agrément et en toute sécurité, la mise en service de nouvelles générations de TCU va élargir leurs possibilités de déplacement et sans doute arrêter l'expansion de l'automobile dans la cité.

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La logística en las empresas de transporte urbano

La logistique dans les entreprises de transport urbain

Logistics in urban transportation enterprises

L.Ojeda Toche
Universidad Autónoma del Estado de México, México

ABSTRACT: The objective of this document is to describe the application of logistics in the services industries, specially, in urban transportation firms, as a mechanism for increase their competitiveness and decrease their impact on the environment.

RÉSUMÉ: L'objectif de cet document est decrire l'application de la logistique dans les entreprises de services de transport urbain, comment une forme d'augmenter sa compétitivité et la diminution de l'impact sur l'environnement.

RESUMEN: El objetivo de este documento es describir la aplicación de la logística en las empresas de servicios, particularmente, en las empresas de transporte urbano, como un mecanismo para aumentar su competitividad y disminuir su impacto negativo sobre el medio ambiente.

1 INTRODUCCIÓN

En la última década la logística se ha convertido en una herramienta estratégica que permite a las empresas competir de manera activa en un ambiente internacional más competitivo. Sin embargo, la definición tradicional de la logística orientada a la producción y distribución de bienes es demasiado estrecha para reflejar su posible aplicación en las organizaciones de servicio. Una definición más amplia que involucra tanto la cadena de abastecimiento como la respuesta de servicio : "*La logística es el proceso de anticiparse a las necesidades y deseos de los clientes, aplicando capital, materiales, personal, tecnologías y la información necesaria para satisfacer estas necesidades y deseos, optimizando la red de producción de bienes o servicios para satisfacer los requerimientos del cliente de manera oportuna*", Little (1991), tiene la ventaja de reconocer que los clientes quieren beneficios, los cuales pueden ser bienes, servicios o ambos.

Por otro lado, el transporte es un factor importante en la logística tanto de empresas de producción como en organizaciones de servicio, más aún, las empresas de transporte pueden clasificarse dentro de éstas últimas, de ahí, que resulte casi natural la aplicación de la logística hacia el interior de las propias empresas de transporte, no sólo como un elemento componente de la cadena de abastecimiento o de la logística de servicio de otras empresas, sino como una empresa de servicio que requiere mejorar su competitividad.

Particularmente, la aplicación de la logística en las empresas de transporte urbano redundará tanto en beneficios económicos como en un menor impacto al ambiente, mediante la mejor utilización de su flota vehicular, un mejor cálculo de su capacidad, un conocimiento más real de su estructura de costos, una mayor preferencia por parte de los usuarios, como consecuencia de un nivel más alto de servicio, una mejor programación de corridas (rutas y horarios), mantenimiento de vehículos y la utilización de tecnologías alternativas favorables al medio ambiente.

Este documento tiene por lo tanto, el propósito de describir la aplicación de la logística en las empresas de transporte urbano, como un mecanismo para aumentar su competititividad y disminuir su impacto negativo sobre el medio ambiente.

2 LA LOGÍSTICA EN LAS EMPRESAS DE SERVICIOS

La logística de la cadena de abastecimiento es el manejo de materias primas, materiales en proceso e inventarios de productos terminados desde su punto de origen hasta su punto de consumo; y es el proceso tradicional asociado con la producción y distribución de bienes. La logística de la cadena de abastecimiento también existe en las organizaciones de servicios, sin embargo, tiene un papel secundario para la administración, programación y soporte de la capacidad de la red para servir. La logística de respuesta de servicio, es el proceso de coordinar todas las actividades necesarias para proporcionar el servicio a un costo y de una manera efectivos. Frecuentemente, la logística de respuesta de servicio es el núcleo de las operaciones de las organizaciones que proveen servicios. Un elemento crítico de la logística de respuesta de servicio, es la provisión de entradas en el punto de entrega del servicio (por ejemplo: una maquina contestadora, un módulo o un teléfono de información). Incluye actividades para anticipar las necesidades, programar la capacidad de la red para servir y brindar los canales necesarios para satisfacer los requerimientos de los clientes.

La logística de respuesta de servicio también existe en las organizaciones que producen bienes pero es relativamente una función menor y tiene un impacto limitado sobre las utilidades y la ventaja competitiva de la organización. La fig.1 muestra la diferencia en importancia de la logística de la cadena de abastecimiento y la logística de la respuesta de servicio en las empresas productoras de bienes y las productoras de servicios.

Tanto las organizaciones que producen bienes como las de servicios deben realizar las mismas funciones básicas en sus negocios, por ejemplo, ambas deben:

Crear o identificar necesidad
Pronosticar y planear la respuesta
Construir capacidad y/o inventario
Aceptar pedidos y autorizar su cumplimiento
Asignar capacidad y/o inventario para cumplir con un pedido
Usar óptimamente la red para responder a un pedido
Entregar beneficio a través del canal de distribución

Dependiendo de la forma en que las organizaciones satisfacen los requerimientos del cliente, se presentan variaciones en estas funciones básicas. Clasificar a las organizaciones por la forma en que ellas satisfacen las necesidades de los clientes es útil para estudiar los procesos logísticos, ya que la satisfacción del cliente es precisamente el papel fundamental de la logística. Existen tres ambientes:

a) En un ambiente exclusivo, las organizaciones son de manera natural o regulada, monopolios. Los ejemplos incluyen compañías locales de teléfonos, el servicio postal, los sistemas de transporte público y los hospitales rurales. Para estas organizaciones, los procesos logísticos que son requeridos para satisfacer los pedidos de los clientes tienden a ser simples y estandarizados y están orientados hacia la mejor utilización de los recursos de la compañía más que hacia la maximización de la satisfacción del cliente.

b) En una ambiente predeterminado, las organizaciones anticipan los requerimientos del cliente y construyen capacidad y/o inventario para satisfacerlos, los ejemplos incluyen bancos, hospitales y hoteles. Lo adecuado del pronóstico y la habilidad para vender la capacidad determina el éxito de la organización. Los procesos logísticos son medianamente sofisticados e impactan tanto la eficiencia de las operaciones como la ventaja competitiva. Los estándares de servicio tienden a ser altos.

c) En un ambiente post-determinado, las organizaciones esencialmente reaccionan a los pedidos del cliente. Los ejemplos incluyen los restaurantes. La logística dentro de estas organizaciones tiende a ser un factor de éxito clave e impacta enormemente los costos de operación y la ventaja competitiva. Los deseos y necesidades de los clientes son más importantes.

Para todos estos tipos de organizaciones los aspectos clásicos logísticos se aplican, sin embargo, existen varias diferencias entre la naturaleza de la producción de bienes y la de servicios, las cuales son importantes cuando se comparan los procesos logísticos entre los dos grupos de industrias. Estas diferencias son descritas abajo:

El papel de la capacidad, las consideraciones de capacidad juegan un papel importante en las organizaciones de bienes como en las de servicios, sin embargo, existen tres diferencias importantes:

Primero, los inventarios de bienes actúan como un resguardo, permitiendo a la firma brindar productos durante periodos de demanda pico dentro de sus parámetros de servicio usuales y sin esfuerzo extraordinario, las organizaciones de servicios no dan este lujo, sin embargo, si ellas no tienen la capacidad en el lugar durante la demanda pico, deben renunciar al negocio, bajar el nivel de servicio o invertir costos y esfuerzo. Por ejemplo, los hospitales no aceptan pacientes cuando ellos están llenos o los colocan en lugares inapropiados en casos extremos (como después de un desastre), en algunos días festivos el servicio de teléfono se ve enormemente afectado, debido a la saturación de la capacidad de la red.

Una segunda diferencia en la administración de la capacidad para las organizaciones de servicios es que usualmente la capacidad puede solamente ser cambiada en cantidades fijas. Por ejemplo un avión completo y una tripulación debe ser programada entre dos ciudades, o un hospital debe agregar capacidad de camas completas. En comparación las organizaciones que producen bienes pueden usualmente producir unos pocos items más sin incurrir en una gran cantidad de cambios. Ellos pueden también frecuentemente expandir su capacidad.

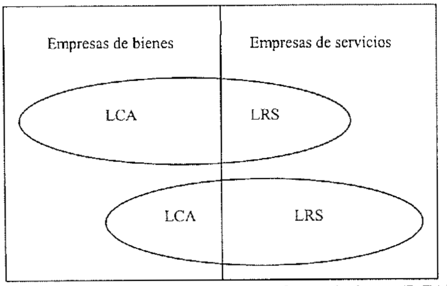

Fig. 1 Logística de la cadena de abastecimiento (LCA) y logística de la respuesta de servicio (LRS)

La tercera diferencia es la relativa a la inflexibilidad de la capacidad en una organización que produce servicios. Por ejemplo, la sección de un hospital no puede ser utilizada para otros propósitos si la demanda de camas en ésta no se da. Las opciones para el exceso de capacidad en un ambiente de bienes, tienden a ser más numerosas, debido parcialmente a que la ubicación o usos de la capacidad es menos crítica. Por ejemplo, la ubicación de un almacén o planta puede ser desafortunada, pero tal desventaja no es visible para el cliente.

Desde una perspectiva logística, la importancia de la administración de la capacidad para una organización que produce servicios es similar a la importancia de la administración del inventario en una organización que produce bienes.

La estructura de costos, la mayoría de los costos en el sector servicios son fijos. La mano de obra y el capital representan más del 75% de los costos de operación total en la mayoría de las organizaciones de servicios. Así, la contribución marginal de volumen agregado es relativamente insignificante,. Por ejemplo un pasajero adicional en un avión tiene bajo costo marginal (y un alto ingreso marginal). Esto es totalmente opuesto en el caso de las organizaciones que producen bienes. Los costos fijos, incluyendo la mano de obra y las inversiones de capital, tipicamente suman menos del 20% de los costos de operación. Los principales costos están en materiales e inventarios. El valor marginal de las ventas adicionales en las organizaciones de bienes, por lo tanto, no es tan grande como en las organizaciones de servicios, y los costos marginales son mucho mayores.

Debido al bajo costo marginal de servir a un cliente individual, la pérdida de ingresos debido a la pérdida de un cliente es mucho mayor que en un ambiente de bienes, enfatizando enormemente el papel del servicio al cliente en las organizaciones de servicios.

3 LA LOGISTICA EN LAS EMPRESAS DE TRANSPORTE URBANO

Para analizar la logística de las empresas de transporte urbano es importante considerar tanto su logística de la cadena de abastecimiento como su logística de respuesta al cliente.

Los varios elementos de la logística de la cadena de abastecimiento (transporte, almacenamiento, control de inventarios, compras y servicio al cliente) están presentes en las empresas de transporte urbano, ellas necesitan comprar, transportar, almacenar y controlar una serie de insumos, partes de repuesto, harramientas, papelería de oficina, boletos, tarjetas de checado etc. El administrar correctamente estas funciones permitirá a los transportistas reducir costos y aprovechar mejor sus recursos.

Por otro lado, la logística de la respuesta de servicio se enfoca principalmente en las tres siguientes áreas:

a) Minimización de tiempos de espera;
b) Administración de la capacidad de servicio; y
c) Entrega de servicio a través de los canales de distribución.

Los tiempos de espera ocurren en muchos lugares del servicio de transporte público (espera de llegada del autobús, ascenso, compra de boletos, transferencia) y juegan un papel determinante en la calidad del servicio.

Las organizaciones de transporte urbano pueden trabajar en la reducción de tiempos de espera, utilizando técnicas tales como:

- Simplificación de procedimientos
- Sistemas de información que guíen al cliente sobre horarios, rutas etc.
- Programas de calidad total

El área más importante para el éxito en la operación de una empresa de transporte público de pasajeros y en general de las empresas de servicios, es la administración de su capacidad (tamaño y configuración de la flota vehicular, número de choferes, número y configuración de rutas, horarios, etc.). Poca capacidad resulta en pérdida de ventas, mientras que demasiada capacidad significa operaciones excesivamente costosas.

Algunas de las herramientas que las empresas de transporte público pueden utilizar para mejorar la administración de su capacidad son:

- Programación proactiva: las empresas de transporte público de pasajeros tienen demandas pico bien definidas, por lo que deben estar completamente preparadas para responder eficientemente a éstas. Por otro lado, durante los períodos de baja demanda pueden planearse programas de mantenimiento preventivo de la flota vehicular.

- Entrenamiento del personal: el personal puede ser capacitado en áreas diferentes a su función principal, y entonces puede realizar diversas tareas, con lo que se expande la capacidad, mientras se mantiene una fuerza laboral estable. Los choferes pueden ser capacitados en reparación de vehículos, en la reglamentación vial, el trato al usuario, etc.
- Sistemas de programación: la habilidad para predecir y/o localizar exceso de capacidad, puede tener un impacto significativo sobre las operaciones. Se han desarrollado técnicas de modelado para predecir flujos de vehículos y volumen de usuarios. Lo adecuado de estas predicciones impacta enormemente sobre la eficiencia de las organizaciones de transporte urbano.

La logística de la respuesta de servicio incluye los diferentes canales de distribución que una organización usa para entregar sus productos (bienes y/o servicios) a sus clientes. Algunos de los diferentes canales que las industrias de servicio utilizan son: correo tradicional y electrónico, teléfono, internet, intercambio electrónico de datos(EDI), en el sitio.

Para el caso de las empresas de transporte público de pasajeros, el canal de distribución natural es en el sitio, esto es, al abordar el usuario el vehículo, sin embargo, los canales de distribución pueden ampliarse mediante:

- La venta automática de boletos
- La venta de tarjetas con un número de viajes predeterminado etc.

4 CONCLUSIONES

A pesar de que el campo de la logística en las empresas de servicio aún es casi inexplorado, basta con revisar algunos de los conceptos relevantes de la logística de la cadena de abastecimiento como de la respuesta de servicio para identificar los beneficios potenciales en costo y efectividad, que las organizaciones de servicio pueden alcanzar.

Para el caso de las empresas de transporte público de pasajeros se han mencionado sólo algunos aspectos generales sobre la logística de estas empresas, mismos que es necesario reconocer, ampliar y desarrollar en investigaciones futuras, ya que representan una oportunidad para ahorrar costos, mejorar el servicio y disminuir el impacto ambiental, tanto a corto como a largo plazo.

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Formal and informal public transport performance assessment: Nairobi case study

Evaluation de la performance du transport public officiel et inofficiel: le cas de Nairobi

Estimación formal y informal del funcionamiento del transporte publico: Caso estudiado Nairobi

Jan H. Koster
Institute for Infrastructural, Hydraulic and Environmental Engineering, Delft, Netherlands

Gerwin Hop
Civil Engineering and Management, Twente University, Enschede, Netherlands

ABSTRACT: This paper reports on a pilot study into the performance of the Nairobi public transport system. This system is fully privately operated and largely deregulated. It consists of two sub-systems competing on the same routes: traditional buses operated by Kenya Bus on the one hand, and a host of minibuses (matatu's) on the other. The main findings of the pilot study are that: (i) the traditional bus subsystem is outperformed, on average, by the minibuses at all times of the day as regards both time and monetary costs to the user, and (ii) the absence of competition from the traditional bus sub-system on a minibus-only route has not resulted in lower frequencies or higher occupancy rates or fares. The paper concludes that competition in the market in Nairobi between two different subsystem may eventually result in the demise of what is in theory the most efficient of the two: the traditional bus system. However, in view of competition which exists between mini buses operating on the same route, this may not necessarily result in the negative consequences for the user associated with 'normal' monopolies.

RÉSUMÉ: Une étude pilote est présenté sur la performance du transport publique à Nairobi. Le système est géré par des entreprises privées et largement dérégIé. Il s'agit de deux systèmes en compétition, les autobus traditionnels, gérées par Kenya Bus, et le flotte des minibus (matatu's). Les résultats de l'étude montrent que (I) le système traditionel est moins effectif que les minibus point de vue financiel et durée de voyage pendent toutes les heures de la journée et (ii) les trajects qui ne sont pas servis par le système traditionel ne montrent pas une fréquence moins élevée ou des tarifs plus chèrs. La conclusion de l'étude est que meme en étant le système le plus effectif, le système minibus risque de disparaître à cause de la compétition entre les deux sytèmes de transport. Pourtant, en tenant compte de la compétition entre les minibus, qui traversent le mème parcours, il n'est pas nécessaire que les voyageurs seront exposés aux conséquences rélatées normalement à une monopole.

RESUMEN: Este documento reporta en un estudio piloto el funcionamiento del Sistema de Transporte Publico en Nairobi. Este sistema es operado completamente privatizado y sin regular en su mayor parte. Este consta de dos subsistemas compitiendo en la misma ruta: Buses tradicionales operados por Kenya Bus de un lado y por el otro minibuses (Matatu's). Lo mas importante encontrado en este estudio fue que: (1) el subsistema de bus tradicional esta fuera de funcionamiento como promedio, mediante los minibuses en cuanto a tiempo y costo monetario para el usuario y (2) la esencia de la competencie del subsistema de bus tradicional con el minibus de una ruta no ha resultado en bajas frecuencias o mayor rango de ocupacion o pasaje. El trabayo concluye que la competencia en el mercado en Nairobi entre dos subsistemas diferentes puede resultar eventualmente en fallecimiento de cual es en teoria el mas eficiente de los dos: el subsistema tradicional. Sin embargo desde el punto de vista de competencia la cual existe entre las operaciones del minibus en la misma ruta, esta puede no necesariamente resultar en consecuencias negativas para los usuarios asociados con los monopolios normales.

1 INTRODUCTION

Within the framework of the Urban Transport Component of the World Bank/UNECA Sub-Saharan Africa Transport Programme, studies have been undertaken in Kenya and Tanzania into the mobility of the urban population. Although this Urban Mobility and Non-Motorised Transport Pilot Project, as the name implies, focusses on walking and cycling, a pilot study was also undertaken within this project into the performance of the public transport system of Nairobi, being the only motorised means of transport available to the majority of the population. This paper describes the reasons for undertaking the pilot study, its objectives and the initial results.

2 BACKGROUND

In the fall of 1998, Stagecoach Ltd. of Scotland sold its 75% share ownership in Kenya Bus (that it obtained in 1992) to an unknown group of Kenyan investors. This event marks the end of a six year period during which the company has attempted to provide, on a profitable basis, public transport services in Nairobi. This decision of Stagecoach Ltd. to end its involvement in a traditional bus company facing fierce competition in the entirely privatised and deregulated public transport environment in Nairobi undoubtedly reflects the company's inability to continue to compete with the minibus system and at the same time provide reasonable returns to its shareholders. 1

This paper reports on the results of a study into the performance of the Nairobi public transport system, which was conducted in the Spring of 1998, i.e. prior to the withdrawal of Stagecoach Ltd. The objective of this study was to obtain an insight into the performance from the user perspective (focussing on frequencies, travel times and fares), and on the differences in performance between the traditional bus company. (Stagecoach Kenya Bus, hereafter called 'Kenya Bus'), and the minibus system (hereafter called, by its local name, 'matatu's).

The results of this survey indicate that Stagecoach 1Ltd.'s decision to withdraw from the Nairobi scene is quite understandable. What is less understable is the Nairobi City Government's laisser faire policy, which has allowed the continuing demise of traditional bus services, to the detriment of not only shareholders, but, more importantly, the users. In this sense, Professor White – one of the UK's leading authorities on public transport -, may well have had Nairobi in mind when he wrote, on the subject of competition in public transport: *'At times, one gets the impression that the government is more concerned with the freedom of individual companies and managers rather than the users as such'. [White 1995].*

1 It is germane to note that Stagecoach have been highly successful in the more regulated UK market

3 STRUCTURE OF THIS PAPER

The next section of this paper provides a brief account of urbanisation trends in Sub-Saharan Africa, and the importance of public transport in providing mobility for large segments of the population of the rapidly growing cities. This is followed by a brief description of the Nairobi public transport system in section 5. The objectives and methodology of the Nairobi public transport performance pilot study are described in section 6, while section 7 presents the first results. Finally, section 8 lists the provisional conclusions.

4 URBANISATION AND PUBLIC TRANSPORT IN SUB SAHARAN AFRICA

4.1 *URBANISATION*

As is the case for other regions in the world, Africa is urbanising rapidly. In fact, the continent currently has the fastest urbanisation rate in the world: some 4.5% annually [United Nations, 1995]. In Eastern Africa, the level of urbanisation (being the percentage of the population living in urban areas) has increased to some 20% currently and is set to continue to increase over the years to come. For individual countries, growth rates in the period 1980-1992 considerably exceeded the average: Kenya 7.7%, Tanzania 6.6% and Zimbabwe 5.9% [World Bank 1994]. Nairobi confirms this overall picture. Between 1979 and 1989, the Nairobi population increased by an average of 6% per year, and is currently (1999) estimated at some 2.5-3 million.

4.2. *Public transport*

This rapid and continuing population growth is accompanied by an equally rapid growth in the demand for public transport, not only because of the increase in the number of (potential) users, but also because the increasing commuting distances, which result from physical expansion of the cities, make other modes of transport (walking, cycling) less attractive. As a result, it is recognised more and more that the availability of viable bus services is vitally important to the efficiency of cities and the well being of their citizens [Armstrong-Wright & Thiriez 1987].

While deregulation and privatisation of public transport in the Western world is, in many cases, just starting, in many African countries, especially in Sub-Saharan Africa, these processes have already gone to the extreme. Government budget deficits and related pressure from such organisations as the

International Monetary Fund and the World Bank, have in many instances resulted in (urban) public transport provision with little or no government involvement or control. This is all the more interesting in a situation where, in distinction to many cities in the West, public transport is not just a social good or an alternative to car travel, but the only motorised mode available (albeit not always affordable) to the vast majority of the urban population, providing 70-85% of all motorised trips [Armstrong-Wright 1993]. With the continuing rapid growth of these cities and the prevailing land-use patterns (concentrated employment, the low-income population concentrated on the urban fringes, resulting in long commuting distances), the importance of public transport can only increase further.

In this connection it is striking to see that very little is known about the performance of public transport systems in these cities, while even less is being done to improve this performance. The reduction of government involvement and control seems to have been accompanied by a decrease in interest in the performance of a system, which provides the majority of motorised trips. Most importantly, questions about crucial demand-related performance parameters -like accessibility, frequencies, and monetary and time costs to the users- usually go unanswered, especially in relation to the important informal (= undocumented) part of the system. In addition, as in the West, many studies evaluating the deregulation and privatisation of public transport, tend to concentrate on the influences of these changes on the supply side: reductions in government spending, financial performance of the operator, etc. Strangely enough, the effects on the user seem to be of lesser importance.

5 NAIROBI PUBLIC TRANSPORT SYSTEM

This paper does not attempt to provide a detailed description of the Nairobi public transport system (which, apart from some limited commuter rail operations, consists entirely of bus services). Readers interested in such detail are referred to other documents [e.g. Armstrong-Wright 1993, Post Buckley International 1998, Kapila *et al* 1981]. The description of the system below is restricted to its main features and those which have a direct relevance to the performance of the system from the user perspective, and on the differences in performance between the two sub-systems (Kenya Bus and matatu's).

The Nairobi public transport system is fully private, and operates without any government subsidies. In addition, the system operates in a largely deregulated environment: there is little or no government control of, or even influence on, such crucial elements as route structure, operational practises, timetables or fares. The system consists of two entirely different sub-systems, which compete on the same routes.

Kenya Bus is a private company operating some 370 large buses (110 pass.) on fixed routes and schedules. Most routes are radial routes, passing through the city centre. This reduces the need for passenger transfers and provides a competitive advantage over the matatu's, which are not permitted to enter the city centre. The market share currently stands at some 30%. This share has declined continuously since the legalisation of matatu operations in the mid-Seventies. The company now transports some 300,000 passengers per day, while the number of passengers transported per bus per day has been steadily declining over the past years: from a high of 1,500 pass/bus/day in the mid 80's to less than 1,000 in 1997. The network has been gradually reduced over time, as routes have been abandoned and taken over by matatu's [Post Buckley International 1998].

The second sub-system consists of privately owned minibuses (matatu's), mostly operating on the same routes as Kenya Bus, but without timetables. Kenya Bus recently estimated the number of matatu's operating in Nairobi at 6,500, out of which 2,500 are 25-seaters and 4,000 are 12-seaters 2. Matatu's largely ignore official bus stops and, especially in peak hours, depart only when fully occupied, and generally drive non-stop to the final destination. In off-peak periods, drivers try to pick-up as many passengers as possible on the way, which leads to erratic driving and stopping behaviour. During congested periods, traffic rules are often ignored (e.g. using the road shoulders to by-pass traffic jams). It is estimated that the matatu sub-system currently captures some 70% of the public transport market, or 700,000 passengers per day. This market share was estimated at some 50% in 1993/94, and has grown substantially over the years [Omwenga *et al* 1994].

Although formal route associations were banned some years ago for political reasons, such associations do exist informally. Operators pay a fee to the route association before being permitted to operate on the route. Although this might in theory lead to an oversupply (maximising the income from entry fees), there appears to be a counterbalance in that minibus operators (who compete with each other on the route), and thereby the route association, have a commercial interest in keeping the number of operators within reasonable limits.

2 In view of the numbers of matatu's operating on individual routes investigated in this pilot study, the total number is in reality probably closer to 4000-5000

Matatu owners reportedly do not pay taxes and fees, whereas Kenya Bus does. This fact, combined with the differences in operating practises and in degrees of adherence to traffic rules, gives matatu's a competitive advantage which at least partly counterbalances the disadvantage of not being allowed to operate within the CBD. Buses and matatu's share the regularly congested carriageway with other road users: dedicated infrastructure such as bus lanes, is absent, as is e.g. preferential treatment at controlled intersections. The most interesting feature about the system is that competition takes place on the same routes, in a deregulated environment, between two very different sub-systems. The question arises as to whether this has resulted in public transport provision, which is beneficial to the users.

6 OBJECTIVES AND METHODOLOGY OF THE PILOT STUDY

In view of the importance of (i) the Nairobi public transport system to the city at large and to the individual users; (ii) the absence of information on the performance of the system from the user perspective; and (iii) the rather unusual situation of two different sub-systems competing on the same routes in a privatised and deregulated environment, it was decided to conduct a pilot study into the performance of the public transport system from the user perspective. The pilot study was conducted at network level and at route level.

The objectives of the pilot study were to:

- obtain, for a sample of origin/destination links and a number of individual routes, information on travel times, fares and frequencies;
- assess the differences in performance as regards these parameters, between the (formal) traditional bus system and the (informal) minibus system;
- assess whether the absence of competition from Kenya Bus has influenced the performance of matatu's on matatu-only routes;
- obtain experience in data collection in the absence of written information on fare structures and timetables for the informal system.

Network level: on-vehicle survey
Data were collected by research assistants who made a total of about 430 trips between two large, low-income residential areas and nine different destination (employment) zones, using both the formal and the informal systems. More than 50% of the entire route system was covered in this way. Each assistant made four trips per day, as follows:

trip 1 morning peak, from origin to destination;
trip 2 off-peak/morning, from destination to origin;
trip 3 off-peak/afternoon, from origin to destination;
trip 4 evening peak, from destination to origin.

For each trip, waiting times, trip times and fares were recorded. In addition, off-peak frequencies were recorded during one-hour periods. Data collected during the study were subsequently analysed at the system level.

Route level: off-vehicle survey
In addition, off-vehicle data were collected for three different routes: two routes on which Kenya Bus and matatu's compete (routes 32/42: CBD-Dandora and 46: CBD-Kawangware), and one matatu-only route (Ford route: CBD-industrial area). Data were collected at terminals at both ends of the routes for two full day periods (the results presented in this paper are based on the analysis of data for one day only). Data collected were time of arrival/departure of the vehicle at the terminal, its registration number and the number of passengers on board.

7 RESULTS

7.1 *Validity*

A word of caution is warranted about the results presented below. All data have been obtained on a terminal- to-terminal basis. Therefor, the results are only valid for such trips. In view of matatu operating practises (depart when full), for peak period trips were the vehicle is boarded somewhere along the route, performance as regards waiting times may be lower (vehicles will not stop because they are full), and performance differences between buses and matatu's less pronounced. Alternatively, for such trips users will first walk to the terminal, resulting in longer access times.

7.2 *Results at network level (on-vehicle survey)*

From the data collected at network level, avarage waiting times, trip times, travel times, fares/km, trip speeds and travel speeds have been calculated. In table 1 below, the results are given for morning peak, evening peak and off-peak periods. It should be noted that the average distance for all trips was 12.7 kilometres.

From these results it is apparent that the:

- Overall system performance is low as regards travel time, for a city with the size of Nairobi. Adding some 15 minutes for access and egress, average total travel time in the morning and evening peak amounts to some 1 hour and 50 minutes for bus passengers, or more than 3.5 hours per day for work-related trips. The average ma-

Table 1: performance comparison KBS – matatu's at network level

Morning peak	bus	matatu	difference (%)
Average waiting time (minutes)	0:26	0:16	-38%
Average trip time *	1:09	0:45	-35%
Average travel time **	1:35	1:02	-35%
Average fare/km (US$/km)	0.035	0.027	-26%
Average trip speed (km/hr)	11.9	14.9	+25%
Average travel speed (km/hr)	8.6	10.8	+26%
Evening peak	**bus**	**matatu**	**difference (%)**
Average waiting time	0:25	0:14	-44%
Average trip time	1:11	0:37	-48%
Average travel time	1:36	0:52	-46%
Average fare/km	0.035	0.024	-31%
Average trip speed	11.5	18.0	+57%
Average travel speed	8.5	12.8	+51%
Off-peak	**bus**	**matatu**	**difference (%)**
Average waiting time	0:22	0:11	-50%
Average trip time	0:56	0:32	-43%
Average travel time	1:19	0:44	-44%
Average fare/km	0.026	0.018	-28%
Average trip speed	14.6	21.0	+44%
Average travel speed	10.4	15.2	+46%

* time taken from moment of vehicle departure to moment of arrival
** waiting time at bus stop plus trip time

tatu user spends some 2.5 hours commuting. It should be kept in mind that these are averages, and that these figures can be much higher for the longer commuting trips: some 25% of bus trips in Nairobi exceed 25 km in length [Post Buckley International, 1998].

- Average trip- and travel speeds are low, dropping to as low as 11.5 and 8.5 km/hr respectively for buses in evening peak conditions. In effect, if traffic safety allowed the use of bicycles in Nairobi, the bicycle would easily outperform the public transport system.
- Matatu sub-system easily outperforms the bus sub-system in every respect during all times of the day: waiting times, trip times and travel times are substantially lower as a result of higher frequencies and trip speeds, while fares are substantially lower.

It is stressed again that for the time being the observation regarding waiting and travel times is only valid for the origin/destination relations included in the pilot study. In view of the operating practises of matatu's, waiting times (and, as a result, travel times) for passengers wanting to board at locations other than the terminals at the end of the routes, may be longer.

7.3 *Results at route level (off-vehicle survey)*

Analysis of the data collected on the two routes on which KBS and matatu's compete (routes 32/42 and 46) gave the following results (table 2):

Table 2: Performance comparison KBS – matatu's at route level

	bus	matatu
Vehicles serving route	20 – 30	160 - 200
Interval (minutes)	9.5 – 14	1.25 – 2.25
Occupancy (% of no. of seats)	75 – 150	60 - 120
Market share (%)	28 – 33	67 – 72

A number of observations can be made on the basis of these results:

- The differences in numbers of vehicles serving the routes, in combination with the respective market shares, illustrates the inefficiency, from a traffic management perspective, of the matatu sub-system: some four times more vehicles are on the road to transport the same number of people as buses do. On the positive side, the matatu sub-system is, in view of the large numbers of vehicles, a major employer.
- The matatu sub-system offers much higher frequencies than KBS does. This results in the considerably lower waiting times reported above (even though, in view of the differences between the average intervals and the waiting times, passengers usually cannot board the first vehicle that departs). To this should be added that the differences in irregularities in the intervals between departures (standard deviation for KBS in the order of 8 minutes; for matatu's 1.5 minutes) result in a lower reliability of the KBS service.
- Matatu's do not appear to be more overloaded than KBS buses, although standing in buses is less uncomfortable than in matatu's.

Finally, a comparison is made (table 3) between the performance of matatu's on the two routes were they compete with KBS on the one hand, and on the CBD-industrial area route, where they enjoy a 'monopoly', on the other.

It is evident from these figures that the absence of KBS competition on this route has not resulted in any significant differences in performance of matatu's on this route compared with the routes on

Table 3: Performance comparison matatu's with/without KBS competition

	competition	monopoly
Interval (minutes)	1.25 – 2.25	1.5 – 2.7
Occupancy (%)	62 – 117	66 - 95
Fare (US$/km)	0.018 – 0.027	0.012 – 0.028

which there is competition. The small difference in intervals is probably explained by the fact that on this route not all matatu's run from terminal to terminal on each trip: some instances occur where the vehicle turns around before reaching the terminal. This results in slightly longer average intervals. Although evidence is limited, as only one matatu-only route has been analysed, it is possible that a matatu monopoly on routes does not necessarily lead to the adverse effects on the users usually associated with monopolies. In view of the competition which exists between matatu operators operating on the same route, there may be sufficient reason to provide sufficient supply and high frequencies, and to keep fares down. More data are currently being collected and analysed to support this.

8 CONCLUSIONS

Public transport in Nairobi has always been provided by private operators (with a varying government minority shareholdership in Kenya Bus Services, but without operational involvement or subsidies). Deregulation has taken place over the last decade, mainly by not enforcing existing regulations, rather than changing or abandoning them. This means that the influence of a privatisation and deregulation process as such cannot be studied in Nairobi.

What is clear, however, is that this fully privatised and largely deregulated public transport system does not perform well from the user perspective, and results in major losses to the economy. This malperformance mainly concerns the low operating speeds and, for buses, the long waiting times. These parameters are obviously interrelated: lower speeds result in lower frequencies and longer waiting times if the number of vehicles serving a route remains constant. As a result of an increasing number of private cars and the total lack of traffic management measures, congestion has increased over the years and operating speeds have declined (e.g. by 40 % on Stagecoach route 28 since 1993). The conclusion is inevitable that traffic management measures are now urgently required, including specific measures such as bus lanes. Such measures might result in lower travel times, increased frequencies, increased patronage, lower fares, or a combination of these. Recent studies into the effects of a possible bus lane on Jogoo Road[3], one of the major corridors in Nairobi, suggest a benefit/cost ratio in the order of 3, mainly as the result of time gains for both bus/matatu operators and users, and other road users. With a price elasticity of 1.0 for routes serving low-income areas [Post Buckley International 1998] lower fares would also be beneficial to those who currently cannot afford public transport, as well as to the operators who would see increased patronage.

Equally inevitable is the conclusion that competition on the same routes between two entirely different sub-systems with different operational practises and degrees of conformity to tax laws and traffic rules, has created a situation where, what should in principle be the most efficient sub-system, is outperformed. The sale by Stagecoach Ltd. of its shares is a logical consequence of this, and there is no reason to assume that their successors will do any better, unless they adopt the matatu operating practises. It is unfortunate, from the perspective of economic efficiency and efficient use of scarce road space, that a continuation of the current situation may eventually result in the traditional bus company terminating its operations in Nairobi altogether, leaving the matatu sub-system a virtual monopoly. There is however no evidence to suggest that such a monopoly would necessarily result in reduced performance of the matatu sub-system from the user perspective.

A side conclusion to be drawn is that the methodology used for data collection in this pilot study is highly appropriate for informal public transport systems and can yield high quality information at very limited costs (in the order of US$ 2,000 for this study). Further studies into the Nairobi public transport system are ongoing.

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A busway on Jogoo road, Nairobi

Un couloir d'autobus dans l'artaire Jogoo à Nairobi

Una vía de omnibus en Jogoo Road, Nairobi

G. Hop
Civil Engineering and Management, Twente University, Enschede, Netherlands

J. H. Koster
Institute for Infrastructural, Hydraulic and Environmental Engineering, Delft, Netherlands

L. de Jong
Civil Engineering and Management, Twente University & Keypoint Consultancy, Enschede, Netherlands

ABSTRACT: Public (bus) transport forms the backbone of motorised passenger transport in the city of Nairobi, Kenya. The system consists of two privately owned subsystems: standard type buses and a host of minibuses, competing on the same routes in a largely deregulated environment. From the user perspective, system performance is low as regards travel times. Low average speeds are mainly caused by congestion and the absence of busways and public transport priority measures. This study estimated the economic effects of a proposed busway on Jogoo Road, a major corridor in Nairobi, with the use of the 'Integration' model. It concludes that such a busway is an economically attractive option as a result of considerable speed increases for both public transport vehicles and general motorised traffic. It also makes the case that restricted use of this busway (prohibiting the use by smaller minibuses) can be an instrument to promote the use of larger, more efficient minibuses.

RÉSUMÉ : C'est le transport par autobus qui forme le pivot des transports automobiles urbains à Nairobi, au Kenya. Dans ce système on distingue deux sous-systèmes gérés par des particuliers: le service régulier d'autobus standard et l'utilization d'innombrables minibus, qui lui font concurrence sur les memes itinéraires dans un environment non-réglé. Du point de vue des utilisateurs, l'éfficacité de ce système est très réduite. Ce qui concerne la durée des voyages. Les vitèsses moyennes réduite sont causés principallement par la congestion de la circulation en l'absence de couloirs d'autobus et le manque de mesures de priorité pour les transports en commun. La presente étude suppose qu'on pourrait augmenter les effets économiques d'un couloir d'autobus telle qu'on le propose pour l'artaire Jogoo, l'axe principal de Nairobi, en appliquant le modèle "d'intégration". Or, on peut concluire que l'aménagement d'un telle couloir d'autobus serait un choix économiquement interesant à cause de l'accroissement considérable des vitèsses pour les véhicules des transports en commun, aussi bien que les transports automobiles en général. On stipule également que l'usage limitée de ce couloir d'autobus, interdissant l'accès en plus petit minubus, permettra de promovoir l'emploit de minibus plus longs, et par consequent plus éfficace.

RESUMEN :En la ciudad de Kenia, Nairobi el transporte público (en ómnibus) forma el espinazo del pasajero motirizado. Existen dos sistemas de ómnibus privados: un modelo corriente y una cantidad de minibuses, los dos tipos compiten en los mismos trajectos que se encuentran dentro de un área ampliamente desregulado. Desde el punto de vista del usuario el rendimiento del sistema es bajo considerando el tiempo de viaje. Principalmente el bajo promedio de la velocidad es debido a la congestión del tráfico y la ausencia de trajectos para ómnibus exclusivamente, además de medidas de prioridad para el transporte público. Este estudio evaluó los efectos económicos de una propuesta para una vía de ómnibus en Jogoo Road, la arteria de mayor transito en Nairobi, usando el modelo "Integration". Concluye que una vía especial para omnibus es una opción atractiva económicamente hablando, permitiendo aumentos considerables de velocidad tanto para vehiculos de transporte público como transporte motorizado en general. Tambien demuestra que el uso restringido de esta vía para omnibus solamente (vedado para minibuses más chicos) pudiera ser el instrumento para promover el uso de minibuses más grandes y más eficaces.

1 INTRODUCTION

1.1 *Background*

Public transport (PT) is the major motorised mode of transport in Nairobi, the capital of Kenya. The public transport system consists of two sub-systems: standard European type busses operated by Stagecoach Kenya Bus and mini-busses (matatus) owned by (small) private investors. The system is fully privatised and there is no government control, except for the provision of bus-terminals and the licensing of public transport. Public transport performance in Nairobi in terms of travel and trip speeds, is already low and deteriorating further, due to increasing congestion, the lack of bus-priority measures and the absence of enforcement of traffic regulations. These low trip speeds result in daily trip times of over 3 hours for commuting distances of up to 12-13 kilometres.

The deterioration of the PT-system leads to increasing operating costs for operators and may result in reduced levels of service and/or fare-increases, which could have serious effects on the access to mobility for the urban poor.

In a recently produced report on transport strategies for Nairobi (Post Buckley Consultants,1998) the importance of a well functioning public transport system was stressed once again.. A network of busways is proposed to form the backbone of this PT-system. One of the pilot projects proposed is a busway on Jogoo road, the case study for this research.

1.2 *Purpose of the research.*

The objective of the research was to make an economic appraisal of the busway on Jogoo road. This appraisal required the estimation of the busway effects, i.e. travel time changes for the PT as well as the general traffic. As regards the use of the busway, particular attention was paid to the different characteristics of the prospective users of the busway: traditional busses as well as small and large matatus.

1.3 *Research description*

The first step in the research consisted of literature study on the traffic situation in Nairobi. This literature study was followed up by data collection on the characteristics of the traffic flow on Jogoo road (January-April 1999).

The data served as input for the calculation of future travel times on Jogoo road. For this purpose the traffic simulation model Integration was used. The calculated future travel times formed the input for the economic appraisal of the Jogoo Road busway. The economic effects taken into account were limited to time benefits for PT-operators and -users, as well as those for the general traffic. Besides the fact that the latter category is a "real" economic benefit it is also crucial for the public and political acceptance of a busway, which will use existing road space. (Cornwell & Cracknell, 1990). The costs taken into consideration are the direct costs of the busway i.e. construction and maintenance costs.

2 THE NAIROBI PUBLIC TRANSPORT-SYSTEM: STAGECOACH AND MATATU'S

The characteristics of the Nairobi public transport system are quite unique. The system consists of two 'subsystems'. On the one hand there is the classical type bus system (operated by Stagecoach Kenya Bus), which operates with standard busses along fixed routes with more or less fixed timetables. On the other hand there is the matatu system: privately owned and operated mini busses, using the same routes as Stagecoach, but without timetables and largely ignoring official bus stops. The confrontation between these two concepts is not very unique, as it can be found in most capitals in developing cities. What makes the Nairobi situation interesting is that both concepts are operated by the private sector almost without government control (Koster, 1998).

Due to its limited passenger capacity and its popularity among the population there is an enormous growth in the number of matatus in Nairobi. There is no exact data available on the number of matatus operating in the city, but estimates vary between 3000 and 6500 vehicles. However, recent research on the main trunk roads in Nairobi (Koster, 1999) indicates that the likely number of matatus is somewhere in the region of 4000-5000.

From an environmental- and road utilisation perspective matatus are an inefficient PT-form. Matatus are very dominant in traffic. On most of the main trunk roads they form 10-20% of the total traffic flow, often causing congestion due to their chaotic driving and stopping behaviour.

There is a large variety in the type of vehicles operating as matatus, but the most common types are the Nissan "homy" with a capacity of 18 seated passengers and the Isuzu "NKR" with a capacity of 25 seated passengers. Stagecoach operates about 400 standard size busses, with an official capacity of 80 to 90 people. Of the 1 million Nairobi public transport passengers daily, about 30% are transported by Stagecoach, while the matatus account for the other 70%.

Figures for the two year period from 1994 to 1996 show a drop in ridership for Stagecoach of 3%, while production (no. of vehicle km.) increased with 10%. This means Stagecoach is transporting fewer passengers but is making more vehicle kilometres. Even though actual figures are not available yet, it is very plausible that this downward trend has continued during recent years.

3 THE CASE STUDY: JOGOO ROAD

Jogoo Road it is one of the main radial trunk roads linking the outskirts of Nairobi with the central city. Jogoo road is a major public transport travel corridor and PT-vehicles form a big part of the total traffic flow. The problems with respect to the disturbed traffic flow in Nairobi i.e. congestion and low average travel speeds are present on Jogoo Road and thus a busway seems to be a potentially successful measure to improve public transport performance. Furthermore, on Jogoo Road the physical conditions exist to allow the creation of a busway, without drastic changes to the surroundings or extensive investments. Jogoo Road stretches from Outer Ring Road in the east to the junction Landhies Road near the city centre (5.1km) and can be divided into three different parts with corresponding road-characteristics.

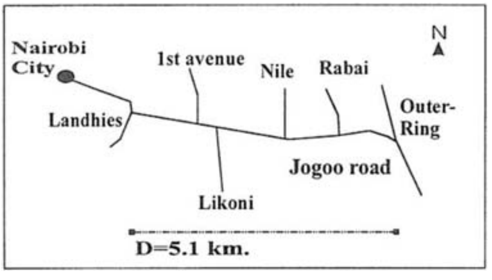

Figure 1: Schematic representation of Jogoo Road

On the first part, between Outer Ring Road and Rabai Road, road conditions are very poor. In the morning peak these road-conditions and high traffic intensities lead to severe congestion and abuse of the sidewalk by motorists.

The second part is the part between Rabai Road and the roundabout with Likoni Road. On this part road conditions improve. The road consists of 2x2 lanes with a width up to 7 meters. The carriageways are segregated by physical means.

On the last part between Likoni- and Landhies Road, road conditions are relatively good. Road width increases to 9-10 metres per direction, corresponding with triple lanes.

Especially on the last part near Lusaka road the busway could easily be realised on existing road space, reducing the width of the carriageway for general traffic to two lanes. However it is uncertain if this re-division of road space is feasible without negative effects on travel times of the general traffic.

As the morning peak is the most congested period on Jogoo road, the decision was made to analyse the implementation of a "town bound busway". In the morning peak the intensity of the town bound traffic is relatively high, with a maximum of about 2.500 vehicles per hour between First Avenue and Lusaka Road. Matatus form a big part of the total traffic flow. In the peak period as well as in the off-peak period matatus account for about 25% (566 and 376 vehicles/hour) of the total traffic flow on the main carriageway. Busses only have a share of 1% (32 vehicles/hour) respectively 2% (26 vehicles/hour) for the peak and the off- peak period.

From the recorded trip speeds in the morning peak, an average trip speed for the whole of Jogoo road could be computed. This speed is 14.7 km/h for matatus, 13.1 km/h for Stagecoach buses and 15.7 km/h for the general traffic. Although these speeds are low, hey are still higher than the trip speeds for busses and matatus (8.6 and 10.8 km/h) that Koster found in his research on public transport speeds. This difference can be explained by the inclusion of severely congested, inner-city routes in the Koster research. Although the traffic flow on Jogoo road is problematic and worsens in time, the situation is still better than on the totally jammed routes in the city-centre of Nairobi.

Every day some 21.000 passengers per hour are transported in the morning peak period on the busiest section of Jogoo road. In the off- peak period this number drops to some 10.000.The biggest share of passengers is transported by matatus. For the peak period as well for the off-peak period, they account for 84% (17.500 passengers) of the total number of passengers.

In the morning peak the biggest share is transported by 25-seaters, while in the off peak period 18-seaters transport more passengers. The larger market share of the 18-seaters in the off-peak period is explained by their constant number and their constant average passenger load during the day, while the number of 25-seaters and their average occupancy decreases after the peak period. The market share of Stagecoach is small. In the morning peak the company transports about 3.300 passengers on Jogoo road.

4 THEORETICAL FRAMEWORK TO ESTIMATE BUSWAY EFFECTS

4.1 *Estimation techniques used*

After the data-collection the next step in the research was the modelling of the traffic flow on Jogoo road. For this purpose the traffic simulation model Integration was used to model the effects of the busway on the travel times of the general traffic and public transport vehicles.

Integration was chosen because this model is pre-eminently suitable to model traffic flows in urban areas. The model is based on individual driver behaviour (microscopic traffic flow relationships) but has been calibrated with data on traffic flows as a whole, in order to capture the characteristics of traffic flow behaviour (macroscopic traffic flow theory). Another advantage of Integration is that it gives an on-screen representation of individual vehicles within the traffic flow. This enables the user to compare the model outcomes with the real traffic situation.

The second "tool" used to estimate the effects of the busway on trip and travel times a formula developed in the Transport Research Laboratory study "The performance of busway transit in developing countries" (Gardner & Cornwell, 1991). In this study about forty operational busways were identified in Africa, Asia, Australia, Europe, Latin America, the Middle East and North America in order to obtain reliable information on performance and likely performance of other specified schemes. The TRL-study was used as a directive for the calibration of the Integration-model.

4.2 *Assumptions underlying the modelling of the traffic flow*

The time horizon for the research was five year (i.e. until 2004). This horizon was chosen because developments in Nairobi follow each other rapidly and are relatively uncertain.

For small private operators it is financially less risky to operate a small vehicle. That is why privatisation of the PT system often leads to an increase in the use of small PT-vehicles. Most of the time this results in a less efficient PT-system because there are more PT-vehicles, transporting the same amount of passengers as before. Especially, on a busway where capacity should be used as efficiently as possible, the use of small PT vehicles is undesirable.

Therefore it is assumed that 18-seat matatus will not be permitted to use the Jogoo Road busway. As a result, operators of 18-seaters will be stimulated to opt for larger vehicles, which would have access to the busway. In this manner the busway as a 'carrot', in an attempt to create a more efficient PT system that puts less pressure on the environment and road capacity. Especially, with a continuing regime of regulation necessary for the implementation of a busway, there is no inherent reason why private operators could not be required to use larger vehicles (Gomez-Ibanez, Meyer, 1993).

In order to evaluate the effectiveness of the busway under different growth circumstances, three scenario's for traffic and public transport growth were introduced. These scenarios consist of a low grow-scenario of 2.4%, a middle grow-scenario of 3.6% and a high grow-scenario of 4.8% (Transurb Consult, Otieno Odongo & Partners, 1992 and Post Buckley Consultants, 1998).

Modal split changes due to changes in trip/travel times of public transport were not addressed in this research, both because of a lack of relevant data and as it is questionable whether improvement of public transport performance would persuade motorists to shift to public transport. In the year 2000 the stretch of road between Outer Ring- and Rabai road will be reconstructed. The road will be upgraded to 2X2 lanes and will be re-paved. This reconstruction was implemented in the model as well.
It is impossible to model the "bus stop behaviour" of public transport vehicles in Integration. That is why it has been assumed that the time spent at bus stops remains constant in the future. This assumption is more reasonable if bus stops are designed and constructed with overtaking facilities. This means that the bus stops are separated from the busway and busses have to leave the busway to pick up passengers.

5 CHANGING TRAVEL TIMES DUE TO THE BUSWAY

5.1 *Calibration of the model*

In order to determine whether Integration is a suitable tool, a model has been built covering the present traffic flow situation on Jogoo road.

Table 1. Outcomes calibration

Comparison actual speeds and model outcomes			
	Matatus	*Busses*	*Cars*
Actual speed from surveys (km/h)	15.7	16.3	14.4
Model speed from Integration (km/h)	15.2	15.3	14.6
Difference %	3.2%	6.1%	2.8%

The results of this calibration are displayed in table 1. As can be seen from this table the maximum difference between the actual speed and the model outcomes is 6.1%. This difference is mainly caused by the chaotic driving behaviour of the matatus which is difficult to incorporated in a traffic model. However the maximum difference of 6.1% together with the on-screen representation which gave a true image of the actual traffic flow on Jogoo road, were convincing enough to consider the use of Integration justified. Another check to determine the suitability of Integration was the comparison of the model outcomes and the outcomes of the TRL-equation. According to the TRL-equation the average travel speed on the busway will be 25.4 km/h. The Integration outcomes showed an average busway travel speed of 23.4 km/h. Considering the fact that both of the estimation techniques are subject to uncertainty, the difference (7.8%) between these outcomes was considered small enough to accept Integration as a tool to model the future situation and to use the Integration outcomes as input for the financial appraisal of the busway.

5.2 *Travel time changes for different busway designs*

Integration was used to model the traffic flow in four different situations:
1 The situation in 1999-2004 without a busway: The 0-scenario.
2 The situation in 2000-2004 with a busway utilising existing road-space between Nile- and Lusaka road: The integrated busway design.
3 The situation in 2000-2004 with a newly constructed busway between Nile- and Likoni road and utilising existing road-space between Likoni- and Lusaka road: The half-free busway design.
4 The situation in 2000-2004 with a newly constructed busway between Nile- and Lusaka road: The free busway design.

5.2.1 *0-scenario*

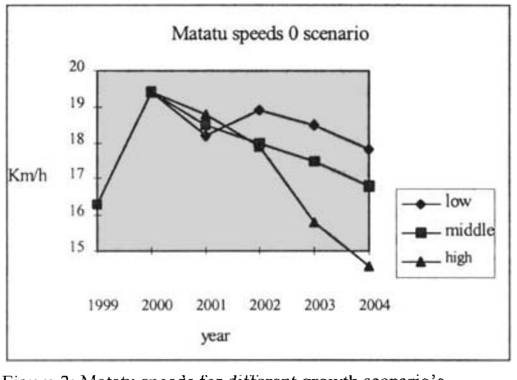

Figure 2: Matatu speeds for different growth scenario's

Figure 2 shows the Integration outcomes for the matatu speeds in the 0-scenario (the outcomes for car- and bus speeds are largely similar). Due to the capacity increase resulting from the reconstruction between Outer Ring- and Rabai Road, travel speeds between 1999 and 2000 increase substantially for all transport modes. However, the reconstruction does not seem to be a structural solution for the traffic problems on Jogoo road, as travel speeds show a steady drop in the period after the reconstruction (2001-2004).

An interesting feature of the 0-scenario outcomes, is that in some cases travel speeds for the middle growth scenario are higher then those for the low growth scenario. For example, average car speed in the year 2000 is 20.0 km/h in the middle growth scenario, compared to 19.9 km/h in the low growth scenario.This apparent inconsistency can be explained by looking at traffic flow behaviour.

Normally, traffic growth results in a decrease of travel speed. There is a greater demand for road capacity, leading to irregularities in traffic flow and a decrease in travel speeds. However, in case of the density-speed curve in this situation a small traffic growth can lead to a more steady traffic flow.

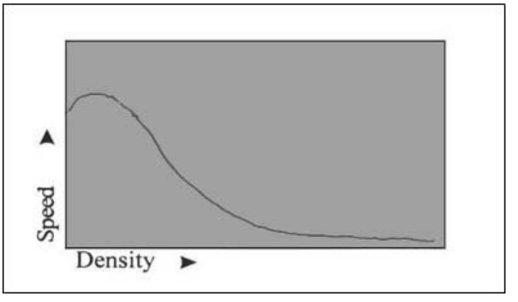

Figure 3: Density-speed relationship in the Jogoo Road model

Faced with a smaller headway (i.e. the distance between two vehicles) road-users are forced to adapt to the speed of the vehicle in front of them, leading to a smaller variability in speeds, a more steady traffic flow and higher average speeds.

5.2.2 *Integrated busway design*

The model-runs of the integrated busway-scenario showed that the integrated busway design (allocating existing road space to exclusive PT use) leads to considerable speed reductions for the general traffic. For this reason, the integrated busway design was not considered to be a viable option.

5.2.3 *Half-free busway design*

The half-free busway will have a positive effect on travel speeds. Both PT and general traffic will experience substantial time benefits, varying from 2.7 up to 12.8 minutes over the length of Jogoo road (5.1 km).

The calculated travel speed increases of matatus and busses are more or less the same under the different growth scenario's. This corresponds with the outcomes of the TRL-study which confirms that the average bus-occupancy is of more influence on the busway speed than the number of busses on the busway.

As speeds are more or less constant for the verious growth scenario's, it was decided to calculate and apply a single average speed for matatus as well as busses for all growth-scenarios. This resulted in an average matatu travel speed of 23.4 km/h and an average bus speed of 22.8 km/h for the years 2000-2004.

5.2.4 *Free busway design*

The comments made about the half- free busway scenario hold for the free busway scenario as well. The only difference is that in the free busway scenario the time benefits with respect to the 0-scenario are even higher. The average matatu- and bus travel speed computed for this scenario are respectively 23.5 and 23.2 km/h

The most important conclusion is that both the half-free as the free busway have a positive impact on travel times, for all motorised modes of transport. Travel time benefits vary from 2.7 to 13.0 minutes. The travel time benefits are slightly higher in case of the free busway scenario.

The integrated busway, which makes use of existing road-space, was rejected as possible busway-design, as it caused substantial congestion for the general traffic.

6 THE ECONOMIC APPRAISAL OF THE BUSWAY

6.1 *Introduction*

The economic appraisal of the busway required an economic valuation of travel time changes for public transport operators and -users, the general traffic as well as the costs of construction and maintenance for the free and half-free busway design.

6.2 *Operational benefits for PT-operators*

The implementation of a busway will cause operation benefits for the vehicles using it. Vehicles using the busway may drive a longer distance and transport more passengers in the same amount of time. However, as no data were available on time-schedules, number of passengers transported and the costs and revenue per individual vehicle, it was not possible to compute the operational benefits per individual vehicle. That is why the following method was used.

The time savings due to the busway are multiplied by the average speed of the public transport vehicles before realisation of the busway. The outcome of this multiplication represents the number of potential extra kilometres each vehicle can drive per day. To deduct the operational benefits these potential extra kilometres have been multiplied with the net income per kilometre driven. The net income per kilometre driven was deduced from World Bank and Sub Sahara Transport Policy Program (SSATP) research.

Time benefits for bus- and matatu conductors/drivers are also been included in the operational benefits. The methodology for valuation of these time benefits is discussed in the next paragraph.

6.3 *Time valuation for PT-users and the general traffic*

For PT users and the general traffic, only working-time was taken into consideration. It was assumed that the people working are not only those that are actually "in business" when travelling (e.g. bus drivers, -conductors, goods-vehicle drivers and businessmen), but also people travelling to work. The decision to take only working-time into consideration is made because no information was available on the people that travel with another trip-motive. The working time was valued as the average wage rate, which differs for bus- and car passengers, car-drivers and bus- and matatu drivers. Since there is no accurate data on goods-vehicle occupancy (some goods-vehicles are used to transport employees to work), goods-vehicles have been considered as normal passenger cars.

6.4 *Construction- and maintenance costs*

The busway was designed according to the guidelines of the Road Design Manual of the Ministry of Transport in Kenya. The cost of construction was computed with unit rates derived from recent tender documents and price lists of various manufacturers. Maintenance costs were assumed to be 1% of the construction costs.

Table 3: construction- and maintenance costs

Cost of realisation	US$
Free busway	714.000
Half-free busway	425.000
Costs of maintenance for both busways (yearly)	7.250

6.5 *Total costs and benefits for the free and half-free busway design*

The data in tables 4 and 5 show that the construction of the busway is a profitable investment. The benefits derived from travel time changes exceed the costs of construction and maintenance by far. Already in the first year after construction the busway generates substantial benefits. These benefits grow in time as the amount of traffic on Jogoo road increases.

Even in the least profitable scenario, the net profit still comes to US$ 836.000 over the period 1999-2004.

Table 4: benefits and costs, *half-free* busway under different growth scenarios (US$)

	Low	Middle	High	Costs
1999	---	---	---	425.000
2000	276.000	286.000	316.000	7.250
2001	372.000	381.000	376.000	7.250
2002	331.000	451.000	499.000	7.250
2003	371.00	530.000	824.000	7.250
2004	464.000	628.000	1.029.000	7.250
*NPV**	1.425.000	1.766.000	2.309.000	420.000
Net profit	*1.005.00*	*1.346.00*	*1.889.000*	

* The net present value (NPV) represents the present value of future costs and benefits.

Table 5: benefits and costs, *free* busway under different growth scenarios (US$)

	Low	Middle	High	Costs
1999	---	---	---	714.000
2000	298.000	310.000	340.000	7.250
2001	396.000	407.000	390.000	7.250
2002	356.000	477.000	525.000	7.250
2003	398.000	553.000	854.000	7.250
2004	490.000	657.000	1.065.000	7.250
*NPV**	1.523.000	1.868.000	2.419.000	687.000
Net profit	*836.000*	*1.181.000*	*1.732.000*	

The half-free busway design is the most cost-effective design or in other words the busway design with the highest benefit-cost ratio. The lower benefits for the half-free busway compared to the free busway design, are compensated by the lower construction costs, which are about 60% of those for a free busway.

The travel time benefits for public transport users form the biggest share of the total busway benefits (±50%). The operational benefits for matatu operators form the second-biggest part (±30%), followed by travel time benefits for the general traffic (±25%). The operational benefits for Stagecoach form the smallest part of the total benefits.

7 CONCLUSIONS AND RECOMMENDATIONS

This study has demonstrated that substantial economic benefits can be obtained from constructing a busway on Jogoo Road. The half-free busway is the recommended option from a benefit/cost perspective. Interestingly, the reallocation of road space under this option, which will reduce the road space allocated to the general traffic, results in a win/win situation: both public transport users and operators, as well as the general traffic stand to gain time and economic benefits under this option. There is no reason to assume that a similar reallocation of existing road space of the rest of the trunk road network in Nairobi would not also result in economic benefits.

A second conclusion to be drawn is that is has appeared possible to calibrate and apply a simulation model (Integration) in traffic circumstances for which it was not originally designed. A final conclusion is that it may be possible, by using busways as a 'carrot', to stimulate the use of larger PT vehicles by small operators, and thus to improve efficiency of the public transport system.

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Urban public bus transport in India – Problems and prospects

Le transport d'autobus public et urbain en Inde – Problèmes et perspectives

Transporte público urbano de autobuses en la India – Problemas y perspectivas

M. Koteeswaran
Association of State Road Transport Undertakings, New Delhi, India

ABSTRACT: The proliferation of personalised transport in the Indian metro cities poses serious threat to the environment and safety. This paper discusses the state of the public transport in metro cities, the competition, modal shift, regulation, technology upgradation, public private partnership, road safety, Intelligent Transport System applications and funding. It calls for policy interventions like the polluter pays and the beneficiary bears and regulatory mechanism to ensure that the public purpose and the public interest are sustained in the provision of public transport.

RÉSUMÉ: La prolifération du transport personnel dans les villes metropolitaines indiennes constitue une menace l'environnement et la sécuril '. Ce document traite de l'état du transport public dans les villes métropolitaines, la concurrence, la modification modale, la régulation, l'augmentation technologigue, l'association public priré, la securil'é routiére, les applications du systéme du transport intelligent et le financement. Il fair appel aux principes d'intervention tels que le paiement par celui responsable de la pollution et le bénéficiaire soutenant ainsi que les mécanismes régulateurs pour assurer que les buts publics et ler intérêl publics sout maintenus dans la provision du transport public.

RESUMEN: La proliferatión del transporte personalizado en las ciudades metropolitanas indias causa grave amenaza al medioambiente y seguridad. Esta ponencia discute el estado del transporte del público en las ciudades metro, la competencia, el cambio modal, reglas, mejoramiento de tecnología, sociedad pública privada, seguridad de carretera, aplicaciones inteligentes del sistema de transporte y financiación. Esto pile intervenciones políticas como pagador contaminante y cobrador beneficiario y mecanismos reguladores para asegurar que se sostengan el objetivo público e interés público en la disponibilidad del transporte público.

1. *Introduction*

The public transport scenario in India is kaleidoscopic, enormous and complex. The public transport system is on the threshold of collapse while the personalised transport has registered a phenomenal growth. This has resulted in unbearable levels of pollution, accidents and congestion in all the Indian cities. There is an urgent need to review the impact and the implications of this situation. Are the present developments conducive to promote public purpose and public interest?

2. *Population*

The population of India is said to have crossed 1 billion in October 1999. 141 mil. people live in 301 cities of more than 100,000 population. The intracity vehicular trips per day were estimated to be 126 mil. in 1994 of which the public transport share was 36%. India has a road length of 2.4 mil. Km. of which 53% is paved. The urban roads accounted for 8.76%. But they served 11.64 mil. vehicles constituting 31.3% of all the registered vehicles in India. The cost of improvement of the urban roads is estimated to be US $ 2.2 billion.

3. *Automobile Policy*

During the 1960s, the foreign technical collaboration and financial participation for specified time was allowed, with regulated annual production. In 1978, to promote competition, capacity licensing was abolished. In 1982, foreign participation was opened up and 14 firms were allowed to manufacture two and four wheelers. The full liberalisation regime was brought in 1992.

4. *Growth of vehicles*

Of the 37.2 mil. registered motor vehicles in India, 69% were two-wheelers, 12.5% 4-wheelers, 6% goods vehicles and 1.3% were buses. Delhi has 2.9 mil. registered vehicles followed by Bangalore with 0.97 mil., Chennai -0. 89 mil., Mumbai - 0.8 mil., Hyderabad - 0.77 milion, Ahmedabad - 0.63 mil. and Calcutta with 0.59 mil.. The metro cities in India where the traffic and transportation measures followed the developments are facing acute congestion, pollution and accidents. Hence a considered public transport policy is required to contain these problems.

5. *Competition*

With the liberalisation, the competition to bus transport has come in varied forms - the auto rickshaws, (3 wheeler and 2 seater) the maxi-cabs, the minibuses, the jeeps, the tum-tums(six seaters) of Pune and the omnibuses. These are growing at the rate of 0.3 mil. per year. They seem to be above law. They cause both air and noise pollution, accidents, reckless criss-cross and overloading and operate not as an intermediate public transport system but as regular stage carriage system. Thus, the liberalisation did not bring competition in market in classified segments but only chaos; the deregulation did not bring discipline but anarchy. The worst affected in the whole process are the public buses.

6. *Modal Shift*

The 16.45 Km. partial underground and surface MRT in Calcutta was built at a cost of US $368 mil. in 11 years. Since inception in 1984-85, it has been consistently underutilised and losing. The Chennai MRT is partially operational and the project is yet to be completed. In Delhi MRT project has just commenced. Chennai and Mumbai have sub urban rail systems. The rail-road modal split which was 80:20 in the early 60s has reversed to 13:87. Lack of flexibility and inadequate expansion of rail services coupled with wide spread expansion of cities have made the Indian cities bus dependant.

The overcrowding in the buses and non availability of the buses at the required frequency, and the improved economic conditions, have steadily pushed the lower middle income group which has been totally bus dependant to two wheelers available on hire purchase across the counter. It can be safely said that with 25.7 mil. of two wheelers, nearly 100 mil. passenger trips per day are lost by this modal shift. The proliferation of the personalised transport system will create more congestion and pollution on the roads and accidents are likely to increase to dangerous proportion if adequate countermeasures are not taken. If the users of the personalised transport system could be persuaded to return to the public transport, then it should be more attractive, comfortable, easily accessible, more frequent and cheap. This requires bus technology upgradation and public transport friendly road infrastructure like bus only lanes and bus priority lanes etc. Such buses should have power steering, air suspension, automatic transmission, low floor and clear engine.

7. *Pollution*

Petroleum consumption has grown from 17.9 mil. tonnes in 1970 to 84.5 mil. tonnes in 1997. Of this, the diesel constituted 36.2 mil. tonnes in 1997. A study conducted in 1994-95, showed that all the gasoline operated vehicles in Delhi produced 191,200 mt of pollutants by mass while the diesel vehicles produced 79,000 mt a year.

The percentage of pollution caused by the vehicles had increased in Delhi from 21 in 1971 to 63 in 1999 and is estimated to touch 72 in 2001. In spite of the fact that the road length in Delhi increased from 8,231 Km. in 1971 to 21,564 in 1991, the vehicle density (no. of vehicle/km.) had increased from 24.78 to 84.08 during the period.

The vehicle emission characteristics depend on the engine technology, the type of fuel, the usage and maintenance of vehicle and the operating conditions like the road surface, speed and congestion.

The two wheelers accounted for 81.82% (8.7mil.) of all the vehicles registered (11.64mil.) in 23 cities in India in 1997. Of these 23 metro cities, 8 accounted for 51% of all the two wheelers in the country. These 8 cities generated 3,282 mt of vehicular pollution load per day, Delhi accounting for 1,046mt, Mumbai 660 mt, Bangalore, Calcutta and Ahmedabad each 300 mt per day. The cost of damages in Indian conditions per vehicle per year is estimated at Rs.43.40/kg or US$ 1000/mt.

8.*Accidents*

Every year about 60,000 people are killed and more than 300,000 are injured on the Indian roads. Ignoring all the other costs, the cost of compensation as per no fault liability alone works out to US $ 250 mil. a year. The share of the state bus companies against 5,700 deaths and 18,000 injuries, is US $17 mil. per year. If a small portion of this amount is invested in driver training, they may be able to reduce the accidents and save many lives. The Central and State Governments should come forward to share the capital and the operational expenses to encourage setting up of modern driver training institutes.

9. *Public Private Partnership*

The key issue is whether the existing urban bus companies which are State owned (except Calcutta) can meet thee challenges. Perhaps not, in their present form. The major problems faced by the state owned transport companies(STCs) could be traced to the high cost of operation, uneconomic routes, high bus staff ratio, high taxes, competition and low fare structure and the delay in fare adjustments. 51% of the cost was on labour. Unless this component was effectively tackled, the STCs would continue to incur losses. The various concessions thrust on the STCs and not reimbursed account for nearly US $ 100 mil. a year.

Most of the States justify the fare increase citing the huge losses incurred by the STCs and their operational cost. The STCs were established to provide mobility in public interest. If fares are to be increased to maintain the high cost of labour and operation of STCs, it is both against public purpose and public interest. It is obvious that public is asked to pay much beyond what the reasonable user cost should be. Indiscriminate increase in bus fare without value addition in service would only escalate modal shift to the personalised transport system. Under the prevailing circumstances, the metro bus companies have almost reached the optimal physical performance levels in fleet utilisation, bus utilisation, engine and tyre life, fuel consumption etc. given the state of the technology. Only way to control costs is to move towards changes in the fare collection system and Public Private Partnership Programmes (PPP). PPP have been initiated in Delhi, Orissa, Andhra and Bangalore, Uttar Pradesh and Punjab.

It may be noted that the strategies adopted in the PPP schemes by Orissa STC on one hand and Andhra Pradesh STC and Bangalore STC on the other, are diametrically opposite in approach, content and delivery. The former is concerned with its survival and sustenance. The latter's strategy is conservation of capital resources and cash flow and cutting costs on interest, labour and infrastructure in short term and consolidation and stability for sustained well being and preemption of competition in the long run. However, the success of both the PPP models which offer different solutions depends upon how meticulously the presently set norms for partnership are adhered to without internal and external interventions and how the obligations and rights are judiciously monitored. In short, transparency holds the key for the success. While the Orissa model is rightly a commercial exercise without assuring a long lasting partnership, the Bangalore and Andhra models, as they should be, are built on mutual faith and a hope for long lasting associateship.

Another important issue is the attitude of the private partners. In Delhi, they have threatened to pull out if their demand for disproportionate increase in contract fee was not allowed. Should such indiscreminate increase be allowed, it would work against the interest of Delhi public, the hirer, Delhi Transport Corporation(DTC) and perhaps themselves and the entire concept of PPP in Public Transport would in jeopardy.

10.*Automation*

The introduction of Automated Fare Collection System(AFC) and upgradation of technology with aggregates which could last the life time of the vehicle and the automated maintenance, have helped metro bus services world over to contain manpower cost and improve reliability and service levels and revenue. Yet, in India, this could be politically sensitive. The fitment of power steering, automatic transmission, modern seats and air suspension will further reduce downtime on the maintenance and the reconditioning frequency with corresponding reduction in labour apart from reducing the driver fatigue and improving road safety and rider comfort.

11.*Automated Fare Collection System*

BEST in Mumbai has taken the bold initiative in introducing contactless smart card system in select routes in Mumbai. BMTC, Bangalore is also contemplating. AFC however should be introduced with great planning and preparation of the organisation, the commuter and the common man. The Contactless Smart card imposes several constraints in the Indian context - sizeable amount of prepayment could be burdensome to low income group and impossible for the economically weeker section which entirely depend on the bus mode. Nor is it necessary for the floating population and occasional travellers who constitute more than a third, unless affordable very low denomination throw away plastic cards are made available (say US $ 1 and without retention fee). The AFC as a dual mode on board equipment, which could accept plastic money and issue tickets against coin drop, would be more effective and acceptable. The Central and State Governments should encourage the metro bus companies to switch over to AFC within the next decade. Keeping this in view appropriate Human Resourse management measures and HRD efforts should be initiated immediately such that the bus system becomes one man operated within 10 years of the introduction of AFC.

12. *Alternative Fuel*

As a pollution counter measure, BEST has in fact commenced trials with CNG in 10 buses. In view of very high pollution levels in Delhi, the Supreme Court of India has ruled that the buses in Delhi should use only CNG. An investment of US $ 26 mil. would be required for this conversion in DTC alone.

Since CNG mode is for social good, the entire burden of such conversion should be borne by the society at large rather than the service provider. The investments and expenses should be specifically identified, and provided by the Central and State Governments. Such incentives for clean engines in USA, UK and Australia have indeed encouraged the bus operators mostly the State owned to switch over to CNG mode. Hence, pragmatic economic packages should be worked out and this should come out of a declared policy under environmental protection. So long as the technology, machines and fuel are made available at current costs, no bus company should hesitate to fully gear up to the cause of keeping the environment clean and safe.

13.*The cost of technology upgradation*

Assuming that the State owned urban bus companies do not expand but modernise their present fleet evenly over the next 6 years, they would require US $100 mil. per year. The situation today is that these Urban companies together have incurred a cash loss of US $ 78 mil. during 1997-98. Hence technological upgradation would be impossible without external assistance.

14.*Road Safety*

Chennai developed an exclusive elevated bus only lane plan to ensure smooth, adequate fast and safe mobility for the metro masses. Bangalore has concluded a comprehensive traffic study with Bus System as core transport medium. It has identified the corridors for high density single and double articulated buses and standard buses. The plan proposes special elevated bus lanes, on surface priority lanes and bus only lanes etc. for the entire Bangalore metro, with adequate linkages with other intermediate modes. The future driver, friendly with electronic gadgets, will have to be a able to read navigation map, listen and respond to all queries on line. Thus the driver training should undergo a sea change. Such infrastructure development and driver training would reduce the road accidents to a great extent.

15. *ITS Application*

GIS and GPS applications are in embryonic stages in BMTC. APSRTC has invited tender for Advance Vehicle Location and Passenger Information (AVLPI) System. It is an ambitious scheme which if implemented successfully is bound to revolutionalise the transport system in the country. Beyond that, it may provide the vital clue to reorganise and restructure the bus company and its role. From the present status of a bus operator, the state owned bus company, with the use of GPS and AVLPI System , could emerge as a service provider and coordinator without owning buses, depots and maintenance shed, men and materials. Ultimately this has to happen.

16.*'Polluter Pays'*

Suitable mechanism should be found to collect annual fees from each vehicle owner to pay for the share of pollution caused by his vehicle. The vehicle pollution load caused by each two wheeler, four wheeler, three wheeler and bus/truck has been estimated to be in the ratio of 1:3:4.5:8.4 and the cost of pollution caused by one two wheeler is at US $ 57 per year.

17. *'Beneficiary bears' Parking*

In metros, nearly 30% of the paved roads are occupied by the 2 and 4 wheelers. The agencies controlling the parking lots fleece the customers. The shop owners occupy the road space for parking their vehicles and for their operations, in front of their shops. Along with it, the pedestrian walk way is also blocked by them. The parking lots should be automated and large infrastructure needs to be created. The beneficiary bears principle should be applied to regulate the parking part of the traffic management. But a regulatory mechanism should be in place before this activity is streamlined. Enormous revenue could accrue out of these in the metro cities which is largely drained off today by the various agencies at different levels.

18. *Policy Based Funding*

To promote public transport, a policy based funding should be in place. The Governments in Centre and States should apportion certain fund as in UK and USA to encourage public transport to improve its services. Funds should be made available to the bus and truck operators who satisfy prescribed norms and who replace their existing vehicles with upgraded technology and meet emission norms. Special assistance should be extended to those who opt for alternative fuel like CNG.

19. *Regulatory Authority*

A Regulatory Commission should be created without further delay to regulate, monitor, review and assist the road transport industry. in restructuring, financing, technology upgradation, automation and pricing all modes of public transport by road as in telecom and power sectors. It should bring order and peace on the chaotic Indian roads which today serve everything against public interest and public purpose. A comprehensive traffic and transportation system should be evolved for each metro city.

20. *Conclusion*

The absence of a transport policy is the root cause of the problems of vehicular pollution, congestion and accidents in India. With the rail based system not in sight for another decade or two in all the metro cities other than Calcutta, Chennai and Delhi, the bus transport holds the key to contain these socio-economic issues. But the bus requires new technology.

Technology upgradation cannot come about without additional investments. Assistance is required as the urban bus companies are in financial ruins. But the assistance should be directly related to distinct objectives of pollution control, decongestion and road safety.

Second, the quantum of assistance or a grant formula should be evolved so that the responsibility of the Centre, State, the bus companies, the vehicle manufacturers and the passengers is shared in equitable proportions.

Third, the Central Government must amend the Motor Vehicles Act to incorporate establishment of an independent Road Transport Regulatory Commission at Centre and in each State with defined objectives, roles, powers and obligations to ensure overall improvement in Traffic and Transportation Management and to fix equitable fares for the services rendered.

Fourth, investments for automation of operations management like AFC, GIS/GPS and ITS application should be encouraged by the same formula or by long term soft loans. These projects though are capital intensive, would be bankable. What is required more is a policy framework to support the bus companies legally and politically to effect the schemes replacing the labour as painlessly as possible.

Fifth, every concession granted by the State Governments to sections of the society should be accounted for and reimbursed from the respective department's budget. The bus companies should be encouraged to display by a separate schedule, the details of the heads of concessions, and amounts involved and reimbursed.

Sixth, the State should encourage setting up of driver training institutes and accident research and automated vehicle inspection units to promote road safety.

Lastly, in order to promote Public Transport as such excise and duty concessions should be allowed to facilitate import or encourage cheap availability of devices and aggregates which promote the objectives of pollution control, technological upgradation and safety.

The ultimate test of an efficient transport system is not only whether it serves free mobility but in doing so whether it serves public purpose and public interest.

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Public transport levels of services in Gauteng, South Africa

J.C.Vorster
BKS (Pty) Limited, Consulting Engineers, South Africa

M.Rademeyer
AfriGIS (Pty) Limited, South Africa

S.Burnett
Gauteng Department of Transport and Public Works, South Africa

Abstract: The promotion of public transport directly benefits the urban environment. This paper reports on the preparation of Current Public Transport Records (CPTRs) by Transport Authorities in the Province of Gauteng, South Africa. The integration of the various CPTRs into a province-wide passenger transport information system is discussed. The paper is concluded by a short description of a research project aimed at quantifying the impact of external land-use, socio-economic and other factors on public transport needs.

Résumé: La promition du transport public beneficie l'environment urbain directement. Ce dosier rapportes sur la preparation d'une Sondage Actuel des conditions du Transport Public (SACTP) par les authorités routieres dans la province de Gauteng en Afrique du Sud. L'integration des divers SACTP sur le transport des passagers dans la province est discutée. Ce dosier est conclut par un brèf description d'un projet de recherche fait dans le but de quantifier les impact de l'utilisation externe de l'espaces, socio-economique et autres facteurs sur les besoins du transport public.

1. INTRODUCTION

1.1 *Economic considerations*

The Gauteng Province in South Africa is the economic hub of the country. Despite its area being only 1,4% of that of the whole of South Africa, it is responsible for 37% of the Gross Domestic Product, it has 38% of the 6,6 million vehicles in South Africa and 30% of all fuel sold nationally is sold within Gauteng. Gauteng Province hosts the largest labour force of all the provinces, providing job opportunities for more than a proportionate number of workers; namely for more than 27% of the total number of formal employees in South Africa. The estimated population of Gauteng in 1996 was approximately 7,7 million people of which more than 99% is considered urban. By 2010 the population is expected to increase to about 15,3 million people. The population density in Gauteng is compared in *Figure 1* with that of other South African provinces and internationally. The urban character of the province is evident from this comparison.

On the other hand, the small overall size and highly urbanized character of Gauteng Province are evidenced by the small percentage, of the country's 200 00 km of national and provincial roads within the Province. This figure is less than 3%.

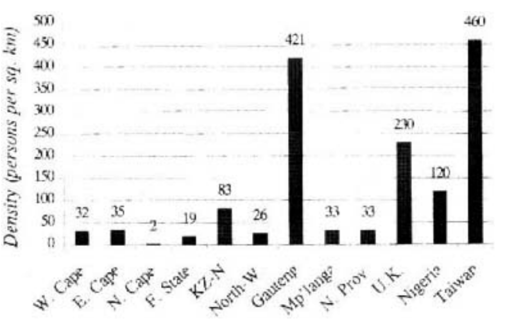

Figure 1. Population density 1996 (estimated)

1.2 *Transport*

The transport modal choice of commuters in Gauteng (1995) is shown in *Table 1*.

Table 1 shows that:

- a large percentage of rural trips are made on foot
- the private vehicle accounts for 40% of urban commuter trips
- public transport accounts for 42% of commuter trips in urban areas, but only 14% in rural areas.

Gauteng has a relatively complex rail network serving commuters, local passengers, mainline passengers and freight. The area of Gauteng is served by over 220

Table 1. Transport Modal Choice (1995)

Mode	Total		Urban		Rural	
	Number	Per-cent	Number	Per-cent	Num-ber	Per-cent
Train	118390	7	188316	7	74	1
Bus	259743	9	254963	9	4879	4
Mini-bus taxi	716948	25	706803	26	10145	9
Bicycle	29506	1	26799	1	2707	2
Car/Mo-torcycle	1134649	40	1104021	40	30629	26
Pedes-trian	416567	15	349612	14	66955	57
Other	90536	3	88379	3	2157	2
Total	2836339	100	2718793	100	117546	100

active railway stations. However, based on the average density of each metropolitan area and a walking distance of 1 km, it is roughly estimated that only 10% of the population lives within walking distance of the rail network. This indicates a significant opportunity for densification close to the rail stations. Large improvements in feeder and distribution services to and from stations are also required to improve the utilisation and effectiveness of the rail mode.

Up to present, road based public transport has been unregulated and uncoordinated to a large extent. It is only now that specific strategies are being implemented to achieve discipline and order in the industry. In 1990, the bus services in Gauteng were provided by an estimated 5200 buses; managed by eight municipal operators (1200 buses), one semi-state operator (1000 buses), one major private operator (2000 buses), and a number of smaller private operators (1000 buses). Since 1990, the number of buses has declined, in particular due to a number of municipal operations which have been terminated. The biggest proportion of commuter transport (in excess of 50% of all public transport trips) is by minibus-taxi. Minibus-taxi services in South Africa are operated on an informal "jitney-type"basis i.e. unscheduled but on a fixed route. A number of operators, typically those operating a specific route or in a specific area, would form an association representing that specific group of operators. Such associations are now acknowledged in more recent legislation dealing with the regulation and control of minibus-taxi services. An estimated 220 taxi associations are registered in Gauteng. They represent approximately 21300 members operating approximately 35000 minibus-taxis. Of the estimated total number of minibus-taxis in the province, 57% is considered illegal in that they are not operating in terms of the conditions of a valid permit.

1.3 *Road congestion*

Many of our freeways and other major roads in Gauteng are facing severe congestion at peak periods every working day. A good example is the N1-21 (Ben Schoeman) freeway between Pretoria and Johannesburg which carries more than 150 000 vehicles a day with volumes growing constantly.

Table 2 shows the length and the percentage of roads that were identified to have a peak hour level of service (LOS) equal to or greater than E. The percentage column relates to the percentage of congested roads in relation to the total road length in the province. The congestion during peak hours in the major urban areas of Pretoria, Johannesburg and Eastern Gauteng is evident.

Table 2. Levels of Service of the Road Network

Area	LOS = E		LOS > E	
	km	%	km	%
Greater Pretoria	44,9	0,68	129,3	1,95
Eastern Gauteng	24,7	0,37	71,9	1,09
Khayalami	21,5	0,32	28,4	0,43
Greater Johannesburg	98,6	1,49	194,1	2,93
Western Gauteng	10,8	0,16	10,5	0,16
Lekoa-Vaal	4,3	0,06	9,7	0,15
Total Gauteng	204,8	3,09	443,9	6,70

2. NATIONAL AND PROVINCIAL POLICY AND LEGISLATION

2.1 *Policy statements*

It is an adopted policy of national government to promote more energy efficient and less pollutant modes of transport, suggesting that preference should be given to public transport over private transport. Gauteng provincial policy is more specific by stating its intention to promote public transport in order to benefit the environment. The use of higher occupancy vehicles is also recognised as a transport demand management tool, to reduce congestion.

The implementation of this policy is however problematic due to the past unavailability of information about public transport (and the unreliability of the little information which is available). Information about minibus-taxi services, which is the biggest component of public transport, has been particularly poor. Very little information has therefore been available about the availability of public transport capacities in relation to existing and potential demand for services. To be more precise: the inadequate information made it impossible to target available funding to areas and communities with the greatest need for public transport.

2.2 *Legal requirements*

In recognition of the identified need for appropriate public transport information, the national Department of Transport initiated a process of establishing records of public transport supply, and public transport capacity utilisation, for all metropolitan transport areas in the country. These current public transport records (CPTRs) became a statutory requirement in terms of national legislation promulgated in 1998.

In Gauteng, the process of preparing CPTRs started about mid-1998 and was initially aimed to be completed by December 1998. Various practical problems however occurred and, perhaps, an under-estimation of the task, resulted in CPTRs only being completed as from May 1999, with that of Johannesburg being finalised only by November 1999. The total cost of this first round of CPTRs amounted to more than R7 million (ie. more than $1 million). It is a legal requirement that CPTRs be annually updated, where appropriate and practical.

2.3 *Transport planning process*

The preparation of CPTRs is only one element of the total transport planning process as being practiced in South Africa. *Figure 2* shows the inter-relationship of transport plans to be executed by each of the three spheres of government – note that national and provincial government are only required to give guidance to municipal government, which has to prepare the detailed transport plans, consisting of the following components:

- Current public transport record (CPTR)
- Permission strategy
- Rationalisation plan
- Public transport plan

All of the above are to be combined into an Integrated Transport Plan.

3. PREPARATION OF CPTRs

At the municipal level, Gauteng can broadly be divided into six areas, each of which had to prepare a CPTR for

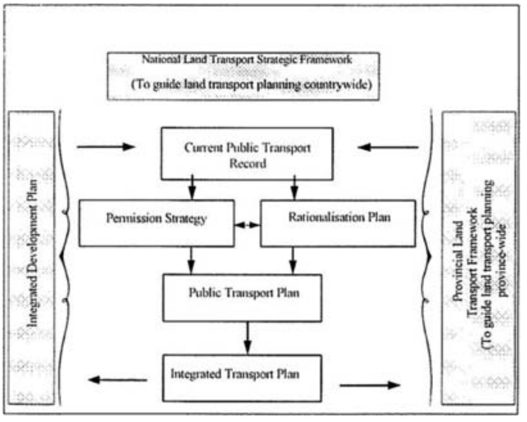

Figure 2. Inter-relationship between Transport Plans

its own area of jurisdiction. Due to its urban character, the whole of Gauteng is covered by the six areas, ranging from densely populated urban areas to fairly remote rural areas.

A Co-ordination Committee consisting in essence of representatives of the Gauteng Province and each of the six municipalities, was established to co-ordinate the data collection and other tasks associated with the preparation of the CPTRs. Due to the national requirements not being very precise as to how, when and where data had to be collected, the Co-ordination Committee's task became very important in order to achieve some uniformity in procedures and deliverables. After the completion of this first round of CPTR preparation, the Co-ordination Committee was then tasked to work towards the integration of the various information systems, with the eventual aim to establish a province-wide public transport information system accessible to all its primary users.

4. DATA STORAGE & DISSEMINATION

The successful storage and dissemination of data from a project such as the one described above is one of the key indicators by which its' success will be measured.

It was found that the nature of the captured alphanumeric data was such that it was difficult to understand and interpret when presented in tabular format. Adding a few graphs and charts alleviated this problem to a certain extent, but spatial adjacency still remains a luxury which could not be obtained. What is meant by the term "Spatial Adjacency" in this context is the relative positioning of routes to other routes in the system, as well as the positioning of routes relative to areas of residence and work.

Questions which cannot be answered easily by interrogating information about passengers in tabular data include ones such as:

- What are the total number of routes travelling across a single road link?
- What is the average walking distance from a boarding point?
- Which areas are not serviced by public transport within a maximum walking distance of 1km?
- What is the relationship between socio-economic characteristics and public transport mobility?

It is therefor imperative, that information for public transport be stored with a spatial dimension. In other words, the information need to be displayed on a map.

The CPTR information gathered in Gauteng was initially only stored in alphanumeric databases. The information was subsequently linked to a common GIS basemap. Linking the information to the basemap allowed the data the required additional spatial dimension. Spatial adjacency was now implied and all different types of queries previously not possible, can now be done. Spatial adjacency will also make it possible to compile and compare the different performance indicators for different areas in the study to quantify public transport levels of service (LOS). Information for land-use and demographics is also available in GIS and, therefor, the different sets of information can be layered on top of one another and analysed. The relative analysis of different parameters is one of the key advantages of storing the information spatially. The following diagram indicates the high level of information flow and storage of information that is possible in this manner.

The dissemination of the information was also simplified by storing the information in a GIS. Planners can thereby be provided with information for certain areas by selecting it from a map. The added advantage of internet mapping technology is that it even allows for this information to be queried and accessed remotely via the internet. A typical interface for extracting information regarding public transportation routes via the internet is displayed on *figure 4*.

Providing effective and accurate information by using a GIS, enhances the decision makers ability to plan and thereby ensure services rendered will be focussed on the clients' needs.

5. POTENTIAL USE OF CPTR INFORMATION

The potential use of CPTR information is shown diagrammatically on *Figure 5*. The original intention with the preparation of CPTRs was to provide information for planning, and for regulation and control purposes, as shown on *Figure 5*. The use of CPTR information for monitoring purposes has so far not been given sufficient attention.

6. ANALYSIS

The development of the GIS-based integrated provincial-wide information system creates a unique opportunity to, as part of the monitoring process, analyse the actual availability of public transport in terms of the available levels of services (LOS). A research project initiated by the Gauteng Province endeavors to compare levels of service between municipalities as well as with external variables such

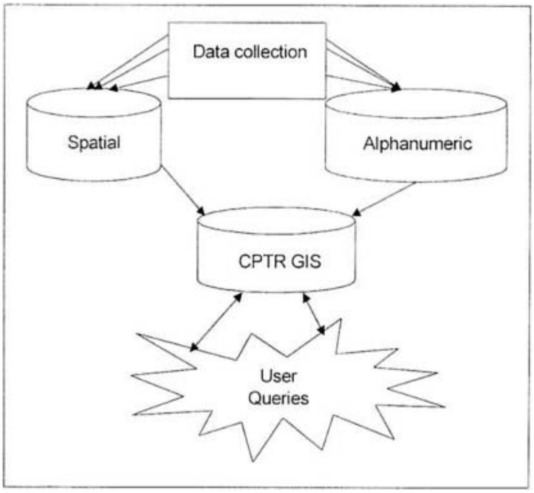

Figure 3. High level information flow

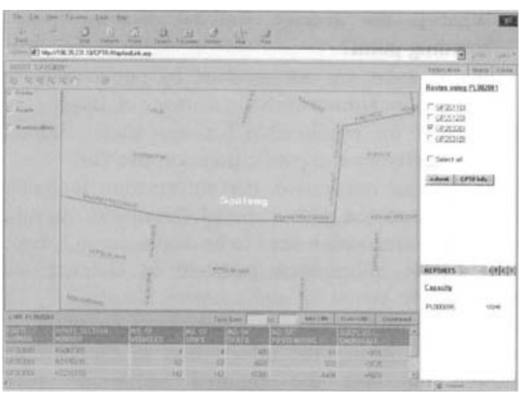

Figure 4.Querying public transport information via t... Internet

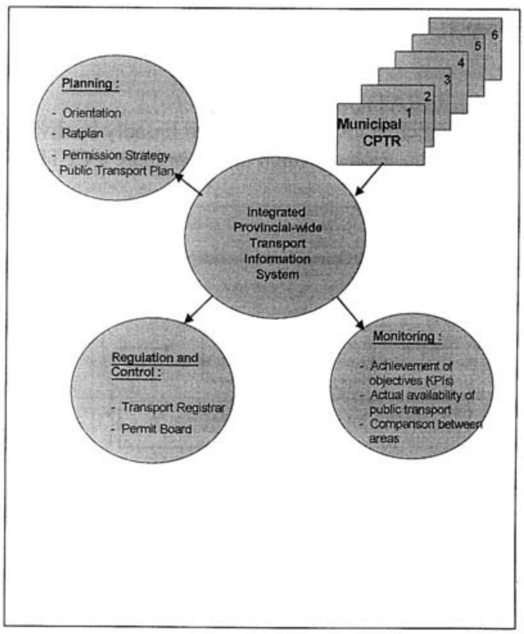

Figure 5. Potential use of CPTR information

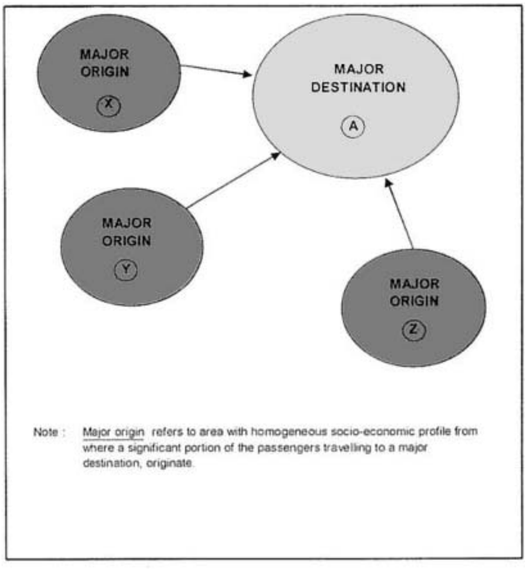

Figure 6. Basis for analysing public transport levels of Service

as land use characteristics, socio-economic characteristics, transport characteristics and funding.

It was decided to analyse public transport levels of service at the micro-level i.e. between a selected major origin and a selected major destination – see *Figure 6* for a diagrammatic illustration of this principle.

This approach allows for a clearer indication of the impact of external factors on public transport levels of service. The careful selection and analysis of different origin-destination (O-D) pairs throughout the province makes it also possible to compare public transport levels of service in different municipalities.

Available information in a GIS format that will be used, in the research project include the following:

- current public transport records (CPTRs) as previously discussed;
- land use information available from municipalities;
- All Media Products Survey (AMPS); and
- Statistics SA (StatsSA) '96 census data

From the above sources it will be possible to derive for each selected O-D pair:

- public transport availability and capacity utilisation; and
- public transport levels of service e.g. walking distances,

which will be compared to:

- land use characteristics (type and density); and
- the socio-economic profile (income, car-ownership, etc.)

It is intended to run the statistical data through the SPSS package to do a cluster analysis on the variables. The purpose will be to finally compare the geographic segmentation with the physical clustering results.

The research project has now only started (November 1999) and is expected to be completed by March 2000.

Initial runs on a selected O-D pair in Pretoria (Mamelodi to Pretoria CBD) indicated that the intended approach is realistic and proved the usefulness of utilising GIS as a tool to improve the understanding of public transport in relation to various external factors.

7. CONCLUSION

The promotion of public transport is an adopted policy of all spheres of government in South Africa. The achievement of this policy will greatly benefit the urban-environment in Gauteng. However, very little knowledge exits about the effect of land use, socio-economic characteristics of the population, funding, and other external factors on public transport availability and levels of service, in the African context. This knowledge is considered essential to be able to target improvements in public transport services to those areas and communities where the greatest need exist, and hence to be successful in our endeavors to promote public transport. The GIS is to be used extensively in Gauteng for the creation of a province-wide passenger transport information system. In addition, it is also to be linked to various other available GIS-based information systems, which describes the passenger transport user and its environment. In Gauteng, this opportunity was identified and a unique research project was launched in order to understand what determines public transport availability and levels of service.

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Public transport system in Delhi – Some issues

Taranjeet Singh Chopra
India

ABSTRACT : The promotion of public transport benefits the urban environment . This paper deals with some issues of public transport system in Delhi

1. URBAN TRANSPORT SCENARIO

1.1 Public Transport policies in urban areas in India are yet to be spelt out rationally. While trying to place « Public Transport » in some sort of a perspective in the context of two scenarios viz. Pre-independence era and the decline in socialistic pattern of societies in the 80's, in the realm of debate associated with Liberalization, Privatisation and Globalization of the Indian economy, whatever clarity there once was with regard to public transport policies, has become blurred.

1.2 Prior to Liberalization, there was a general acceptance that transport as a public utility carried sizeable amount of social costs. As a consequence, the pricing of public transport was deliberately pegged down to make it affordable to users and the gap between Expenditure and Income were covered by the Government to compensate the social costs.

1.3 There are several ways in which social good has been compensated the world-over and one of the accepted method has been to provide capital as grant for rolling stock and infrastructure and to allow transport undertakings to charge only for the operating costs. Even this has not been possible and, in a large number of European and American cities, revenue expenditure is also subsidized to the extent ranging from 25 to 75 per cent.

1.4 In the Indian context, no such delineation of Government grants for capital and revenue expenditure has been made. All funds received from Government are being treated as loan capital bearing interest. Thus, even the social costs borne by State Government Undertakings on behalf of the Government were covered by loans rather than by grants.

1.5 The decline of public transport which occurred essentially due to paucity of funds to maintain the desired service levels, in turn, led to a large number of personalized vehicles invading the urban scene. The roads were not, even with marginal widening, planned for this enormous growth. The result was low speeds, congestion and traffic jams. Along came the pollution caused by automotive emissions.

2. TRANSPORTATION SYSTEM IN DELHI.

2.1 Till the beginning of the 1990s, DTC has had a near monopoly of operating stage carriages in the entire metropolitan region of Delhi. During the late 1970s and in the 1980s, there has been a massive induction of personalised vehicles in all urban areas in the country. Delhi, however, absorbed more vehicles than other cities with the result that today Delhi has more number of automobiles than Bombay , Calcutta and Madras put together.

2.2 The policy should have been to improve the adequacy and quality of public transport systems in order to save Delhi from the ill-effects of a large number of personalized vehicles. Unfortunately, however, this was not to be. At exactly the same time, DTC was plagued with inability to replace its worn-out buses and a financial crisis was brewing.

2.3 In an effort to improve availability of transport, the Government took a decision following amendments to the Motor Vehicles Act in 1988 to introduce private buses. This was in keeping with the mind-set that privatization was a cure-all for public sector inadequacies or inefficiency. Public utilities, and particularly public transport, have certain indivisibilities and adhoc injection of private sector complicates and even worsens matters further. This was precisely what happened in Delhi.

2.4 It may be pertinent to quote here the observations of the Balakrishnan Committee which was set up as a follow up of the recommendations of the Sarkaria Commission to look into the status of Delhi :

« The question whether the transport services in the metropolitan city should be operated by private agencies or by governmental agencies is one on which there has been a lively debate for quite some time.
Everyone is familar with the arguments advanced in support of these Differing points of view. However, for very valid reasons, our government has long since adopted the policy of a nationalized transport system on the ground that it is the best course in the interests of the people at large.
There are, however, still some persons who are strong advocates of a privately operated transport system. But it is in Delhi that we see the phenomenon of the public transport system being simultaneously operated by both a government undertaking and private operators. We are not clear as to how and why this system has come into vogue, but what is quite clear to every one by now is that the system has been a failure from the point of view of the public of Delhi. In the view of quite a few, this arrangement has been responsible for many of the present problems faced in regard to urban transport as well as for the heavy loss of revenue to the exchequer. It is also common knowledge that the private buses are, more often than not, responsible for complaints like wrong parking, overspeeding, rash driving, etc. as also for most of the traffic accidents. »

3. NEW ECONOMIC POLICY

3.1 The 1990s began with a new economic policy which was designed to encourage private entrepreneurship wherever possible and the withdrawal of Government and Government aided enterprises from several sectors of the economy. It was obvious that the financial losses incurred by DTC and the funds that were needed annually to cover its deficits became the obvious target of economics reforms. Although, there is an increasing realization that sectors such as transportation, which have traditionally borne the brunt of social cost, should have been treated more selectively ; the overall thrust of privatization seems to have engulfed DTC too.

3.2 The policy issues which enamate from the liberalization reforms being talked of can broadly be summarized as follows.

i) Resource mobilisation for development and operation ;
ii) Restructuring of DTC to enable it to operate on business-led principle ;
iii) Formulation of a suitable regulatory framework to ensure fair competition between its own buses and the private buses - safeguarding inter-alia the consumer interests, public safety and the environment itself ;
iv) Suitable policy frame for re-development of surplus man power.

3.3 While considering the above policy issues, a clear cut decision would need to be taken by the Government as to what extent the development and operation of public transport could be left to the market forces and to what extent it would have to be financed by the Government from the exchequer resources, because transport is considered as a « public good » or because of the « external » effects of transport such as air pollution, urban congestion etc.

3.4 Considering that the Government continues to be the owner of the organization, it needs to be sorted out as to what sort of relationship there should be between the Government and the management. Commercialisation of DTC will imply that it must enjoy more powers in its pricing, investment and operational matters. Another related issue with regard to commercialisation of DTC would entail fixing responsibility for the costs of social obligations carried by it in the form of various concessional passes, provision of an-economic services, provision of special services like U-Specials, office-goers specials etc. Such social obligations would need to be quantified and the issue with regard to pricing/subsidy resolved there of.

3.5 To recapitulate, given that the thrust of the new policy is to withdraw budgetary support to DTC to enable it to operate on business lines, the decision on following would need to be taken without further delay :

a) The extent to which DTC is permitted to set the prices of its products ;
b) The extent to which it is left free to determine its investment after provision of desirable equity base ;
c) The extent to which it is forced to carry social obligations ; and
d) The extent to which it is allowed autonomy and freedom Governmental intervention in carrying out its day to day functions.

It may be relevant to mention here that during the last 40 years or so, DTC has hardly enjoyed any power or freedom to make decisions on any of these matters in its interests. The crucial decisions taken in the past were in favour of its social or political considerations than corporate interest of the organisation. If all these policies are to be reversed in the changing environment, it must not be done half-heartedly.

4. EXECUTION OF URBAN TRANSPORT POLICY - SOME IMPLICATIONS.

4.1 The question arises as to why did it happen the way it did ? We had allowed the cities to grow in a way that transport needs transport needs always outstripped an affordable transport supply. India's transportation plans had opted for capital intensive solutions and even our industrial policy has favoured manufacture of personalized modes of transport rather than of buses.

4.2 Added to the above scenario was the fact that the growth in volume of traffic has not been matched by an increase in road capacity.

4.3 Incidentally, from the point of view of quality of urban life, the percentage of Urban Space used for Transportation to Total Urban Space in major urban centres in India is of the order of 11 to 15 % as against an average of 30 % and above in Western Cities. In Chicago and Los Angeles, this percentage is as high as 40 % and 60 % respectively.

5. CORRECTIVE ACTION IN THE SHORT RUN.

5.1 In order that the situation doesn't go out of hand, the plans encompassing the following would need to be prepared :

a) Facilitating movement of pedestrian, cyclists and public transport vehicles ;
b) Preferential treatment of buses and reservation of lanes for them ; and
c) Reducing travel demand by locating work places near residential areas.

5.2 The above plans would need to be dovetailed into environmentally free Sustainable Transport System Networks.

5.3 Pending execution of plans pertaining to Mass Rapid Transit System, the case for strengthening the Bus Transit System in the next 5 to 10 years cannot be over-emphasized.

1.6 Pedestrians, two wheels
Piétons, deux roues
Peatones, dos ruedas

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Investigating the effects of motorcycle traffic on air pollution in Asian and African cities

Investigacíon del efecto del tráfico de motocicletas en la contaminacíon del aire en ciudades Asiáticas y Africanas

Etude de l'effet du trafic motocycliste sur la pollution atmosphérique dans les villes asiatiques et africaines

E.O.Akinyemi & T.O.Medani
Institute for Infrastructural, Hydraulic and Environmental Engineering, Delft, Netherlands

ABSTRACT: In many Asian and African cities, motorcycles constitute a significant proportion of traffic on many roads. Unfortunately, in spite of this situation and the increasing importance of motorcycles in the economic and social conditions in the cities, there is little or no understanding by traffic engineers and managers of the current and likely future effects of motorcycle traffic on the quality of traffic movement and the urban environment in the cities. In addition, in many countries, motorcycles characteristics and behavior have not been internalized in urban traffic engineering and environmental pollution analysis.

This paper describes a technique which can be used for two main functions. First, it can be used to determine the likely impacts of the quantity and operational characteristics of motorcycle traffic on the quality of air near urban roads. Secondly, it can be used to develop appropriate traffic management strategies in cities with significant proportions of motorcycles in the traffic streams.

The paper also describes the results of a simulation study of the implications of the typical situations in Hanoi, Vietnam and Bangkok, Thailand and the likely future situation in some African cities.

RÉSUMÉ: Les deux-roues représentent une grande part du trafic routier dans les villes asiatiques et africaines. Malheureusement, en dépit de l'importance croissante prise par les deux-roues dans la vie économique et sociale, les conséquences futures du trafic motocycliste sur la qualité des mouvements du trafic et sur l'environnement urbain est à l'heure actuelle mal ou pas comprise des ingénieurs en charge du trafic et des gestionnaires. En outre, dans de nombreux pays, les charactéristiques et le comportement des deux-roues ne sont pas prises en compte dans l'analyse du trafic et de la pollution de l'environnement. Le présent article décrit une technique ayant deux fonctions principales. La première est la détermination des impacts probable des quantités et des caractéristiques du trafic motocycliste sur la qualité de l'air au voisinage dex axes urbains. Elle peut également être utilisée pour le développement de stratégies adéquates dans les villes où les deux-roues représentent une proportion élevée du trafic.

La présente contribution décrit également les résultats d'une simulation sur les implications des situations types à Hanoi au Vietnam et à Bangkok en Thailande et les situation susceptibles de se développer à l'avenir dans un certain nombre de villes africaines.

RESUMEN: En muchas ciudades de Asia y Africa, las motocicletas constituyen una significante parte del trafico en muchas vías. Desafortunadamente a pesar de esta situacíon y del incremento de la importancia de la motocicleta en las condiciones económicas y sociales en las ciudades, hay poca o ninguna compresión por parte de los ingenieros de trafico y managers del efecto existente y futuro de la motocicleta en el movimiento del trafico y en el medio ambiente en las ciudades.

Además en muchos países la caracteristicas y comportamiento de la motocicleta no han sido interiorizadas en análisis de la contanimación del medio ambiente y la ingeniería de trafico urbano.

Este documento describe una técnica que puede ser usada por dos funciones fundamentales. Primero puede ser usada para determinar los probables impactos de la cantidad y característica operacional del trafico de motocicletas en la calidad del aire en vías urbanas. Segundo, puede ser usado para desarollar apropiades estrategias para administrar el trafico en ciudades con proporciones significantes de motocicletas en la corriente de trafico.

El documento tambien describe los resultados de un estudio simulado de las implicaciones de una situacion típica en Hanoi, Vietnam y Bangkok, Thailandia y la posible futura situación en algunas ciudades de Africa.

1 INTRODUCTION

1.1 It is internationally known for decades that high proportions of motorcycles have characterized traffic streams in many Asian cities such as Bangalore (India), Bangkok (Thailand), Hanoi (Vietnam), Taipei (Taiwan) and Surabaya (Indonesia). However, in the last two decades a number of African cities, for instance Coutonou (Benin) and Lagos (Nigeria) have started to experience the same phenomenon. The rate of growth of motorcycles has been higher than expected in some Asian and African countries. For instance, in Bangalore (India) the number of motorcycles increased from around 50,000 in 1977 to over 500,000 in 1992 (Heierli, 1993), and in Nigeria motorcycle imports increased from 5,000 units in 1991 to 30,000 units in 1994 (Howe and Oni, 1996). The increasing use of motorcycles is believed to be related to the following:

a) The increasing level of poverty in several developing countries. For example, in Nigeria a medium sized car that used to cost 1.5-2 years average salary of a middle class earner in the 1970s costs 20-25 years salary in 1996 (Howe and Oni, 1996).
b) The increased congestion in cities of relatively poor developing as well as those in relatively rich countries. Bangalore is a good example of the former and Taipei is a good example of the latter.
c) The travel flexibility offered by motorcycles reduces travel time and cost.
d) The deterioration of the condition of the public transport encourages the use of motorcycles as a, door to door, means of transport.
e) The increased acceptance of this mode by the middle class.

1.2 Unfortunately, motorcycles are hardly mentioned in most of traffic engineering textbooks. Many traffic engineers seemingly think that motorcycles have no significant effect on the quality of traffic movement on urban roads. As a result, motorcycles are often discarded in traffic counts, and even traffic detection equipment often fails to incorporate detection of motorcycles (Powell, 1997). Research by May and Montgomery (1986) showed that while motorcycles crossing the stopline in the first six seconds of effective green time imposed little impedance on traffic and therefore had a passenger car equivalent (pce) of zero, motorcycles crossing the stop-line later in the cycle had a pce of 0.53 to 0.65 depending on the lateral position that the motorcycle adopted to undertake its movement..

1.3 Very little attention has been paid to motorcycles as a serious source of air pollution in most countries, perhaps with the exception of Taiwan, which seems to be the only country with a policy of encouraging the use of specific types of motorcycles. Motorcycles, especially the two-stroke engine type, have a considerable contribution to air pollution. In particular, hydrocarbons (HC) and organic particulate (SPM). This is because of the high emission rates, due to the absence, in most cases, of catalytic converters and use of motor oil and fuel mixtures. According to Tzeng and Chen (1998), the HC and CO emissions of motorcycles occupy the first and second places among all transportation means in Taipei. In addition, review of results from Asian case studies shows that in some cities, motorcycles may be contributing up to 92 % to 100% of SPM pollutant emissions and 78 % to 100% of HC pollutant emissions.

1.4 The preceding analysis indicates that motorcycle characteristics and behavior need to be internalized in urban traffic engineering and air pollution analysis. Internalization and better understanding of motorcycle characteristics and behavior will ensure:

• better estimation of motorcycle contributions to exhaust emissions.

• optimal design of traffic control signals.

• better geometric design of urban segments used by motorcycles.

• more efficient allocation of lanes for different types of vehicles.

1.5 Consequently, a research project has been initiated to develop appropriate tools for analysis of the effects of motorcycles in mixed traffic on urban roads. This paper describes one of such tools. It deals with a simulation model of motorcycle behavior at signalized road intersection approach sections. The rest of the paper is organized into four sections. Section 2 describes a theoretical model simulating maneuvering characteristics of motorcycles. In section 3, an application of the model for estimation of air pollution is presented. Discussion of the results is presented in section 4, and section 5 presents the conclusions and notes the practical benefits of the research.

2 THEORETICAL MODEL SIMULATING MOTORCYCLE MANEUVRES ON URBAN ROADS

2.1 In his pioneering work, Powell (1997) described the behavior of motorcycles. He stated that their behavior is fundamentally different from that of

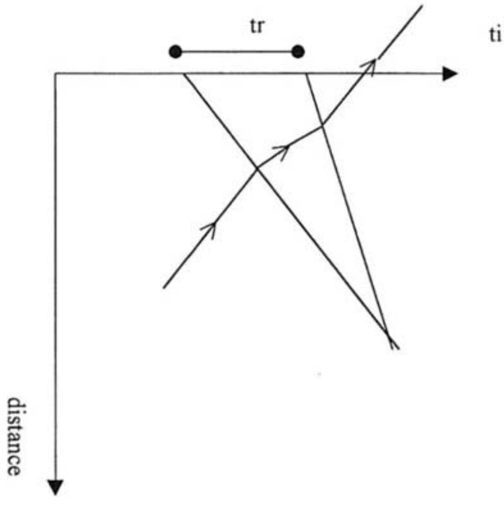

Figure 1.a: Desired behavior

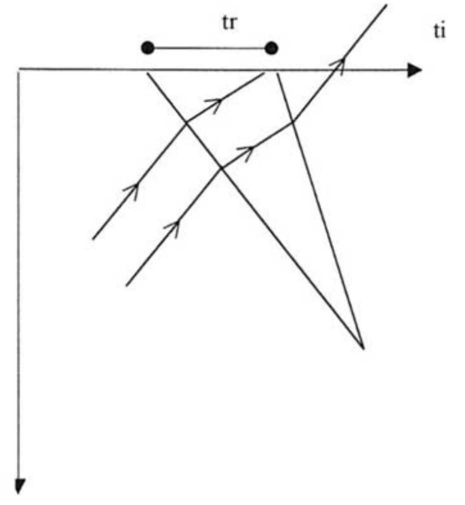

Figure 1.b: Realistic behavior

four-wheeled vehicles in that they travel at a cruise speed along a link until encountering queuing four-wheelers and then travel at a reduced (percolation) speed within the queue. According to him, a proportion of the motorcycles is able to percolate unrestricted, whilst others get blocked by other vehicles within the queue. This behavior is illustrated in Fig. 1

The shock wave analysis was used to model traffic behavior at signals. The following mathematical relationships were derived using simple geometry to allow the calculation of four points in time, cut-off point 1 (COP 1), cut-off point 2 (COP 2), cut-off point 3 (COP 3) and cut-off point 4 (COP 4). These cut-off points define time windows within the cycle. Motorcycles arrive in a time between COP 1 and COP 2 at a distance D downstream will be queuing at the signal line. Those who will arrive in a time between COP 2 and COP 3 will be percolating within the queue, while those who will arrive between COP3 and COP4 will cruise.

2.2 Based on the assumption of this behavior, the theory of shock wave analysis (Edie, 1974) and simple geometry, a number of mathematical relationships have been derived. The relationships involve the calculation of four points which define time windows within a cycle.

The four cut-off points are defined as COP 1; COP 2, COP 3 and COP 4 respectively in Figure 2.

The derived relationships are as follows:

$$t_1 = \frac{3.6D}{v_c} \tag{1}$$

$$t_2 = \frac{s_1 tr}{s_1 + v_p} \tag{2}$$

$$t_0 = \frac{t_2 v_p + v_c(t_r - t_2) - 3.6D}{v_c} \tag{3}$$

$$t_4 = \frac{3.6L_{que}}{s_2} \tag{4}$$

$$t_3 = \frac{t_4 v_c + s_2 t_4 - 3.6D}{v_c} \tag{5}$$

where:

s_1= speed of stopping wave

s_2= speed of starting wave

v_p= average percolating speed of motorcycles

v_c= average cursing speed of motorcycles

tr= effective red time

- The total length of the queue L_{que}, can also shown to be

$$L_{que} = \left| \frac{s_1 s_2 tr}{3.6(s_2 - s_1)} \right| \tag{6}$$

From shock-wave analysis the speeds of stopping wave s_1 and speed of starting wave s_2 can be expressed to be:

$$s_1 = \frac{Q}{\frac{Q}{RS} - KJAM} \tag{7}$$

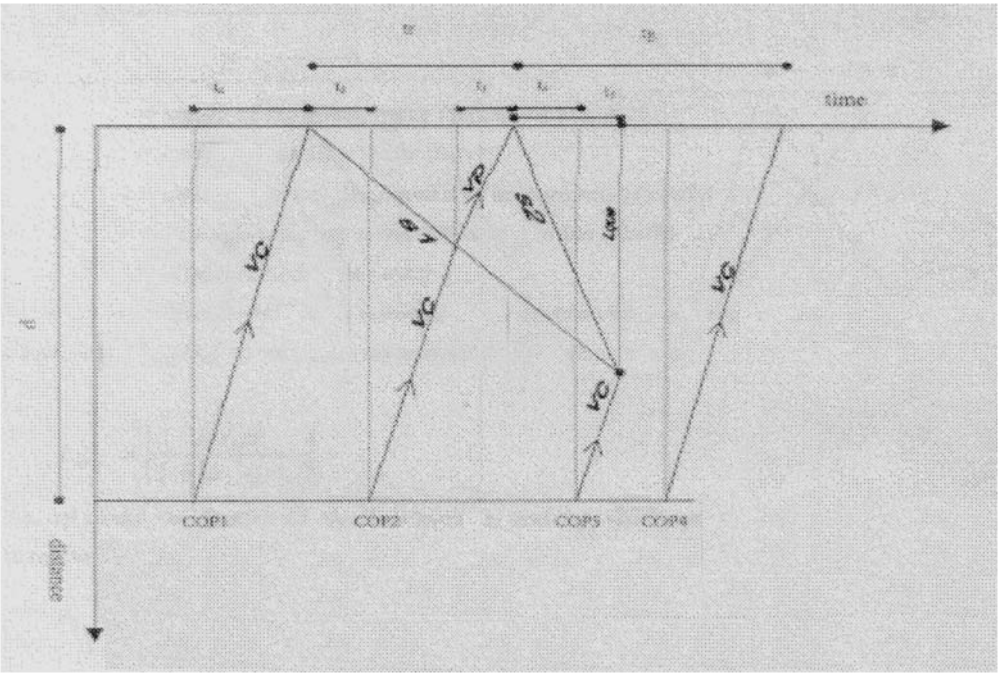

Figure 2: Time distance diagram showing cut-off points within cycle

$$s_2 = \frac{SATFLOW}{KCAP - KJAM} \quad (8)$$

where:

Q = vehicles (four-wheelers) flow rate, (vph)

$KJAM$ = jam density,(veh/km)

$SATFLOW$ = saturated flow rate,(vph)

$KCAP$ =density at capacity,(veh/km)

Furthermore, if: n

Then it can be shown that:

- n = number of motorcycles arriving in a traffic cycle
- n_1 = number of motorcycles arriving in time between COP1 and COP2, at a distance d downstream which are likely to queue at the signal line
- n_2 = number of motorcycles arriving in time between COP2 and COP3, at a distance d downstream which are likely to percolate within the queue
- n_3 = number of motorcycles arriving in time between COP3 and COP4, at a distance d downstream which are likely to continue cruising

Then it can be shown that:

$$n_1 = \frac{(t_1 + t_0)n}{TC} \quad (9)$$

$$n2 = \frac{(t_3 + t_R - t_0)n}{TC} \quad (10)$$

$$n_3 = \frac{(tg - t_3 - t_1)n}{TC} \quad (11)$$

Where:
= cycle length (sec.) and other variables are as previously defined.

For the above equations to hold, the following assumptions were made:

- the arrival rate of motorcycles is uniform.
- motorcyclists are free to achieve their *desired* behavior.

In reality the last assumption does not hold, as only part of n_1 will be queuing at the front of the queue and the remaining part will be *trapped* in the queue. Similarly, only part of n_2 will continue percolating within the queue, whilst the remaining will be blocked in the queue. If we assume the proportion of motorcycles' queuing at the front of queue is α_1 and the proportion of motorcycles percolating within the queue is α_2 then

$$n_{1(true)} = \alpha_1 n_i \quad (12)$$

$$n_{2(true)} = \alpha_2 n_2 \quad (13)$$

where:

$n_{1(true)}$ = True number of motorcycles queuing at front of the queue

$n_{2(true)}$ = True number of motorcycles percolating within the queue

α_1, α_2 =Calibration factors

Data collected from the city of Hanoi and from Bangkok was used to estimate the calibration factors α_1 and α_2. Using simple statistics it was found that:

2.3 Based on data collected from the cities of Hanoi (Vietnam) and Jakarta (Indonesia) it was found that the values of a, and a2 depend mainly on width of lanes, number of lanes, number of buses/trucks and lane usage.

In addition, it was found that the best estimates of a, and a2 are:

α_1= 0.81±0.10

α_2= 0.84±0.07

3 APPLICATION OF THE MODEL FOR AIR POLLUTION ANALYSIS

3.1 In order to illustrate the applicability of the model, it was combined with a vehicular traffic emissions model (Akinyemi and Medani, 1999) to investigate the effects of the quantity and behavior of motorcycles on air pollution. The following scenarios were analyzed:

1. Increasing proportion of motorcycles in a *congested vehicular* -traffic stream. This is a scenario that exists in many developing cities such as Bangkok.
2. Increasing proportion of motorcycles in a traffic stream *congested with motorcycles.* This scenario exists in developing cities such as Hanoi.
3. Increasing proportion of motorcycles in a *non-congested* traffic stream.

3.2 The results obtained for both two-stroke and four-stroke motorcycles are shown in Figures 3, 4, 5, 6, 7 and 8. In addition, regression analysis of the results showed that the data fitted well an exponential model in the form of:

Y = B,,.EXP(Bi X)

where:
y = pollutant concentration (g/m,
X = proportion of motorcycles in traffic stream N

B0, B, = regression constants

The values of *Bo, B,* and the adjusted R~ are shown in Table I and 2.

4 DISCUSSIONS OF THE RESULTS

4.1 As expected, the results indicate that the effect of motorcycles on air pollution is dependent on the prevailing condition of traffic and the characteristics of the motorcycles. In addition, a detailed analysis of the results gives the following findings.

4.2 Under congested vehicular traffic conditions, a 10% increase in the number of 2-stroke motorcycles is likely to result in an increase of 1-5% of CO, 2-8% of SPM and 9-28% of HC pollutants concentration. A similar increase in the number of 4-stroke motorcycles is likely to result in an increase of 2-7% of CO, 0-1% of SPM and 1-8% of HC pollutant concentration. These imply that under congested traffic conditions the effect of 2-stroke motorcycles on CO concentration is similar to that of 4-stroke motorcycles. They also reveal that 4-stroke motorcycles have less contribution to SPM as well as HC concentration. The most significant adverse contribution to air quality under congested vehicular conditions is that of 2-stroke motorcycles on HC.

4.3 The effect of increasing the number of motorcycles on air pollution is much more significant under conditions in which traffic is already congested with motorcycles. In general, a 10% increase in the number of 2-stroke motorcycles is likely to result in an increase of 20-55% of CO, 32-82% of SPM and 73-160% of HC **pollutant concentration.**

A similar increase of 4-stroke motorcycles is likely to result in an increase of 11-47% of CO, 2-10% of SPM and 15-60% of HC concentration. Similar to scenario 1, the most significant adverse contribution to air quality is that of 2-stroke motorcycles on HC.

4.4 In non-congested traffic conditions, the effect of motorcycles is moderate as a 10% increase in the number of 2-stroke motorcycles is likely to result in an increase of 2-11% of CO, 3-15% of SPM and 16-40% of HC pollutant concentration. Also, an increase of 4-stroke motorcycles is likely to result in an increase of 2-9% of CO, 0-2% of SPM and 3-12% of HC pollutant concentration. Similar to scenarios I and 2, the most significant contribution to air quality is that of 2-stroke motorcycles on HC.

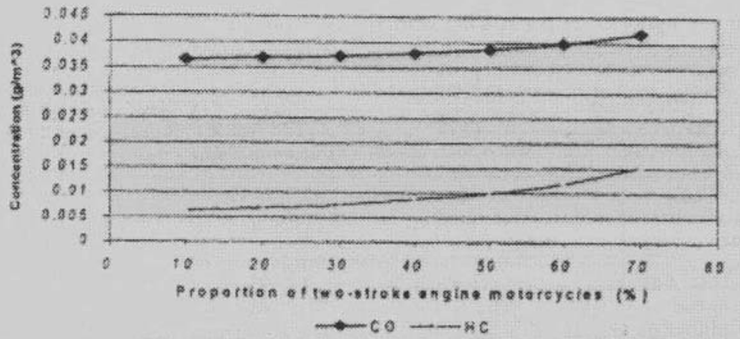

Figure 3: Effect of increasing proportion of motorcycles on pollutants concentration (Scenario I)

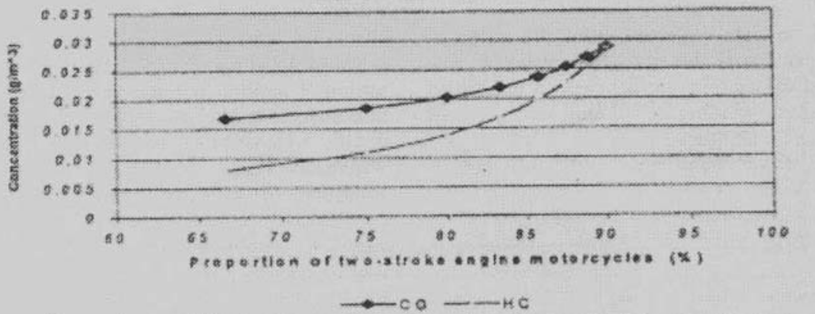

Figure 4: Effect of increasing proportion of motorcycles on pollutants concentration (Scenario 2)

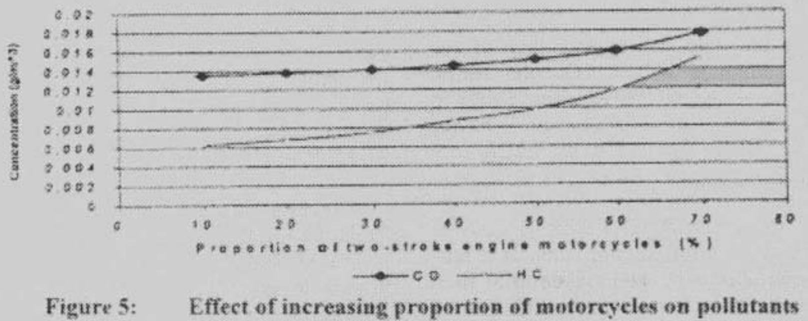

Figure 5: Effect of increasing proportion of motorcycles on pollutants concentration (Scenario 3)

5 SUMMARY AND CONCLUSIONS

5.1 A model that describes the maneuvering of motorcycles at signalized intersection approach sections has been derived. The theoretical model is based on an assumed behavior of motorcyclists and on the shock-wave theory and has been calibrated with data collected from Jakarta and Hanoi. The model allows the estimation of the number of motorcycles, which are likely to queue at the signal line, percolate within the queue and cruise on intersection approach sections.

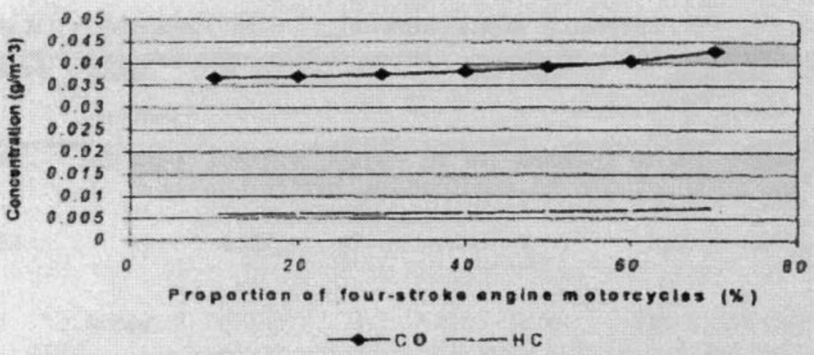

Figure 6: Effect of increasing proportion of motorcycles on pollutants concentration (Scenario 1)

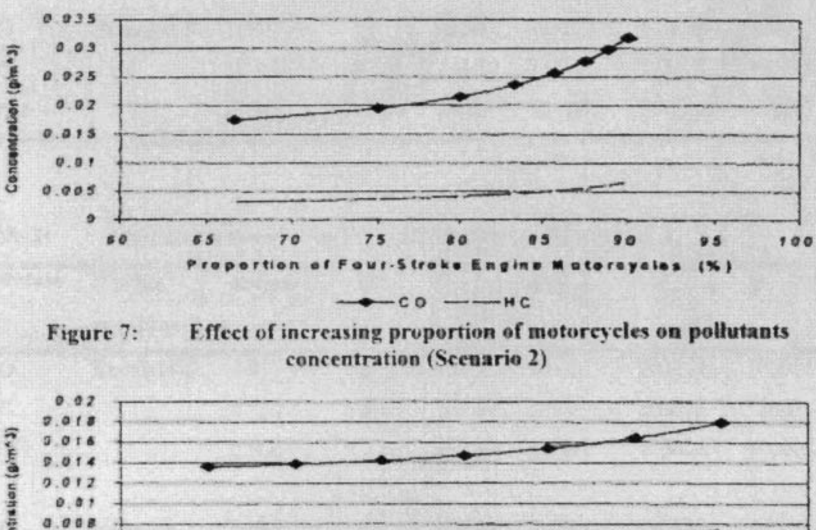

Figure 7: Effect of increasing proportion of motorcycles on pollutants concentration (Scenario 2)

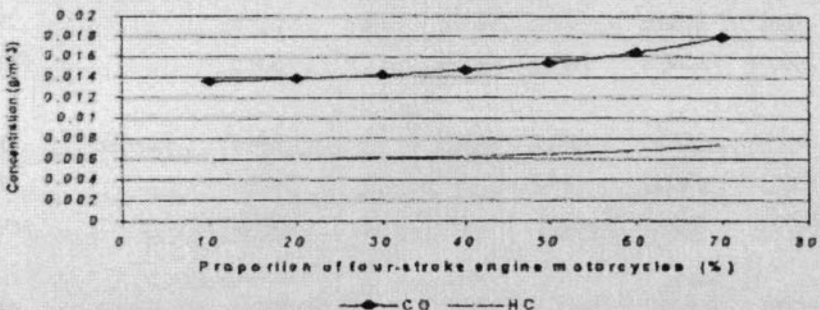

Figure 8: Effect of increasing proportion of motorcycles on pollutants concentration (Scenario 3)

5.2 The results of an example application of the model for estimating motorcycles' contribution to exhaust emissions show that both 2 and 4-stroke motorcycles have a significant contribution to air pollution, especially in traffic streams which are already congested with high proportion of motorcycles. However, 2-stroke motorcycles have a much higher contribution, especially for HC and SPM pollutants.

5.3 The model can be used for the assessment of the effects of motorcycles in mixed traffic conditions. It can also be used for the development of management strategies for signalized intersections.

5.4 Finally, the results of this research show that more attention needs to be paid to the adverse effects of motorcycles on air quality. They also show that factors such as overloading and different operating

Table 1: Regression Results for Two-Stroke Engine Motorcycles

Pollutant	Traffic condition	Rsquare	d.f	F	SigF	B_0	B_1
CO	Scenario 1	0.915	5	47.07	0.001	0.0351	8.2E-05
HC	,,	0.965	5	137.43	0.000	0.0051	0.0144
SPM	,,	0.922	5	59.16	0.001	0.0003	0.0036
CO	Scenario 2	0.901	5	45.25	0.001	0.0126	0.0041
HC	,,	0.980	5	246.02	0.000	0.0018	0.0214
SPM	,,	0.928	5	64.89	0.000	9.8E-05	0.0067
CO	Scenario 3	0.901	5	45.25	0.001	0.0126	0.0041
HC	,,	0.980	5	246.02	0.000	0.0018	0.0214
SPM	,,	0.928	5	64.89	0.000	9.8E-05	0.0067

Table 2: Regression Results for Four-Stroke Engine Motorcycles

Pollutant	Traffic condition	Rsquare	d.f	F	SigF	B_0	B_1
CO	Scenario 1	0.917	5	55.01	0.001	0.0354	0.0025
HC	,,	0.922	5	59.16	0.001	0.0055	0.0036
SPM	,,	0.906	5	48.20	0.001	0.0006	0 0004
CO	Scenario 2	0.937	5	74.26	0.000	0.0128	0.0045
HC	,,	0.944	5	57.25	0.000	0.0020	0.0063
SPM	,,	0.920	5	57.85	0.000	0.0002	0.0008
CO	Scenario 3	0.934	5	84.46	0.000	0.0030	0.0254
HC	,,	0.943	5	99.97	0.000	0.0004	0.0316
SPM	,,	0.898	5	53.09	0.001	0.0001	0.0059

modes of motorcycles which have effects on emission rates and have not been investigated in this research, may be significant contributors to air pollution in many cities.

ACKNOWLEDGEMENT

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An integrated planning for the 'environmental island' to promote sustainable mobility

Une planification integrée de l''Ile de environnement' pour la mobilité durable
Una planificación integrada de la 'Isla Ambiental' para la movilidad sostenible

Lucia Martincigh
Dipartimento di Progettazione e Scienze dell'Architettura, Università degli Studi Roma Tre, Italy

ABSTRACT: Quality of life improvement, sustainable development and transportation are today main targets in european policies. In large cities, to improve the environmental quality of urban spaces, shifting, as much as possible, from the use of personal vehicles to the use of public transport, improving intermodality, also with non motorized travel modes, interchange points and pedestrian itineraries seem to be the keys to success. The "environmental island", defined using a methodology of integrated design, becomes the occasion for urban upgrading: on one side traffic control, through traffic calming techniques, and enhancement of alternative transport modes, on the other side an intermediate spaces configuration, able to satisfy the users exigences on their whole, material and immaterial, and able to be globally perceived and to induce appropriate behaviours.

RÉSUMÉ: L'amèlioration de la qualitè de la vie, le dèveloppement et les moyens de transport durables sont les grands objectives.de les politiques europénnes d'aujourd'hui. Pour améliorer la qualitè des espaces urbains dans les grandes villes, il faudrait remplacer, autant que possible, les moyens de transport privés par des moyens de transport public. Amèliorer l'intermodalité en utilisant aussi des moyens non motorisèes, les noeuds de correspondance et les itinèraires piètonniers, semblent donc être la clè du succés. L' "île de environnèment", ainsi dèfinie, grâce á une mèthodologie de planification integrèè est l'occasion d'une remise en valeur urbaine. D'un cotè avec le côntrole de la circulation par des tèchniques de "traffic calming", la promotion des moyens de transport alternatifs, et de l'autre cotè avec une configuration des espaces intermediaires en mesure de satisfaire le exigences gènèrales materielles et immaterielles des usagers et capable d'être perçue globalement et de susciter des comportements appropriès.

RESUMEN: Mejoramiento de la calidad de vida, desarrollo y medios de transporte sostenible son, actualmente, los objetivos mas importantes de la politica europea. En las grandes ciudades, el mejoramiento de la calidad de los espacios urbanos, se concentra, sobretodo, aumentando la utilizacion del transporto publico en relacion al automovil privado, mejorando la intermodalidad, tambien con los medios no motorizados, puntos de intercambio y itinerarios peatonales parecen ser los puntos claves del suceso. La "Isla Ambiental", definida utilizando una metodologia de diseño integrado, representa una ocasiòn para mejorar el ambiente urbano: por una parte el control del trafico a travḗs de tecnicas de "traffic calming", y el incremento de medios de transporte alternativos; por la otra parte configurando una serie de espacios intermedios con el fin de satisfacer las exigencias de los ususarios completamente, en sentido material e inmaterial, y en grado de ser percibidos globalmente e inducir a comportamientos apropiados.

1 THE TOPIC ISSUES

1.1 *Urban upgrading*

In european policies, quality of life improvement and sustainable urban development are nowadays two main goals; the rehabilitation of the urban structure seems to be the aptest procedure to achieve them. Problems related to mobility, to traffic and parking, to safety and security, to noise and air pollution, to physical and functional decay, and to the architectural and environmental quality lack, are common to all large urban areas, even if they differ under many aspects, and are particularly heavy in pericentral or peripherical residential districts; thence the rehabilitation process must be characterized by a comprehensive and integrative approach.

1.2 *The role of urban mobility*

Since mobility, as currently structured, plays one of the main roles in this urban environment de-qualification process, its reorganization, becomes a major social and political issue. The experiences already achieved within cities in various European Countries, take to set that this must be based on some fixed points: improvement of urban and suburban transportation and of intermodality, also with non motorized travel modes; reduction of personal vehicles use; promotion of collective and public transport use for the longest routes, and of non motorized travel modes for the shortest ones.

The concomitance of such actions has manifold positive consequences; some direct ones, as traffic reduction and congestion fluidification, air and noise pollution decrease, accessibility and safety increase; and some indirect ones, as improvement of health conditions and decrease of traffic accidents for the most vulnerable users, and thence social costs reduction.

Indeed for people living in large urban areas and spending a great length of time in everyday O/D movements, travel conditions, for any kind of travel mode, walking included, become an essential factor to define their life quality.

1.3 *The role of public urban spaces*

The urban environment quality depends from a complex interlacing of functional, spatial, social and cultural aspects; in particular the quality of the intermediate spaces in the residential districts is tightly connected to the mobility and exchange possibilities. Walking is an integrant part of the european cultural tradition; in the past urban spaces were shaped according to such aim and, offering varied and comfortable walking and rest places, favoured social relations. In modern cities, mainly planned in order to meet vehicular mobility requirements, pedestrian mobility has been pushed to minor spaces that, lacking any safety, comfort and attractiveness, have lost completely their function of spaces for gathering and have become mere clearances of hurried passing.

Since life quality thence is strictly related to the performances offered by public spaces, it is necessary not only to regain them controlling car mobility, but also to upgrade them. A good integration among all modes of transport, well organized interchange points, comfortable and attractive pedestrian itineraries seem to be the keys to success; their planning must be then made with a holistic approach.

2 THE RESEARCH GOAL

2.1 *The european research*

The EC, in the IV Framework Program, has financed researches in order to identify and coordinate innovative strategies and measures to develop a sustainable urban mobility; some of these researches have been directed towards the promotion of travel modes that are alternative to personal cars traffic, and in particular to non motorized travel modes.

The V Framework Program maintains this goal in the key action "The city of tomorrow and cultural heritage", drawing scenarios that integrate urban planning and sustainable mobility, with attention to energy and social aspects, for improving both the life and the urban environment quality.

2.2 *The national research*

The research in the field of Technology of Architecture has dealt since long with these topics, in particular the group I coordinate has faced them setting up analysis and planning methodologies, and experimental applications aimed at evaluating the potentialities inherent the promotion of pedestrian mobility as a way to upgrade residential districts in modern cities. Just in these days the italian Ministry of Scientific and Technological Research has funded a national research, for which the author is one of the responsibles: "Safety and quality in urban areas: strategies, tools and techniques to promote pedestrian mobility".

These short notes result from a research: "Urban rehabilitation and pedestrian mobility", that has been carried out since 1996 by an interdisciplinary university group coordinated by the author, within the EC - COST Programme - Action C6: "Town and infrastructure planning for safety and urban quality for pedestrians".

2.3 *The study articulation*

The study, run both at national and european level, in its first phase, has defined the state of the art regarding political and legislative, strategic and technical aspects, and best practices, about the topics related to safety, to mobility management, to infrastructure and intermediate spaces re-design, and about those related to urban quality, and so to its meaning and to the related requested performances.

The second phase has dealt with case study applications in some cities of the 12 participating Countries; the third phase, still in progress, basing itself on the shared knowledges acquired in the two preceding phases, gives suggestions on what to deepen and on how to plan both urban environment and mobility to enhance walking, making it safer, more attractive and easier.

3 THE EXPERIMENTAL APPLICATION

3.1 *The integrated design*

The collaboration with Rome Town Municipality has allowed to run a pilot project; as case study, has been chosen a residential district in Rome, representative of the suburban areas typical negative features: Pietra Papa, at Viale Marconi (Fig. 1).

The intervention proposal has taken advantage of the research results; thence, the elaboration has started from the assumption that, to re-create livable districts, is necessary to manage, in a synergetic way, the aspects related to the reorganization of mobility, and those related to the improvement of the intermediate spaces quality on its whole, individuating the relations between the specific techniques individually used for their planning. This holistic criterion has characterized the whole project; during the work various strategies and innovative tools, aimed at different objectives, have been used.

3.2 *People partecipation and consensus*

Change is never easily accepted; so it is necessary to consider not only its practical aspect, but also its cultural one; to reduce the level of resistance to it, it is necessary to let new cultural value ripen, to induce awareness and therefore consensus. In this district, this has not had enough time and possibility to happen yet; so some problems have arisen anyway at implementation local level. How to open the users-residents participation in the decision process in a positive, and not only demagogic way, remains a delicate aspect of the planning process. Trying to keep in consideration both the above mentioned aspects, it has been used a planning process that, on one side, using an anthropocentric methodology focused on the requirements/performances meeting, involved the residents in the transformation process, and on the other side, creating a more appropriate urban environment, were able to foster the choice of new behaviours, alternative to the use of the personal car.

Figure 1. Negative effects of the vehicular presence in the school area of Pietra Papa District.

3.3 *High quality design*

If the upgrading process must be successful from the environmental, social and economical point of view, it is basic to obtain a product of high qualitative level; the use of an innovative integrated planning methodology, that defines appropriate and congruent criteria, codes, methods and techniques, lets reach a level of accuracy and detail in design apt to manage the complexity of the urban public spaces devoted to mobility and rest.

3.4 *The implementation*

Since the implementation aspects play a main role, the work has been based on the prescriptive concept of "Environmental Island", as mentioned in the Italian Law on Urban Traffic Plans; the contents of this direction are in the lead: micro urban environments as a whole, which the pedestrian dimension is privileged in, practicable in areas, that are mainly residential, to manage urban mobility at local level.

May be because its innovative purport has not been yet caught, or may be because it is not backed by proper implementation codes and techniques, it is not yet implemented in a diffusive way. In an english report, lately published, it is suggested the investigation of a similar approach, to face in a comprehensive way the rehabilitation of urban residential areas, naming it "Home Zones".

4 THE ENVIRONMENTAL ISLAND

4.1 *The innovative purport*

The study has thence tried to individuate which are the problems, the limits and the potentialities of the "Environmental Island", applying the types of intervention it foresees or it adumbrates, widening in this case their purport; thank also to the indications given by the study run by arch. Maria Vittoria Corazza for her Doctoral Thesis, of which the author has been tutor, it has been possible to define guide lines for the implementation process (Fig. 2).

The Environmental Island is thence interpreted and perceived as a chance for urban residential areas rehabilitation and, being aimed both at the required urban space quality and mobility control, is defined and implemented with an integrated planning, that organizes and shapes, in a synergic and innovative way, continuous pedestrian networks and vehicular roads, with the aim of upgrading their performance levels for pedestrians.

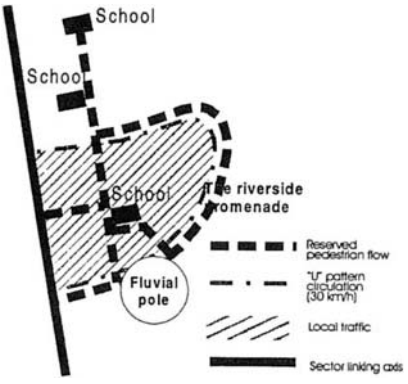


Figure 2. The "Environmental Island": Gathering poles and vehicular and pedestrian mobility at "Pietra Papa" in Rome *
* Proposal by Prof.arch. L.Martincigh, Work Coordinator. Working Group: Prof.arch.L.Martincigh, arch.s M.V.Corazza, A.Tosone. Collaborators: arch.s U.Bevilacqua, A.Marino, L.Feliciani. Consultants: Prof.s arch.s G.Boaga, F.Bianchi, ing.S.Gori; arch.s O.Santilli, P.Ferro, ing. S.Carrese, dr.R. Squarcia. Participants: arch.s F.Fabrizi, M.Canciani, ing.C. Napoleoni, L.Urbani, dr.C.Villani.

4.2 *The sustainable mobility*

On one side, through the traffic control, the relation between the vehicular and pedestrian and/or cycling areas, and their size, have been rebalanced, with the aim to improve their accessibility and safety, and to reduce the air and noise pollution.

To achieve safer and healthier outdoor pedestrian networks and spaces, it is important to eliminate the through traffic, to limit the speed at 30km/h, and thence to re-design the local road infrastructure using prescriptive rules and innovative traffic calming devices, since long already in use in other european Countries, such as gates, raised crosswalks, chockers, narrowed carriageways, chicanes, roundabouts etc.

Also in the application of such techniques, the approach must be holistic; therefore all the involved aspects must be studied, as the road geometric characteristics, the building techniques, the materials, the colors, the lighting, the environmental setting and the sign system, so to decrease the driving speed and, at the same time, to increase the driver's state of attention, thanks to the use of characterizing urban "signs", that create stimulating visual images.

4.3 *The coexistence space*

On the other side, regarding the urban quality, it has been made a functional and environmental transformation of the city "ground" that, creating a plurality of events and of qualified spaces, heralding various different uses, fosters again the social and cultural relations and promotes the process of re-appropriation also from the most vulnerable users categories, which are the most conditioned ones by the outdoor urban spaces configuration; it has been hypothesized an itinerary mainly pedestrian, consisting of routes and rest places located in the reconquered spaces, that links facilities and residences, and that plays the role of connective tissue supporting some urban functions.

Following to the most recent formulation of some european researches, it has been deepened the concept of "intermediate space" and, overcoming the concept of "pedestrian island", nothing else but a new urban zoning, in favour of a life in common for vehicular and pedestrian mobility, it has been developed the concept of "coexistence space".

The rights of the pedestrian and those of the driver are studied at the same time, so to make them live together without disadvantaging only the pedestrian any more.

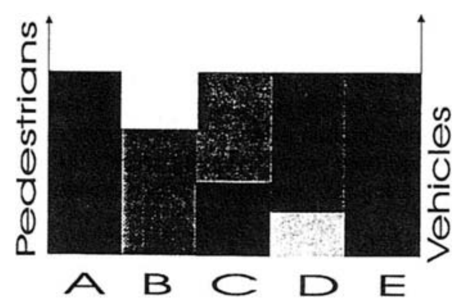


Figure 3. The various paths classification: nuances of vehicular and pedestrian coexistence, besides "Islands".

In this sense it has been made a definition and classification of the pedestrian spaces in relation to the vehicular ones; in this way five categories of spaces have been identified, that allow, depending on their geometric and morphologic characteristics, and environmental performances, different way of using them (Fig. 3).

4.4 *The methodology*

In the used planning methodology, two are the basic steps: the "a priori" analysis and the "a posteriori" validation. The opportunity of the informing principles, of the strategies and of the intervention criteria has been confirmed by the users exigential requirements come out of the investigations, analyses and "local" experiences; besides accessibility and fruibility, are reckoned to be fundamental and widely shared: safety from traffic accidents and of use, security, physical and psychological comfort, and "attractiveness" of the urban space, due both to its inner values and to the ones related to its perception. For these latter aspects, that cannot be easily quantified, it is advisable to integrate the current indexes, objectively measurable, with specifically individuated quality indicators (Fig. 4).

The monitoring, subsequent to the intervention, allows to evaluate the effects induced by the re-design of the urban "voids", by the improvement of safety and comfort, by the structuring of appropriate intermodal exchange points, and the impact on the reduction of the air and noise pollution, besides the effects on the maintenance.

A district more answering to the people expectations arouses in the residents the feeling of belonging to the place, and awakens the civic proud that induces them to maintain it. This should make the Local Administrations think over the opportunity of facing the interventions considering their complete life cycle: programme, management, upkeep and funding.

5.THE QUALITY OF THE URBAN SPACE

5.1 *The various techniques*

To fulfill the prefixed goals, the interventions have been aimed at making the pedestrian spaces not only usable but also desirable by the diversified users categories. Through the ergonomic configuration, have been defined the required activities, the related performances and equipments, to be grouped in single environmental units; the units themselves have been then located in the aptest spaces at disposal, already classified following the identified five space typologies, and depending on the performances actually offered (Fig. 5).

The configuration of such spaces has been designed to satisfy the different requirements; as for comfort, particular attention has been paid to the microclimate for locating the various activities in the intermediate spaces, and different strategies have been used to improve it in the different situations and seasons: besides appropriate green and water systems, also other types of vegetation and of "natural" elements have been inserted, both as acustic and polluted air filters, and for satisfyng a much felt lust of "green". As for attractiveness, keeping in mind the visual perception of the users-pedestrians, and thence the meaning and the value given to the parts, the intermediate spaces have been re-designed, individuating as priority fields of intervention the basal parts of the built environment and the details, and using a set of "signs" apt to strenghten the place identity and to create a continuity with the traditions that are still meaningful. Also lighting has been studied from the pedestrian point of view, keeping in consideration both its capability of preventing traffic accidents and assaults, and the one of enhancing the values and hiding the faults of the environment.

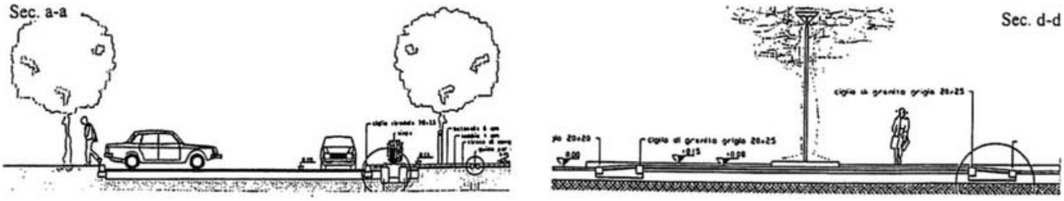
The chosen solutions are to be related to the various existing typologies of spaces, to the satisfaction of the performances required to the whole section of the space, but also to the desire to let people free of interpreting, and ideating, its possible uses (Fig. 6).

requirements / list of interventions		safety								
		traffic	pollution	movement	socialization	autonomy	knowledge	identity and memory	ease	wellbeing
1	residential streets	•							•	•
2	pedestrian paths	•		•	•	•		•	•	•
3	cycle tracks	•		•		•				•
4	safe crossings	•				•			•	
5	parking areas	•				•			•	
6	short rest areas				•	•			•	•
7	"the plazza"				•		•	•		•
8	sporting areas			•	•					•
9	leisure areas				•		•	•		
10	green barriers	•	•				•	•		•
11	urban plantings		•			•	•	•		
12	birdgardening		•				•	•		
13	kitchen gardens and greeneries				•	•	•	•		•
14	fluvial habitat		•	•	•	•	•	•		•
15	"scenic points"						•	•		
16	toponymy						•	•		
17	lighting				•	•				
18	interchanges					•			•	•
19	signs and signals	•				•	•	•		

Figure 4. The requirements meeting.

spacial and functional unities / type of paths	A	B	C	D	E
U1 - "the view over the Tiber"		•			
U2 - "the rest"		•			
U3 - "the pergola"		•			
U4 - "the neighborough youth"	•				
U5 - "the schoolyard"	•				
U6 - "the drinking fountain"	•				
U7 - "kitchen gardens and greeneries"	•				
U8 - "the piazza"	•				
U9 - "the promenade"		•			
U10 - "the path to the piazza"			•		
U11 - "the post office"		•			
U12 - "the shopping"			•		
U13 - "the kids path"			•		
U14 - "waiting for the schoolchildren"		•			
U15 - "the church"		•			
U16 - " strolling in the neighborough"				•	
U17 - "the way home"					•

Figure 5. Activities and Enviromental Units: their location in the intermediate spaces.



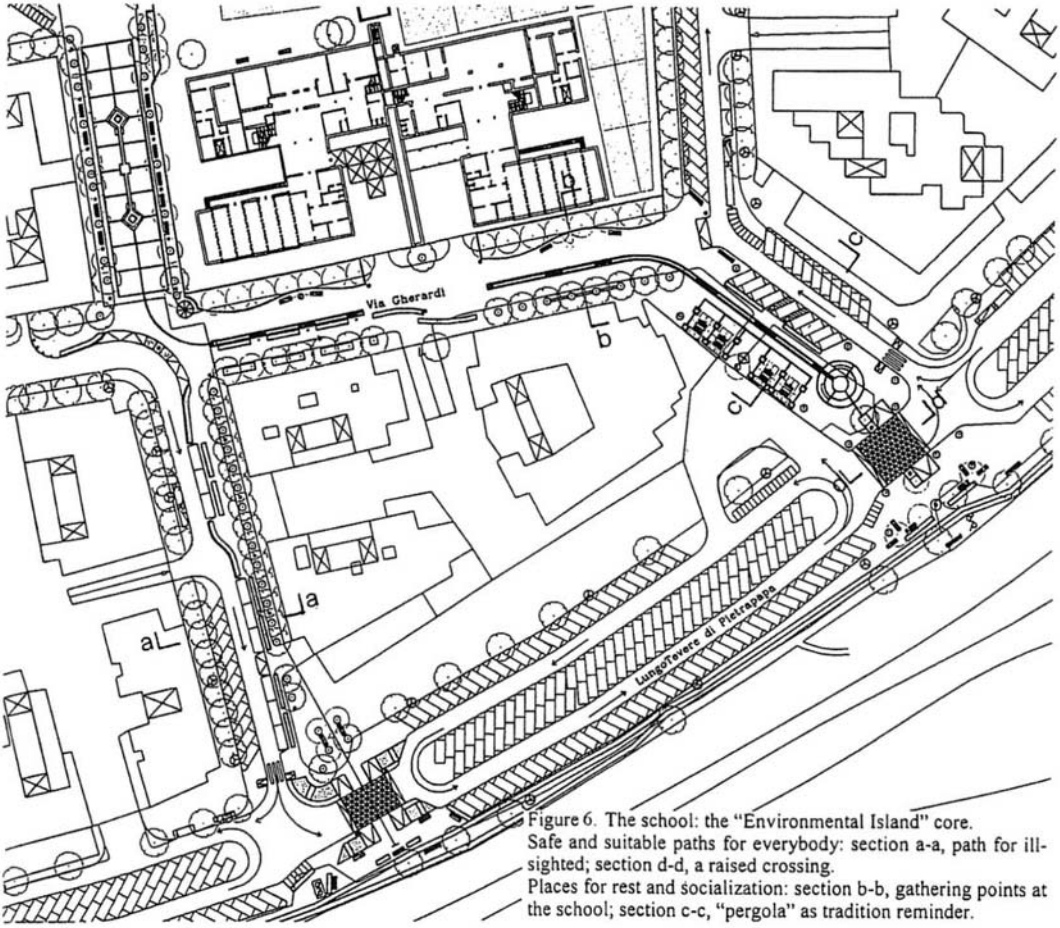
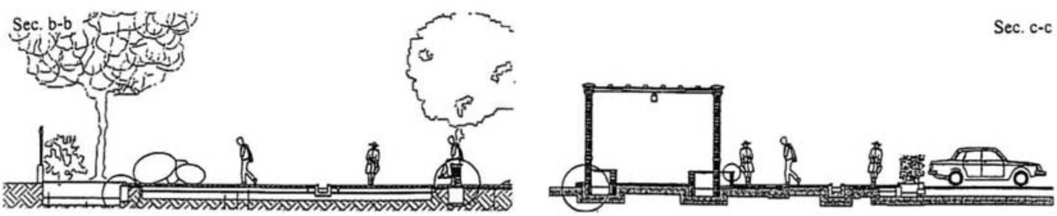


Figure 6. The school: the "Environmental Island" core.
Safe and suitable paths for everybody: section a-a, path for ill-sighted; section d-d, a raised crossing.
Places for rest and socialization: section b-b, gathering points at the school; section c-c, "pergola" as tradition reminder.



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Pedestrian accepting gap in Jakarta

Endang Widjajanti
Department of Civil Engineering, Institut Sains and Teknologi Nasional (ISTN), Jakarta, Indonesia

ABSTRACT: Providing adequate facilities for pedestrian should be an important factor in deciding the location of highways, particularly for highways in urban areas. Special attention must be given to the provision of adequate pedestrian facilities in planning and designing urban highways. Road crossing behavior study is very important in the design of road crossing facility. This paper discussed about the distribution of pedestrians accepting gap in Jakarta, Indonesia. The results of study give the value of threshold gap for the 33.32 km/hour traffic in Jakarta is 25 meter, and there is a significant relationship between the pedestrians accepting gap and the speed of anticipated car.

1 INTRODUCTION

Providing adequate facilities for pedestrian should be an important factor in deciding the location of highways, particularly for highways in urban areas. Special attention must be given to the provision of adequate pedestrian facilities in planning and designing urban highways.

Planning for pedestrian ways should consider all aspects of the pedestrian's environment. This environment includes elements such as vehicles, buildings, streets, curbs, sidewalks, overpasses, underpasses, signs, signals, street furniture, trees, noise, air, odor, the elements of weather and other people. Pedestrian characteristics relevant to traffic and highway engineering practice include those of the driver characteristics. The characteristics consist of visual, hearing and walking characteristics.

Road crossing behavior study is very important in the design of road crossing facility. Pedestrian habits while crossing roadways, which called gap acceptance of pedestrian, should be studied to know the road-crossing behavior.

2 OBJECTIVES

The objectives of the study are as follows:

1. To know the gap acceptance of pedestrians from car before crossing
2. To know the relationship between pedestrians gap acceptance and the speed of car in front of pedestrians

3 SCOPE OF STUDY

The study is conducted under the following conditions :

1. Single crossing
2. The pedestrians is not running while crossing
3. Unsignalized crossing in two lane one way road

4 PEDESTRIAN WALKING RATES

Walking rates are reported by Sleight from several studies where the average adult and elderly moved at approximately 4.5 feet per sec (1.4 m per sec). Children moved more rapidly at approximately 5.3 ft per sec (1.6 m per sec). Study by Widjajanti,E (1995) reported that the average speed of workers in Central Jakarta is 74.7 m/min (1.245 m per sec).

5 PEDESTRIAN GAP ACCEPTANCE

Pedestrian habits while crossing roadways have been studied and reported by Jacobs in which the so-called Threshold gap (defined as the gap accepted by 50 percent of pedestrians) for 20 mph (32.186 kph) traffic is 84 ft (25.6 m). The distribution of gaps is shown in Figure 1.

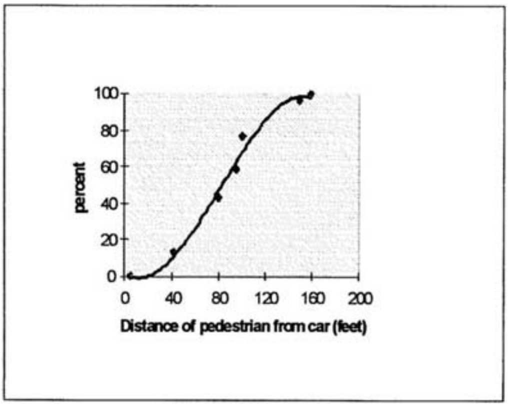

Figure 1. Percentage of Pedestrian Accepting Gap

A study of actual gaps in the traffic stream will enable the determination of adequacy of existing control measures, or the necessity of initiating control at an uncontrolled location. The actual delay for pedestrians is also useful value in analyzing the control situation. At unsignalized locations, measuring gaps in the traffic stream, and considering the percentage of time during which a gap is available may estimate this.

6 DATA COLLECTION

The criteria of study location are as follows :

1. Two lanes one way road (2/1)
2. As a link, not intersection
3. Has low side friction
4. Has many pedestrian crossing (100-1250 Pedestrians/hour[1])
5. The segment of road has a normal urban road average speed (± 40 km/hour)
6. Traffic volume in the range of 2000-5000 vehicle/hour [1])

There are three locations meet those criteria as shown on Table 1.

Table 1. Location of Study

Name of street	Volume of pedestrian crossing (pedestrians/hour)	Traffic Flow (vehicle/hour)
Kalibata	142	2850
Lenteng Agung	109	2880

Data requirements for the study are as follows:

1. The gap between the crossing pedestrians and the car which pedestrians anticipated in.
2. Speed of the car which pedestrians anticipated in.

A video recorder was used to record the situation at the observation site.

The following data were measured from the recording:

1. The time when the pedestrian begin to cross the street (at point A) : ta
2. The time of the car which pedestrian anticipated in reaches the point of crossing (point A) : tb
3. The time of the car reach the first line of observation (point C) : tc
4. The time of the car reach the end of observation line (point D) : td

Layout of the observation site is shown on Figure 2.

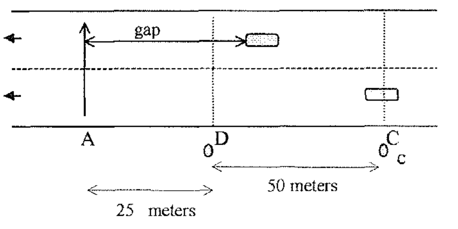

Figure 2. Layout of observation sites

where

Car Speed = 50/(td-tc) * 3.6 in km/hour (1)

Time Gap = (tb-ta) in second (2)

Distance Gap: {50/(td-tc)}*(tb-ta) in meter (3)

7 TESTING OF VARIANCES

Computing the "F" ratio as follows tests the homogeneity of variances:

$$F = \frac{s_1^2}{s_2^2} \qquad (4)$$

where s_1^2 = the larger variance; s_2^2 = the smaller variance

The computed value of F is then compared with the critical value obtained from tables. If the computed (test) value is less than the critical (table) value, the variances are accepted as homogenous

The variability of the speed measurements in the two studies, which is characterized as the standard deviation of the difference of the means and can be calculated as:

$$s = \sqrt{(s_1^2/n_1) + (s_2^2/n_2)} \qquad (5)$$

where s = standard deviation of the difference of the mean; s_1,n_1 = standard deviation and the number of observations in study 1; s_2,n_2 = standard deviation and the number of observations in study 2

The difference between means of samples (Δ) taken from the same population due to chance only would be expected to be within $\pm$ 1s, $\pm$ 2s and $\pm$ 3s in 68.26, 95.46 and 99.73 percent of the cases.

The results of data compilation for speed of anticipated car are shown on Table 2.

Table 2. Average Speed of Anticipated Car

Speed of car	Lenteng Agung	Kalibata
Mean (km/hr)	34.83	32.46
Standard deviation	14.08	12.49
No. of sample	119	206

The results of the Homogeneity of Variances and Significant Differences between Variances Tests are shown on Table 3. This table shows that the data got from two locations are homogeneous and there are no significant differences between variances tests.

Table 3. The results of the Homogeneity of Variances and Significant Differences between Variances Tests

Δ	2.366
2s	3.114
F	1.269
F table	1.302

8 GAP ACCEPTANCE

The average speed of the all speed data is 33.32 km/hour. The distribution of gap acceptance for the 33.32 km/hour traffic in Jakarta is shown in Figure 3. From this figure, the threshold gap (gap accepted by 50 percent pedestrians) could be computed, that is 25 meters.

Comparing with the previous study by Jacobs (1968), pedestrians in Jakarta look have similar gap acceptance in the similar traffic condition.

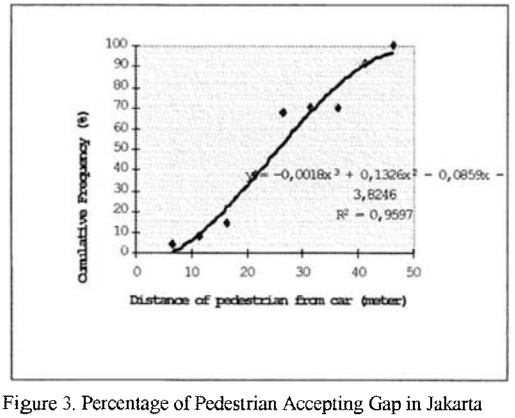

Figure 3. Percentage of Pedestrian Accepting Gap in Jakarta

9 PEDESTRIANS GAP-SPEED OF CAR RELATIONSHIP

The class interval of the car speed computed according to Sturges equation (19..) is 5 km/hour. The percentage (15 %, 50 %, 85%, and 100%) of pedestrians accepting gap are determined after all the speed data had been grouped into this speed range.

The values of pedestrians accepting gap for each speed range indicated that there is a significant relationship between pedestrians accepting gap and car speed. The increasing of car speed in the traffic flow will result increasing of pedestrians accepting gap.

Significance of the relationship indicated by the coefficient of correlation (r^2) value. Relationship between pedestrians accepting gap (y) and speed of car (x) for each percentage are shown in Table 4.

Table 4. Relationship Between Pedestrians Accepting Gap (y) and Speed of Car (x) For Each Percentage

% accepting gap	Equation	r^2
15	y=1.1156x+3.6791	0.9746
50	y=0.6865x+3.0125	0.9587
85	y=0.4982x+0.8519	0.9567
100	y=0.1591x+13.827	0.7844

Pedestrians accepting gap for each speed range computed based on the equation above is shown in Table 5.

Table 5. Pedestrians Accepting Gap

Car Speed Range (km/hour)	Pedestrians accepting gap (meter)			
	% accepting gap			
	15%	50%	85%	100%
14.1-19	11.85	20.56	32.72	36.08
19.1-24	16.22	27.54	42.32	60.73
24.1-29	20.59	34.53	51.92	85.38
29.1-34	24.95	41.51	61.52	110.03
34.1-39	29.32	48.49	71.12	134.68
39.1-44	33.69	55.47	80.72	159.33
44.1-49	38.06	62.46	90.32	183.98

10 CONCLUSIONS

1. The value of threshold gap for the 33.32 km/hour traffic in of Jakarta is 25 meter. Comparing with the previous study by Jacobs (1968), pedestrians in Jakarta look have similar gap acceptance in the similar traffic condition.
2. There is a significant relationship between the pedestrians accepting gap and the speed of the anticipated car.

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Future of non-motorised transport in developing countries

P. Kumar & M. Parida
Transportation Engineering Section, Civil Engineering Department, University of Roorkee, India
S. S. Jain
Transportation Engineering Section and Centre Engineering Department, University of Roorkee, India

ABSTRACT : Now a days a point of discussion in developing countries is that whether the slow moving vehicles, also know as non-motorised vehicles have any future. The answer is certainly positive. To verify this some studies were conducted in different parts of the World. This paper presents the conclusions of some of those studies and stresses the need of non-motorised transport.

1. INTRODUCTION

1.1 General

Man has relied on only animal drawn vehicles for centuries. It was in the 19^{th} century, when man started using the auto-engines for transport purpose on fair weather roads. Since then, the scenario is changing fast and the motorised vehicles are replacing more and more the non-motorised vehicles on roads. But in developing countries like India, the transportation is still typical example of mixed traffic comprising fast moving motorised vehicles like buses, cars, mini-buses, motor cycles, tractors and animal drawn vehicles like bullock carts, horse carts and camel carts, all sharing the same road space without any segregation. The trips on foot and bicycles also prevail. It is true in case of trips from suburban areas.

1.2 Signification of Non-Motorised Transport

Transportation Problems in general can be simply characterised by the dissatisfaction of the traveller everywhere. This is so despite enormous expenditure incurred on various transportation infrastructure facilities. The policies adopted are often criticized, as they do not provide equity to al sections of the society. The economic and social efficiency of a city or region is strictly dependent on how everyone makes use of the transport system. Though the nature of problem can be quite different, both developing and developed world are plagued with numerous critical issues related to the repetitive daily travel. Congestion, delay, accident and pollution are the by-products of modern transportation systems, and spiraling investments of richer economies for increasing roadway capacity could not satisfy all in the society and proved to be a black-hole theory of transport development. The spatial organisation of the society may have to be altered to fill the gaps in the prevailing transport supply (transport modes and network) arrangements. In this context the role of Non-Motorised Transport (NTM) will be significant and its promise is already know from the experiences around the world. Basically those transportation strategies will be sustained in the foreseeable future, which meet the basic mobility needs for all without destruction of the resource base.

In developing countries majority of people rely on NMT, often supplemented by public transport and intermediate public transport (IPT). The inadequate and inefficient public transport affects more people in developing countries than the traffic congestion and limited parking supply. Even the cheap public transport cannot be afforded by large section of the population. The various forces which determine the degree of use of different motorised and non-motorised modes of transportation are investment, subsidy, tax and tariff policy, infrastructure planning and design, regulatory actions, topography, climate culture and habits, income levels, and land use pattern which evolve from long term policies. Transport planning has been more biased towards motorised modes and offered policy options for high investments. Traditional non-motorised low-cost modes like walk, bicycle, rickshaw, cart, boat, etc. ; have generally been ignored and discarded without studying their relevance in their relevance in the particular context.

2. TRIP CHARACTERISTICS OF NON-MOTORISED TRANSPORT

2.1 Study in Suburban Areas

Ghaziabad district is situated adjacent to Delhi, the capital of India. A survey (1) was conducted in suburban areas of various towns in Ghaziabad district. The sample size is as given below :

- Total Subdivisions 5
- Total Families 711
- Total Persons 4255

The users were asked to give their trip frequency, trip mode, tripe length etc. A mode choice distribution of the persons interviewed in this area is given in Table-1. The results show that 45.1 % persons are using motorised transport to reach the city/towns for their work trips. On the other hand, 37.5 % persons still prefer to use the non-motorised transport. The remaining 17.4 % persons reach their destination on foot in these suburban areas. Although, this study does not separate out transit captive and choice riders, but gives a clear picture of non-motorised transport which is still having a good share of preference.

In another study (2) of suburban areas near Jaipur (India), it was found that 24 % of the trips are made by bicycles only, to reach their destination and vice-versa. The various reasons for adopting the bicycle as a mode for reaching the work place include health consideration, inexpensiveness, and sometimes the only available alternate. This result was based on the interview of 427 families. The preference to bicycles in particular and other non-motorised mode i.e. horse cart, camel cart etc., in general, was more profound in case of shorter travel distances.

2.2 Study of University Students

A survey (3) of the staff and student at the Townsville campus of James Cook University was conducted in march 1996 with a view to assess their attitude towards the bicycle mode and identifying limitations in the mode and network characteristics. The respondents were classified into three groups based on the extent of bicycle. The bike-user group includes respondents whose usual mode of transport is bicycle. This group uses bicycle as the normal mode for travel to and from the University as well as some trip purposes. A substantial number of respondents form the non-bike-user group. These people do not use bicycle at all. The final group comprises those respondents who use bicycle some of the time for some purposes. They may use bicycle to go to work on some days or they may ride for recreation or other purposes. This group is designated as casual bike-user group. Percentage of respondents for these three groups was 26.6 %, 45.1 % and 28.3 % respectively.

Of all responses, 443 were valid responses in respect of the suburb of residence. The respondents had stated widely different distances to the University from the same suburb. This was modulated by using the average distance from any suburb to the University. For the purpose of analysis, the suburbs were classified into five groups according to the average distance in increments of five kilometers. The overall distribution of respondents with respect to the distance from the University is shown in Table-2. In comparing the three groups on the basis of proximity (14.2 %) compared to all respondents (9.5 %). Bike-Users had a significant smaller proportion living over 15 km from the University (3.3 %) compared to non-users (15.4 %) and all respondents (11.5 %).

- Non-bike user and casual bike-user groups are similar in socio-economic characteristics and are contrasted from the bike-user groups in gender participation, income, proportion of staff, and car ownership. The bike-user group comprises more males, students, younger age group, lower income and with lower car availability. It was found that casual bike-users traveled an average of 40 km per week by bike which could be for a few work trips during the week, for recreation and pleasure, or other purposes. On an average, a bike user traveled 88 km per week for works trips. This ranged from a low of 42 km per week for respondents living in close proximity (< 5 km)to a high of 154 km per week for those living 15-20 km away. The total distance traveled by bicycle for all respondents was 109 km per week with a range of an average of 55 km to 183 km per week depending on the proxility to University. A direct correlation exists between proximity to University and the amount of travel undertaken. About 40 km of travel per week is added for every 5 km increase in distance to home. Some of the salient observations regarding mode choice are given below :
- Non-bike users with sole access to car use the car (solo and sharing) for almost all of their travel.

- Over half of the non-bike users without sole access to a car travel in car as a sharing passenger.
- It is surprising to note that some respondents without sole access to car also travel by car as solo drivers.
- As expected, the use of non-car modes is several times higher for those without access to a car owning group, although the patronage of non-car modes is not high in absolute terms.
- Casual bike-users combine bike travel with car and other modes which is independent of car availability.

A similar small study (4) was conducted for the students of University of Roorkee (UOR). UOR is a residential University and all the students reside in the hostels only. The planning of hostels has been done in such a manner that the students need not to travel more than 1.5 km for any trip including education & recreation, and the average trip length is 1 km. About 200 students were interviewed regarding their vehicle ownership. The results show only 5 % students have motorised vehicle i.e ; scooter or motor cycle, 40 % students have bicycle and remaining 55 % students do not have any vehicle. The main reason for not having the motorised vehicle and preferring bicycle was found to be « Not Required for Shorter Distances ». The other reasons include health, inexpensiveness of bicycle, easy to handle and noise free in educational environment etc.

2.3 Bicycle Network in Developed Countries.

In 1992, the Victorian State Bicycle Committee devised a principal Bicycle Network (5) for Melbourne, Australia. The network consisted of 1, 000 km of paths and 2, 000 km of on road lanes. All these routes are intended to link up so that people can travel safely and conveniently by bicycle to any place in the metropolis. As the mean distance covered on a bicycle trip is 3 km, it is essential that a cyclist should not have to travel far from any starting point to reach the network. It may seem difficult to create designated space for cycling when every metre of road width is being exploited to squeeze in additional travel lanes or parking space. Bicycle Victoria's analysis of more than 400 km of main roads in Melbourne shows that it can be done by either shifting space, trading space or providing alternative space. The starting point is to define the requirements of the interested parties.

3. BENEFITS FROM NON-MOTORISED TRANSPORT

- Social cost of congestion is the additional travel time, vehicle operating cost, stress anf pollution. Thus, by a shift to non-motorised modes for passenger and goods may have substantial savings.
- Walking, bicycling and other NMT modes virtually create no pollution. In fact replacement of short trips by motor vehicles, particularly two wheelers which have highest pollution rate will have dramatic effect on ambient air quality and noise levels.
- User cost savings is normally accounted in benefits in transportation improvements. Although operating speed is slower (higher travel time) for NMVs the door to door travel times are comparable to motor vehicles.

Moreover, the overall savings in user cost make NMVs attractive.

- Parking is a major cost for motor vehicle use, and also a major subsidy to driving public. Savings through parking cost and facility creation for NMVs can be huge.
- Through NMVs there is total saving of energy. It is even more when short trips are subsisted as the internal combustion engines are least efficient for cold starts.
- Road Maintenance is a function of vehicle weight. Thus the road and its appurtenances are never damaged by NMVs, even in case of collision.

4. FUTURE OF NON-MOTORISED TRANSPORT

Undoubtedly, the non-motorised transport in the most environment friendly mode of transport. Nonetheless, this has been ignored for very long time in the main stream transport planning. Experience of Asian cities with NMT shows it to be a desirable complement to motorised modes. Therefore, explicit policy support is required to preserve and expand their potential role in the form of Non-Motorised Transport Strategy at local, urban, region and country level. NMTS should be continuous effort in synthesising the availability and use of NMT reflecting income, cost, trip length and other factors so that its development can be integrated in overall transport system planning.

Table 1
Mode Choice Distribution of the Users of Suburban Areas.

SN	MODE	NUMBER OF USERS	PERCENTAGE OF TOTAL USERS
	(A) MOTORISED TRANSPORT		
1	MOTOR CYCLE	115	5,4
2	BUS	656	31,1
3	TEMPO	98	4,6
4	TRACTOR	28	1,3
5	CAR	5	0,2
6	TRAIN	51	2,4
	TOTAL	953	45

	(B) NON - MOTORISED TRANSPORT		
7	CYCLE	404	19,1
8	RICKSHAW	55	2,6
9	HORSE-CART	334	15,8
	TOTAL	793	37,5
10	(ON FOOT)	367	17,4
	GRAND TOTAL	2113	100

Proximity	distance (km)	No of Respondents	Percent
1	< 5	42	9,3
2	5-10	226	50
3	10-15	123	27,2
4	15-20	30	6,6
5	>20	22	4,9
Not Stated		9	2

5. CONCLUSIONS

Non-Motorised vehicles can bridge the gap between walking and motorised transport. NMT is economical for both user facilitator, as well as it can serve as an alternative for solving the problem of urban mobility. It is high time that planners in developing countries should accept them as part of formal transport planning. At the same time, the community has to be educated for their efficient use.

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Planning for low cost transport modes in urban India

T.S. Reddy, S.Gangopadhyay & P. Parida
Traffic and Transportation Division, Central Road Research Institute, New Delhi, India

ABSTRACT : In India more than three hundred million people live in urban centres. The demand for travel is rapidly growing with the increasing size of cities and rising socio-economic levels of the urban residents. All most all the cities are dependent on road based transport systems consisting of buses, cars, motorised two wheelers, autorickshaws, taxis, cycles, cycle rickshaws. In the absence of well thought out policies for development of urban transport the transport modes are growing haphazardly and are in conflict with each other. This situation has resulted in growing traffic congestion and concomitant environmental pollution and traffic accidents in the cities. Therefore there is a need to critically appreciate the urban transport problems and issues with a view to evolve plausible planning options for a sustainable urban transport in India. This paper describes the existing situation and problems of urban transport in India in general and attempt to appreciate the imminent role and issues of low cost modes (LCM) along with suggestions for improved operations.

1. INTRODUCTION

The urban population in India has grown from 25 millions (1901) to 217 millions (1991). As of today an estimated population of over 300 millions live in urban India. More than two-thirds of this urban population live in class-I cities (population hundred thousand and more). Again the population of class-I cities is skew distributed with about thirty cities accounting for nearly 50 percent of the class-I city population. These trends and features of urbanisation are expected to continue in the future, as the policies of development in rural areas are found to be ineffective. The expanding cities and growing socio-economic levels of urban residents have resulted in increasing travel demands. In majority of the cities the travel demands have increased by two to three folds in the last two decades. The development of transport infrastructure has not kept pace with the growing needs. This has resulted in high levels of traffic congestion, overcrowding of public transport buses, high incidence of accidents and environmental pollutions. The growing gap between the demand and supply of public mass transport system has culminated in the rapid growth of private vehicles ownership and rising numbers of low cost intermediate public modes of transport. Besides this, owing to low income levels, sizeable proportion (30%) of the urban population can not afford to have access to mechanised modes of travel in Indian cities. Considering the existing situation as well as future scenario there is a definite need to have a rational approach to plan for efficient and safe movement of low cost modes of transport in urban India.

2. GROWTH IN VEHICLE POPULATION

The growth of registered motor vehicles in India is quite phenomenal. Motor vehicles have increased from around 0.3 million in 1951 to around 40 million in 1998. The current trends indicate an annual increase of 10 percent in the motor vehicles. The number of vehicles and their growth in the country is presented in Table 1. Nearly 70 percent of these vehicles are located in urban areas.

Growth of motor vehicles in metro cities has been alarming. Vehicle related pollutions have crossed the acceptable limits. The average level of vehicle ownership in the metropolitan cities of India comes to 0.1 per person. Delhi, the capital of India tops with 0.2 vehicles per person. In the last three decades the motor vehicle population has grown by 100 times while the road length has grown by only

Table 1. Vehicle Population – Future Trends

Mode of Transport	1985	1990	1995	2000*
Buses	209650	278075	388856	545567
Cars, Jeeps, Taxi	1462100	1911187	2514069	3314054
2 Wheelers	4870850	9610959	17559629	34637500
3 Wheelers (Auto Rick)	242841	465026	892904	1717821
Trucks	773450	1084804	1521493	2133972
Total	7558891	13350051	22873951	42358914

* Projected
Source : CIRT, Pune

10 times. This situation becomes dreadful when the growth in urban vehicle population and corresponding road lengths are considered in conjunction. This is evidenced in the form of Traffic Congestion, Environmental Pollution, Traffic Hazards and Parking Problems.

2.1 *Traffic congestion*

Traffic congestion may be described as the situation that arises when the transport networks are loaded with traffic more than its economic capacity. The level of traffic congestion on the urban transport networks is found to vary with time of the day, the maximum being during the peak hours when journeys to and work places occur. Besides causing irritation, delay and environmental pollution, congestion is responsible for enhanced out of pocket expenses and consequent economic losses. The lowering of vehicular speeds due to traffic congestion directly affect the vehicle operating costs (VOC). Depending upon vehicle type VOC is found to vary from 1.2 to 2.8 times with the fall of speeds from 40 kmph to 10 kmph.

In Urban India the mix of slow and fast moving modes is one of the prime reasons for traffic congestion. The difference in operating speeds of motor vehicles and non-motorised modes is responsible for a number of other problems. Figure 1 shows a typical scene of mixed traffic on city roads in India.

2.2 *Environmental Problems*

The heavy volumes of mixed traffic with predominant share of motorised vehicles on the metropolitan city roads are responsible for

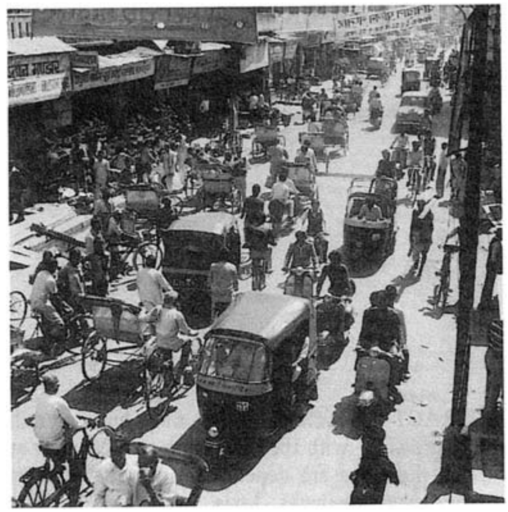

Figure 1

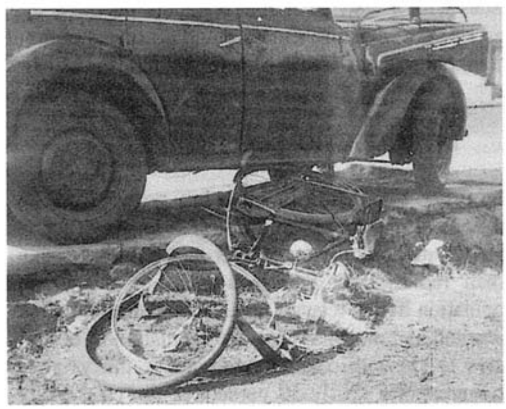

Figure 2

environmental degradation resulting from noise and air pollutions. The observed noise levels along major arterials in Delhi, Bangalore and Mumbai are found to range between 80-90 dBA. These levels are much above the permissible limits. The pollution load due to vehicular exhausts in Delhi and other major cities is reported to be more than 1300 tonnes per day (TPD). The environmental pollutions due to vehicular traffic are of particular concern as they result in many health problems to the urban dwellers.

2.3 *Deteriorating Road Safety*

In India around 70,000 persons are killed in road accidents annually. Nearly 15 percent of these deaths occur on urban roads. The situation is particularly alarming in Delhi, the national capital of India. About 2000 persons die annually on Delhi roads. More than 50 percent of these deaths are constituted by pedestrians and cyclists. The vehicles causing maximum fatal accidents in urban areas are the buses and heavy goods vehicles. The reasons for high incidence of accidents are multifold and multifaceted. The mixed operation of fast and LCM is one of the major reasons for this high rates of accidents. Figure 2 shows a scene of accident involving a cyclist.

2.4 *Fuel Consumption*

Consumption of petroleum products registered an average annual growth rate of 8.5% during the last three decades in India. Transport sector is the largest consumer of petroleum products (31%). Transport, based on Petroleum fuel, has been a strain on the Indian economy. The demand for petroleum fuel for the year 2000 AD is estimated at 20 million tonnes. The foreign exchange requirement to procure this huge amount of fuel would affect the development programmes in all other sectors. Therefore it is imperative for a developing country like India to search for alternative modes of transport that are less energy intensive and employ alternative fuels and be sustainable in the long run.

3. TRAVEL DEMAND

Travel demand has increased in all the cities. For example in Delhi per capita trip rates have increased from 0.42 in 1970 to 1.0 in 1990. Similarly the per capita trip rates in Mumbai have also increased more than two fold. The travel needs are met in Indian cities by employing different modes of travel like private automobiles, public and intermediate public transport and slow moving vehicles. The modal shares of the travel vary from city to city mainly with the size. Table 2 presents the modal shares in a few selected cities of India. From the table it can be seen that proportion of trips by non-motorised low cost modes vary from 15 percent to 40 percent amongst various cities. It can also be seen that with increase in size (population) the share of fast mechanical modes increases. However the quantum of trips by the slow modes is very large and need proper consideration in planning. It is also to be noted that slow moving vehicles can not be eliminated from Indian cities as long as the sizeable portion of population belong to low income groups.

Table 2 : Modal Share of Trips in Selected Cities

City	Year	Fast Moving		Bicycle
		Bus	Private	
Surat	1989	10.00	54.00	36.00
Bangalore	1965	38.23	29.47	32.30
Delhi	1992	62.00	18.00	20.00*
Jaipur	1998	36.10	43.10	20.20

* includes cycle rickshaws
Source : CRRI, New Delhi

4. LOW COST TRANSPORT MODES – ISSUES

As indicated earlier the continuation and growth of low cost modes basically cycles and cycle rickshaws is likely to persist in the future. The animal drawn carts are dwindling down and they are being replaced by more cycle rickshaws and auto-rickshaws. To understand the needs of planning for these modes it is necessary to have a detailed features of the trips made by these modes. In the following sections attempts are made to describe these features.

4.1 *Purpose of Travel*

The purpose for which the slow moving low cost modes are used was analysed for a few cities. Table-3 indicates the break up of purpose wise trips in a few selected cities.

From the table it can be seen that in bigger cities the slow moving low cost modes are used basically for essential trips like work and education. It is also seen work trips are very predominant in each of the cities excepting Nagpur. The higher percentage of education trips by cycles reflects the dominance of colleges and educational institutions. From this it

Table 3 : Purposewise dustribution cycle trips in selected cities.

City	Year	Population Million	Work	Education	Others
Bangalore	1965	1.4	81.8	4.2	4.0
Delhi	1969	3.4	75.3	6.9	17.8
Nagpur	1998	1.6	35.0	56.0	9.0
Surat	1988	1.5	67.8	26.7	5.5
Jaipur	1994	1.8	62.0	32.5	5.5
Delhi	1981	5.7	86.3	12.7	1.0

can be inferred that the low cost slow moving vehicles will be moving simultaneously with fast moving vehicles during peak hours.

4.2 Modal Shares

The modal share of slow moving vehicles vary with size of the city and the socio-economic characteristics of the resident population. From table-3 it can be seen since 1965 cycles remained a significant mode of transportation (20-35 percent) in the metropolitan cities. In cities like Delhi, Bangalore and Jaipur where per capita trip rates are about 1.0 the quantum of cycle trips shall be very huge in number and they shall be highly concentrated in the peak hours of the morning as well as in the evening. Besides the cycles, cycle-rickshaws are becoming popular mode for short trips upto 2 to 3 kms, to access the mass transport systems as well as other service centres like hospitals, shops and schools. Therefore these modes cannot be ignored in attempting any planning exercise of urban transportation.

4.3 Trip Lengths

An analysis of the trip lengths made by cycles and cycle rickshaws are shown in figure 3. From the figure it can be seen that the average trip length of cycles remain in the range of 3 to 5 kms. This could be a permanent feature of the cycle trips and may be taken as a basis in planning for the LCMs.

4.4 Traffic Safety

The safety of LCM operation is greatly affected by the mixed operations. In the absence of segregated tracks or carriageways the LCMs are forced to operate along with fast moving vehicles of different kinds. Road accident statistics indicate that cyclists are very vulnerable for accidents. In Delhi they constitute the third largest numbers of people killed

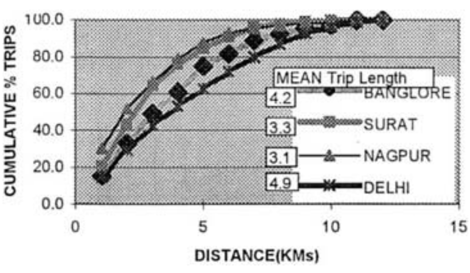

Fig.3. CUMULATIVE FREQUENCY DISTRIBUTIONOF CYCLE TRIP LENGTHS IN SELECTED CITIES OF INDIA

in road accidents. Majority of the accidents are expected to occur when the lane charging takes place while using the common carriageway.

5. PLANNING STRATEGIES

In the foregoing section it is illustrated that the LCMs are carrying a considerable share of passenger trips in urban centres of India. This situation is going to continue and as such there is an imminent need to consider planning strategies to enhance the efficiency and safety of the operations of these vehicles.

5.1 Segregated Traffic Lanes

In cities where cycle traffic exceeds 20 percent of the traffic flows segregated traffic lanes be evolved from amongst the available carriageways along the major routes. This situation normally arises in smaller and medium size cities with population ranging from three to ten hundred thousands. In other cities where the LCM traffic has to move along the major corridors they should be provided totally segregated tracks along the corridors.

5.2 LCM Network

In bigger cities the LCM traffic is less in proportion but sizable in absolute numbers. This situation calls for developing on all together separate network of LCM tracks to serve the needs of this traffic. Since LCMs are light in weight the structural designs of pavements can be different and less expensive. Since the speeds of LCM are low the geometric standards are also going to be considerably low when compared to normal road network. The crossings of LCM network and other traffic roads could be controlled either by signal or grade separated to exclude conflicts. Where the conditions permit the LCM be treated along with pedestrian traffic.

5.3 Crossings and Junctions

Maximum number of accidents involving LCMs are found to occur at or near the road crossings or junctions. Therefore movement of LCMs has to be given special consideration at the junctions and crossings. There are a number of methods by which this traffic can be handled at junctions. As general guidelines the treatment to be imparted depends upon the volume of LCM traffic. If the volume is sizable in number LCM boxes be created or otherwise they may be given right of way alongwith the pedestrians. It is advisable to grade separate the crossings of the LCMs with other traffic wherever feasible.

5.4 *Traffic Regulations*

In view of the low speeds of operation LCMs become impediments on arterial roads. They not only reduce the operating speeds of traffic stream but also become potential hazards. Therefore there is need to prohibit the movement of the LCMs on major roads of the cities and their role, particularly of cycle rickshaws could be better defined to serve the local needs of movements upto distance of 3 to 4 kilometres. In bigger cities these are becoming popular because of the limited penetration of bus transport into residential colonies. The role of LCMs can also be better exploited as access modes to mass transport systems specially MRTS and major bus corridors. Better management of parking for private vehicles and regulations of LCMs could become positive aspects in urban transportation in India and enhance the environmental quality and safety of pedestrians.

6. CONCLUSIONS

The urban population in India is very huge in magnitude and their skew distribution amongst cities is to be properly considered in evolving transportation plans. Low cost modes like cycles, cycle-rickshaws are likely to continue to play significant role in urban India. Keeping in view their operating speeds and vulnerability to accidents when moving with other vehicle appropriate strategies special planning efforts are needed to enhance safety special planning efforts are needed to enhance safety and efficiency of LCM operations. Segregated lanes along major corridors and separate network of tracks could be seriously considered to improve the LCM operations in urban India. At junctions and crossings appropriate treatment in the form of grade separators or signals will have to be considered to accommodate the LCM traffic.

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Model to select the best routes in cycle's transport

Modèle pour déterminer les routes optimums dans le transport avec l'utilisation de la bicyclette

Modelo para determinar las rutas óptimas en el transporte por ciclos

P.E. Muiño Coto & I.E. García Fernández
Centro de Investigación y Desarrollo del Transporte (CETRA), Habana, Cuba

ABSTRACT: The paper is concerning to a description of a mathemathic model which involves two main aspects in the selection of routes in bicycles movement in network. These two aspects are: the effort to be made by the cycle's driver and the safety conditions of the way.

The model, which has been automated, chooses the best way for the cyclist among all the points of a network, taking as fundament the minimum effort and the maximum safety of the way. The result is a new network formed by the best ways, which gives a great help in order to design bikeways.

RÉSUMÉ: Le rapport aborde la description d'un modele mathématique que contemple deux aspects fundamentals a considérer dans la sélection des rues pour le déplacement des cyclistes parmi les réseaux de routes dans une aire déterminée: l'effort a réaliser pour les cyclistes et les conditions de sécurité dans la voie.

Le modele qui a été élaboré dans l'ordinateur peut dederminer le chemin optimun pour le cycliste entre chaque paire des noeuds de cet réseau avec un minimun d'effort et une sécurité maximale. Le résultat s'obtient a travers d'une réseau de routes qui offre une assistence grande au dessin des rues nécessaires pour les bicyclettes.

RESUMEN: La ponencia consiste en la descripción de un modelo matemático que contempla dos aspectos fundamentales a considerar en la selección de rutas para el desplazamiento de los ciclistas dentro de la red vial de un área determinada: el esfuerzo a realizar por el conductor del ciclo y las condiciones de seguridad existentes en la vía.

El modelo, implementado computacionalmente, logra determinar el camino óptimo para el ciclista entre cada par de nodos de dicha red, basándose en la minimización del esfuerzo a realizar y la maximización de la seguridad en la vía. El resultado se obtiene a través de una red de rutas óptimas que brinda una gran ayuda en cuanto al diseño de obras viales donde sea necesario incluir vías para ciclos.

1. INTRODUCCIÓN

La bicicleta constituye un medio de transporte muy apropiado a la hora de tener en cuenta, como objetivo fundamental, el traslado del hombre de un lugar a otro sin menoscabar el medio ambiente y la ecología, tan dañados ya por los vehículos tradicionales. Si, además, consideramos que le brinda al ser humano una opción de movimiento sumamente independiente y sana, estaremos en presencia de una alternativa ideal de transporte, tanto en áreas urbanas como rurales.

El progresivo incremento de su uso en Cuba, debido a las ventajas que provee como alternativa al transporte público, y a la solución que ofrece ante las dificultades con la adquisición de combustible, ha introducido un nuevo elemento en la corriente vehicular, que requiere de determinadas condiciones para su circulación, la cual va a tener lugar en paralelo con la de otros vehículos motorizados, acorde a los cuales se ha diseñado tradicionalmente la red vial.

La coexistencia de ambos tipos de vehículos en la circulación hizo que se tratara de brindar al ciclista condiciones elementales en su desplazamiento dentro de la corriente mixta, con carriles preferenciales, vías exclusivas y ciclovías. Además, se diseñó una herramienta automatizada que ayudaría en el diseño y selección de las rutas apropiadas para el movimiento de los ciclos dentro de la ciudad, consistente en un modelo matemático que considera dos aspectos fundamentales en la determinación de las mejores rutas para los ciclistas dentro de una red: el esfuerzo que realiza el conductor del vehículo y las condiciones de seguridad que prevalecen en la vía.

2. DESCRIPCIÓN DEL MODELO

2.1. Esfuerzo que realiza el ciclista

La bicicleta utiliza como energía la fuerza humana, transformando el trabajo realizado por el hombre en una nueva forma de trabajo, para permitir el movimiento de traslación del conjunto hombre-bicicleta.

La siguiente ecuación expresa cómo la potencia generada por el trabajo realizado se utiliza para vencer la resistencia al movimiento:

$$W = V / N \{M * g [R + S / 100 + a / g (1 + L / M)] + 0.5 D * A * d (V + B)^2\} \quad (1)$$

Navarro, Ricardo A., Urs, Heierli & Victor Beck (1985)

Donde:

W: Potencia transmitida a los pedales (vatios)
V: Velocidad de la bicicleta (m/seg)
N: Eficiencia mecánica de la transmisión (0.95, sin unidades)
M: Masa total del ciclista más la bicicleta (kg)
g: Aceleración de la gravedad (9,806 (m/seg^2)
R: Coeficiente de resistencia al rodamiento (0.008, sin unidad)
S: Pendiente (inclinación) de la calle hacia arriba (+) o hacia abajo (-), en porciento (%)
a: Aceleración del vehículo (m/seg^2)
L: Masa efectiva de la llanta (kg)
D: Coeficiente de arrastre aerodinámico (1.2, sin unidad)
A: Área frontal del ciclista y la máquina (0.5 m^2)
d: Densidad del aire a 25° C (0.409 kg/m^3)
B: Velocidad del aire en la dirección opuesta al movimiento del ciclista (m/seg)

Sabiendo que: Masa de la bicicleta: 15 Kg
$R * g / N = 0.08258$
$0.5 D * A * d / N = 0.38716$

Lo cual, después de la sustitución de valores y teniendo en cuenta que este principio es aplicable a su vez en la medición del esfuerzo en función al espacio recorrido en lugar del parámetro velocidad, daría lugar a la siguiente formulación de la igualdad:

$$Wt = I / 100 [M (8.258 + 10.32 S + 106.3 a) + 38.716 (V + B)^2] \quad (2)$$

Donde:

Wt: Trabajo transmitido a los pedales (joules)
I: Distancia (m)
* M: Masa total del ciclista más la bicicleta (80 kg)
S: Pendiente
** a: Aceleración del vehículo (m/seg^2)
*** V: Velocidad de la bicicleta (5.56 m/seg)
**** B: Velocidad del aire en la dirección opuesta al movimiento del ciclista (2.89 m/seg)

Siendo los factores señalados con * a su izquierda, asumidos por el modelo como sigue:

* 65 kg (peso promedio del ciudadano cubano adulto) más 15 kg (peso de la bicicleta)
** Debido a los frecuentes cambios de velocidad (aminoramientos de la misma o paradas en caso necesario) producto de las dificultades existentes en la circulación para los ciclistas, los valores de aceleración alcanzados son tan pequeños que tienden a cero.
*** Velocidad media del ciclista (20 km/h)
**** Velocidad promedio anual registrada en la Ciudad de La Habana por el Instituto de Meteorología de la Academia de Ciencias de Cuba (10.4 km/h)

Como puede observarse, en esta última fórmula quedan como variables la pendiente y la longitud del tramo de vía, parámetros que valora el sistema para cada tramo de la red vial de la ciudad.

2.2.Seguridad de la vía

La vulnerabilidad del conductor de la bicicleta constituyó otra preocupación a tener en cuenta en el modelo, cuestión fundamental si se considera que el mismo requiere de un nivel de protección mayor, ya que carece de "carrocería", en un accidentecon otro tipo de vehículo, resultará siempre más dañado el ciclo y más perjudicado el ciclista.

Por tanto, al sistema se le implementó la forma de tener en cuenta los factores que afectan la seguridad vial, combinando esto con el cálculo del esfuerzo de forma tal que, al valorar el resultado final, se minimizaran esfuerzo e inseguridad en conjunto.

Para evaluar la seguridad de la vía se consideraron los elementos viales cuyo estado facilita o dificulta la circulación del ciclista, agilizando o entorpeciendo su recorrido. Estos factores son:

- Intensidad vehicular (ciclos y/o vehículos automotores)
- Capacidad vehicular (ciclos y/o vehículos automotores)
- Estado de la capa de rodadura
- Tipo de superficie
- Estado de la limpieza
- Pavimento seco o mojado
- Pavimento ondulado o continuo
- Peralte
- Estado de la iluminación nocturna

Relacionados de la siguiente forma:

a) $$F = (I_{(i)} / C_{(i)}) * Cr_{(i)} * Ts_{(i)} * L_{(i)} * H_{(i)} * Co_{(i)} * P_{(i)} * Lu_{(i)} \quad (3)$$

Donde:

F: Factor de seguridad
$I_{(i)}$: Intensidad en el subtramo i
$C_{(i)}$: Capacidad en el subtramo i

$Cr_{(i)}$: Estado de la capa de rodadura del subtramo i
$Ts_{(i)}$: Tipo de superficie del subtramo i
$L_{(i)}$: Estado de limpieza del subtramo i
$H_{(i)}$: Pavimento seco o mojado en el subtramo i
$Co_{(i)}$: Continuidad del pavimento en el subtramo i
$P_{(i)}$: Peralte en el subtramo i
$Lu_{(i)}$: Estado de la iluminación en el subtramo i
i: Número del subtramo

b) $S_{(i)} = D_{(i)} * F$ (4)

Donde:

$S_{(i)}$: Seguridad en el subtramo i
$D_{(i)}$: Longitud del subtramo i

c) $St = \sum_{i=1}^{n} S_{(i)} / \sum_{i=1}^{n} D_{(i)}$ (5)

Donde:

St: Seguridad del tramo

2.3. Correlación entre esfuerzo y seguridad de la vía

Los resultados obtenidos en los cálculos anteriores (tanto para el esfuerzo como para la seguridad) se correlacionan mediante la siguiente expresión:

$M = Wt * St$ (6)

Donde:

M: Resultado a minimizar
Wt: Esfuerzo a realizar en el tramo (se calcula en (2))
St: Seguridad del tramo (se calcula en (5))

Todo esto considerando que en el análisis del nivel de seguridad de la vía, los valores asignados a las características de la misma se incrementan a medida que éstas se tornan más desfavorables para el ciclista, lo cual influye positivamente en la evaluación de la inseguridad. Por tanto, al minimizar el producto M, indicado en (6), se obtendrá el camino donde intervengan el menor esfuerzo y la seguridad mayor.

3. ALGORITMO EMPLEADO PARA DETERMINAR EL CAMINO MÍNIMO

El algoritmo empleado para determinar el camino de valor mínimo, desde un nodo previamente designado como origen al resto de los vértices de la red analizada, es el algoritmo de Ford.

Este algoritmo es aplicable tanto a redes orientadas como no orientadas y consiste en el examen sistemático de los nodos sucesores de cada vértice, a fin de determinar la sucesión de arcos que conforman el camino de valor mínimo.

Su aplicación primeramente desde un nodo inicial al resto de los nodos y luego repitiendo el proceso para cada nodo de la red (forma recursiva), permite obtener la red de caminos mínimos de la zona.

4. RESULTADOS EMITIDOS POR EL SISTEMA

Los resultados pueden visualizarse de 2 formas distintas: por tabla y gráficamente. En la tabla se relacionan secuencialmente, para cada par de nodos origen – destino, los nombres de los nodos (intersecciones de dos o más vías) que conforman el camino de valor mínimo, o sea, la ruta de menor distancia. Las salidas gráficas proporcionan un nivel mayor de comprensión en cuanto a la representación de la red de caminos mínimos resultante.

5. EFECTO SOCIAL

El beneficio que brinda el modelo matemático es eminentemente social, ya que mediante su aplicación es posible brindar servicio tanto a un ciclista en particular que desee conocer cual es la ruta más cómoda, corta y protegida para realizar un viaje determinado, como a la población ciclística en general, fungiendo, en manos de los especialistas en transporte, como una herramienta de gran valor para definir una red vial donde sea necesario incluir vías para ciclos. En este último caso, el sistema automatizado estructura la red final con las rutas donde el ciclista podrá circular con mejores condiciones y reduciendo al mínimo las probabilidades de ocurrencia de accidentes.

CONCLUSIONES Y RECOMENDACIONES

1. El sistema automatizado para la organización del transporte por bicicletas, calcula los caminos óptimos para el ciclista, tomando como parámetros determinantes el esfuerzo a realizar por el mismo y el grado de seguridad que ofrece la vía.
2. El modelo relaciona ambos factores (esfuerzo y seguridad) de todos los caminos posibles, de forma tal que, al ser minimizado el valor resultante por el algoritmo de Ford, se obtiene el camino de condiciones óptimas para el ciclista.
3. Su utilización resulta de gran valor tanto en manos de los encargados de la planificación, diseño y construcción de obras viales a la hora de definir una red vial con participación de ciclos, como al servicio de ciclistas en particular, interesados en conocer el recorrido óptimo entre un par de puntos determinados de la red.
4. Se recomienda continuar profundizando en la correlación existente entre los factores que influyen en la seguridad del ciclista, con el objetivo de perfeccionar el modelo y contribuir de esa forma a estimular el uso masivo de este vehículo.

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Bicycle use for everyday trips with mobility solution and better environment

L'utilisation de la bicylette pour des voyages de tous les jours avec la solution de la mobilité et un meilleur ambiance

Uso de la bicicleta para viajes diarios con solución de la movilidad y un mejor ambiente

H. Valdés Rios
Centro de Investigación y Desarrollo del Transporte (CETRA), Habana, Cuba

ABSTRACT: Main problems as result of ecological crisis are widely acknowledged by scientists and many of the world's governments and international agencies. The bicycle as means of transportation gradually is reappearing on the political agenda in many countries. This is encouraging because it clearly offers a potential contribution to solutions for the traffic congestion and pollution problems which almost all the world are facing now.

The role of bicycles differs widely over time and between societies. There are a lot of experiences in North America, Europe, Asia, Africa and Latin America, including Cuba. Cuban is demonstrative experience that the large-scale introduction of bicycles use in the life of the Cuban people for everyday trips to works and study centers, as well as social/recreative purposes is common now, and the population acquired a new positive attitude toward the bicycle.

RÉSUMÉ: Les principaux problemes comme résultat de la crise écologique sont tres connus par les scientifiques et pour les gouvernements et les agences internationales du monde. La bicyclette comme moyen du transport dans la vie politique de plusieurs pays.

La bicyclette se développe parce qu'on offre d'une maniere tres claire une contribution a la solution des problemes de la congention du transit et de la contamination de l'environnement.

Le role de la bicyclette differe grandement dans le temp et dans les sociétés. Existe une grande quantité d'expériences dans l'Amérique du Nord, Europe, Asie, Afrique, et dans l'Amérique Latine ainsi que Cuba. L'expérience cubaine démontre que l'introduction massive de la bicyclette dans la vie du peuble cubain pour les voyages de tous les jours au centres des travails et établicements scolaires et culturels est un intéret commun et une nouvelle attitude vers la bicyclette.

RESUMEN: Los principales problemas como resultado de la crisis ecológica son ampliamente conocidos por los científicos y por los gobiernos y agencias internacionales del mundo. La bicicleta como medio de transporte está reapareciendo en la agenda política de muchos países. Esta se está promoviendo, porque claramente ofrece una contribución potencial a la solución de los problemas de la congestión del tránsito y de la contaminación ambiental, a los cuales se están enfrentando actualmente casi todos los países del mundo.

El papel de las bicicletas difiere ampliamente en el tiempo y entre las sociedades. Hay una cantidad de experiencias en América del Norte, Europa, Asia, África y América Latina, incluyendo a Cuba. La experiencia cubana demuestraque la introducción masiva de la bicicleta en la vida del pueblo cubano, para los viajes diarios a los centros de trabajo y de estudio, así como para propósitos sociales y recreativos es común actualmente y que la población ha adquirido una nueva actitud hacia la bicicleta.

1 INTRODUCTION

World leaders were agree at the United Nations Earth Summit in Rio de Janeiro (1992), that if were to leave share of the world's resources to those who follow us on this earth, we need to develop a more sustainable way of living.

In our days, the decisive factor in urban ecology is that cities must guarantee that it citizens are able to carry out their activities adequately and this implies that it must facilitate mobility.

We are moving forward to enter in the 21st Century and the concept of, livable cities, is becoming a generally accepted idea. In this idea mobility is a function of the diversity of modes of transportation, in which the daily use of the bicycle for everyday trips will be a key factor in achieving the type of city that we all desire.

On the other hand, the most recent tendencies in the development of society in the present century are greatly influenced by the increasing attention to the economy, the society and the environment, and the emphasis has been on active, invigorating, safe and sustainable transport system in which the bicycle actually plays an important role.

The bicycle as transport means is gradually reappearing on the political agenda in many countries. This is encouraging, because it clearly offers a potential contribution to solutions for the traffic congestion and pollution problems, which almost all-urbanizing communities of the world are facing now. Boosting bicycle use is one means of preventing a further increase in traffic and pollution problems.

The Director for Youth and Sport at UNESCO (A. Guillete) in an opening lecture to delegates at the 9th Velo City Conference in Basel (1995) described cycling as a "mode of urban transport for the future worldwide", argued that cycling corresponds to four main UNESCO mandates: education, science, culture and peace.

Then, the main best way to get people out of their cars and onto their bicycles must be to create a changed transportation system that offers not only choices among travel modes (cars or bicycles) for specific trips (to work, leisure or others purposes), but more importantly presents these options in a way that they are real choices that meet the needs of individuals and society as a whole.

In the present context of economic globalization, more pragmatic and sound strategies should be conceived in order to make cycling, part of the solution for urban daily life, in which cycling to work, school, shopping, leisure or elsewhere, will be part of people's regular day-to-day routine. Then, promoting cycling will require some hard choices in the way that cities and urban transport systems will developed, and how resources must allocated, to create the right conditions for the use of the bicycle as an ordinary means of transport.

2. PROMOTING BICYCLE AS MEANS OF TRANSPORT FOR EVERYDAY TRIPS

The World Bank in his publication titled "Sustainable Transport-Priorities for Policy Reform", wrote: "Transport is central to development. Without physical access to jobs, health, education and other amenities, the quality of life suffers, without physical access to resources and markets, growth stagnates, and poverty reduction cannot be sustained". Attitudinal change is a prerequisite, merely promoting cycling as economically and environmentally sustainable in manner comparable to the common current practice in parts of the "North" countries, would not have a noticeable impact. In situation with poor cycling experience, like in some of the Third World Societies, where use and attitudes to bicycles differ widely, in accordance with socioeconomic conditions, the terrain and cultural values, the promotion activity is as important as the creation of new infrastructures.

In some developed countries, as car ownership and incomes increased, bicycles become associated more with leisure and recreational use.

A variety of interrelated factors contribute to a person's decision to get out of their cars and onto their bicycles for everyday trips. These have to do with physical conditions, personal motivation and institutional considerations, because cycling is available to all segments of society-people of all ages and socioeconomic levels.

The cyclist must be given a more prominent place in the future traffic and transport system. This can be achieved by making the most of the favorable characteristics of the bicycle and by removing obstructions to the use of the bicycle. These obstructions are mainly found in the physical layout, traffic hazards and its great susceptibility to theft.

Stimulating bicycle usage does not only entail a higher percentage of cyclists in the modal split. Keeping those people who use their bicycle safe on it is at least as important. If nothing is done or if no qualitatively well developed cycling facilities are provided, the cyclist's share in the modal split may decrease, instead increase.

There are many arguments for starting the cycling policy:

- Cycling increase accessibility
- Cycling is better for the environment
- More cycling leads to road safety
- Cycling policy is a recognizable choice
- There is a broad basis for a cycling policy
- Bicycle usage saves a great deal of money
- The bicycle offer ample prospects

The main precondition for a successful cycling policy is supplying an infrastructure, which offers cyclist a quick, comfortable and safe link during everyday journeys. Evidently, from this point of view, there is no reason to distinguish between the various trip purposes, because cyclist would like to have effective, comfortable and safe connections at his/her disposal during every journey's purpose.

Carry out activities that increase the safety of cycling and conduct promotion and awareness activities to increase the level of cycling for all trip purposes and to legitimize this travel mode within the transportation system, as well as provide funds for a cycling-friendly infrastructure, that include new facilities and infrastructure retrofitting, education for all road users and enforcement programs for all road user, are key factor in cycling promotion.

For promoting bicycle use for everyday trips, there are at least five main demands to satisfy, which more or less represent all wishes of cyclist regarding the infrastructure: comprehensive, direct, attractive, safe, and comfortable.

Clearly, successful programs have realistic options, and enlightened public and strong Government supports. Any single strategy, by itself, realized only modest gains. The best approach is a combination of strategies that creates a comprehensive system, similar to what motorized traffic enjoy.

3. LEARNING FROM INTERNATIONAL EXPERIENCES

The role of bicycles differs widely over time and between societies. In recent years there has been an enormous revival in the popularity of cycling. There are large and imaginative catalogues of worldwide practices that make life easier for cyclist and that have been tested extensively in practice for more than 20 years. The implementation and funding of many cycle schemes is "piggy backed" on other major infrastructural projects, such as: Quality Bus Corridors, Light Rail Transit, and Traffic Calming Schemes.

In the United States of America, the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 recognizes the transportation value of cycling and offers mechanisms to increase considerations of cyclists' needs within the Nation's Intermodal transportation system. President Bill Clinton said: " Without question, bicycling is an efficient economical and environmentally sound form of transportation and recreation. Bicycling is a great activity for families, recreational riders and commutes" (Bicycling Magazine, November 1992).

The integration of cycling into U.S.A. transportation system is underway, but, while progress can certainly be seen and documented, such change comes slow and very unevenly.

Cities as Seattle (Washington), Portland (Oregon), Boulder (Colorado), Palo Alto (California), Davis (California), Tucson (Arizona), Gainesville (Florida) and others seen to have discovered a working formula for what it takes to increase levels of cycling.

In Canada there are good examples in Montreal (Quebec) and Toronto, that are increasing step by step the levels of cycling in these cities for everyday trips.

The Netherlands is perhaps the best know example of a country where cycling is a high priority. This country has gone so far to establish an official national bicycle policy (Dutch Bicycle Masterplan).

In Austria, Vienna and major state capitals, like Salzburg and Graz, pursue an activist policy in the planning, construction and operation of bike paths.

In the period from 1995-1997, the Danish government spent more than $10 million USD to develop and implement a demonstration project on traffic safety and the environment, a great deal of the projects aim at promote safe cycling in urban areas.

In France, the bicycle has a favorable image. Over the last ten years, some cities, including Paris has developed policies very favorable to cycling.

In Great Britain, cycling plays minor but growing role in urban transportation. The National Cycling Strategy, launched in July 1996, will be measured in grow of bicycle use very soon. The aim is restore cycling as a convenient and appropriate transport choice, including the development of National Cycle Network.

In Dublin, is bringing back the bicycle as a mode of transport, putting cycling on the public agenda and developing strong cycling policies.

The Scandinavian countries (Sweden, Norway and Denmark), as well as Germany, Switzerland and Finland, have programs to encourage cycling in some of their major cities and the participation of bicycles in urban traffic represents a third or more of all the trips made. In the period from 1995-1997, the Danish government spent more than 10 million USD to develop and implement a demonstration project of traffic safety and the environment. A great deal of the project aims at promoting safe cycling in urban areas.

In Eastern Europe, in the Baltic region, Poland, the Czech Republic, Hungary and Albania, among others, cycling accounts for five to ten percent of all the trips.

Bicycles are the predominant types of private vehicles in many Asian cities, and they are the most efficient means of mobility over short distances. For example both China and Japan in Asia, are highly affluent and strong cycling tradition countries where cycling plays a major role in mobility, but in China the level of car ownership is very low, while in Japan is very high, Another Asian countries as India, Bangladesh and Vietnam have also tradition in the use of bicycles and tricycles as means of transport.

In African countries as Uganda and Ghana, bicycle transport has increased at a high rate. In Ghana the World Bank is supporting a Project for the increase of bicycle use. In Uganda, the bicycle has been seen as an effective means of transport and a source of income for families and youth.

In Latin America, some cities have programs to promote bicycle use and for the increase of bicycle facilities, as bicycle ways and lanes, parking areas, among others, The World Bank has been supported a Project in Lima for the increase of bicycle use in this City. There are other cities as Leon (Nicaragua), Quito (Ecuador), Rio de Janeiro, Sao Paulo and other Brazilian cities, Rosario (Argentina), Santo Domingo (Dominican Republic) that have isolated programs in bicycle facilities.

The variations in the use of cycling mode in the above mentioned different countries cannot be well explained by income, climate and level of car ownership, although clearly these have some effect. How this mode is perceived socially, how safe people feel cycling, and particularly, the character of land use and urban design, all appear to play greater roles in determining the level of cycling. But in all cases is obviously that a strong political will is necessary in order to help the introduction of bicycle as means of urban transport in the cities of all countries. The most important success factor of all programs must be the introduction of bicycles as part of the transport chain; it meant their integration with the different transport modes.

4. THE CUBAN EXPERIENCE

Cuba is a developing country, fighting untiringly for obtain a sustainable level of economic and social growth

In mid-1990, the petroleum crisis, joint to many other economical and political factors made off the Government decision about the introduction of bicycles and tricycles as a way to replace share of mass transportation in buses and also some other passenger and freight transport, like the most appropriate and affordable means of urban transport, that enables conservative use of energy and capital resources to fulfillment the mobility needs, and also brings advantages, environmental quality and human health.

Bicycles appeared like a new opportunity in transportation development, as an answer in response to external debt problems, which had been exacerbated by unsustainable levels of petroleum and motor vehicle imports.

A comprehensive program has been developed in Cuba which included: promotion of bicycle use, creation of bicycle infrastructure in cities, traffic education, production of Cuban bicycles, network of services to cyclists, parking places, integration with others transport modes (bike-on-bus system in tunnel under the Havana Bay, bike-on-train in railways, bike-on-boats in ferry boats in operation in main bays of the country) among others.

Recently, Hein Verbruggen, President of the International Cycling Union said: "Must people associate Cuba with sunshine, sea beaches and tourism, but it is also well-known for cycling".

Bicycles have become part of the transportation landscape in Cuba, and even if the economic conditions that led to their introduction should improve in the short, medium or long term, the President Fidel Castro said: "they are in Cuba to stay" as part of the transport system.

In the Main Report presented by President Fidel Castro to the 5th Congress of the Communist Party of Cuba in October 8, 1997, he said: " Bicycles, how many problems bicycles have solved! Especially for young people, students, many workers, in the city and in the countryside. That was one of the first measures that were taken and one of those that solved the most problems. A million and half bicycles were imported; more than half a million have been produced in the country in new bicycle factories. There are more than two million bicycles in the hands of the population, and so many problems have been solved."

Thus, a new era in transportation has begun in Cuba: the era of the bicycle- a form of sustainable transport capable of meeting present needs without remove future generations abilities to meet theirs.

Therefore, increased use of bicycles in Cuba, far from being a step backward, is an indicator of progress, a gesture of respect for the ecosystem, benefiting the country economically with a sounder use of limited resources. Bicycles stand for the improvement of the quality of life, and human development in Cuban society.

Because in Cuba was not tradition in the use of bicycle as means of transport, numerous steps have been taken to create a "bicycle culture", that is to integrate the use of bicycles as efficient means of transportation. Despite existing financial and material limitations, television and radio programs have been produced on bicycle safety, articles on the topic appears frequently in newspapers, and booklets with information on bicycle safety have been published and distributed, as well as information on bicycle services and repair workshops, lectures at work and study centers has been done.

In terms of promoters, the most active is the President of the Cuban Council of State and Ministers, who in numerous national public speeches mentioned the bicycle as a solution to people transport demand, contributing to improve public image of the bicycle, and encouraging their use by all segments of population.

In Havana City, 13,8 km of bike-lanes.15, 8 km of bike-paths with physical segregation of motorized transport and 84,0 km of rights-of-way have been establish, and the first bike-path (7,8 km) was opened in July 1991, linked the Alamar residential community to El Mégano Beach, both on the Eastern side of Havana City and its purpose is to facilitate cyclist's safe access to East Havana year round, particularly during the summer, when most students and workers have vacation time.

Bicycle promotion in Cuba has shown that not only bicycle lanes and bicycle paths are required, but also a network of facilities for bicycles and cyclists integrated in the society.

The large-scale introduction of bicycle use in the life of the Cuban people has obliged all of the population to acquire a new positive attitude toward the bicycle. That attitude was a new one, not previously generalized in Cuba. More than that, they had to begin riding bikes. In Cuba bicycle as means of transport has been incorporated in the Strategic Plan for Passenger Transport Development. For example, in Havana City, 13,6% of everyday trips are made on bicycles, with the following average indexes:

- Travel distance 4,4 km
- Travel time 34,4 min.
- Travel speed 7,7 km/h

In Havana City has been establish a state network with 84 workshops for bicycle's mechanical repair, 105 workshops for tube's puncture repair, 110 points that offers compressed air services for tubes and a lot of shops in which cyclists can buy spare parts and accessories for their bikes. Such services are also offer by the private sector.

A positive impact of bicycling police in Havana City is the reduction of fatalities and injuries in road accidents between 1991 and 1998 as follow:

- In 1991 were 303 fatalities and 1946 injuries.
- In 1998 were 241 fatalities and 1423 injuries.

CONCLUSIONS

1. Public transport, pedestrians and cyclists are partners in the development of sustainable transport solutions, combining their respective advantages for mobility solutions.
2. Bicycle transportation is efficient, flexible, and ecologically and economically viable and there is in position to complete successfully urban transport system.
3. The bicycle can benefit the environment by giving high local accessibility to the relatively sparse public transport network, even for longer-distance movement.
4. Bicycles can play a primary role in cities for work, shopping and other travels.
5. Much more can be done at low cost to incorporate bicycles into an overall urban transport strategy.
6. Appropriate measures for bicycle promotion might include at least the provision of routes and parking facilities for bicycles.
7. Proper recognition of bicycles as slow-moving vehicles within traffic management schemes helps cyclists´safety.
8. Public transport and the bicycle most have a greater share in urban mobility.
9. In principle, the bicycle can replace the cars on many of trips and thus contribute substantially to reducing car use and air pollution.
10. The bicycle is; understandably, popular for social/recreative purposes, but the bicycle also rates highly as means of transport for shopping and for going to the work and to study center.

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Enhancing pedestrian safety in Indian cities

Y.P. Sachdeva
RITES, New Delhi, India

ABSTRACT: A large part of transport demand is conducted by walk in Indian cities irrespective of their population size. However, pedestrian facilities are grossly inadequate in almost all cities. Consequently, pedestrians are the major victims of road accidents. This paper discusses the characteristics of pedestrians in Indian cities, examines their problems and recommends that the present levels of walk trips should be increased or at least be maintained through various engineering, enforcement and education measures which will facilitate the movement of pedestrians and enhance their safety.

1 INTRODUCTION

Walking has remained a vital means of transportation since ages. Walking is certainly the cheapest and most dependable mode. Although motorisation levels have been growing, still a large part of transport demand is conducted by walk in Indian cities. Not only the trips are conducted by walk in their entirety but most of the trips by mechanical modes also include a walk component at the beginning and the end. Walk travel plays an important role in all Indian cities irrespective of their size.

However, walking has rarely been recognised as a mode of transport. As a result of growing motorisation, the concentration of city planners and administrators has centred mainly around the infrastructure associated with motorised transport. In comparison to huge walk transport demand; pedestrian facilities in Indian cities are grossly inadequate. Consequently, pedestrians are the major victims of road accidents.

This paper discusses characteristics of pedestrians in Indian cities, examines their problems, availability of their facilities and recommends measures to create a conducive environment for pedestrians.

2 WALK TRAVEL CHARACTERISTICS

Recent household travel surveys conducted in 21 Indian cities by RITES as part of a national level urban transport study indicate that a significant part of the total person trips are conducted by walk in cities of various sizes. Table 1 shows that their contribution in total daily trips ranges from 12% to 50% in different cities. Thus a significant part of transport demand in Indian cities is satisfied by walk trips.

Generalised national level walk travel characteristics are given in Tables 2 and 3. Table 2

Table 1. Share of walk trips in total daily intra-city person trips in Indian cities-1994

City	Population (million) (1994)	% of walk trips in total trips
Shimla	0.12	50
Guruvayur	0.12	12
Agartala	0.17	26
Panipat	0.21	22
Tirupur	0.32	24
Udaipur	0.34	44
Rourkela	0.43	15
Guwahati	0.64	22
Hubli Dharwad	0.69	36
Dhanbad	0.86	25
Vijayawada	0.91	25
Varanasi	1.11	24
Ludhiana	1.12	32
Vishakhapatnam	1.12	17
Vadodara	1.21	31
Bhopal	1.22	31
Nagpur	1.77	17
Kanpur	2.17	34
Pune	2.65	26
Ahmedabad	3.88	40
Calcutta	11.64	12

Table 2. Generalised walk travel characteristics

City population range (million)	Share of walk trips (%)	Average walk trip length (km)
0.1 – 0.5	31 – 29	0.8 – 1.0
0.5 – 1	29 – 27	1.0 – 1.2
1 – 2	27 – 25	1.2 – 1.4
2 – 4	25 – 23	1.4 – 1.6
4 – 8	23 – 21	1.6 – 2.0
8 +	21 – 19	2.0 – 2.2

Table 3. Generalised walk travel characteristics

City population range (million)	PCTR for walk trips	Total PCTR
0.1 – 0.5	0.29 – 0.35	0.94 – 1.22
0.5 – 1	0.35 – 0.34	1.22 – 1.27
1 – 2	0.34 – 0.32	1.27 – 1.28
2 – 4	0.32 – 0.29	1.28 – 1.24
4 – 8	0.29 – 0.24	1.24 – 1.17
8 +	0.24 – 0.22	1.17 – 1.12

Table 4. Proportion of travel expenditure in monthly household income

City population range (million)	Expenditure on travel (%)
0.1 – 0.5	8.1 – 8.6
0.5 – 1	8.6 – 8.9
1 – 2	8.9 – 9.2
2 – 4	9.2 – 9.7
4 – 8	9.7 – 10.4
8 +	10.4 – 10.7

shows that share of walk trips decreases as city population increases. In general, its share decreases from 31% for cities with population 0.1-0.5 million to 20% for cities with population more than 8 million. Thus a large proportion of trips are conducted by walk even in large cities. Hilly urban areas e.g. Shimla have very high share of walk trips due to topographical reasons. Walk trip lengths have been found to be reasonably longer as indicated in Table 3. In general, average walk trip length increases from 0.8 km to 2.2 km with increase in city size.

In conformity with above, the Per Capita Trip Rate (PCTR) for walk trips decreases from 0.35 to 0.22 with increase in city size as given in Table 3. In contrast, overall PCTR increases with increase in city size although it reduces slightly after reaching a population of 2 million.

As share of walk trips in total transport demand is more in lower order cities, average household expenditure on travel is also lower as compared to higher order cities. As indicated in Table 4, percentage expenditure on travel in household income varies from 8.1% to 10.7% with increase in city size. This signifies the importance of walk trips in lower order cities.

3 AVAILABILITY OF FACILITIES FOR PEDESTRIANS

Although a large proportion of trips is conducted by walk, the facilities provided for pedestrians are very meagre. Table 5 shows the availability of sidewalks provided with the major road network of various cities. Percentage of roads having sidewalks is generally less than 5% in small- and medium-sized cities although a little higher proportion of major roads in large cities have been provided with sidewalks. Even the small sidewalk lengths available are mostly encroached upon by parking of vehicles, hawkers, goods of abutting shops, etc. 25% to 35% of available length of sidewalks have encroachments in most cities.

Generally sidewalk surface is poor and their surface level high which is inconvenient for most pedestrians. There is no continuity in the available sidewalks, which have frequent breaks for access to properties abutting the roads. These factors force the pedestrians to use carriageways thus conflicting with vehicular traffic. Few pedestrian subways / footbridges are available only in large metropolitan cities such as Bombay, Delhi, Madras and Bangalore. Most of the traffic signals do not provide for pedestrian phases which endangers their safety.

There is also a tendency amongst road organisations to reduce sidewalk width to provide

Table 5. Availability of sidewalks and level of encroachment in various cities

City	Major road length having sidewalks (%)	Encroachment of sidewalk length (%)
Shimla	2	NA
Guruvayur	-	-
Agartala	4	33
Panipat	2	34
Tirupur	1	38
Udaipur	23	28
Rourkela	24	35
Guwahati	30	32
Hubli Dharwad	22	NA
Dhanbad	13	24
Vijayawada	41	NA
Varanasi	12	11
Ludhiana	5	34
Vishakhapatnam	48	34
Vadodara	29	NA
Bhopal	19	32
Nagpur	50	32
Kanpur	36	27
Pune	39	26
Ahmedabad	37	31
Calcutta	30	24

more room for vehicular traffic. These factors force pedestrians to use the carriageways indiscriminately and haphazardly. It results in slowing down of vehicular traffic and increases accidents thus becoming counter-productive.

No wonder, with large pedestrian traffic and practically very little facilities available for them, involvement of pedestrians in road accidents has been very high. Table 6 shows road accident data for the city of Delhi for the period 1985-93. The table reveals that more than 40% of total road users killed in fatal accidents have been pedestrians.

Table 6. Involvement of pedestrians in road accidents in Delhi

Year	Pedestrians		Total Road Users	
	Killed	Injured	Killed	Injured
1985	572	2213	1269	6366
	(45)	(35)		
1987	503	2125	1271	6388
	(40)	(33)		
1989	666	2392	1581	7377
	(42)	(32)		
1991	738	2689	1778	8051
	(42)	(33)		
1993	706	2645	1783	8236
	(40)	(32)		

(figures in parenthesis denote percentages)

4 URBANIZATION AND MOTOR VEHICLE OWNERSHIP

The urban population of India is expected to reach about 540 million by the year 2021 which will be 37% of India's total population. Not only will the Class-I cities (with population 100,000 and more) grow, small towns will also participate in this march towards urbanisation to join the group of Class-I cities. The number of cities and the population in various ranges that have been projected up to the year 2021 are shown in Table 7. The table indicates that the number of Class-I cities which was 301 in 1991 is expected to grow to 450 by 2001 and to 781 by 2021. The number of million plus cities will increase from 23 in 1991 to 51 by 2021. Total population in Class-I cities will grow to about 350 million in 2021 i.e. an increase of 145% from 1991.

Considering the improving socio-economic levels in Indian cities, inadequate mass transport system and pedestrian facilities, personalised motor vehicle ownership has been growing in Indian cities. The scooters / motor cycles and car ownership levels in Class-I cities at all-India level is expected to become 4 times in 2021 as compared to 1994 as shown in Table 8. Thus, even in next 25 years, motor vehicle ownership levels in India are expected to be lower than developed countries.

Table 7. Projected number and population of Class-I cities in India

Population range (million)	1991		2021	
	No. of cities	Population (million)	No. of cities	Population (million)
0.10 – 0.25	193	28.8	540	97.9
0.25 – 0.50	54	19.9	144	54.8
0.50 – 1	31	22.4	46	32.4
1 – 2	14	17.2	32	43.4
2 – 5	5	16.2	12	32.4
5+	4	37.4	7	87.8
Total	301	141.9	781	348.7

Table 8. Projected motor vehicle ownership in Class I cities in India

(vehicles per 1000 population)

Vehicle	1994	2021
Car	14	48
Scooter/Motor cycle	102	393
Total	116	441

5 MEASURES FOR PROMOTING WALK TRAVEL

The urban transport policy must capitalise on the forecast that motor vehicle ownership levels are expected to be lower in India as compared to developed countries in next couple of decades. This policy should also capitalise on existing levels of walk travel in cities. Considering that the urban poor constitute a good part of the population (upto 45% of households in many cities have monthly incomes less than Rs. 2000) and is not able to afford personalised and public transport, non-motorised modes such as walk assume great importance. On the other hand, importance of this mode to conserve non-renewable energy (petroleum products), its non-polluting nature and in a way the beneficial effect for health of people has been well-recognised. There is an increasing trend towards encouraging walk as a part of sustainable city development programmes in many countries.

Thus walk travel is extremely important for Indian cities and must be planned for. Therefore, it is important that present proportions of walk trips in total person trips should be maintained or even increased through various measures. For effective pedestrian management, it is necessary to adopt 3-E approach covering engineering, education and enforcement measures.

All primary and secondary roads in cities should be provided with adequately wide sidewalks on both sides as recommended by Indian Roads Congress. In central areas, even wider sidewalks should be provided. Sidewalks are necessary even at the cost of carriageways in busy areas. These sidewalks should be kept free of encroachments to provide conducive environment for pedestrians. Sidewalks should be continuous and not broken at entry to properties. The access to properties should be given by ramping the sidewalk on either side. Sidewalks should be free of obstructions such as electric and telephone poles, junction boxes and transformers. Wherever provision of such equipment is inescapable, the remaining width available should be adequate for unhindered flow of pedestrians. Safety of pedestrians should be ensured by providing adequate infrastructure like railings, zebra crossings, separate pedestrian phase in traffic signals at intersections, etc.

Encroachments on sidewalks being a major issue, particular action for removing these encroachments by enforcement should be taken. Re-location of existing hawkers can be made on one time basis by creating centralised markets away from major roads for each zone. These facilities should be easily accessible and be kept tidy so that these can attract customers who patronise sidewalk hawkers.

Roads with high volume of pedestrians should be pedestrianised and vehicular traffic banned. Pedestrian subways / footbridges should only be provided after careful study of road network as well as vehicular and pedestrian movement characteristics. However, efforts should be to keep pedestrians at ground level as far as possible.

Even greater attention needs to be paid to hilly, industrial and pilgrimage cities and facilities for pedestrians provided liberally. In hilly towns, difference in ground levels is a major problem. Facilities such as elevators, escalators and cable cars should be provided at required locations in these towns.

An action plan should be drawn up to provide such facilities by classifying facilities according hierarchy of roads and estimated pedestrian traffic.

The traffic sense amongst pedestrians is also not adequate to cope up with the situation due to lack of traffic education and awareness. Thus there is a need for regular publicity campaigns to create traffic awareness and to inculcate a sense of discipline amongst pedestrians to obey traffic rules thereby increasing their safety. There are numerous methods for publicity campaign, some of which are listed below:

(a) Traffic education by audio-visual programs
(b) Display / telecast of specially designed slides / road safety films on TV and cinema halls
(c) Film shows in different areas and schools
(d) Erecting hoarding giving the information about accidents
(e) Announcements / exhortations by traffic police on road discipline and behaviour at vintage points
(f) Traffic education by distribution of literature
(g) Conduct of training programs for pedestrians
(h) Organising group discussion / talk shows on TV / Radio
(i) Organising regular traffic weeks
(j) Constructing traffic training parks

Machinery for traffic enforcement is traffic police. With expansion of cities and high growth of traffic, need to manage and monitor traffic more efficiently has become very essential. The situation is becoming unmanageable due to lack of adequate trained manpower. Traffic police personnel needs to be properly trained to undertake the task of effective traffic enforcement.

Considering the significant impacts of land use distribution on the mobility requirements of people in a city, a long-term solution should be integrated land use transport planning. A mix of residential, commercial, educational, recreational and low-pollution industrial areas would improve access to education and employment opportunities, and reduce transport demand. In turn, this would also promote modes such as walk and bicycles.

6 CONCLUSIONS

(a) A significant part of transport demand in Indian cities is conducted by walk.
(b) However, available facilities for this mode of travel are very meagre.
(c) Involvement of pedestrians in road accidents is very high.
(d) A large number of city dwellers will continue to depend on this mode as they cannot afford to own a motor vehicle.
(e) Existing share of trips by walk should at least be maintained in cities of various sizes keeping in consideration the income levels, travel characteristics and the issue of sustainable transport development.
(f) Various facilities such as adequate sidewalks free of encroachments, pedestrian phase in traffic signals, pedestrianisation of streets, grade-separated pedestrian facilities, etc. should be provided to make their movement safe.
(g) Traffic education and enforcement measures are also important in encouraging walk travel and making their movement safe.

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Re-thinking urban transport policies in Africa: Walkways?

Nouvelles politiques de transport urbain en Afrique, les pieds par terre?

Establecer un movilidad satisfecho en las ciudades Africanos: Pietonales

M.de Langen

Institute for Infrastructural, Hydraulic and Environmental Engineering, Delft, Netherlands

R.Tembele

Temeke / DSM NMT Team, Tanzania

ABSTRACT: The rapid growth of cities in Africa presents urban governments and urban transport planners and engineers with enormous challenges. How can adequate mobility be achieved for the entire population in a manner that is financially feasible for the government, affordable for the inhabitants from their available household budget, and acceptable with respect to the level of traffic accidents and environmental degradation that the traffic produces. And how can the provision of transport infrastructure create maximum value for money in stimulating the urban economy. This paper explores the potential of a type of urban transport infrastructure that has been almost completely neglected in African cities: walkways.

RÉSUMEE: La croissance rapide de la population dans les villes Africaines présente un defi enorme aux gouvernements et aux planificateurs et engénieurs de transport. Comment établir une mobilité satisfaisante pour la population entière? Et de faire ca d'une manière qu' a la fois peut être financée par le gouvernement, que leur budget permet aux voyageurs d'utiliser, et qu' est acceptable en vue du détruit de l'environnement naturel quelle cause (bruit, air pourri). Et comment âchever "valeur pour monnaie" en termes de stimulation de l'économie urbaine? Cette communication explore le potentiel d'une type d'infrastructure de transport urbain très négligée en Afrique en ce moment: trottoirs et sentiers pour piéton(ne)s.

RESUMEN: El crecimiento rapido de las ciudades en Africa presenta un desafio inmenso a los municipalidades, los ingenieros y a los planificadores de transporte. Como se puede establecer un mobilidad satisfecho para la poblacion de tal modo que el gobierno lo puede financiar, los habitantes lo pueden pagar dentro de su presupuesto domestico, y acceptable con respeto al nivel de accidentes y degradacion ambiental? Y de que modo la provision de transporte puede producir el valor maximo con respeto a la estimulacion de la economia urban? Este papel investiga la potencial de un tipo de infraestructura de tranporte urban que casi completamente ha sido desquidado en las ciudades African: pietonales.

1. INTRODUCTION

Stagnating urban economies. The economies of many cities in Africa have during the last decade been stagnant. The internal urban market does not diversify and grow, faster than the population. Why not? The number of obvious urgent problems that must be addressed and can be tackled with the local expertise, money, skills and labour force, is significant. Why is that not happening widely?

The causes for the stagnation form a complicated knot, in which the low efficiency and labour productivity of the internal market are key elements. Among the reasons for low productivity, the highly constrained mobility seems to play an important role. Evidence from e.g. Nairobi and Dar es Salaam indicates that lower-middle and low income households spend as much as 20-30 % of their household income on daily transport, mainly bus fares, and yet the household members walk half their trips, and are unable to make more than 2.0-2.5 one-way trips per day. Low mobility, too expensive and tiresome access to employment, to social contacts (family, friends) and to shops, low productivity in official and informal jobs and low income, are all part of a cluster of negative factors.

Livelihoods. Initially developed to research rural communities, the livelihoods model (DFID, 1998) is a useful tool to support a better understanding of urban mobility problems. The livelihood model describes a community as a productive unit, with its assets, profit and loss account, "vulnerability" context and management arrangements. This facilitates putting transport and mobility in proper perspective: transport is a cost factor on the profit and loss account, requiring part of a communities financial as well as time budget. Mobility is the factor that determines the physical limits to which natural and physical assets are accessible, and within which the available human capital can be "marketed" -get engaged in productive activity.

In an urban environment, important "natural" assets within reach of a person are (i) the diversity of the supply of goods and services that the city offers, and (ii) -in as much some is still left- quiet, clean air, clean water, and tree cover, to enjoy, rest and maintain a better health. The most important physical assets are the urban infrastructure and the building stock, social assets the safety net of personal relations. The actual value of these assets is reduced the more difficult it is to access them, like the present value of future benefits or costs is their nominal value discounted by the opportunity cost of capital (the interest rate). More simply: the asset value of a an income earning opportunity, a social contact or a health clinic that is three hours or 40% of a daily wage away is less than that of one 30 minutes or 10% of a daily wage away.

Mobility strategies. If mobility is very constrained as a result of unaffordable transport costs, the two logical strategies are (i) to aim at a reduction of the distances that need to be travelled, and (ii) attempt to reduce the cost per tripkm by either a more efficient use of the same mode of transport, or by reverting to a cheaper mode of transport (cheap: total cost, including value of time).

However, in most urban areas in the developing world the opposite happens: trip distances grow, the costs of motorized modes of transport (MT) increase, and the shift is away from the cheapest modes of transport (cycling and walking), because those are increasingly dangerous, and face an increasing lack of road space. This is a worrying development which threatens to further undermine the economic base of already weak urban economies. A comparable development in South-East Asia, in Chinese cities in particular, may well hurt their economies, that were so successful in the past two decades, while having extremely efficient low-cost/high-performance urban transport systems based on massive cycling (often still dominant at this moment).

The hard reality of severe mobility constraints is felt by many Africans in urban areas. Due to the lack of infrastructure that enables convenient and safe trips on foot and bicycle, many inhabitants are condemned to live within a small "action radius" dictated by walking on bad earth tracks, dangerous road shoulders and walking routes with sometimes long detours. The assumption that city dwellers would have the "comparative advantage" over the rural population of the variety of supply of goods, services, employment and schooling opportunities that a large urban area offers is not true for many of them: they are immobilized in remote slums.

Urban road infrastructure construction. Although in many policy documents a lot of emphasis has been placed on improved traffic management as the obvious instrument to reduce urban traffic problems (Worldbank, 1986), in practice the most widely applied and most influential urban transport policy instrument has simply remained the construction of new roads (Gakenheimer, 1999), usually equated to MT roads, with marginal attention for other roadusers. In addition, in most cases the roads were designed for mixed use by cars, buses and trucks. Dedicated road infrastructure for public transport (busways) in Africa is rare (Allport, 1998). It is not useful to generalize about the level of success of such road construc-tion in catering for the transport needs. However, from an overview of the present performance of the transport systems in large cities in Africa, the impression arises of increasingly unmanageable problems, and of severe mobility differences between different income groups.

One of the reasons why the positive impacts of many road construction projects on the bulk of the urban (poor) population have been disappointing, appears to be that it was seldom figured out in detail what types of mobility and access improvement would create the highest benefits for the poor. Safe roadway capacity for the low-cost modes of urban transport (walking and cycling) has been notoriously overlooked. Strange? Yes, because in many cases more than half of all trips are entirely on foot. Yet, neighbourhood walkway infrastructure often hardly exists and pedestrian trips are uncomfortable and inefficient. Surprising? No, because the mental map of transport experts and decision makers both in African countries and in international agencies has for a long time been that urban transport in Africa would, could and should develop towards the British, French or North-American model of increasing private car orientation. And mental maps are only changing gradually (Gakenheimer, 1999).

Micro business location factors. Inside most large residential areas in African cities it is difficult to move around efficiently. Typically, pedestrian routes have a bad pavement, are difficult to pass during periods of rain, and are missing at important spots. Road infrastructure that enables cycling often does not exist at all.

To operate viable micro- and small businesses (small shops, repair workshops etc.) inside these areas is difficult because of the low visibility and accessibility of their locations to potential clients. Their market is limited to the those living very nearby. Attractive "road frontage" locations for small businesses are scarce. If, as a result of the adverse locational conditions the internal economic product of an area remains low, the number of expensive long distance trips goes up and savings that could be used productively down.

Mobility and gender. Many of the poorest households are female (single-)headed. This has a big impact on their time budgets and the acuteness of mobility constraints. Good mobility policies must take that into account. For women, convenient and safe walking routes in the immediate surroundings of the house are very important.

Environmental damage caused by traffic. The mobility problems of the poor and their improvement relate strongly to the efficient use of the cheapest modes of transport and to trip distance minimizing strategies. Both these strategies also have the effect of reducing the environmental damage created by traffic. Walking and cycling hardly create noise and air pollution problems.

Since the problems of environmental degradation affect all population groups -not only the poorest-, and even have global consequences, the platform of support for transport policies to reduce the negative environmental impacts of traffic is broader and more powerful than the one primarily concerned with better mobility and more mobility equity for the low-income population. A broad understanding among transport experts and policy makers that environmental transport policies and mass-mobility and local economy stimulating transport policies can be made to overlap to a large extent, will hopefully contribute to the long overdue land-slide in transport policy thinking and choices in cities in Africa.

2. WALKWAYS AS INSTRUMENT TO (RE-) VITALISE URBAN AREAS

If it is true that the two most promising transport strategies for large cities in Africa are (i) to control the increase of trip distances and (ii) to enable efficient and effective use of walking and cycling, what interventions can be used to implement them? Or, assuming more uncertainty about the promises of different urban transport strategies, if significantly different transport strategies must be tested to find out their merits, how can a proper test with strategies to minimize trip distance and optimize walking/ cycling be designed and implemented?

Recent urban mobility pilot projects in East Africa, in the World Bank's Sub Saharan Africa Transport Programme (de Langen, 1999), show a large majority of all urban trips of up to 5 km long being made on foot (in some medium-size cities also by bicycle). The cost of bus transport and the available travel time budget dictate this modal choice, and the related trip distance limitation. In the pilot projects it was possible to test the effect of improvement of walk- and cycle-infrastructure at a small scale. The tests show that improving pedestrian routes and con-structing short "missing NMT links" significantly improves pedestrian safety and mobility. Analysis of the costs and benefits of walkways in low-income residential areas shows that the break-even traffic that justifies paving with concrete bricks or slabs lies at an ADT of 800-1200 (pedestrians per day; 1.5m wide track, capacity of 500/hour; de Langen, 1999). Many routes carry much higher pedestrian volumes. "NMT-only" routes also turn out to be attractive locations for micro businesses, due to the high number of potential clients using them.

Employment generation. The construction of walkways does not only in most cases have a high financial B/C ratio. Their construction has a high labour and materials cost component. Typically local labour costs are up to 25-30% and materials up to 55-60%. This means that the economic cost of construction is much lower than the financial cost, and that construction of walkways can be used well as an economic recovery programme.

Labour based infrastructure programmes are implemented successfully on a large scale now in the RSA (McCutheon, 1998), but with a focus on MT roads (i.e. missing the transport strategy part).

Economic policies of this type, which date back from the period of the great recession in the US and Europe in the 1930's, have not been popular among economic advisors recently. However, there is little indication that their preference for monetary policies has been advantageous for the bulk of the urban populations in Africa either. In general, the economic fortunes of countries in Africa appear to have improved most where labour participation goes up and internal markets grow.

The remaining part of the paper documents a number of small scale tests along the lines sketched above. The tests have been summarized here very briefly in a narrative manner, full information can be found in de Langen (1999).

3. EXAMPLE 1, UNOBSTRUCTED WALKWAY

Intervention. A narrow side-street in the town center of Morogoro (Tanzania, popul. 200,000) opposite the intercity bus station, is an important pedestrian shortcut. The intervention that was tested consisted of: (i) pedestrianizing the side street, and paving it (slabs pavement), and (ii) constructing a raised zebra crossing on the main road opposite to it, to prioritize pedestrians on this route, and (iii) eliminating parking on the walkway by placing bollards, and (iv) allocating demarcated areas in the side street where street traders could be accepted. Total investment costs: 4,500 USD.

Previous conditions. Before the intervention the side street was unpaved, often blocked by parked vehicles and petty traders and difficult to pass on foot during the rainy season. No facilities allowed safe pedestrian crossing. The pedestrian crossing volume near this spot is 7300 (from 7.00AM-19.00PM), the maximum motor vehicle flow along the road is 870 veh/hr. The estimated speed of the vehicles, v(85%), was 43 km/hr. Modal split:

Walk	Cycle	(mini)Bus	Car	Truck	Total
40	36	2	7	12	100%

(in counting units, excluding vehicle occupancy)

Problems. Inefficient (slow) pedestrian movement. Significant traffic accident hazards, in particular for pedestrians that cross or walk on the carriageway; non-fatal accidents happen regularly. The walking route through the side street is often not accessible, forcing pedestrians to make a detour.

Objectives. Enable unobstructed walking on the walkways along the main road and through the short-cut route, and eliminate pedestrian walking on the carriageway. Create safe traffic conditions for pedestrians.

Effects. The route functions well. The MT speed went down to 16 km/hr at the raised zebra spot. Pedestrians now move on the walkways, without the need to walk on the carriageway. Road safety at/near this spot has been restored, no accidents were reported in the year after implementation.

4. EXAMPLE 2: WALKWAY IMPROVEMENT ALONG A ROAD CORRIDOR

Often, the speed, convenience and safety of walking trips in African cities strongly depends on the difficulties encountered at a limited number of spots. Examples of difficult spots are bus and taxi stops, fuel stations, open drains and other spots that can only be crossed via the carriageway, and open road shoulders. Often there is no need for expensive reconstruction of an entire route, after the main problems have been removed.

Intervention. A walking-route improvement package tested in Morogoro consisted of: (i) construction of a walkway along the regional hospital compound, separated from the taxi and bus stands (flower beds with low masonry walls were used as part of the separation), (ii) walkway reconstruction past a fuel station, (iii) reconstruction of a Y-junction to T-shape, (iv) construction of 3 traffic calming spots to improve road safety, one in front of the hospital (speed humps) and two at intersections (narrowing with bicycle slips), and (v) construction of four pedestrian bridges over small streams (open side drains), and (vi) spot improvements to the walkway pavement (mostly compacted earth, filling and compacting).

Total costs US$ 18,000 (12,000 of it for the pedestrian bridges and drain/culvert repairs.

Previous conditions. This road is one of the most important pedestrian routes in Morogoro, linking residential areas to the city center. The pedestrian ADT reaches 10,000/day where the road enters the town center. The local soil is of reasonable quality. Shaped properly, compacted and not damaged by parked vehicles, an earth track remains accessible during rains. Apart from walking, the traffic on the road is a mixture of motorvehicles (± 40% of all vehicles) and bicycles (± 60% of all vehicles). The bitumen carriageway is 8-10 meter wide and of "fair" pavement quality. Total improved walkway section length: 900 m.

Problems. Low average walking speed due to many obstacles. Traffic accident hazards, resulting from walking on the carriageway, too high vehicle speeds (v(85) 50 km/hr) and no safe crossings.

Objective. Enable a safe and convenient walking route along this road.

Effects. The improvement of the walkway was very positively received by the public, pedestrians as well as other road users. It was interesting to note that "fine-tuning" of the first round of improvement (including extra pavement repairs, protective concrete bollard and walkway re-alignment at one place) greatly increased the public appreciation. The devil is in the details!

Costs and benefits. The capital costs of the investment are 2,400 USD per year; the estimated walkway maintenance costs are 1,800 USD/year. The absence of pedestrian crossings over side-streams at two intersections significantly reduced their capacity (pedestrians on the carriageway). The average walking-time gain on the improved route is 4 minutes/km. The value of time used is 0.1 USD/hr (=0.5*10% of a miminum unskilled daily wage). The pedestrian ADT is 8,000, so the benefit/year 14,400 USD. This gives a B/C ratio of 3.4, based on increased walking speed only. This B/C ratio excludes benefits from accident risk reduction and intersection capacity increases. The difference between benefits and costs is so large, that an intervention like this should have a high priority in any municipal road maintenance plan.

5. EXAMPLE 3: PEDESTRIAN ROUTE NETWORK DEVELOPMENT

Intervention. This intervention consists of the construction of a pedestrian route to a new market (±

500 meter track, this section connects with another one, along which improvements were also made). Part of the track is paved with slabs, part is compacted gravel. One section is without is MT crossing: one access road along the market was converted into a dead-end road. Drains were constructed as part of the intervention, and the MT carriageway improved (gravel standard).

The intervention was prepared with intensive user participation, including explicit debate and decision making concerning perceived conflicts of interests between pedestrian road users and motorvehicle road users.

Previous conditions. Most walking routes have no official alignment and are unpaved. All access roads in Temeke that can be used by motorvehicles are in bad condition. In the absence of strong enough pavements, MT and erosion have transformed the left-overs of roads into a sandy desert (with pools of stagnant water during the rains). The main pedestrian routes in the area do not follow the collector roads, but cross those at right angles, towards the central part of the ward, or the adjacent industrial area.

Different people the area have conflicting interests. For example, some illegally occupy part of the roads with small structures or permanent parking, and see a municipal initiative to upgrade walking routes as a threat (it requires public land that they now use as their own). Others for their business depend on good accessibility for low-income customers on foot, and highly appreciate the improved walkways.

Construction of pedestrian walkways in the area was not possible without proper drainage (re-)construction. Moreover, it is could not be durable unless the pavement of MT access is improved. Failure to do so will make pedestrian facilities so superior to MT roads that vehicles start driving on walkways, and destroy them quickly. No bollards or other obstacles could prevent that, they would be taken away, as experience showed in earlier tests with "pedestrianizing" interventions that were highly contested by MT users.

Problems. Too much MT transit traffic uses roads in the central part of the ward as a "short-cut". Due to the high pedestrian volume that is undesirable. Transit traffic should use the surrounding urban corridors.

Objectives. The long term objective is to enable safe, direct and comfortable access on foot to the central part of the ward, from all residential neighbourhoods, as part of a good traffic solution for accessibility of the new market and its surrounding area. This intervention is only the first step. The plan should finally result in a pedestrianized core access network to the market from three sides, with a minimum number of NMT/MT crossing points, more efficient MT circulation on the collector roads around that the area, constraining minibus routes/stops to the collector roads, good MT access for freight traffic and to businesses in the central area (for supplies), concentrated MT parkings and no parking along the collector roads.

The immediate objective of the intervention was to demonstrate that a good NMT route from the unplanned parts at the back of the ward to the central area can be constructed at modest costs, and significantly improves the mobility of residents of those parts.

Effects. The immediate positive effect on the image of the area surprised everyone, and created a very positive response. This was reinforced by the fact that walkways, drains and improvements to the MT carriageway were combined, so benefits are felt by all parties, including MT interests. The number of daily users of the new walkways cannot be assessed properly at this moment, the market still has to come in full swing. Traffic counts directly after opening of the walkways indicate pedestrian ADT's at different spots of 1- 4,000.

With increasing trade in the market, parking pressure is increasing. One businessman already attempted to take away separations that block parking on the walkways (bollard, open drains), to create a "private" parking spot. The municipal authority had (has) to react quickly and decisively to such actions, to prevent that a small number of individuals significantly harm the public interest.

Costs and benefits. Total costs: US$ 70,000 (of it: 15,000 for walkways, 19,000 for MT carriageway reconstruction, and 38,000 for drains). This is a typical situation, without proper drainage, road improvements, whether walkway or carriageway, are short lived and a waste of money. Compared to the cost of drains, walkways are cheap (unit costs: walkway+blockage of MT entry: USD 5-12 /m2, depending on pavement type; stone-masonry drain: USD 40-70 /m1).

The average travel time gain of a trip on foot using the new walkway is estimated at 4 min./km. Per pedestrian ADT of 1,000 this means a benefit of USD 2,000 per year. This implies that the break-even ADT for this 4.0 m wide walkway is 2,600 (where paved with compacted murram) and 3,200 with concrete slab pavement. The estimated peak capacity of a 4 meter wide walkway with bi-directional walking and some disturbance by street trading is 2,000 pedestrians per hour (effective transit width 2.0 meter, speed 4-5 km, LOS "acceptable", de Langen, 1999). This corresponds to an ADT of 12-15,000 per walkway (more than 4 times the break-even ADT), and is compatible with approx. 20,000 daily visitors to the market area, after the market has been fully developed.

6. EXAMPLE 4: NMT-ONLY ROUTE

Intervention. The intervention (in Eldoret, Kenya, 250,000 inhabitants) consists of: the construction of a NMT bridge over the summer bed of a river (reinforced concrete pillars and deck), construction of a paved connecting track into the town center and of an extra steel bridge (l=20m, w=1.5m) over the main river, and improvement of the track to the residential area side. And: establishment of a legal road reserve for the route.

The intervention was selected by the "Eldoret Transport Committee", consisting of representatives of different neighbourhoods and roaduser groups in Eldoret. Constructing a NMT route at a spot like this is not cheap, and at first decision makers assumed that such an investment in "only an NMT route" is a waste of money. However, benefit/cost calculations show that this is in fact a very sound investment.

Previous conditions, problems. The route in this example already existed. It is the shortest one between a new low-income neighbourhood and the center of the town. In the early 1990's, a 1.5 m wide foot-bridge over the main riverbed was constructed, but the route was still difficult to use or impassable during the rainy season. The pavement of the route was in very bad condition.

Objectives. To create a good direct all-weather NMT-only route from the south towards the town center, that can be used by pedestrians as well as by cyclists and carts. And also: to establish a legal right of way for the route, to prevent that later, with increasing densification of land use the route might become blocked by private building developments. This danger is not hypothetical, as recent examples in Eldoret have shown.

Effects. Opening of the new "Sosiani causeway" NMT route was widely appreciated, by the users of the route as well as by Eldoret inhabitants in general. The improved attractiveness of the route has started to influence the land-use. It will be important to protect the route against its own success: encroachment of kiosks and street traders on the main track must be prevented. The example has a positive impact on public opinion, in favor of investment in walkways, cycle tracks, crossings, and NMT-only routes.

The initial increase in bicycles on the route is from 100/day to 400/day. The development of the number of pedestrians using the route (ADT around 6,000) has to be analysed over a longer period of time, before conclusions can be drawn.

Costs and benefits. The total cost of the intervention (300m route pavement, 3.5cm premix, gravel base, bridge) were USD 43,000. Total annual costs per year (maintenance plus capital) are USD 7,100. Estimated benefits are:
(a) Pedestrians: gain in travel time USD 15,000/y (ADT 6,000, average time gain 5 min/trip);
(b) Cyclists, cost savings of: for existing bicycle traffic 0.015 USD/trip; for modal shift walk-to-cycle 0.12 USD/day (composed of higher direct costs for the bicycle and a -much larger- saving in value of travel time); for modal shift minibus-to-cycle a cost saving of 0.23 USD/day (round-trip). After opening of the new route bicycle ADT went up from 100 to 400. Since bicycle traffic on other river crossing routes did not go down, the 300 represent a growth of traffic or a modal shift. Total saving for bicycle traffic: USD 14,000 /year. A further increase can be expected.
(c) Increased land value for street trading, along the city-side part, is estimated at 2,000 USD/year. The reduced risk of accidents for trips re-routed via this NMT route has not been considered.

The estimated total B/C ratio is 4.4 (a+b+c). This is high. It means that the investment in the route will be gained back after only one and a half year. The conclusion is that it is a sound economic policy to invest heavily in direct and safe NMT-only routes, on newly established road reserves, unrelated to the existing MT road network.

One observation: the same profitability (pay back period of 1-2 year) is widely reported for the informal minibus industry. There is a clear relation between the high profitability of that industry and the captiveness of the public to the minibuses, which has at least in part be caused by the absence of proper pedestrian and cycle route networks and traffic safety. Immediately the question arises: if this type of NMT investment is so beneficial, why has it not been made a long time ago?

The answer is simple, but its consequences not easy to alter: the difference between beneficial and profitable. In the case of the minibus industry, the benefits come to whom invests (or controls the buses). In the case of municipal investment, the benefit goes to the low-income population and cannot be charged for. So how to get it financed?

7. CONCLUSION

It appears that there is a sound case for re-thinking African urban transport policies, and for full-scale testing of urban transport re-orientation strategies that focus on:
(i) enhancing the efficiency of local urban markets by improving the ease of trips on foot , and
(ii) a shift to low-cost modes of transport (walking, cycling),
(iii) creating a local employment impulse through employment intensive infrastructure construction.

Based on the findings of the tests reported in the paragraphs above, the paper concludes:

> *a programme of walkway improvements has a great potential to enhance the mobility in, and economic activity of, low-income urban areas, and can be an important ingredient of urban economic recovery policies in Africa.*

Full scale tests of such programmes are strongly recommended (in big city districts of 200-300,000 inhabitants and in entire medium size towns).

The size of the paper does not allow to also discuss the potential contribution of urban cycling. The recommendation to start a re-orientation of urban transport strategies in Africa with walkway programmes is based on the conclusion drawn from the pilot projects mentioned above that effective urban cycling policies are only feasible after urban walking has been taken care of properly (not explained in this paper, see de Langen, 1999).

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2 Transport planning and urban development
Planification du transport et développement urbain
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Public transport, from ad-hoc development to integrated planning

Transport public, du développement ad hoc à la planification intégrale

Transporte público, del desarrollo ad hoc a la planificación integral

R. Díaz Padilla & C. D. Autheurs
Design Academy, Eindhoven, Netherlands & CONACYT, Mexico D.F., Mexico

ABSTRACT: Guadalajara 's public transport is a dangerous, unreliable and environmentally unfriendly system, implemented and maintained as problems occur (ad-hoc). The problems lie not in the capacity of the system, rather in the poor quality. If we wish to prevent Guadalajara from having the same chaotic experience (pollution, congestion, accidents) as its older sister, Mexico city, public transport must become more integrated into the developing urban landscape and more friendly for its users and the environment. This research is a distillation of critical success factors for public transport planning, carried out within three case studies from diverse cultural context (Westcorridor Connecting-line, Eindhoven. Jubilee Line Extension, London. Bi-articulated bus, Curitiba). These critical success factors when taken together form an integrated planning package, which could be seen as a recommendation for decision-makers in Guadalajara. It is hope this concept will persuade decision-makers to carryout a more inclusive planning process for public transport to avoid unwanted situations in the future.

RÉSUMÉ: Le transport public de la ville de Guadalajara est un système dangereux, instable, et peu favorable pour l'environnement qui a été implementé et maintenu au fur et à mesure que les problèmes se présentent (ad hoc). Les problèmes ne résident pas dans la capacité du système mais dans sa pauvre qualité. Si on veut prévoir que Guadalajara ait la même expérience chaotique (pollution, congestion, accidents) que sa grande soeur, la ville de Mexico, le transpot public doit être plus intégré au developpement urbain et devra être plus amical avec les usagers directes et avec l'environnement. Cette recherche est une distillation des facteurs critiques clés de la planification du transport public; déroulée dans trois études de cas avec divers contextes culturels (Westcorridor Connecting-line, Eindhoven. Jubilee Line Extension, Londres. Bi-articulated bus, Curitiba). Quand ces facteurs critiques clés sont combinés, forment un paquet de planification intégrale qui pourrait être considéré comme une recommandation pour les leaders de décision à Guadalajara. On espère que cette pensée persuade ces leaders de décision pour dérouler un procès intégral de planification plus inclusif et éviter des situations indésirables au futur.

RESUMEN: El transporte público en la ciudad de Guadalajara es un sistema peligroso, inestable, y poco favorable para el medio ambiente que ha sido implementado y mantenido conforme los problemas van presentándose (ad hoc). Los problemas no radican en la capacidad del sistema, sino en su pobre calidad. Si deseamos prevenir que Guadalajara tenga la misma experiencia caótica (contaminación, congestionamiento, accidentes) que su hermana mayor la ciudad de México, el transporte público deberá de estar mas integrado al desarrollo urbano y deberá de ser más amistoso con los usuarios directos y el medio ambiente. Esta investigación es una destilación de los factores críticos claves de la planificación del transporte publico; llevada a cabo dentro de tres estudios de casos con diversos contextos culturales (Westcorridor Connecting-line, Eindhoven. Jubilee Line Extension, Londres. Bi-articulated bus, Curitiba). Cuando estos factores críticos claves son combinados, forman un paquete de planificación integral que podría ser considerado como una recomendación para los lideres de decisión en Guadalajara. Se espera que este concepto persuada a los lideres de decisión a llevar a cabo un proceso más inclusivo de planificación integral, para así evitar situaciones indeseables en el futuro.

1 INTRODUCTION

This research was carried out as the topic of a Master degree in design research at the Design Academy Eindhoven, The Netherlands. It began in September 97 and it was concluded in July 1999. The research was sponsored by CONACYT (Consejo Nacional de Ciencia y Tecnología), which is a Mexican institution that undertake scientific research and supports research activities, which deemed valuable for the development of Mexico. The project was also supported by CEIT (Centro Estatal de Investigación del Transporte) with valuable information about the public transport condition of the city of Guadalajara.

The research focuses in the problems of public transport in the city of Guadalajara, Mexico. Since the 1970's public transport in Guadalajara has been one of the principle challenges and a focus for action. Current estimates suggest that at least 70% of the population in the metropolitan area (2.2 million people) use some form of public transportation. (Morales & Ruiz 1997) The urban sprawl that increases the extension of the city creates further points of interaction (work, education, leisure, culture, shopping) which demands complex transportation systems. Guadalajara 's public transport system has become a dangerous, unreliable and environmentally unfriendly system, having been implemented and maintained (ad-hoc) as problems occur. (Romero 1995) The problems, therefore, lie not in the passenger capacity of the system, but rather in its poor quality that doesn't meet at all the real requirements of the users (safety, reliability, comfort, and accessibility) and the environment.

Since the beginning, the research project was advised by experts from many different disciplines: industrial designers, urban planners, traffic engineers, sociologists, transport planners and environmentalists. They all agreed that in order to increase the quality of public transport in a city, first of all, a functioning system has to be consolidated in order to allow integrated solutions to be useful to the problems of public transport. One can conclude that improved products, as important as they are, can only be useful within a functioning system.

It is assume that if we wish to prevent Guadalajara from having the same chaotic experience (pollution, congestion, accidents) as its older brother, Mexico city, planning public transport must become more integrated into the developing urban landscape, user needs and environmental demands. Isolated proposals (or products), even the best of them, applied to a system with deep flaws, function at best as a palliative and at worst as a distraction, having a limited application at a high social, economic and environmental cost.

From these premises, it was decided to investigate the planning processes of specific public transport projects in order to identify the critical success factors that have a positive (social, economic and environmental) impact in the final results for public transport. Accordingly with the time and scale of the project, three specific projects were chosen as candidates to create three case studies. These case studies provided the information and examples from which conclusions from a comparative analysis led the author to the creation of an integrated planning package.

As a conceptual exercise, a possible application of an integrated planning process has been created as a desirable scenario. The scenario describes the planning process of a specific project in the city of Guadalajara "The Chapala Corridor Line". It is hope the scenario will be helpful to embody and communicate the benefits of an integrated planning process on public transport and will persuade decision-makers to consider integrated developments for the near future.

2 CASE STUDIES

The case studies were chosen as examples due to their high degree of integration (different disciplines, different aspects of urban life, different organizations etc.) during the planning process. The Westcorridor Connecting-line, Eindhoven, The Netherlands; The Jubilee Line Extension, London, United Kingdom and; The Bi-articulated bus, Curitiba, Brazil. These projects were chosen according to the following criteria. a) Each of the projects claimed to have an integrated planning process, b) each project was a well-documented process with planners willing to share their experience and knowledge, c) each of the projects was developed in variety of cultural environments, organizational structures and physical settings in order to allow comparable diversity.

Each of the case studies has been fully documented in order describe the planning process thus facilitate a comparative analysis. These descriptions are included in the complete version of the research document, which can be consulted through the research's web-site:
www.designacademy.nl/publictransport/index.html

3 INTEGRATED PLANNING PACKAGE (CRITICAL SUCCESS FACTORS)

The result of the research is the lessons learned from three case studies. These lessons were translated as an "integrated planning package for public transport" composed of "critical success factors". These factors derived from the investigation and comparative analysis of three innovative projects in public transport had indeed a major impact in the success of the complete projects. The case studies provide ample evidence of the efficacy and advantages of these critical success factors and useful examples of how best to use them. A major conclusion drawn from this research is that the critical success factors work best in combination as an integrated and comprehensive planning package.

The eight critical success factors that follow can therefore be seen as the recommended components (for decision-makers such as politics, urban planners, transport planners, designers, private developers, and transport enterprises) of an integrated planning process for public transport, which taken together form a comprehensive planning package. This package, if adopted and tested by cities with a less integrated planning process, can be expected to improve the quality of public transportation in social, economic, and environmental terms.

3.1 *Political decisions as the first step of public transport developments*

It was found that in all three case studies a political decision has been a determining factor in order to support the developments of public transport. It seems unlikely that without political support favoring public transport it would be possible to carry out an integrated planning process. Political decisions must, therefore, be considered as the first step in an integrated public transport planning process.

In Eindhoven, the national Ministry of Transport strongly supported the development of specific projects in public transport, in order to overcome a critical situation of road overcrowding in the Netherlands. Consequently, the City Development of Eindhoven, together with other cities in the Southeastern Brabant region, organized a traffic and public transport workshop in order to outline alternatives to improve the quality in public transport in specific cities. The HOV bus network in the city of Eindhoven grew directly from these regional workshops (Splint 1998).

In Curitiba, the initial political decision favoring public transportation, which is reflected in the choice of a Master Plan, was further enhanced by a unique situation in which planners from the municipal planning department became governing politicians (Meurs 1999). This created an optimum situation for public transport where the political power was combined with both the will and the knowledge to prepare and approve specific plans for public transport. As a result, public transport projects in Curitiba have demonstrated an unusually clear direction over 25 years of continuous evolution (Rabinovitch 1996).

3.2 *"Central Planning Authority" an essential element for integrated public transportation.*

A Central Planning Authority functions as the organizational entity where all the various issues of urban life can be taken into account. In order to be effective, a central planning authority requires three important aspects: 1. Centrality, which includes the participation of an inter-disciplinary team able to analyze and make use of diverse information. 2. Authority with sufficient power to carry out the decisions it makes. 3. Respect from the political parties to allow continuity to long term projects, which are necessary for public transport developments.

In Eindhoven, the City Development is a highly integrated and well organized Municipal authority which includes within itself departments of transportation, traffic, land-use, economic, housing, and finances. The City Development in Eindhoven stresses open and frequent communication from the different departments before moving forward with the plans. As a result, the Westcorridor Connecting-line project will be more than just an effective public transport system; it is expected, the project will provide benefits to the city of Eindhoven in many facets of urban life: economic, social and cultural (Splint 1998).

3.3 *Dynamic relationship between land-use and public transport*

The land-use activities and public transport relationship is a dynamic process that can be broken into two parts. One is the influence that land-use activities have over public transport facilities, the other is the impacts that public transport causes to land-use activities. In the first instance, this relationship takes into account the allocation of land use activities (housing, industry, commercial, public space) to determine the type of transportation that will be required in a specific area in development. The second part of this relationship, which has been less developed, recognizes that there is a dynamic influence between the public transportation choices that are made today, and the impact that public transport investments will have on land-use activities in the future. In order to make decisions on public transport; planners must consider the allocation of land-use activities to accurately determine transportation needs. Additionally, it has been observed that public transport investments have had strong impact on future land-use activities. The evidence of the case studies points to the conclusion that a better understanding of this dynamic relationship will lead to: 1 Improved opportunities to predict where future transportation-needs will lie, allowing for better long term planning. 2 Increased opportunities to organize and direct urban growth through public transport to "grow the city". 3 A more flexible public transport systems, better able to respond to a growing and changing urban environment.

Although all three case studies demonstrated the relationship between land-use and public transport, Curitiba is the most outstanding example of conscious use of the dynamic interaction. In Curitiba, the revolutionary use of the structural axes both predicted and directed the growth of the city (Meurs 1999). In addition, they implemented a phased and flexible system able to respond quickly to population growth or attrition and unusually easy to upgrade. One can conclude, the success of these strategies has resulted in a public transportation system that takes people where people want to go quickly, efficiently and safely.

3.4 *Quantitative Analysis: a necessary but limited tool*

The quantitative analysis is a mathematical planning model that is used to analyze large amounts of hard data to determine the origin, destination, frequency and volume of passengers in a specific area. The model is based on the use of quantitative information such as: population distribution and travel patterns, which are determined by the allocation of land-use activities and development policies.

Quantitative analysis is a useful and necessary tool to determine present and future transportation. However, it is a static tool with no power to predict developing changes in the urban landscape (Willis 1998) nor to improve the qualitative aspects of the transportation system that the end-users requires. Therefore, quantitative analysis must (necessary) be combined with other planning factors such as dynamic land-use analysis, qualitative analysis of the user's behavior and analysis of critical barriers to the use of public transport.

Although neither the planned residential nor commercial development in Eindhoven's west area has yet been built, housing, economic development and road decisions have been made in concert with the Westcorridor Connecting-line. In addition, the HOV project is a phased and flexible one, capable of adapting to future needs (Splint 1998). In this type of integrated project, the use of quantitative methods and land-use activities allow the City Development of Eindhoven to determine the transport needs and to estimate future expansion of commercial and residential areas.

3.5 *Parallel strategy "push and pull" incentives*

Push and pull incentives is a parallel strategy system of rewards and penalties designed to increase the use of public transport not only by providing incentives in the form of quality public transport, but also by discouraging the use of private cars within cities.

Push incentives are provided through raising prices in parking spaces, reducing situations in which traffic priorities are given to private-cars, restricting private-car access within certain areas in cities. Pull incentives are provided through increased quality of public transport, such as improved travel speed, accessibility and reliability, safety, comfort and improved usability. Some sort of push and pull incentives have been used in all three case studies, although in some cases they were more clearly developed than in others. Push and pull incentives have only recently been considered an integral part of the overall planning process; however, parallel strategies have proved to be a successful complement to the planning process of public transport.

In Eindhoven, push and pull incentives were taken into consideration at the theoretical planning phase in combination with other factors. The West-corridor Connecting-line will be a comfortable and convenient system that have priority over private cars (Splint 1998). At the same time, parking fees have been raised and the road system in Eindhoven has been modified in order to restrict the use of private cars within the city. Although it is too soon to confirm the projections, the City Development of Eindhoven assumes that this combination of push and pull will increase ridership over the next five years by 30%.

3.6 *Qualitative analysis: Representation of the end-users*

Qualitative analysis for public transport is an activity that is used to determine physical and psychological needs of end-users of public transport and their limitations and barriers to use public transport facilities. The aim of a qualitative analysis for public transport is to create requirements to specifying the needs of potential end-users and to establish a qualitative monitoring system to evaluate and improve the usability of public transport facilities. This is a critical factor that has been identified as the least developed aspect of the planning process at the municipal planning on the three case studies. At the municipal planning, the end-user has been represented through general information largely based on common sense assumptions and intuition. The end-user, it is assumed, wishes for a comfortable, safe, reliable, fast, convenient and inexpensive system. However, these criteria, while useful goals, are not specific enough to challenge the design vendors to create improved facilities that fully meet the qualitative standards that planners would like to see implemented.

Curitiba provides the best example of using an intuitive method that created qualitative requirements at an early stage of planning. Through comparing the advantages of several systems the planning committee established (early in the planning process) a specific set of qualitative requirements, (protection from the weather, comfort, improved access and improved speed of loading) which resulted in the innovative solution of the Boarding Tubes and the Bi-articulated bus (Meurs 1999).

At the designer desk the end-user is represented through generic guidelines and tables, which are based on general information concerning ergonomics, user capabilities and limitations, user behaviors, etc. (Klostermann 1998). However, these specific requirements and criteria concerning qualitative aspects have been left entirely to the discretion of design vendors (in the case of developing countries).

The HOV bus concept for the Westcorridor Connecting-line represents a completely original design; an entirely new concept that was created in response to specific quantitative requirements set by the department of City Development (Splint 1998). The HOV bus solves the problem presented by planners' requirements (quantitative) creatively and effectively. It is logical to infer that design vendors similarly challenged by qualitative requirements, would produce equally original, creative and high quality solutions for the specific demands of the end-users. Another way to state the above conclusion is that outcomes inevitably reflect inputs. If we limit our inputs to quantitative analysis, outcomes will fall short on qualitative measures.

3.7 *The end-user as an active participant in a planning process*

Public transport is, in the final analysis, not only about economic, urban development or technological innovations, as important as these are. It is, in the end, about people. Yet it often seems that the end user (almost completely absent from the planning process) is the least considered aspect in the planning of public transport. Although both Eindhoven and London made some effort to reach out to end-users, in both cases the participation of the end-user had little or no effect on either the planning process or the end result.

In Eindhoven, the City Development invited the participation of representatives of the west area and an effort was made to çhoose key representatives of the community. This proved an effective means for planners to communicate and gain the support of the potential end-users (Splint 1998). However, the feedback gained through that process had little or no impact on the final design of the Westcorridor Connecting-line.

In London, an even more encouraging sign is the study being undertaken to determine physical and psychological barriers to multimodal interchange. This study will necessarily involve direct questioning of the end-user and a weighing of the user's experience against the assumptions on which the design was based. Although the study will be performed after construction and therefore can have no direct impact on the design of the Jubilee Line extension, the experience of the end user, as expressed in the conclusions of the study, may well be integrated into future projects (Sale1998).

3.8 *Dynamic monitoring system*

Ongoing maintenance involves the monitoring of hard data, such as ridership and fare receipts, and is naturally used to adjust street level operations. The data collected through monitoring systems can also be returned to the planners at the theoretical level, thereby providing insight into the success (or failure) of the plans once implemented.

While both London and Eindhoven monitor their systems as part of routine maintenance in the operational phase, only Curitiba uses that wealth of data to evaluate and reconsider plans at the theoretical level. The communication of monitoring data to planners at the theoretical planning level has demonstrated dramatic benefits in Curitiba. It is the researcher recommendation that this communication should be included in any integrated planing package. The initial purpose of the Integrated Transportation Network in Curitiba was to accurately coordinate financial aspects and payments to the concessionaires (Rovani). However, planners quickly discovered that it was an extremely effective tool for on-going evaluation. Plans, once implemented, could be monitored for success, and future plans adjusted accordingly. The happy result can be seen in the smooth, trouble free transitions as the system has evolved.

4 AN INTEGRATED PLANNING PROCESS SCENARIO (CHAPALA CORRIDOR LINE)

The scenario focuses on a fictional, specific area of development in Guadalajara and the creation of the Chapala Corridor Line, a public transport system connecting Guadalajara with the international airport and Chapala Lake. The scenario is described in the form of newspaper articles written between the years 2002 and 2008 from different perspectives. The Chapala Corridor Line scenario reflects the critical success factors developed in this research. By combining these factors with key-players and key-events, it intends to envision the application of an integrated planning package and its benefits.

5 CONCLUSION

Recent studies such as "Jalisco a Futuro" and "Metacity Datatown" have revealed that in the future, urban growth (Mass 1998) and the use of private cars (CEED 1999) will inevitable increase as part of our "tendency" way of living. Of course, the problems of public transportation that we are facing now will be even more intense in the near future. These studies let us raise few questions in relation to public transport: Are we ready to propose solutions for an even more complex world? The traditional way of solving-problems (isolated proposals) will remain the same in the (near) future according to our so-called reality? The way we answer these questions is in relation to the way we will prepare our own future. In the studied cases, public transport problems have been solved satisfactorily for the higher number of people involved (end-users, entrepreneurs, politics, designers, urban planners, etc) on public transport developments. With no intention to follow a pre-determined planning model, it has been learned from their success as well as from their failure. This integrated planning package does not intend to be a direct solution for public transport, rather it is a collection of critical success factors that still need futher development in relation to specific areas (politics, management, engineering, urban development and human factors) and its relationship. It is hope the results of this research will be appreciated by decision-makers working in the field of public transport planning. It is expected the integrated planning package will be explored and discussed in depth (through an inter-disciplinary team) in order to find a suitable application for the development of public transport in Mexican cities.

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Lo que se debe y lo que no se debe de hacer: La Ciudad de México

What you should do and you should not do: Mexico City experience

Ce qu'on doit faire et ce qu'on ne doit pas faire dans la ville de Mexique

A.R.Molinero Molinero

Urbanismo y Sistemas de Transporte SA de CV (USTRAN), Ciudad de México, México

ABSTRACT: This paper presents a summary Mexico City's transportation development during the last twenty five years. It underlines the pros and cons that the transportation system has faced and it concludes that organization, orderly conduct and a clear and transparent normativity are ingredients that are lacking in order to attain the desired transportation.

RÉSUMÉ: Dans ce texte on présent une esquisse du déroulement que les transports ont montré dans la ville de Mexique, où on signale les réussites et les erreurs que cette ville a éprouvé dans ce demier quart de siècle. On a conclu que ce sont l'organization, l'ordre et une réglementation claire et transparente les éléments qu'on a omis pour obtenir un transport d'excellence.

RESUMEN: Se presenta un esbozo del desarrollo que ha presentado el transporte en la Ciudad de México, en el cual se señalan los aciertos y los errores por los que ha pasado esta urbe en este último cuarto de siglo. Se concluye que la organización, el orden y una normatividad clara y transparente son los ingredientes que han faltado para lograr un transporte de excelencia.

1 INTRODUCCION

A lo largo de este último cuarto de siglo, la Ciudad de México ha experimentado un sinnúmero de políticas y estrategias encaminadas a proveer de movilidad a su creciente población. Los resultados obtenidos seguramente podrán servir de ejemplo o de aviso de precaución para otras tantas ciudades que se han visto forzadas a absorber una población inmigrante deseosa de encontrar en la gran urbe su sustento y desarrollo.

2 LOS CAMBIOS EXPERIMENTADOS

El Area Metropolitana de la Ciudad de México (AMCM) ha pasado de una población de 11.7 millones de habitantes en 1975 a 16.7 millones para finales del siglo. En términos espaciales, pasa de una concentración del área urbana de lo que es la Ciudad de México a una dispersión de esta población hacia la periferia, al grado que en estos momentos la población está repartida equitativamente entre las dos entidades que conforman el AMCM (Distrito Federal y Estado de México).

El crecimiento poblacional y espacial ha obligado a ampliar las funciones de la administración del transporte así como la búsqueda de un mayor grado de especialización. De esta manera las áreas encargadas del transporte pasaron de ejercer funciones meramente policiales y reguladoras a funciones de planeación, coordinación y organización. Este cambio se dio a un grado tal que en ambas entidades surgió un órgano de gobierno con características prioritarias, dándose por vez primera una atención fundamental al transporte sobre la vialidad. A esta organización interna se sumó la necesidad de buscar la coordinación interestatal para ordenar y regular el transporte metropolitano. Los Cuadros 1 y 2 muestran el desarrollo durante el periodo bajo estudio.

La prestación del servicio de transporte sufrió cambios radicales donde el metro se mantuvo como el transporte por excelencia hasta principios de la década de los noventas, cediendo parte de su demanda a la cada vez más fuerte competencia de los minibuses. Por otra parte, el transporte prestado por autobuses en el entorno del Distrito Federal pasó de manos privadas a las manos del

Cuadro 1. Conceptos seleccionados de evolución del transporte en la AMCM

Concepto	Hace 24 años 1976	Hace 14 años 1986	Hace 4 años 1996[1]
Población (millones de habitantes)			
Distrito Federal Edo de México TOTAL	8.2 70% 3.5 30% 11.7 100%	8.0 55% 6.6 45% 14.6 100%	8.5 51% 8.2 49% 16.7 100%
Area urbana (km^2)			
Distrito Federal Edo de México AMCM	nd nd nd	617.0 609.2 1 226	751 721 1 472
Autoridades transporte y vialidad			
Distrito Federal	•DGITT • DGPT	•CGT •COVITUR •DGAU	•STV
Edo. de México	•SDUOP •Instituto AURIS	•SDUOP	•SCT
Metropolitanas	•CCCP	•COMICOT	COTAM ⇓ •COMETRAVI
Operación del transporte público			
•Metro	DDF	DDF	GDF
•Trolebús, tranvía, tren ligero	DDF	DDF	GDF
•Bus urbano	Privados	DDF (AUPR100)	En transición
•Bus suburbano	Privados	COTREM/ privados	Privados
•Taxis/ colectivos/minibús	Privados	Privados	Privados

[1] Datos disponibles a 1996. nd = no disponible

Notas:

DGITT.- Dirección General de Ingeniería de Tránsito y Transporte
CGT- Coordinación General de Transporte
COVITUR- Comisión de Vialidad y Transporte Urbano
STV- Secretaría de Transportes y Vialidad
DGPT- Dirección General de Policía y Tránsito
DGAU- Dirección General de Autotransporte Urbano
SDUOP- Secretaría de Desarrollo Urbano y Obras Públicas
SCT- Secretaría de Comunicaciones y Transportes
CCCP- Comisión de Conurbación del Centro del País
COMICOT- Comisión Mixta Consultiva de Transporte
COTAM- Comisión de Transporte Metropolitano
COMETRAVI- Comisión Metropolitana de Transporte y Vialidad

estado en 1981 para enfrentar un proceso de privatización, aún incompleto, en 1995.

Cuadro 2. Parámetros en la evolución del transporte en la AMCM

Concepto	Hace 24 años 1976	Hace 14 años 1986	Hace 4 años 1996[1]
Parque vehicular en operación			
•Metro	37 km 537 carros	116 km 2161 carros	178 km 2559 carros
•Trolebús, tranvía, tren ligero	390 trolebuses 116 tranvías	320 trolebuses 15 trenes	439 trolebuses 19 trenes
•Bus urbano	7 800 unidades	4 650 unidades	1 269 unidades
•Bus suburbano	7 500 unidades	5 695 unidades	1 284 unidades
•Taxis, colectivos/minibús	40 000	96,500	116,562[2]
•Automóvil	919,188	1'329, 942	2'776,593
TOTAL (veh)	1'136,235	1'588,208	3'005,598
Reparto modal (millones de tramos vpd)			
Total	15.7	22.0	29.2
Reparto modal (%)			
•Metro	10%	19%	13%
•STE	4%	3%	1%
•Autobuses Urbanos	41%	26%	7%
•Autobuses Suburbanos	8%	16%	4%
•Taxis, colectivos/minibús	12%	11%	58%
Subtotal	75%	75%	83%
•Automóvil	25%	25%	17%

[1] Datos disponibles a 1996.
[2] Incluye minibuses. vpd = viaje-persona-día

Durante estos catorce años de manejo estatal, se promovieron una serie de políticas, muchas veces contradictorias entre sí: estatización, cambios a unidades de baja capacidad, impulso a la propiedad atomizada, privatización. Sin embargo, es de reconocerse que durante ese periodo la ciudad gozó de un transporte digno y eficiente: se respetaba la ubicación de las paradas, se impulsó un correcto mantenimiento al parque vehicular, se introdujo un primer sistema tarifario integrado, se fortaleció una red conformada por rutas alimentadoras y rutas directas que obedecían a una planeación, entre otras muchas acciones más.

Esta serie de ires y venires en las políticas de transporte y la urgencia por mostrar soluciones inmediatas dió lugar a que muchas de estas acciones fueran instrumentadas sin un tiempo de maduración previo, con las consecuentes ineficiencias de la improvisación a un grado tal que la Ciudad de México no ha alcanzado una definición del camino que habrá de seguir. Por su parte el Estado de México, a menor escala ha seguido la pauta del estado vecino, con resultados aun más catastróficos.

Durante estos 25 años el crecimiento de la red del metro se ha incrementado de los 37 kilómetros que contaba en 1976 a 202 km para 1999. Con esta red pasó de movilizar 1.7 millones de viajes en 1976 a transportar 4.6 millones para 1996. A su vez, el crecimiento en la oferta del transporte de superficie se dio a través del fomento de medios de transporte de baja capacidad que substituyeron casi totalmente al transporte en autobuses. Esta política permitió un crecimiento desmedido de la oferta al pasar de 320,000 asientos por día (7,800 autobuses) en 1976 a 710,000 asientos por día (27,000 minibuses y 1,269 autobuses) en 1996. A su vez, el número de taxis pasó de 2.6 unidades por cada 1000 habitantes en 1976 a 10.5 unidades por cada 1000 habitantes para 1996. Con esta oferta se pudo absorber el aumento del 90% que registraron los viajes persona día en este lapso, debiéndose señalar que la movilidad se incrementó en un 33%.

El cambio más importante que se registró en este periodo se centró en los cambios en el reparto modal. Fue notoria la pérdida de participación de los sistemas de mayor capacidad unitaria a la vera de unidades de menor capacidad. Las políticas tomadas en esta dirección en la segunda mitad de los 80s, sin duda, han sido de los mayores errores en materia de transporte y medio ambiente a los que se ha enfrentado esta ciudad.

Este cambio modal, impulsado tanto por las autoridades de ese momento como por la banca de desarrollo internacional, trajo un retroceso del que apenas la ciudad se está reponiendo. Así, el transporte masivo eléctrico redujo su participación del 22% en 1986 al 14% para 1994. A su vez, el transporte en autobuses diesel pasó del 42% a tan solo el 11%, mientras que unidades de baja capacidad (10 a 27 plazas) propulsados por motores de gasolina y conformados por miles de

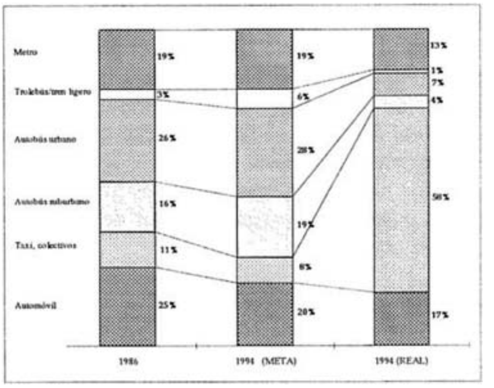

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Figura 1. Evolución del reparto modal 1986-1994 (programada y real).

prestatarios independientes lograron que su participación pasara del 11 al 58% en el mismo lapso. Por otra parte, se presentó una ligera reducción en la participación modal del automóvil, pese a las deficiencias detectadas en las demás opciones de transporte. Esta situación se muestra en la Figura 1.

3 LO QUE SE DEBE HACER Y LO QUE NO SE DEBE DE HACER: EVALUACION DE 25 AÑOS DE POLITICAS DE TRANSPORTE

En el aspecto económico y financiero, las diferentes políticas de reducir gradualmente el subsidio en el transporte operado en el Distrito Federal han dado frutos ya que éste se ha disminuido en términos reales por pasajero transportado. A su vez, se han buscado mecanismos para adecuar los niveles tarifarios, dado los niveles de inflación ha padecido el país. De un esquema de definición tarifaria meramente política se ha pasado a un esquema legislado y con bases técnicas basado en una fórmula de aplicación sencilla en una primera etapa y una fórmula mas elaborada a partir del segundo semestre de 1999.

Desafortunadamente, las medidas para eficientar el uso de los recursos no han tenido el resultado esperado, resultado de las discrepancias políticas, de la duplicación de recursos y funciones y de las sobreposición de los servicios de transporte, principalmente. A esto se suma la poca cultura para jerarquizar las inversiones bajo criterios de beneficio-costo o costo-efectividad y a la tendencia de hacer obra sobre la conservación y el mantenimiento así como sobre la organización y el ordenamiento de lo que se tiene. En este sentido, los últimos años marcan un parteaguas, al darse una atención prioritaria a las acciones de gobierno, de orden y de normatividad sobre las de construcción de obra.

En cuanto al reparto modal y la integración de los diferentes medios de transporte, los resultados no han sido del todo satisfactorios ya que las ampliaciones del metro han contribuido a un mayor número de pasajeros en las terminales alimentadas por un gran número de rutas suburbanas, haciendo que las terminales operen bajo regímenes de sobrestación. Esto ha degradado la imagen y ha promovido la competencia a lo largo de su trayecto con otros medios no regulados, con alta frecuencia de paso.

Entre las razones que han servido como justificación para este cambio modal se encuentran: las presiones de promover fuentes de trabajo en los años 80s, la tendencia de la banca de desarrollo mundial por medios de baja capacidad sobre los de alta capacidad centrados en la idea económica de que una alta frecuencia reducirá las externalidades debidas a los tiempos de espera perdidos y la hejemonía del sindicato de la empresa estatal de autobuses sobre la administración de la misma, amén de los intereses creados y políticas de caciquismo. Asimismo, la poca conciencia ambiental sobre los problemas que traería consigo un crecimiento de los minibuses, propulsados por motores a gasolina, modificó la política de mantener la participación modal de los medios de baja capacidad (taxis, colectivos y minibuses) en un 8% tal y como se tenía previsto en el *Programa Integral de Transporte y Vialidad de 1987* a un crecimiento real para 1994 del 58%. Los efectos de estas decisiones se están viviendo hoy en día y son ejemplos de lo que no se debe hacer.

A esto se suma que la participación esperada del autobús dentro del documento antes citado era de un 47% para 1994, resultando, finalmente, un 11% real. Naturalmente, las situaciones anteriores afectaron al metro al reducir su influencia del 19% al 13% en el mismo periodo.

Hoy en día se reconocen estos errores y se quiere retomar el camino pero el costo económico de su

Cuadro 3. Diagnóstico síntesis del transporte eléctrico.

Hace 24 años 1976	**Hace 14 años 1986**	**Hace 4 años 1996**
Sistema de Transporte Colectivo (metro)		
•Alto crecimiento de la demanda •Tarifa subsidiada •Estancamiento en la oferta •Faltan trenes en horas pico •Buen mantenimiento •Planeación a cargo de quien construye	•Operación desequilibrada •89% de demanda concentrada en tres líneas •Nuevas líneas con baja captación •Tarifa subsidiada •Congestión en paraderos •Falta de conexión intermodal •Reflexión sobre la validez de metodología de planeación •Planeación a cargo de quien construye •Plan Maestro Metro 1985	•Disminución de desequilibrios de explotación •Mejora conectividad •Captación estancada •Reducción de subsidios •Líneas al Estado de México •Alta congestión en paraderos •Falta de conexión intermodal •Problemas de mantenimiento •Planeación a cargo de la STV •Plan Maestro 1996
Servicio de Transportes Eléctricos (trolebuses y tren ligero)		
•Mayores tiempos de recorrido •Interferencias en zonas altamente transitadas •Unidades antiguas restauradas •Tarifas más bajas; existe abono sin límite de viajes	•Falta mantenimiento preventivo •Fallas continuas en el servicio •Altos índices de captación por unidad •Pocas unidades •Tarifas subsidiadas •Abono de transporte	•Recursos presupuestales insuficientes •Renovación de flota •Nuevo esquema de planeación •Poca coordinación con R-100 •Pocas unidades •Tarifa subsidiada •Abono de transporte

corrección es fuerte y se presenta una oposición, natural y esperada, por parte de los miles de concesionarios que hicieron acto de presencia en dicho lapso y que ahora temen perder sus fuentes de ingresos. El buscar que el transporte sea un paliativo a los problemas sociales o económicos termina, finalmente, en un problema político y técnico de difícil solución. La organización del sector y el replanteamiento de un reparto modal razonable es por ello una meta impostergable.

Los Cuadros 3, 4 y 5 sintetizan el desarrollo del transporte público en la Ciudad de México de 1976 a la fecha y en el cual se muestran las principales acciones tomadas en dicho lapso.

Cuadro 4. Diagnóstico síntesis del transporte en autobuses

Hace 24 años 1976	Hace 14 años 1986	Hace 4 años 1996
Autobuses Urbanos		
•Bajo nivel de servicio •Falta mantenimiento rutinario •Rutas con desviaciones innecesarias •Exceso paradas •Insuficiencia de capacidad en terminales •Servicio no programado •Rutas radiales •Falta de integración •Tarifas de mercado/subsidio al combustible	•Red ortogonal y alimentadora •Bajo nivel de servicio •Alta captación de pasajeros por unidad •Baja en la flota real en operación •Insuficiencia de garages •Grandes recorridos en vacío •Falta de mantenimiento •Nula reposición de unidades •Crecimiento burocrático del organismo •Subsidio	•En transición •Concesiones a diez nuevas empresas en el corto plazo •Marco tarifario sin subsidio •Reordenamiento de rutas •Sustitución de microbuses por autobuses •Voluntad de ejercer mayor control y vigilancia sobre la prestación del servicio.
Autobuses Suburbanos		
•Desconocimiento parque vehicular •Carencia de orden respecto a tarifas, frecuencias y recorridos •Diversidad permisos y concesiones	•Insuficiencia de rutas de penetración EM-DF •Carencia rutas metropolitanas •Ausencia programas de operación •Falta de renovación del parque vehicular y de mantenimiento	•Exceso de rutas •Duplicación del servicio •Diversidad de permisos y concesiones •Dificultad de control de las concesiones •Operación en la periferia

Cuadro 5. Diagnóstico síntesis de los taxis, colectivos y minibuses

Hace 24 años 1976	Hace 14 años 1986	Hace 4 años 1996
Colectivos y Minibuses		
• Servicio prestado en automóviles • No regulado	•Modalidad en rápida expansión •Nicho de demanda por calidad insatisfecha •Opera con tarifas altas •Medio de baja capacidad que opera en rutas troncales y alimentadoras •Prestado con combies y minibuses •Sin reglamentación	•Crecimiento desmesurado •Desorganización •Anarquía en la prestación del servicio •Alta participación en corredores troncales •Insuficiente integración •Inicio de substitución minibús por autobús •Reglamentados (1996)
Taxis		
•Servicio caro •Servicio utilizado para ciertos viajes •Padrón vehicular controlado	•Modalidad de transporte en rápida expansión •Función específica de transporte individual •Dificultad de operación integrada •Dificultad sustitir y renovar equipo	•Voluntad de ejercer mayor control y vigilancia sobre la prestación del servicio •Sobreoferta •Tarifas bajas •Reglamentados (1999)

4 CONCLUSION

Las experiencias en materia de transporte en la Ciudad de México son múltiples y muchas veces, dadas las presiones por dar soluciones a los problemas del ayer, éstos se han ido resolviendo bajo el metodo de prueba y error. Esto le ha permitido, a un enorme costo, aprender de sus yerros y sus experiencias debieran ser consideradas por otras ciudades en etapas similares de desarrollo.

La experiencia de esta ciudad indica que cuando un sistema de transporte se reestructura o pasa de una administración privada a una estatal se debe tener un esquema claro de las funciones que va a desempeñar; se debe contar con personal capacitado en los mandos medios y preparado para tomar decisiones en los mandos superiores; y se debe contar con la infraestructura suficiente para encarar el problema. Estas son las principales diferencias entre un sistema exitoso como lo es el Sistema de Transporte Colectivo Metro y un sistema que evolucionó a tumbos como lo fue la empresa estatal de autobuses AUPR-100.

Una ciudad de las dimensiones de México requiere una gama de medios de transporte que cubran las expectativas de su población. Por ello, es recomendable que en los corredores con requerimientos de transporte de gran capacidad, se ofrezcan medios de alta captación mientras en los sistemas alimentadores y periféricos, se prestan con medios intermedios o de baja capacidad. Resulta poco razonable que en su momento se haya buscado satisfacer la alta demanda existente en los principales corredores con un sinnúmero de unidades operando sin regulación operativa y orden alguno cuando existía la posibilidad de organizar el transporte con unidades acordes a las demandas requeridas. En este caso las presiones sociales y políticas dieron al traste a un desarrollo congruente del transporte de superficie.

Un crecimiento anárquico, sin organización ni orden o legalidad no puede ofrecer un servicio económico y de calidad por mas gasto en infraestructura y equipo que se realice. Es por ello importante organizar, ordenar y establecer un marco normativo y legal antes de iniciar la adquisición de equipos y construir obras de ingeniería. Los momentos de éxito en el transporte de esta ciudad han recaído mas en lo primero que en la construcción de obras o en la adquisición de equipo.

El crecimiento urbano desmedido que en muchos casos ha fomentado la movilidad sobre la accesibilidad ha roto la cohesión de esta área urbana. La Ciudad de México, no ha sido capaz de vigilar la segregación de las actividades sociales y productivas dentro del entramado urbano y no ha podido contener la inercia del desarrollo inmobiliario y comercial hacia la periferia. Aún mas, este desarrollo no ha ido acompañado ni de los esquemas de organización y orden deseados ni de la infraestructura requerida para contener o aminorar el impacto del desarrollo urbano. Es por ello que los territorios periféricos de esta gran ciudad deben acercar los servicios al usuario, al hogar y al barrio, promoviendo el uso mixto del suelo y dejando a un lado un esquema urbano de expansión que fomenta la movilidad y la infraestructura para el automóvil y que depende de una marcada centralización de las actividades.

La promoción y desarrollo de medios de transporte informales permiten, inicialmente solucionar problemas sociales o presiones políticas, pero con el tiempo resultan en dolores de cabeza. Esto ha quedado constatado con la evolución de los taxis colectivos a combies y posteriormente a minibuses, los cuales han ido absorbiendo poco a poco el mercado de medios mas eficientes. Un problema similar se enfrentará esta ciudad con la promoción que se ha hecho al bicitaxi como medio turístico de transporte en la zona centro y como generadora de empleo en la periferia.

En suma, la experiencia de la Ciudad de México es rica y aprovechable y nos señala la importancia que tienen las consideraciones de orden, organización y desarrollo institucional sobre el crecimiento de la infraestructura, del equipo de transporte o de otras acciones paliativas de problemas ajenos al movimiento de personas.

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Modelling urban form / structure and transport-interrelationship and interactions: Case study Delhi urban form / structure

Modelage d'une forme / structure urbaine et transport: Relations mutuelles et interactions: étude spéciale de la forme / structure urbaine de la ville de Delhi

R.K.Khanka
RITES, New Delhi, India

N.Ranganathan
School of Planning and Architecture, New Delhi, India

ABSTRACT: India is experiencing massive population growth and rapid urbanization. It is therefore important to plan, develop and manage metropolitan cities in an optimal, efficient, and effective manner within the financial resources available/ affordable. Urban transport system is one of the major areas that influences urban form/ structure and thus determines the quality of life within metropolitan cities. In the context of accelerated growth of metropolitan cities and large investments in metropolitan transport systems, it is necessary to appreciate the inter-relationship, develop simplified, operational models and use them, as a first step, to select the most appropriate transport system that is consistent with the proposed land-use of the city, and further to restructure the city's urban form/ structure with reference to proposed transport system. An attempt has been made in this paper to quantify the relationship between transport system and urban form/ structure. For this purpose, Delhi, the capital of India, has been taken as the case study for formulating and calibrating the urban form/ structure model as a result of introduction of mass rapid transport system (MRTS). The model has been applied to evaluate the potential pattern of spatial distribution of population and employment that can be further translated into land-use pattern.

RÉSUMÉ: L'Inde est en train d'un accroisement massif démographique et une urbainisation rapide. Donc, il faut planifier, développer, et gérer les grandes villes d'une maniére optimale, efficace et effective dans les limites des ressources financiéres disponibles. Le Transport urbain est un des domaines principaux qui influence la forme/ structure urbaine et ainsi il détermine la qualité de vie dans les grandes villes. Dans le contexte d'un accroissement accéléré des grandes villes et les grands investissements dans les transports urbains, il faut comprendre les relations mutuelles et développer des modéles simplifiés et opérationnels et les utiliser initialement, pour choisir le réseau le plus connenable, qui est compatible avec l'utilisation optimale du terrain et en plus, restructurer la forme/ structure de la ville par rapport au transport urbain prévu. On a essayé dans ce document de quantifier la relation centre le systéme de transport et la forme/ structure urbaine. A cet effet, on a pris Delhi, la capitale de l'Inde, pour notre étude spéciale afin de formuler et calibrer le modéle de la forme/ structure urbaine du a l'introduction du métre urbain. On a utilisé le modéle pour évaluer le potentiel de la répartition spatiale démographique et le emplosis générés qui etre davantage transformée en une utilisation optimale du quartier.

1 INTRODUCTION

The choice of appropriate transport systems and their proper relationship to the land use has become important, with a view to optimize the use of land as well as to minimize the total cost of transportation of the cities. With the increase in traffic congestion in cities world over, there are efforts to adopt one or the other form of mass transport system. But these systems entail high capital investment, which the developing countries often find difficult to mobilize. This leads to the basic question of selection of the proper project that would give maximum benefit to the economy and be consistent with the overall development plan of the cities.

The present practice followed for selecting transport projects for investments is, normally, the standard cost benefit analysis. On this basis, the project that imparts maximum benefit to the economy is recommended to be taken up for investments from a pool of pre-selected transport options. This approach relies heavily on the minimization of costs to the economy and leaves the other crucial physical parameters untouched. In case of urban transport projects the quantification of physical relationship between a transport system and the urban form/ structure is a crucial parameter which should not be ignored while selecting a transport system. Otherwise, a cost efficient transport system may lead to unaffordable urban form/ structure, and also may result in a change in land use contrary to that envisaged in the Master Plans of the cities.

An attempt has been made in this paper to quantify the relationship between transport system and urban form/ structure model. For this purpose, Delhi, the capital of India has been taken as the case study for formulating and calibrating the urban form/ structure model. Delhi with more than 10 million population, is faced with transportation related problems. At present the bus transport with limited capacity is the only mass mode of transport. Acknowledging the limitations of the bus based transport system, a Mass Rapid Transport System (MRTS) for Delhi has been considered and construction work has started.

As contrast to the existing bus transport system, the MRTS would influence the urban form/ structure in a different manner. The paper examines the impact of the MRTS on Delhi's urban form/ structure and the extent to which it would be in accordance to the development/ expansion of the city as envisaged in the present master plan (Master Plan for Delhi-1981-2001). It would also serve as a tool for selecting projects that would be consistent with the future urban form/ structure of the city.

2 URBAN FORM/STRUCTURE DEFINITION & QUANTIFICATION

Urban areas are characterized by various activities, i.e., social, economic, cultural, administrative and physical, that are needed for the day to day functioning of a city. The growth in the population coupled with the technology progress imparts dynamism to a city and also shapes its urban form. There is an inherent relationship among the land use activities, the spatial distribution of urban activities (structure of the city) and the characteristics of transport system operating in the city. This finally reflects in the physical form of the city.

Different theorists have defined urban form/ structure in various ways. For the purpose of the present paper the definition of urban form/ structure is conceptualized on the basis of the parameters affecting urban form and the ease with which it can be measured.

A city can be viewed in a two dimensional frame through the concentration of population and the scale of employment in an area. Thus the population and employment are the two basic parameters that define urban form, and their distribution over the geographical area of the city imparts a certain shape to the city. Urban form can be measured through a proper quantification of these two parameters. The other parameters that affect urban form can be said to be derivatives of population and employment levels. For example, through the population estimates and its distribution in an area the requirement of the land-uses such as housing, social infrastructure, open spaces, etc. can be estimated. Similarly, the land-use required for commercial activities, work centers, etc. can be estimated through the employment levels and its distribution over the space.

There are various land-use models that are used for quantification of urban form/ structure. The basis of these models are mainly the measure of 'accessibility' of an area vis-à-vis the transport system. Accessibility links functionally the spatial location of land-use activities with the service provided by the transport system. In this paper attempt has been made to develop a land-use model on the concept of accessibility of an area measured in terms of transport system productive capacity.

3 DELHI URBAN FORM/ STRUCTURE & TRANSPORT SYSTEM

Historically, Delhi has been an administrative center and a major center for trade and commerce. As per 1991 Census (the latest one conducted in India) figures the total area falling in Delhi Urban Area (DUA) was about 63533 hectares and the population was about 9.5 million, depicting an overall population density of 133 persons per hectare (pph). In the past, there has been a high growth in population at about 4% per annum. In the decade 1981 to 1991 the population density increased sharply by over 37%, indicating the compact population distribution. An over view of the growth in population and density during the period 1951 to 1991 is shown in Table 1.

The predominant mode of transport in Delhi is the road based bus transport system. Delhi is the converging point of nine major roads of which five are National Highways and the remaining four are major arterial roads. The city has a network of ring

Table1. Population and Density of DUA

Year	Population (000)	Annual (%)	Area (Hectare)	Density (pph)
1951	1440	7.5	21500	67
1961	2360	5.1	32600	72
1971	3650	4.5	44600	82
1981	5710	4.6	59200	97
1991	8480	4.0	63500	133

Source: Compiled from different sources

shaped roads (inner and outer) and other sub-arterial roads connect these major roads to each other. All the major roads converge at the central core of the city, the central business district.

The transport demand in Delhi is very high at 1.14 (including walk trip) per capita trip rate. The per capita trip rate, excluding the walk trips, is 0.79. About 62% of the transport demand is met by the public transport system, i.e., bus transport system and the remaining 38% by personalized modes of transport, of which major share (17.59%) is accounted by two wheelers. Also the share of two wheelers to the total vehicles, have grown phenomenally from about 1% in 1957 to 17.59% by 1994. The trend in growth of share of different vehicles over the period 1957 to 1994 (Table 2) indicates the limitations of the present bus system and the growth of personalized mode of transport.

The average trip lengths of the different modes of transport provide the reasons for the modal share depicted in Table 2 and also the spread/ shape of the city. In the year 1957 slow mode of transport (cycle) met about 36% of the transport demand whereas its share declined substantially to about 7% by 1994.The growth in average trip length of the different modes as indicated in Table 3, depicts a dispersed distribution of population. The average trip length of all the mechanized modes have increased considerably.

Delhi has been following planned growth under the two master plans, viz., Delhi Master Plan (MPD)(1962-1981) and Master Plan for Delhi (1981-2001). The third master plan for the period 2001 to 2021 is being prepared. The salient features of these plans that relate to the subject matter of the paper are indicated below.

The basic objective of MPD-62 was to organize all developments on the basis of large districts that would be developed as relatively self-contained for daily purposes and needs. This close locational relationship was considered to be of over-riding importance in greatly diminishing the demands on and cost of transport system and travel.

The second master plan took into account the basic postulates of the previous master plan. It proposed that the future development of Delhi to be low rise high density, i.e., the residential development to be compact and with low rise structures. The gross residential density was proposed in the range of 350 pph to 400 pph and the gross city level density was proposed in the range of 180 pph to 200 pph. The plan proposed a multi-modal transport system comprising bus transport, light rail transit (LRT) system, and ring rail plus spurs.

A proper plan for integrating the land use with transport system was not followed. While the policies of decentralize work centers were adopted, there was no method to plan their locations. Apparently, the location of district centers (workplaces) was decided on the basis of their proximity to arterial roads. However, this ad-hoc practice has resulted in some of the highly accessible areas being neglected.

Table 2. Growth in Modal Share of Modes of Transport

Mode	1957 (%)	1969 (%)	1981 (%)	1994 (%)
Cycle	36	28	17	7
Bus	22	40	60	62
Car	10	16	5	7
Two Wheelers	1	8	11	17
Others	31	8	7	7
Total	100	100	100	100

Source: Compiled from different sources

Table 3. Growth in Average Trip Length (km) of Transport Modes

Mode	1957	1969	1981	1994
Cycle	5.00	4.77	3.80	4.89
Two wheelers	4.50	5.62	7.32	10.03
Car	4.00	5.10	8.10	11.28
Bus	5.00	6.64	8.60	10.66
Taxi	5.00	4.81	4.40	11.47
Auto	5.00	4.81	4.40	6.14

Source: Compiled from different sources

4 URBAN FORM MODEL

In order to predict the urban form/ structure of Delhi a two-stage model has been conceptualized and formulated. It is basically a land-use model, which integrates the transport system characteristics with land-use. Here, the capacity and speed of a transport system/ mode define the transport system characteristics. For example the capacity of a road based public transport system is the number of passengers it can carry in a given time period. The speed of the bus system in a given area specifies how fast the passenger movement takes place. Put together, the capacity and speed of a transport system has been defined in the literature as productive capacity of the system. Accessibility of an area can be said to be directly proportional to the productive capacity of the transport system serving the area. Higher the productive capacity of the system serving an area, higher will be the accessibility of that area. Also, if an area were served by more than one mode of transport, the productive capacity of that area would be the sum of the productive capacities of the individual transport modes/ systems.

Of the two-stage model conceptualized, stage one is the formulation of an accessibility sub-model that estimates transport zone/ area-wise accessibility indices as defined by the characteristics of the transport system serving the transport zone/ area. The second stage of the model relates to the formulation of the distribution sub-model that takes the out-put of stage one, i.e., the accessibility indices of the zones/ areas as inputs and distributes the population and employment on the basis of these accessibility indices.

Stage-one: Accessibility Sub-Model

$$A_i = \frac{C_i\ Vi}{\Sigma Ci\ Vi} * \frac{1}{\Sigma d_{ij}^{\alpha}} \qquad (1)$$

where A_i = accessibility index of zone 'i'; C_i = capacity of transport system serving zone 'i' expressed in terms of number of passengers moved by the transport system in a day; V_i = average speed of the transport mode in zone 'i'; d_{ij} = time taken by a transport system from zone 'i' to zone 'j'; α = a parameter to be calibrated.

Stage-two: Urban Form Sub-Model

$$P_i = a_1 + b_1 * (A_i) \qquad (2)$$

subject to population density constraint for a transport zone, such that, population density ≤ 400; and

$$E_i = a_2 + b_2 *(A_i) \qquad (3)$$

where P_i = population in zone 'i'; E_i = employment in zone 'i'; a_1, a_2, b_1 and b_2 are the parameters to be estimated.

5 CALIBRATION AND VALIDATION OF URBAN FORM MODEL

The study area comprises the area falling in Delhi urban area as defined in the Master Plan for Delhi (1981-2001) and the areas in urban extension that would be required by 2021 to accommodate the projected urban population for Delhi. The study area is divided into transport zones as demarcated by Delhi development authority (DDA), The urbanisable area that would be required to accommodate the population by 2021 has been represented by 177 transport zones.

The urban form sub-models have been calibrated to reflect the base year (1991) urban form as revealed by distribution of population and employment in the various transport zones prevailing in Delhi during 1991. The calibration exercise would entail estimation of the parameters indicated in equation (1), (2) and (3). The inputs for calibrating the urban form/ structure model are discussed below.

- Population and employment distribution in the base year (1991) in the geographical limits as defined by the 177 transport zones. The data source was household survey for Delhi organized by RITES in 1994.
- Road transport network covering the existing and proposed roads having right of way (ROW) 30 meters and above.
- Distance and speed matrix (177 X 177) for 177 transport zones.
- Route wise information on bus transport system prevailing in the year 1991. The details such as number of routes operated; path followed in each route; frequency of bus per day; etc. were gathered from the Office f Transport Authority, Delhi.
- The average number of passengers per bus was taken as 58 passengers.

The basic information indicated above was used to estimate the transport zone wise values of C_i, V_i, and dij. The number of passengers moved per day by the buses (C_i) were worked out by estimating the number of bus trips passing through the zone in a day and multiplying it by the average number of passengers carried per bus. The average speed of bus in a zone (V_i) was estimated through the speed matrix summed and averaged for the zone. The d_{ij} values for each zone were estimated by dividing the shortest path distance matrix (with respect to time) by the speed matrix.

Having worked out the zone wise values of C_i, V_i and d_{ij}, the value of α was estimated through calibrating the urban form models. Using the relationship (1) and (2) the value of α for estimating population distribution (α-pop) and through relationship (1) and (3) the value of α for estimating employment distribution (α-emp), were worked out. Various values were assigned to α and the corresponding values of Ai were estimated and put into urban form sub models represented by relationship (2) and (3). For each of the Ai values, the corresponding regression coefficient (R^{-2}) was estimated and those values of α (population and employment) were selected for which the R^{-2} was maximum. Based on this exercise the value of α-pop was estimated as 0.01 and that of α-emp as 0.8. The corresponding R^{-2} is 0.7595 and 0.6291 respectively.

Using the selected values of A_i and the base year (1991) Pi and E_i, the parameter a_1, b_1 in case of relationship (2) and parameters a_2, b_2 in case of relationship (3) were estimated. Having estimated these values the population and employment distributions for the base year were made and validated against their actual values. The validated sub-model of stage-two was used to predict the population and employment for the year 2021.

6 APPLICATION OF MODEL

The urban form models for estimating population and employment distribution are shown below.

Population Distribution Model

$$P_i = (-)\ 44256 + 15854604 * (A_i) \quad (4)$$

Employment Distribution Model

$$E_i = (-)\ 14150 + 4070730 * (A_i) \quad (5)$$

As it stands today, the future transport system for Delhi can be considered to be the augmentation of existing road transport system and the proposed mass transport system (MRTS). Therefore the urban form models have been applied under the two transport scenarios.

- The proposed MRTS and existing road network including the proposed roads.
- Existing road network including the proposed roads without MRTS (only population distribution).

The productive capacity of MRTS is planned to be higher than the road transport system. Its impact on the urban form of Delhi would be different than the impact of the road based transport system. Due to it, the accessibility of the transport zones would undergo change resulting in the change in the distribution pattern of population and employment. The quantification of such changes is done through the application of relationship (4) and (5). The inputs used for projecting the urban form/ structure of Delhi for the year 2021 are elaborated below.

- The net work (full system) of the proposed mass transit system (184.50 kms) comprising of: existing ring rail and proposed spurs to the existing ring railway (140 kms); under ground metro rail corridor (27 kms); and dedicated bus transport corridor (17.50 kms).
- Road transport network covering the existing and proposed roads having right of way (ROW) 30 meters and above.
- System configuration of MRTS: average speed 25 kms per hour; maximum number of passengers per train = 2700; 2 minutes gap (headway) between two consecutive trains.
- Road traffic would double by the 2021 from its existing level

These inputs were used to estimate the zone wise accessibility indices for the year 2021 using the relationship (1) and the calibrated value of α-pop and α-emp. The capacity Ci and speed of the proposed MRTS and road system were estimated for each zone. In case of zones that are served by both these systems, their productive capacities were added to form a single value. The value of dij was estimated using the shortest path matrix with respect to time. Thus the separate estimates of accessibility indices for population and employment distribution for the proposed MRTS were put into the validated stage-two sub-models represented by relationship (4) and (5).

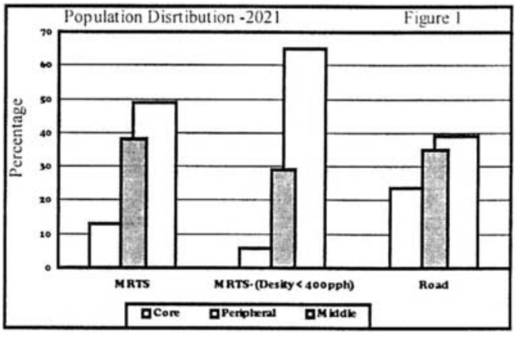
Table 4. Delhi Urban Form/ Structure 2021

Area	Population		Population*		Employment
	(%)	Density	(%)	Density	%
Core	13	707	6	356	26
Middle	38	276	29	216	33
Periphery	49	96	65	129	41
Total	100		100		100

* Population density with constraint (≤ 400 pph)

Table 5. Distribution of Population based on Road Network - 2021

Area	Population (%)	Density (pph)
Core	24	1256
Middle	35	268
Peripheral	39	69
Total	100	



The total population and employment for the year 2021 have been projected at 22.80 million and 7.60 million respectively. The population and employment distributions were regrouped in three categories, viz., core city area, middle and peripheral areas. The urban form thus arrived at for the year 2021 is quantified in Table 4.

The distribution of population based on road network (in case MRTS does not materialize) has been analyzed and the results are presented in Table 5.

On comparison of Table 4 and Table 5, it is observed that in case the MRTS does not come, the form/ structure of the city would show relatively higher population concentration in and around the core area, and dispersed one in the peripheral area. Whereas, in case of MRTS, the population is likely to move away from the city core area. A graphical view of the urban form/ structure of Delhi under the two transport options considered, for the year 2021 is shown in Figure 1.

This fact is also brought out in Table 6, where the projected population and employment for the year

Table 6. Percentage increase in Population and Employment (2021) over 1991 Distribution

Area	Population (MRTS) (%)	Population* (MRTS) (%)	Employment (MRTS) (%)	Population (Road) (%)
Core	138	12	97	322
Middle	111	66	78	106
Peripheral	385	550	544	249

* Population density with constraint (≤ 400 pph)

2021 for both options (with and without MRTS) are compared with the corresponding figures for the year 1991.

It can be observed from Table 6 that the population concentration in the peripheral area would increase due to introduction of MRTS (as compared to only road option) as the people would like to take economic advantage (rent) as a result of the higher speed and capacity offered by MRTS resulting in increase in the accessibility of the peripheral areas.

An analysis of the population and employment distribution along the transport zones abutting MRTS corridor revealed that about 78% of the total population (2021) would be located in these zones and by introducing the density constraint, the percentage would reduce to 70%. The employment level along these zones would be about 74% of the total employment in the year 2021.

A further analysis relating to location of major work centers (non-industrial) was carried out. The sub- central business districts (sub-CBDs) and district centers (DCs) are the areas with high employment levels. The locations of these centers are influenced by the accessibility of the area in planning. It has been observed that certain areas having high accessibility get neglected and other areas with low accessibility get selected. The result is that these work centers are highly under utilized due to lack of proper planning.

In case of Delhi, it is proposed to set up 22 DCs and 2 sub-CBDs. Some of these work centers are already operational and the others are being planned/ under implementation. An exercise was done to estimate the number of sub-CBDs and DCs required by the year 2021 and the location of these work centers. The employment norms for identifying work centers were taken as 80, 000 and more employment level for sub-CBDs and between 40,000 to 80,000 for DCs. Based on these norms the requirement of work centers (non-industrial) by the year 2021 were: 8 sub-CBDs and 51 DCs. It was identified that due to the introduction of the proposed MRTS, about six DCs identified earlier in the master plans for Delhi would require to be relocated.

7 CONCLUSION

The foregoing analysis establishes the intricate inter-relationship between urban form/ structure and urban transport. The 'productive capacity' defined in terms of capacity and speed of a transport system influence the urban form/ structure in different manner. The introduction of the proposed MRTS having superior 'productive capacity' than the present road based bus transport, would change the future urban form/ structure of Delhi in terms of decongestion of core city area and more dispersal of population and employment in the peripheral areas of the city.

The present Master Plan for Delhi (1981-2001) would expire by the year 2001 and the next master plan is to be introduced after that. Also the construction work on the proposed MRTS has started recently. In this context the urban form/ structure model would be very useful for the city planners to effectively plan the future growth of city that would be consistent with the planned transport system, and thus avoid certain unnecessary investments and expenditures.

The urban form/ structure model developed can be used at various stages of policy formulations. At the initial stages it can be used for making investment decision among the various transport systems selected for a city. It can also be used to restructure the city's urban form/ structure with reference to the proposed transport system. The authors strongly feel the need to take up detailed studies in these areas and develop the model as a useful tool for planning/ restructuring of urban form/ structure.

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Développement urbain, transport et énergie à Douala, Cameroun
Urban development, transport and energy in Douala, Cameroon
Desarrollo urbano, transporte y energía en Dúala, Camerún

Ch. Eboumbou Jemba
Département de Génie Civil, ENSET de l'Université de Douala, Cameroun

ABSTRACT : The urbanization of the town of Douala generates on the energetic plan, an urban organization relatively little thrifty, discriminatory and making the object of preoccupations in all levels. This study will be attached to analyse the social specifities and spatiofunctionals which mould the mobility in the big Cameroonian metropolis, in order to bring out, in a perspective between others economy of energy, of justice, the principal ways of thought.

RÉSUMÉ : L'urbanisation de la ville de Douala génère sur le plan énergétique, une organisation urbaine relativement peu économe, discriminatoire et faisant l'objet de préoccupations à tous les niveaux. Cette étude s'attachera à analyser les spécificités sociales et spatio-fonctionnelles qui modèlent la mobilité dans la grande métropole camerounaise, afin de dégager, dans une perspective entre autres d'économie d'énergie, de justice, les principaux axes de réflexion.

RESUMEN : La urbanización de la ciudad de Dúala genera sobre el plan energetíco, una organización urbana relativamente Poca ecónoma, discriminatorio y haciendo objeto de preocupaciones en todos los niveles. Este estudio si atará a analizar las especificaciones sociales y espacio-funcionales que modela la mobilidad en el gran metrópoli - Camerúnes, a fin de desempeñar, en una perspectiva entre otras una economia de energía, de justicia los principales ejes de reflexión.

1 - INTRODUCTION

L'enjeu énergétique ou de la pollution dans la planification urbaine est une préoccupation très récente dans les pays de l'Afrique Sub-Saharienne. Aussi, nous a-t-il semblé très intéressant, sur un plan général et à titre exploratoire, de se pencher sur la problématique énergétique des déplacements urbains dans la ville de Douala, première agglomération et la plus importante aire de développement du Cameroun, afin d'en dégager les principaux traits saillants.

Cet ensemble, important de nœud de communication, est sous-tendu par de réelles possibilités de mobilités et d'échanges urbains. Mais, suivant quels schémas spatiaux s'effectuent les distributions de ses activités économiques, emplois, autres équipements et zones de résidence... qui induisent les déplacements urbains courts ou longs ? Sur le plan énergétique, a-t-on à faire à une organisation urbaine planifiée, équilibrée et rationnelle ?

L'étude exploratoire que nous développons ci-après rend compte des principales tendances à la fois : d'une enquête socio-économique faite dans les années 80 auprès d'un échantillon de 3 400 personnes/ménages de l'agglomération de Douala divisée en couronnes urbaines, et d'autres enquêtes auprès d'un certain nombre de services acteurs du développement urbain.

2 - LES SPECIFICITES SOCIALES ET SPATIO-FONCTIONNELLES DE L'AGGLOMERATION

L'urbanisation à Douala, avec un taux de croissance annuel de 6 % environ, est particulièrement accélérée, spontanée et grande consommatrice d'espace. Certains regroupements et localisations privilégiées des activités par catégorie indiquent,

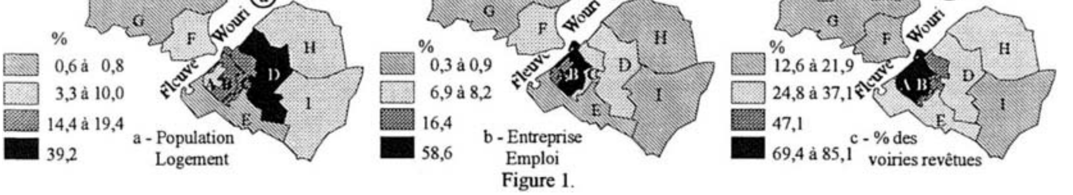


Figure 1.

cependant, que nous avons à faire un espace hiérarchisé et spécialisé dans lequel les couronnes urbaines se distinguent par telles ou telles fonctions, se caractérisent par des attractions plus ou moins grandes. Grâce aux tableaux synoptiques présentés dans la suite et par l'intermédiaire de quelques indicateurs retenus, nous allons résumer et dresser à grands traits la typologie de cette agglomération en localisant les principales fonctions et activités urbaines. A-t-on à faire à une configuration spatiale favorable ou pas à la gestion économe de la mobilité ?

2.1 - Les caractéristiques socio-économiques des populations

2.1.1 - La démographie (Fig. 1a)

En 1987, l'ensemble, la population urbaine est relativement jeune avec 55 % des moins de 21 ans. La frange la moins âgée est particulièrement localisée dans les quartiers périphériques des couronnes d'extension G - H - I qui accueillent les premières, les jeunes issus de l'exode rural et dont le statut foncier est fragile (Tabl. 1) seuls 6,9 % des terrains sont immatriculés aux domaines. C'est une population particulièrement mobile sur le plan résidentiel. Elle est concentrée à près de 55,6 % dans les parties périphériques et suburbaines de la rive droite.

Tableau1. Typologie et structuration des opérations foncières de l'origine à 1987 - les coûts fonciers de 1982 - 1987

Couronne urbaine			Imma-tricu-lations	Mor-celle-ments	Lotisse ments privés	Coûts/m² 1982 - 1987
N°		Désignation	%	%	%	%
Douala ville	A	Centre ville	23,0	8,9	0,7	36,1
	B	1ère couronne	20,0	6,6	1,4	29,9
	C	2ème couronne	21,2	3,8	3,5	9,0
	D	3ème couronne	13,7	33,6	31,4	5,5
	E	Port-Aéroport	0,2	0,6	2,1	6,0
	F	Bonabéri	15,0	8,6	9,8	5,6
Dla Ext.	G	Bonabéri Ext.	5,2	8,8	14,7	2,4
	H	Extension Est	1,1	16,5	15,4	3,0
	I	Extension Sud	0,6	12,6	21,0	2,5
TOTAL			100	100	100	100

2.1.2 - L'organisation de l'habitat (Fig. 1a)

La répartition générale des ménages selon le mode d'occupation des lieux est la suivante : propriété avec titre foncier (8,3 %), propriété sans titre foncier (40,5 %), location (41,6 %), logé par l'employeur (3,1 %), logé gratuitement autre que l'employeur (3,3 %). Sur le plan foncier, nous notons une grande précarité de l'occupation de sol qui explique le caractère provisoire de l'habitat urbain dont les unités sont bâties à près de 50 % à l'aide de matériaux provisoires. Cet habitat de type pavillonnaire à plus de 90 % donne lieu, généralement en Occident, à une forte motorisation de ménage. Qu'en est-il pour Douala ?

Le Tableau 1 souligne sur le plan des opérations foncières, les contradictions et oppositions entre, en particulier, les couronnes centrales A - B et celles d'extension G - H - I.

2.1.3 - Les activités économiques commerciales et l'emploi (Fig. 1b)

En 1987, la population active est évaluée à 41,6 % dont 79,2 % est occupée et 20,8 % est inoccupée. La population inactive représente 57,6 % et se compose de ménagère (31,0 %), étudiant et élève (61,6 %), handicapé (0,8 %) et autres (6,6 %).

La répartition de cette population occupée selon le statut dans l'emploi est la suivante : indépendant (32,6 %), employeur (0,8 %), salarié permanent (55,8 %), salarié temporaire (4,2 %), apprenti rémunéré (0,8 %), apprenti non rémunéré (3,4 %), aide familiale (1,8 %) et statut non déclaré (0,8 %).

Tableau 2. Classification des couronnes urbaines en 1987 selon les immeubles les plus chers, les entreprises existantes et le parc de téléphones des sociétés (%)

Couronne		Immeu-bles les + chers	Entre-prises cumu lées	Capi-taux cumulés	Chiffres d'affaires cumulés	Téléphone des sociétés
Désignation		%	%	%	%	%
Douala ville	A	57,9	16,4	23,7	18,1	31,9
	B	10,5	58,6	66,1	54,1	47,7
	C	0,0	6,9	1,0	3,4	4,6
	D	10,5	8,2	3,8	11,9	9,4
	E	0,0	0,5	0,0	1,2	0,6
	F	0,0	7,8	3,8	10,7	5,5
Dla Ext.	G	5,3	0,9	1,6	0,6	0,2
	H	0,0	0,4	0,0	0,0	0,0
	I	15,8	0,3	0,0	0,0	0,1
TOTAL		100	100	100	100	100

La répartition spatiale des activités formelles issues du Tableau 2 met en évidence, la forte polarisation des entreprises dans les couronnes centrales A et B, avec des conséquences qu'on peut imaginer en matière de déplacements urbains, sur le reste de l'agglomération.

Après avoir identifié et localisé les principaux déterminants de la mobilité urbaine (Fig. 1), disposons-nous suffisamment de données pour expliquer, apprécier qualitativement et quantitativement le comportement des usagers en matière de déplacements urbains ou de mobilité ?

2.2 - Les particularités de la demande

2.2.1 - La motorisation

Parmi les personnes/ménages enquêtées, 82,4 % n'ont pas de voitures particulières, 12,5 % en ont une et 5,1 % ont deux. Entre 15 % et 22 % des propriétaires des véhicules sont localisés dans les couronnes A - B contre 7 % à 13 % dans les couronnes d'extension. En examinant le bilan migratoire du Tableau 3, la couronne A est la moins émettrice en main d'œuvre avec 7,5 % de résidents qui travaillent en dehors d'elle. En plus, les soldes très excédentaires des couronnes A - B confirment leurs fortes attractions vis-à-vis des autres et soulignent, s'il en est encore besoin, le rôle majeur qu'elles jouent dans l'agglomération.

La proportion des ménages disposant d'une voiture particulière évolue de 5,0 % pour les revenus inférieurs à 50 000 F CFA la plus faible tranche ($1^{ère}$) en passant par 28,0 % pour la tranche intermédiaire (4^{e}) de 150 001 - 200 000 F CFA jusqu'à 40,0 % pour les revenus supérieurs à 300 000 F CFA, tranche la plus élevée (7^{e}). Ce qui correspond pour les 3 classes de revenu citées à des taux de motorisation

Tableau 3. Classification des couronnes urbaines selon la migration alternante des travailleurs

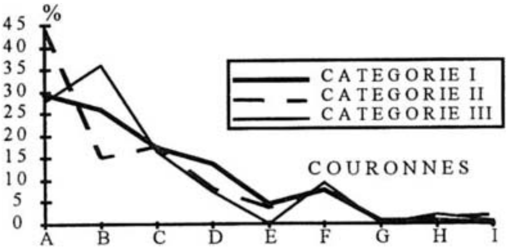
Couronne de Résidence		Résident travaillant hors de la couronne (a)	Non résident travaillant dans la couronne (b)	Solde migratoire (a) - (b)	
Désignation		%	%	% > 0	% < 0
Douala ville	A	7,5	92,5		- 85,0
	B	27,6	72,4		- 44,8
	C	65,0	35,0	+ 30,0	
	D	59,8	40,2	+ 19,6	
	E	59,8	40,3	+ 19,4	
	F	62,0	38,0	+ 24,0	
Dla Ext	G	42,7	57,3		- 14,6
	H	83,5	16,5	+ 67,0	
	I	59,1	40,9	+ 18,2	

respectifs de 7,1 %, 37,1 % et 69,5 %. 54,6 % de propriétaires des logements disposent de 1 voiture particulière contre 45,4 % de locataires. Prenant en considération le sexe, nous relevons les chiffres suivants : Propriétaires de 1 voiture : hommes 76,3 %, femmes 23,7 % ; Propriétaires de 2 voitures et plus : hommes 72,3 %, femmes 27,7 %.

Le parc automobile se compose de 74,1 % de véhicules de 2 - 10 CV et 25,9 % de véhicule de 10 CV sont détenus par près de 20,0 % de ménages camerounais et expatriés, à tranches de revenus les plus élevées, au taux de motorisation le plus fort (69,5 %), habitant les luxueux quartiers résidentiels de la couronne A, exerçant la plupart de leurs activités dans ces mêmes couronnes centrales A - B et effectuant, par conséquent, des déplacements courts, grands consommateurs d'énergie.

2.2.2 - L'accessibilité au travail et à l'école

L'étude de la motorisation sous l'optique énergétique doit nécessairement associer le facteur accessibilité en l'absence duquel la perception de la demande de transport ne serait pas complète. La Figure 2 ci-dessous présente les capacités en voirie urbaine des différentes couronnes. La qualité de la circulation est jugée très dégagée pour 27 % à 33 % de résidents des couronnes A - B contre 13 % à 18 % pour les couronnes d'extension G - H - I dont les résidents qualifient la circulation de difficile pour 40 % à 60 % d'entre eux. Ces difficultés entraînent souvent un surcroît de consommation d'énergie pour les déplacements courts ou longs, et elles s'accroissent



Largeur circulable des catégories I : 14 m - II : 10,5 m - III : 7 m

Figure 2 : Classification de la densité des voiries (%) selon les catégories et les couronnes urbaines

en fonction d'une part, de la distance parcourue : 31,9 % pour la tranche de 0 - 6 km, 42,1 % pour celle de 6 - 10 km, 66,1 % pour celle de 10 - 15 km et 72,3 % pour celle de 15 km et plus, d'autre part, des distances moyennes par déplacement. De ce qui précède, il s'avère que les difficultés sont plus nombreuses pour les longs trajets - les plus motorisés - conditions favorisant une grande consommation d'énergie.

Lors du trajet domicile-travail, les points d'embouteillages rencontrés varient en fonction de la distance moyenne par déplacement : inexistants pour les distances courtes de 2,2 km, variables pour les distances de 5,0 km, nombreux pour les distances plus longues de 5,8 km qui favorisent donc une augmentation de la consommation d'énergie.

2.2.3 - La possession du permis de conduire

30 % des personnes interrogées ont déclaré être titulaires du permis de conduire. 72,3 % d'entre elles ont une voiture à disposition. 45 % des personnes non titulaires du permis souhaitent le passer, ce qui laisse présager une progression future de la motorisation et une modification du partage modal. Parmi les titulaires du permis de conduire, les grandes parties des distances parcourues sont le fait des personnes ayant une voiture à disposition. Leur nombre, ainsi que la consommation d'énergie croissent avec la distance parcourue. C'est ainsi que pour la classe de distance parcourue [0 - 2 km [66,5 % de personnes ont une voiture à disposition contre 33,5 % qui n'en ont pas, pour la classe [2 - 4 km [on compte 73,7 % contre 26,3 %, pour la classe [4 - 8 km [79,3 % contre 20,7 %, et enfin pour la classe [8 km et plus 82,9 % contre 17,1 %. La tendance d'utilisation de la voiture particulière ne peut fléchir qu'avec l'existence parallèle d'alternative modale de qualité. Est-ce le cas en ce moment ?

2.3 - L'offre de transport

Elle est essentiellement prise en charge par le transport terrestre routier dans lequel la voiture particulière tient une place dominante.

2.3.1 - La voiture particulière et autres

Le tableau 4 établit, entre 1976 et 1987 pour chaque catégorie de transporteurs, le ratio pour 1 000 habitants. Cet indicateur s'élève à un minimum de 31 en ce qui concerne les taxis dans la ville de Douala.

Tableau 4. Structure et évolution du parc des transporteurs par catégorie dans la province du littoral de 1976 à 1987

Catégorie		Transporteurs enregistrés		Ratio par Catégorie
N°	Désignation	Effectif	%	(pour 1000 hbts)
1	Catégorie I	12 700	74,0	31
2	Catégorie II	460	2,7	1
3	Catégorie III	1 700	9,9	4
4	Catégorie IV	2 300	13,4	6
TOTAL		17 160	100	

Catégorie I : Taxi de ville
Catégorie II : Taxi hors de ville - banlieue, département.
Catégorie III :Car de transport interprovincial de voyageurs.
Catégorie IV : Camion de transport marchandises nationales.

Dans la répartition modale, tous motifs confondus, le taxi occupe à la fois, la première place pour les déplacements motorisés (Fig. 3) et pour les longueurs cumulées des déplacements. Analyser la relation planification urbaine - énergie, c'est entre autres reconnaître que les différents modes de transport - surtout motorisés - peuvent être associés dans une organisation spatio-économique capable de les transformer ou inversement. Compte tenu du rôle central que jouent les taxis dans le fonctionnement de l'agglomération de Douala, toute réflexion porteuse, sur la constitution d'un espace dit économe, ne peut passer que par une action sur ce mode. S'agit-il de lui réserver une place beaucoup plus prépondérante ou devra-t-on favoriser les transports en commun ? Quelle est la capacité de pénétration ou de desserte de chacun des deux modes dans le tissu urbain eu égard à l'importance et la qualité des infrastructures routières ? Ces actions ne doivent-elles être envisagées que sous un angle antagoniste ? La restitution des volets liés à l'intermodalité et à leur complémentarité s'impose aussi : les statistiques non détaillées portant sur la vente des vignettes dans la ville de Douala pour l'exercice budgétaire 1987 - 1988, ont recensé 52220 engins motorisés officiellement en activité compte non tenu de la circulation de transit et du défaut de vignettes. Ce qui, ramené à la population, donne un ratio d'environ 80 engins motorisés - tous genres - pour 1 000 habitants. Tenant compte de la distribution par genre, des véhicules et engins immatriculés dans la province du Littoral pour la période 1976 - 1987, qui fixait à près de 54 % la part des voitures particulières (Tabl. 5), nous admettons un ratio de 43 voitures particulières (taxi + voiture personnelle) pour 1 000 habitants, soit une équivalence de 28 000 voitures particulières environ officiellement en circulation en 1987 - 1988. En 1996 - 1997, ce nombre passe à 32 000 voitures particulières d'après les statistiques officielles.

Tableau 5. Structure et évolution de l'offre de transport, tous modes confondus dans la province du Littoral de 1976 à 1987

Genre		Véhicules et engins immatriculés		Ratios par :	
				Mode	Ménage
Désignation		Effectif	%	Pour 1000 habitants	
1	Voitures P.	66 860	53,9	160	0,63
2	Camionne.	16 000	12,9	39	
3	Motos	24 650	19,9	59	
4	Camions	7 300	5,9	18	
5	Autocars	5 500	4,4	14	
6	Tracteurs	1 250	1,0	3	
7	Semi-Rem	1 050	0,8	3	
8	Engins M.	650	0,5	2	
9	Remorques	850	0,7	2	
TOTAL		124 110	100		

Tableau 6. Hégémonie de la voiture particulière dans les modes motorisés

% des immatriculations des voitures particulières : 55,0 %	% des voitures particulières dans les déplacements motorisés				
	Travail	Achat courant	Achat Occas.	Admin Service	Temps libre
Ventilation modale	65,5%	90,8%	87,9%	88,9%	86,6%
Distances parcourues	68,7%	90,2%	89,4%	89,7%	86,0%

Le tableau 6, qui illustre nettement et dans tous les cas de figure, l'hégémonie de l'usage de la voiture particulière, restitue en fait deux réalités, primo : la voiture particulière supporte une charge de déplacements nettement supérieure à sa représentation - déjà élevée - par rapport à l'ensemble du parc motorisé roulant pour voyageurs, secundo : elle est de très loin le principal mode de déplacement motorisé devant les motos, camionnettes et les autocars. Cette situation appelle le constat suivant : la position de force que détient la voiture particulière laisse entrevoir la possibilité d'opérer un transfert modal en faveur d'autres moyens de transport de grande capacité à l'instar du transport en commun par autobus. Toutefois, la structuration de la répartition modale ci-dessus donne effectivement de Douala, l'image d'une ville à urbanisme pour voiture particulière, faisant écho à l'urbanisation de type pavillonnaire évoquée plus haut. On peut dès lors s'interroger sur la capacité de ses infrastructures routières à assumer convenablement la prise en charge des transports en commun renforcés ?

2.3.2 - Les transports en commun et le réseau viaire (Fig. 1c)

Dans le périmètre urbain, les transports en commun sont normalement l'exclusivité de la Société des Transports Urbains du Cameroun (SOTUC) en 1987. Cependant, en raison d'une demande très forte et du maillage insuffisant du réseau surtout en périphérie urbaine, des minibus, voire des camionnettes assurent une part des transports. On se rend bien compte dans le Tableau 7 que ce soit au niveau de la longueur du réseau ou des points d'arrêt, la SOTUC n'est pas présente à plus de 1 % dans les couronnes d'extension G - I. Il n'en est pas de même pour la couronne H traversée par l'importante route nationale n° 1 reliant Douala : Capitale Economique, d'Affaires et Yaoundé : Capitale Politique du Cameroun.

Tableau 7. Niveau d'offre de voirie urbaine et de transport en commun selon la couronne urbaine en 1987 (%)

Couronne		Voirie urbaine		TOTAL	Popu urb.	Surface	Réseau de bus	
		Revêtue	Terre				Long.	Arrêt
Douala ville	A	85,1	14,9	100	3,3	1,0	5,4	6,9
	B	69,4	30,6	100	14,4	2,4	15,4	14,5
	C	47,1	52,9	100	19,4	2,2	21,5	23,9
	D	24,8	75,2	100	39,2	6,9	30,3	35,3
	E	27,9	72,1	100	0,6	7,7	5,3	4,5
	F	12,6	87,4	100	5,9	4,8	8,9	4,5
Dla Ext.	G	20,0	80,0	100	0,8	14,9	0,8	0,7
	H	37,1	62,9	100	10,0	30,7	11,5	9,0
	I	21,9	78,1	100	6,4	29,4	0,9	0,7
Total		32,0	68,0	100	100	100	100	100

Au démarrage de la SOTUC en 1973/1974, 3 lignes étaient desservies avec un parc roulant de 18 bus sur un parc total de 20 bus, soit un taux d'immobilisation de 10,0 %. En 1987/1988, ces chiffres ont évolué de la manière suivante : 15 lignes sont desservies avec un parc roulant de 151 bus sur un parc total de 246 bus, soit un taux d'immobilisation de 38,60 %. Avec le rapprochement pour 1987 du nombre de bus en activité : 151 et du nombre de voitures particulières en circulation : 28 000 on saisit l'ampleur du déséquilibre modal au détriment des transports en commun. La longueur totale du réseau de bus s'élève à 143 km pour un total de 422 points d'arrêt, soit une moyenne de trois points d'arrêt/km. Malgré l'importance de ces chiffres, nous notons que plusieurs points ou zones importantes de la ville sont hors du réseau qui est concentré à une moyenne de 70,0 % dans les trois couronnes B - C - D.

Par ailleurs, les transports en commun par bus ne peuvent emprunter que les voies revêtues qui, elles-mêmes, ne sont pas étudiées en fonction des transports urbains. Nous notons également qu'ils empruntent en priorité les voies de catégories I - II toujours concentrées (17 % - 44 %) dans les trois premières couronnes A - B - C (Fig. 2) celles-là mêmes qui ont les plus importants pourcentages (47 % - 85 %) de voiries revêtues (Tabl. 7). Enfin, le maillage des lignes n'exploite pas l'ensemble du réseau revêtu.

En revanche dans les couronnes périphériques et d'extension, le réseau viaire est contrarié localement par : des coupures de site, son caractère incomplet et incohérent avec une grande proportion de routes non bitumées à plus de 70 %. La faiblesse des transports dans lesdites couronnes dont pourtant une grande partie de la population en est captive et est contrainte aux grandes distances, incite paradoxalement à une motorisation accélérée. C'est ce qui explique sûrement les longues files matinales, les bouchons et autres embouteillages rencontrés sur les principaux et rares axes périphériques menant vers la ville, créant ainsi des conditions d'une surconsommation énergétique de masse. Quelle peut être l'influence de l'état actuel de l'offre de transport sur la mobilité urbaine ? Quelle répartition modale, en fonction des différents motifs de déplacement, en découle ?

3 - LES DEPLACEMENTS QUOTIDIENS

3.1 - La répartition modale et les motifs de déplacement

Les analyses faites ci-après restituent les résultats des enquêtes qui ont saisi la pratique des déplacements selon les habitudes des usagers. La figure 3 présentant la ventilation générale des déplacements selon les différents modes et motifs souligne dans 4 cas sur 5,

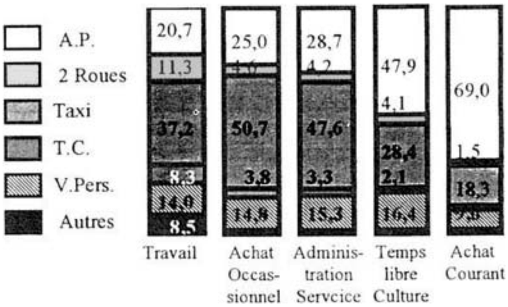


Figure 3. Ventilation des déplacements urbains selon les différents modes et motifs (%)

la prépondérance des déplacements motorisés à l'exclusion du motif achat courant pour lequel les déplacements motorisés ne représente que 30,7 %.

Ces chiffres appellent les remarques suivantes : les déplacements motorisés sont généralement l'apanage des longues distances. On s'en sert moins pour les achats courants ou de proximité, à l'occasion desquels la marche à pied est utilisée, les distances étant plus courtes (Tabl. 8). Le niveau d'équipement des quartiers de toutes les couronnes en produits de

Tableau 8. Ventilation des déplacements, tous modes confondus selon les différents motifs et la distance

Distances Parcourues	Travail	Achat Courant	Achat Occasionnel	Administration Services	Temps Libre
[0 - 6 km [	48,1	85,8	47,6	54,9	74,5
[6 - 10 km [	32,9	8,3	28,3	26,4	15,8
[10 - 15 km [	16,5	5,8	24,0	18,7	9,3
[15 km et +	2,7	0,1	0,1	0,1	0,5
TOTAL	100	100	100	100	100
Distance moyenne (km)	5,5	1,6	5,4	4,5	2,7

première nécessité est satisfaisant. Par contre, le sous-équipement (emplois, grands marchés et commerces, administrations et services centraux, équipements tertiaires,...) sur le lieu de résidence entraîne un éclatement ou un éloignement des destinations finales qui se trouvent être souvent les couronnes centrales A - B telles qu'il est apparu plus haut. Les déplacements qu'engendrent ces motifs sont, par conséquent, plus longs et motorisés (Fig. 3) : 70,7 % pour les démarches administratives, services, 74,5 % pour les achats occasionnels, 78,5 % pour le travail. A y regarder de près, lesdits déplacements sont surtout le fait de la voiture particulière : à 51,2 % pour le motif travail à 62,9 % pour les démarches administratives et services, à 65,5 % pour les achats occasionnels. On note également la faiblesse de la part des transports en commun (3,3 % - 8,3 %) pour ces mêmes motifs.

3.2 - Déplacements courts et déplacements longs

Le Tableau 8 établit des relations hiérarchiques entre les motifs de déplacement et les distances parcourues. Cette échelle de valeur est par ailleurs confirmée par l'approche des distances moyennes.

Les déplacements les plus courts sont le fait des motifs : Achat courant (1,6 km) et temps libre (2,7 km), alors que les plus longs sont favorisés par les motifs : achat occasionnel (5,4 km), travail (5,5 km) et démarches administratives (4,5 km). De tout ce que dessus, on est tenté certes de croire que l'amélioration en général de l'offre de transport à Douala, notamment sur le plan de l'économie d'énergie, passe par une nouvelle répartition des déplacements entre modes. Mais, est-ce que le rééquilibrage en faveur des transports en commun va dans le même sens que la réduction de l'usage des modes des déplacements motorisés individuels ? Cette amélioration ne va-t-elle pas plutôt réduire la part des déplacements piétonniers ?

Nous avons établi plus haut pour tous les motifs de déplacement, les distances moyennes, il est apparu qu'avec 5,5 km, c'est la moyenne de déplacement pour travail qui est la plus importante. Pour ce même motif, une autre lecture des résultats de l'enquête fournit des informations ci-après (Tabl. 9) sur les distances moyennes parcourues par les travailleurs selon la couronne de résidence. Ces dernières progressent pratiquement d'une manière linéaire en fonction de l'éloignement à partir de la couronne centrale B principal bassin d'emplois, pôle d'activités économiques et le plus important centre d'affaires de la ville.

Tableau 9. Distance moyenne parcourue pour motif travail selon la couronne de résidence

Couronne	Douala ville						Douala Ext.		
Distance moy. :	A	B	C	D	E	F	G	H	I
Motif travail (km)	3,5	2,6	5,3	5,0	5,5	6,5	7,1	9,1	6,0

4 - CONCLUSION

La répartition générale des déplacements entre modes semble liée à la fois à l'offre de voitures particulières et à la mono ou pluri-fonctionnalité des couronnes. Ainsi, sous l'optique territoriale et de la consommation énergétique, promouvoir une meilleure intégration urbaine, sans discrimination, pour toutes les catégories socioprofessionnelles et démographiques, vouloir atténuer les disparités entre couronnes urbaines et réduire les distances des déplacements des habitants... passent par une meilleure dotation en emplois des différentes couronnes avec équipement de celles les plus excentrées d'entre elles et ce, nonobstant les logiques locales et universelles qui sous-tendent la formation de la ville. Parallèlement, compte tenu de la place prépondérante et croissante de la voiture particulière dont l'image est associée à la réussite sociale, à la liberté retrouvée, une action en direction des transports en commun s'impose. Elle est destinée à renforcer leur capacité tout en promouvant surtout la qualité de service. Trois objectifs sont visés : primo, améliorer les conditions de déplacement des piétons captifs, non titulaires ni de véhicules, ni de permis de conduire, secundo retenir ceux des piétons titulaires de permis de conduire, n'ayant pas de voiture à disposition, mais tentés en revanche par une motorisation - somme toute légitime - cependant, très vieille, polluante et dangereuse, car souvent de deuxième ou de troisième main voire des épaves roulantes, tierto favoriser, pour certains destinations et motifs, le transfert modal de la voiture particulière vers les transports collectifs. Le bilan de toutes ces mesures devrait concourir théoriquement à un meilleur équilibre "territoire - déplacement - énergie" dans un contexte en amont d'une prise en compte des transports urbains dans la planification urbaine.

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Transportation and urban structure system – 'urban policy: The necessary integration'

I. M. Bianchi
Municipal Transportation Department, City Hall of Porto Alegre, Brazil

B. S. Ribeiro
Municipal Planning Department, City Hall of Porto Alegre, Brazil

ABSTRACT: The present work is aimed at evaluating the public transportation system of the city of Porto Alegre, Brazil, when the Urban Development Master Plan is being re-assessed and the Transportation Sectorial Master Plan is being promoted. The purpose of both plans is combining the mobility and accessibility policies with the urban development and environmental policies, in order to generate a flexible and integrated transportation model for the city, which will act as an inductor of the sustainable urban development

1 - INTRODUCTION

At the present time, the complexity of the needs for mobility in the big cities requires us to rethink the public transportation system, working the issue out through the sustainability/sustenance perspective. Important aspects, which transcend the strict engineering point of view must be taken into account, and incorporate a transdisciplinary approach to the discussion should be incorporated to the discussion, due to the diversity of the urban physical and social interfaces. Thus, it is expected to cause a disruption in the sectionalist perspective, which considers transportation in its own right, as a market to be explored, like many others.

The traditional perspective for transportation planning is unable to answer to the big challenges of generating freedom of moving according to the growing needs and possibilities of the citizens. We are projecting a possible future for the urban mobility through a quality project that is turning commuting into a less forced not so forced and/or less expensive facility. The search for solutions integrated with the urban land use and occupation policies are the imposed pertaining conditions to sustentation and life quality in the urban environment.

Thus, the transportation planning will have to excel the classic projected aspects of the added demand, aggregating scenario studies from the potential demand which is not accomplished due to the lack of fulfillment of the users' other needs, and the inducted demand, as a consequence of the facilities available that become attractive to those users who would not make use of public transportation, instead of their private cars.

The urban planning, traditionally supported by the standardization of the use and occupation of the private land, will give rise to the strategic planning which, going beyond the perspective of the real estate market, through programs and projects will focus in a spatial model of development in accordance with the community.

In this context, the public authority that manages the public transportation and the urban planning of Porto Alegre and the Metropolitan Area starts to develop integrated actions so that a multidirectional transportation model is produced, flexible, integrated and articulated enough to equalize operational costs and social benefits, concerned with a relevant performance in the concretion of the urban structure, environment qualification, and social and economic promotion.

The present work presents the experience of the city of Porto Alegre, political administrative capital of the State of Rio Grande do Sul, Brazil, located in the far south part of the country, in developing the Transportation Sectorial Master Plan and its combination with the Urban and Environmental Development Master Plan's urban soil use and occupation policies.

2 - THE CITY OF PORTO ALEGRE

2.1 - *Contextualization*

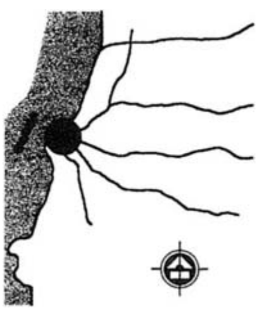
Porto Alegre has a surface of 470.25 km², with a population of 1.3 million inhabitants, distributed in intensive, extensive and rural areas. In the last decade, the average annual growth rate was of 1.055%.

As a capital, the city also polarizes the metropolitan area, comprised by 24 cities, in a physical area of 6,800 km^2 and a population of 3 million inhabitants. The per capita income is of US$ 4.474,00 , the literacy rate is of 89.5%, the life expectation is of 72.6 years of age, with water supply available to 98% of the population and sewage system available to 73%. The city is a typical producer of tertiary activities, especially public utilities. It is also a cultural, educational, and health pole.

For strategic reasons, the original colonization, which started in the beginning of 1750 with the arrival of the Portuguese immigrants, took place in a promontory that projects itself to the west into the Guaiba's estuary. This way, the site expanded to the east, following the original paths, through the winding lines of the valleys of the region relief, connecting the city to nearby towns.

2.2 - Urban structure

The original location on the banks of the estuary and the physiographic conditioning of the region determined the physical structuring of the city in a semi-circle, from the historical center, through radial axles, following the original paths. As the city developed, these paths became structural routes, and the interior areas were randomly detached and lotted. The resulting arrangement of streets gave rise to the present network, extremely irregular and discontinued, especially in the north-south crosswise sense.



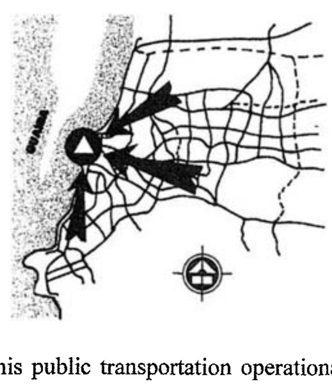
From the present historic center, which originally surrounded the whole city, including the port, railway, and industrial activities, the spatial distribution of the activities spontaneously segregated took place heading east, during the 19th and the 20th centuries. Trading and services prevailed along the radials, and residential areas. in their inner sites.

From 1914 up to 1970, consecutive plans for organizing and improving the city confirmed the original urban structure drawing, consolidating the commercial and service vocation of the central area, and the on the radial routes. The industrial activities, originally located to the north, by the central area, due to industrial policies, were gradually transferred to nearby towns, or simply disappeared, because of the substitution of the industrial headquarters, or because of the consolidation of the tertiary activities as a characteristic of the city. Nevertheless, the wholesale commercial and transport activities have persisted in the area.

From the 70s on, with the acceleration of both the inflationary process, and the income concentration in the country, the low income population was pushed down to the outskirts of the city, submitted to a distorted logic of social exclusion, occupying inadequate sites (wetland, or hill slopes), in an attempt to find areas with low commercial value or no value at all. In the outskirts, far from the social opportunities, sub-housing nuclei developed in a process of retrofeeding the socioeconomic exclusion.

2.3- Public Transportation

The history of the public transportation in Porto Alegre goes back to 1870, when the rail transport service provided by animal traction started, connecting the sections that were spontaneously formed, surrounding the original central nucleus. With the substitution of the rail technology by the modal on tires, the transportation network became more flexible in terms of expansion, providing transport to the new contingent of population growing in the sections, however maintaining the original line organization, connecting the sections to the downtown area, confirming the radial structure of the city, centered in the political administrative area near the Guaiba estuary.



This public transportation operational model has been kept so far, in a process of overlapping the lines on the main radial axles, causing an increasing saturation. Due to that, exclusive corridors for buses were created in the 70s. This tendency has been kept so far, in a process of overlapping the lines on the main axles to access the downtown area, causing the saturation of the corridors due to the excessive amount of trips.

Today, the public urban transportation is structured mostly through the bus modality, with 260 lines carrying 1.2 million passengers/day, in 25,000 trips/day, with a bus fleet of 1500 buses of average capacity. A 100 thousand passenger/day are carried by means of 40 lines in 5.000 trips/day through a fleet of 403 micro-buses with 21 seats. The system is complemented by the selective service of 2,900 taxis. The municipality, as the public authority that controls the operationalization of the public transportation service regulates and establishes the service offer, and the fares and inspects the different fleets.

The population keeps on making increasing use of the private transportation vehicles, 650 thousand in the present time. The private fleet increases at an average rate of 5% a year, opposed to 1% for the population growth, showing a mobile rate of 2,23 inhabitant/vehicle.

2.4- *The Urban Development Model*

As the process of urban development accelerates, especially from the 50s on, when the preliminary project of urban planning was devised, inspired by the Athens Letter of 1933, the consolidation of former spontaneous and the development of new poles of economical activities. The process took place following the main radial routes to access the downtown area, where there was a concentration of offer for public transportation - confirming the hierarchy of the accessibility variable as a determinant factor to attract demand activities.

The observation of these facts led to the conclusion that it was necessary to stimulate this new polarizing structure that starts to develop in the city, aiming at the retention of part of the demand before it enters the downtown area, already showing signs of saturation and structuring accessibility conflicts. On the other hand, this new polarization will reduce the time spent with commuting, thus minimizing the problems due to the excessive polarization of the central area.

These decentralization principles were incorporated to the 1st Urban Development Master Plan (1ºPDDU), in 1979, established through building control differentiated devices, Corridors and Commerce and Service Poles, or linear sectors and on surface, respectively following or near the structuring radial axles of the network.

Currently, after 20 years of the 1st Urban Development Plan a new structure of polarization can be observed, decentralized enough competing with the central area in terms of diversity of commercial, and

services offer. This new activity zoning, consequence of the guidelines of the land use and occupation, is mostly determined by the real estate market, since there are insufficient public projects and investment.

As time goes by, the new structure, even though spatially weak, ends up rebounding in the circulation and transportation systems. Right now, the central area represents 35% of the commuting intention. The remaining 65% stay in their own sections, next to the radial axles, or in inter-sections moves. As a consequence, the public transportation system is put under pressure either by excess or lack of trip offers, respectively in terms of the east-west radial directions and the north-south crosswise direction.

3 - THE PROBLEM SITUATION

As a result of the line created to respond organically to the urban development process, the existing public transportation operational model has proved to be inadequate, since 90% of the total trips of the system are still offered for the radial section-center. Even though the center continues to be the main attraction pole for the urban and metropolitan trips, it has decreased in 20% of the attracted trips, as a result of the decentralizing policies established by the Urban Development Master Plan. On the other hand, in terms of the crosswise connections inter-sections, the 10% offered now represent only 1/3 of the potential demand, not considering the created demand.

Thus, the demand growth rate of the central area tends to decrease, or, for better, to stabilize, while the crosswise inter-section moves tend to increase. This has proven that the present operational model is used up, for it does not fulfill the population's mobility needs anymore.

The excess of trips on the radial structured axles, because they compromise the physical transportation network's capacity of absorbing the traffic of vehicles - some axles are in the brink of saturation, even having exhausted the technical reserve for widening the lane and having established exclusive corridors for the public transportation. This saturation degree rebounds negatively in the mobility in general and, especially in the accessibility of the real estates nearby, and as a consequence, of the commercial and service activities installed in the area, causing losses in formerly prosperous businesses. Nowadays, the northern and northeastern axles that make the metropolitan connection, overlap the urban and metropolitan trips, with a concentration of trip/hour in one only sense of up to 350, imposing operational speed reduction to the system, time of trips increased, as well as atmosphere pollution levels that affect the urban environment.

The reduced number or complete absence of crosswise trip offers and the fare policy that limits the use to only one vehicle per fare paid keep reinforcing the centralized urban model, since the intersection commuting that are not fulfilled have to make transfer and double pay the fare. It is observed the amount of 14% of passengers that come daily to the central area just in order to make a stop to take another vehicle to other sections.

The radial urban design of the main transportation network that structured the city's development up to the 60s, is substituted from 1979 on by means of the conception of ringed or peripheral itineraries to the planning territorial units (ptu's). Thus, the transportation model becomes a side effect to the distributive pattern of the planning units, not the total territory. This way, the present structural transportation network of the city, conceived as a contour and mediating element within territorial extensions of the city, underestimates the inter-relationship required by the population's needs for commuting.

4 - THE INTEGRATED MODEL PROPOSAL

At the present level of the network system bind, the traditional traffic engineering solutions are not enough to face the increasing needs for displacement, either on the commute or in the private modal, without huge investments in infra structure works. On the other hand, the insufficient investments of the public sector in necessary works makes us rethink the general policy for urban mobility, inverting the logic for fulfilling the manifest demands, consequence of the spontaneous process of trip production and attraction.

In this context, the need to integrate the public transportation system to the rules of the urban structuring is crucial, the first being the inductor and the latter the propulsory of the city's sustainable development. Therefore, the public transportation systems must allow increasingly the physical integration and inter-modal fare, allowing the whole population to accessible commuting, with more flexibility, rationality, and comfort.

In the integrated model, the public authority starts to plan not just the commuting itself, but the production of the commuting as well, together with the city's production process, giving it an order in time and space. Concerning space, the model should foresee the macro structuring of the public transportation for preferential and faster access to the decentralization poles; concerning time, measures to redistribute working schedules for the activities so that the rush-hour demand could be reduced.

4.1 - The Urban Land Use and Occupation Model

At present, the managing agency of the transportation and circulation system is developing the Sectorial Master Plan for the Public Transportation of the city of Porto Alegre, which intends to offer guidelines to develop the system for the next two decades, combined with the new recasting determinations of the Environmental and Urban Development Master Plan (PDDUA). In this context, new guidelines for an integrated operational model for the public transportation, seeking modals that will comprise their network macro structuring, when, in medium and long term, necessarily alternative modals will need to be implemented to fulfill the paradigm changes required by operational exhaustion of the systems and or physical of the structural transportation network.

The PDDUA urban structure guidelines, in contrast to the "atomized " 1st PDDU's model of poles and corridors for commerce and services establishes a "territorial-linear" model, materialized in centrality, urbanity, development and production corridors. Therefore, the present structural transportation model (that overlaps to the historical radial structure, a contour and mediating transportation structure of the PTUs will be gradually recast to obtain a "linear-weaving" drawing. This procedure will keep the decentralization of the activities, but through territorial corridors supported by at least two structural transportation axles. Thus, the offer to the east-west radial direction of diversified, mixed up and perceivable activities concerning the network of public areas, will prevent the trips east-west radial bound and north-south crosswise bound, respectively.

The proposal is to go from emphasis in the normative control to a process of programs and projects supported by social participation as a permanent mechanism of adjustment and control. This way, the plan establishes an urban mobility strategy which will deal with the qualification of the commuters and cargo circulation across the city area in a transdisciplinary way. It will be supported by five programs: public transportation, interchanges and transfer centers, transportation, garages and parking lots, and traffic programs.

Among the new proposals, it calls the attention the "functional" classification of the public areas that are part of the municipal transportation network. That is to say, after having considered the urban structure, the infra structure of the services and the public equipment, the geometry and the phisiography of the routes, the use and the nearby building morphology, the environmental and historical patrimony, etc., the routes will take the following categories: transition, arterial, collector, local, secondary, exclusive for pedestrians and bikeway .

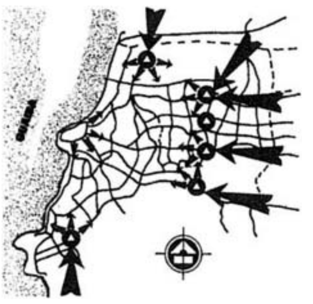
Aiming mostly at the disciplinary use of the car, and not the other way round, the strategy of mobility proposes the maintenance of certain areas of the city for the local traffic and the regaining of the routes to their original functions as public areas of vehicle and pedestrian circulation. This will be accomplished through the stimulation of either private or commercial parking facilities.

4.2 - The operational model of the public transportation.

Proposed by the Urban Development Master Plan, the Public Transportation Sectorial Master Plan of the city of Porto Alegre it is being currently developed by the managing agency of the transportation and circulation system. The plan intends to provide the guidelines for the development of the commuters' public transportation for the next two decades, in accordance with the new guidelines for the recasting of the urban development regulating plan, just recently concluded with the institution of the 2nd Urban and Environmental Development Master Plan.

The guidelines for the new operational model are devised in this context, integrated to the public transportation, seeking new modals to comprise the macro structuring network. New modal alternatives will necessarily be devised, at medium and long term, to fulfill the paradigm changes required either by the operational exhaustion of the system or the physical exhaustion of the structural transportation network.

The operational models keep the bus modality as the structuring modal for the urban commuting, and organizes the lines on the bi-directional transportation network, articulated in knots, connection points and terminals with the purpose of allowing the users all degrees of freedom to accomplish stops to change the direction of the wanted movement without having to go downtown.



The implanting of the operational model presupposes a physical model with prioritized routes for public transportation through the construction of exclusive corridors for buses and a constellation of transfer terminals at the tangency points of higher stop concentration and also the special treatment of all tangency points of the structured lines of the system. On the other hand, the fare integration will be guaranteed through the use of smartcard as a means of payment to access the public transportation. It will allow its revalidation in another vehicle without the discount of a new fare, so that integration to the virtual terminals is accomplished.

5 - SYSTEM INTERFACES

The developmental process of the city of Porto Alegre demonstrates the inter-relationship between the urban expansion processes and the coverage of new inhabited areas by the public transportation services , always as a consequence of an organic and spontaneous process. In this inter-relationship, the former meant the search for new areas of settlement near the poor suburban areas, and the latter, a market strategy to access new users.

Thus, the public transportation is expanded to new inhabited areas on line extensions with offer addition, always connecting the new urban nuclei to the historical center of the city, where there was a concentration of jobs, commerce and service offers.

The main transportation system, structured over 7 main radial routes, becomes the support to the increasing number of transportation lines, converging to these main axles heading the downtown area,and causing a line overlapping process.

From the 70s on, the transportation system starts to have an incipient inductor role in the distribution of the urban activities, while causing the spontaneous arising of small commercial and service nuclei outside the historical center, on the main radial axles where the offer for urban transportation was accumulated, for the first time pointing to the importance of the accessibility variable in the production of the commuting.

The Urban Development Master Plan that was established in the end of the decade acknowledges the strategic importance of these sub-centers to alleviate the compromising level of the central area which already demonstrated signs of exhaustion. This plan establishes favorable constructive rates to the commerce and services implantation on the radial axles as a way of inducing decentralization. These axles become consolidated right after, due to the privileged accessibility offered by the transportation system that used to overlap in these areas.

The activities distribution model creates intersections or crosswise movement needs, which, in the operational transportation model would only be reached by means of stops in the central area to shift radial lines.

The first crosswise lines arise, then, in semicircle, irradiating from the central area, and allowing the inter-section connection for those sections that were located in its design coverage area.

Even with the creation of the crosswise lines, the inter-section network coverage was still partial, since its contour would not advance to the interior of the outskirts sections where most of the trips were generated. Thus, the inter-section movements that were not located in the contour influence area of the few existing crosswise lines were forced to make stops and face double fare, between the radial lines that provided the micro accessibility in the interior of the crosswise lines which allowed the transfer to radial axles.

Thus, the public transportation operational model did not yet stimulate the potentiation of the decentralized poles located on axles other than the original ones.

On the other hand, the land use and occupation policies that promoted the creation of the sub-centers in linear corridors on the main axles, with excessive offer for public transportation again generates a centralized model structured on one only axle, reproducing the same problems already faced in the downtown area.

It becomes necessary to devise a review of the activities development and distribution model into an atomized one with a number of routes to support it, providing accessibility to these poles. The review of the Master Plan in 1998, as the 2nd Environment and Urban Development Master Plan contemplates this atomized model and establishes strategies for urban mobility for the sustentation of the spatial model of urban development, recommending the designing of a Sectorial Transportation Master Plan to accomplish these targets.

Based on a survey, the transportation plan acknowledges the decentralizing tendency, and proposes a flexible and articulated model that privileges other moves besides the existing radial one.

On the other hand, the urban development plan acknowledges the accessibility potential provided by the transportation equipment as it proposes central corridors between the transportation axles of the structuring transportation system.

6 - EXPECTED IMPACTS

As the integrated transportation model is established, allowing access to the city with one only fare, it is expected an alteration in the matrix of the existing modality. Movements that are restricted today, due to the need of double fare payment will be potentiated in the new model, contributing for the consolidation of the urban development policies, especially the viability of the Centrality Corridors.

Economically speaking, the model will provide a rationalization of the transportation system with the improvement of the offer. The indicators below present the advantages of the establishment of the new public transportation operational model, compared to the present operating model:

Performance indicators	Percentile variation
Fleet	- 22%
Journey time	- 11%
Mileage	- 20%
Operational costs	- 18%
Pollutants emission	- 20%

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Ensuring accessibility through integrated corridor development: The Mabopane Centurion development corridor

Assurer l'accessibilité en développant un corridor intégré

Accesibilidad aseguradora a través del desarrollo del corredor integrado: El corredor de desarrollo de Mabopane Centurion

M.N.Krynauw
Greater Pretoria Metropolitan Council, South Africa

S.J.Andersen
Africon Transportation Division, Pretoria, South Africa

ABSTRACT: The Mabopane Centurion Development Corridor (MCDC) is a comprehensive strategy to revive and develop the economy of the Western part of Greater Pretoria. The aim is to promote densification along the identified corridors, resulting in more efficient transportation (i.e. promote public transport) thus ensuring and stimulating economic growth along the corridor. Various development scenarios and spatial strategies were considered for the MCDC. The most appropriate alternative in terms of meeting the goals was further refined and developed as the MCDC Integrated Development Framework. This paper then specifically addresses transportation aspects of the MCDC, focusing on its role within the larger strategy to ensure that the original corridor objectives are met.

Five strategic transportation projects, to support and strengthen the development potential of the MCDC, were identified. Demand modelling of the corridor assisted in determining the impact and importance of these proposals. Through an accessibility analysis, the impact of transportation improvements to the system is assessed, i.e. whether a reduction of travel times and/or trip lengths is attained. The paper concludes by highlighting current development/implementation initiatives and reflects on lessons learnt thus far.

RÈSUMÈ: Le corridor de développement de Mapobane-Centurion (MCDC) est une stratégie globale pour revigorer et développer l'économie de la partie ouest de l'agglomération de Pretoria. Son but est d' augmenter la densité le long des corridors identifiés, pour obtenir des transports plus efficaces (c-à-d. les transports publics) et ainsi assurer et stimuler la croissance économique le long du corridor. On a considéré plusieurs scénarios de développement et stratégies spatiales pour le MCDC. L'alternative qui convient le mieux pour atteindre les objectifs a été peaufinée et développée davantage sous le nom de structure de développement intégré du MCDC. Cette communication aborde spécialement les aspects de transport du MCDC, et plus particulièrement leur rôle dans la stratégie plus vaste pour assurer que les objectifs originaux du corridor sont atteints.

On a identifié cinq projets stratégiques de transport pour soutenir et renforcer le potentiel de développement du MCDC. Un modèle de la demande dans le corridor a permis de déterminer l'impact et l'importance de ces propositions. En faisant une analyse d'accessibilité on a évalué l'impact des améliorations du transport sur le système, c-à-d. si on abouti à une réduction du temps et/ou de la longueur du trajet. La communication se termine en soulignant les initiatives actuelles de développement/et de mise en application et réfléchit sur les leçons apprises jusqu'ici.

RESUMEN: El Corredor de Desarrollo de Mabopane (Mabopane Centurion Development Corridor-MCDC) es una exhaustiva estrategia para restablecer y desarrollar la economía de la zona oeste de Greater Pretoria. El propósito es promover la densificación a lo largo de los corredores identificados dando como resultado un medio de transporte más eficaz (i.e. promoción de transporte público) y asegurando y estimulando de esta forma el crecimiento económico a lo largo del corredor. Fueron considerados variados escenarios de desarrollo asi como estrategias espaciales para MCDC. La alternativa más apropiada en cuanto a la realización de objetivos fue refinado y desarrollado como el Marco de Desarrollo Integrado de MCDC. Este documento se dirige de forma específica a los aspectos de transporte de MCDC, centrándose en su papel desempeñado en una mayor estrategia para asegurar que se cumplan los objetivos originales del corredor.

Se identificaron 5 proyectos estratégicos de transporte, para apoyar y reforzar el potencial de desarrollo de MCDC. La petición de un modelado del corredor ayudó a la hora de determinar el impacto e importancia de estas propuestas. El impacto de las mejoras del transporte en el sistema se evalúa por medio de un análisis de accesibilidad, i.e. si es factible una reducción en las horas de viaje y/o las distancias del recorrido. El documento concluye destacando las iniciativas de desarrollo/implementación actuales y reflexiona sobre las lecciones aprendidas hasta el momento.

1 INTRODUCTION

The Mabopane Centurion Development Corridor (MCDC) is a comprehensive strategy to revive and develop the economy of the western part of Greater Pretoria. The project was initiated in 1995 jointly by the National Department of Transport, the Provincial RDP Office and the Greater Pretoria Metropolitan Council (GPMC). The MCDC is located to the western side of Pretoria, runs in a north-south direction and encompasses parts of Centurion, Pretoria as well as the Northern Pretoria Metropolitan Local Council (see Figure 1).

The main aim was to promote densification along the identified corridors, resulting in more efficient transportation (i.e. promote public transport) thus ensuring and stimulating economic growth along the corridor / node.

The MCDC was initiated as a joint venture planning exercise involving all spheres of government. Consistent with national and provincial development principles, the following elements were identified to direct the corridor initiative:

- economic growth and job creation
- accessibility and integrated transport development
- investment or recreation of investment opportunities
- development of human resources
- environmentally sustainable development through urban reconstruction.

The above elements were addressed in an integrated planning process through a multi-disciplinary project team. Various development scenario's and spatial strategies were considered for the MCDC. The most appropriate alternative in terms of meeting the goals was further refined and developed as the MCDC Integrated Development Framework. The next step was to identify strategic projects for implementation, together with projects which support and strengthen the development potential of the MCDC. These projects have been supplemented with additional projects addressing the community needs that have been identified as part of the community involvement process. Finally, a strategy was developed to guide the implementation of projects in the MCDC.

This paper specifically addresses transportation aspects of the MCDC, focusing on its role within the larger strategy to ensure that the original corridor objectives are met.

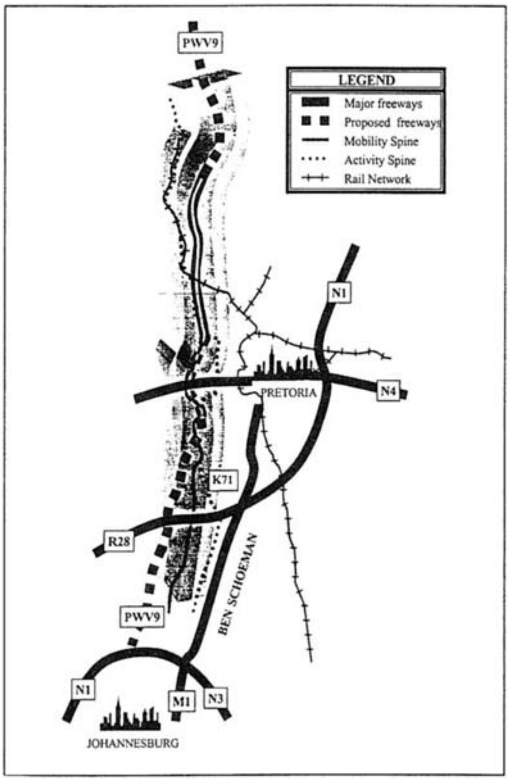

Figure 1: Mabopane / Centurion Development Corridor

2 ESTABLISHMENT OF THE MCDC TRANSPORTATION FRAMEWORK

A transportation system supporting the principles of the MCDC was identified as one of the major elements to ensure the successful development of the corridor. Several goals with respect to transportation aspects were identified, including the following:

- promote public transport by the provision of an integrated public transport system
- provide a functional and balanced road network
- ensure route continuity throughout the corridor
- optimal use of existing infrastructure

- integrate the development with metropolitan and regional planning frameworks
- provide cross-linkage with other corridors
- ensure flexible transportation infrastructure proposals that can be phased as development within the corridor occurs
- provide a transportation framework that develops, strengthens and supports nodes of opportunity

Ultimately, the successful implementation of the above factors along with economic and land use strategies, should result in a two-fold outcome:

- the settlement of workers closer to their place of work
- a resultant reduction in travel times and/or trip lengths thus improving the social environment of the individual.

The above approach is in line with Moving South Africa's Strategy (a long term vision for transport in South Africa) for urban transport, where one of the key actions is the densification of transport corridors. Through the increased use of controls and incentives and the provision of public transport investments to support corridor densification, a much more efficient transportation system can be provided. For example, the densification of parts of the MCDC corridor (Soshanguve-in the north of the corridor-to Pretoria CBD) would result in improved vehicle utilisation and a total net transport cost saving of R 3 million per annum.

In order to move towards the implementation of the corridor vision, several structuring elements of the MCDC Transportation Framework were identified and are discussed below (Figure 1 also depicts the various elements of the framework):

2.1 *Mobility Spine*

The Mobility Spine can be seen as transportation infrastructure providing mobility throughout the region. This affects both through traffic movements as well as regional accessibility requirements.

The mobility function within the MCDC is shared by both road and rail infrastructure. In the northern parts of the MCDC area the PWV9 fulfills the role of road-based mobility requirements while K71 fulfills that role in the south, thus forming the central spine of the corridor. The Mabopane-Pretoria CBD rail line also plays a major role providing mobility in the northern parts of the corridor area, complementary to the road-based spine.

2.2 *Activity Spine*

An Activity Spine refers to a major road accommodating mixed land uses and high-density development immediately adjacent to this facility. Activity Spines should be major routes that are connected to one or more large activity nodes. Public transport should form a major feature along Activity Spine.

Within the MCDC, the activity spine is generally aligned parallel to the mobility spine and is continuous where possible.

2.3 *Accessibility Road*

Accessibility Roads generally provide a linkage between the mobility and activity spines. Within the study area various such roads exist or are planned, mostly running in an east-west direction – thus supporting the north-south oriented mobility and activity spines.

2.4 *Activity Street*

An Activity Street is of a lower order than an Activity spine, referring to a local road that allows for a high degree of accessibility along its length. Within the MCDC, activity streets are planned to mostly provide access to railway stations/intermodal facilities and/or direct access to development. The activity streets link the activity spine with the railway stations.

2.5 *Transfer Facilities*

Transfer facilities were identified as a major element of the future public transport strategy for the MCDC generally chosen to be close to main development nodes, also corresponding to the various desire lines. It was necessary to initially identify such locations where transfer would take place between road-based transport modes and rail.

3 STRATEGIC PROJECTS

The compilation of a Transportation Framework resulted in the identification of several projects regarded to be strategic so as to ensure the success of the MCDC. Five strategic transportation projects were identified and are discussed below:

3.1 *Establishing a mobility link across the Witwatersberg*

The southwards extension of the PWV9 freeway through the Witwatersberg Ridge is seen as one of the major catalysts for development of the western part of Pretoria. A continuous mobility spine throughout the corridor will be established by the completion of this link.

3.2 *Creating a link to the Witwatersrand*

No direct or freeflow link exists between the MCDC and the Ben Schoeman corridor (such as the eastern bypass around Pretoria). It is imperative that such a link be investigated to ensure a more direct link with the daily commuter traffic travelling between Pretoria and Johannesburg. Such a link should follow the desire lines of movement between the two corridors. The current planned major road network does not support this movement.

3.3 *Establishing the MCDC Activity Spine*

The activity spine should form the backbone of development throughout the corridor. This is where mixed land use will be established and core activities will take place. It is necessary to ensure that the activity spine be planned and aligned as such that it supports the proposed development, provides access to development as well as access to major stations.

3.4 *A Public Passenger Transport System for the MCDC*

Corridor development started out as an initiative to provide more efficient transportation (specifically public transport) between two major nodes. Within the MCDC it is necessary to develop focused public transport strategies to facilitate and support mixed land use development. These strategies need to be integrated with land use strategies to ensure the provision of an efficient transportation system.

3.5 *Urban Port Development*

The Urban Port, at the intersection of two major freeways (PWV9 and PWV2), is seen as a major development node with a window of opportunities. Whilst the economic potential needs to be established and maximised, the success of such a development is largely dependent on its accessibility. The need to ensure maximum accessibility and adequate circulation within the Urban Port, was identified at an early stage.

4 MCDC DEMAND MODELLING

4.1 *Objectives of Demand Modelling*

Demand modelling of the MCDC was necessary to address inter alia, the following:

- to assess the impact of the proposed MCDC land use on transportation infrastructure
- to evaluate the various strategic transportation projects (identified earlier) from a regional perspective
- to specifically evaluate the need for the PWV9-link as a strategic link for the western side of Pretoria
- to establish first order transport cost implications with respect to the provision of the PWV9 and supporting road infrastructure
- to assess network-wide accessibility and mobility requirements
- consider the impact of tolling the PWV9 extention to the south

4.2 *Study Methodology*

Road network modelling and public transport aspects were assessed jointly in order to address the objectives of the study.

The GPMC Emme/2 model was utilized as the tool to assess the impact of implementing development proposals for the MCDC. The traditional four-step modelling process was followed i.e. trip generation, trip distribution, modal split and trip assignment. Trip generation was determined using a land use scenario based on a "most probable" economic growth projection. The year 2010 was chosen as the future year for implementation.

Three alternative road network scenarios were created, based on the existing 1998 road network. The 2010 committed road network represents a scenario which includes projects likely to be implemented by 2010 (according to various construction programmes), but excluding the PWV9. A PWV9 No-toll road network was developed, based on the 2010 committed network but inclusive of the PWV9 and several additional road linkages supporting the PWV9. This scenario does not allow for PWV9 to be tolled. The PWV9 Toll road network is similar to the no-toll network, but takes into consideration the provincial Gauteng Toll strategy.

Trip distribution, modal split and trip asignment were based on the same procedures or factors that were applied to develop the original GPMC Emme/2 model. The gravity model was applied to distribute trips between origins and destinations, based and calibrated on socio-economic characteristics of the Greater Pretoria Metropolitan Area (GPMA). Modal split differentiated between the various modes of transport, and was assessed for each of the road network scenarios. Trips were assigned according to user equilibrium principles, and allowed for additional delay in the toll road scenario. The tolling effect was modelled by adjusting the volume-delay functions by converting actual toll tariffs into time delay on the appropriate links.

The adjusted volume-delay functions on links where toll plazas are proposed, therefore has the following three elements:

Total delay on toll link = delay due to normal congestion + toll tariff delay + plaza delay

Throughout the above analysis process, distinction was made between the various modes of transport within the corridor i.e. minibus-taxi, bus, rail and private car. Demand for each mode was established and considered in the public transport assessment.

4.3 *Study Results*

The study results are discussed in conjunction with the study objectives.

4.3.1 *Impact of the proposed MCDC land use.*

The impact of the proposed MCDC land use on transportation infrastructure is best summarised by comparing the output of the demand modelling process for each road network scenario. The summary statistics for the various scenarios are provided in Table 1.

Table 1 : Land-use Scenarios

Statistics	LAND-USE SCENARIOS				
	Base Year		2010 MCDC		
	Base Network 1998	Base Network 1998	2010 Committed Network	PWV9 Network No Toll	PWV9 Network Toll
Average speed in the study area	58	12	25	34	25
No. of links at capacity (% of total)	27	60	51	44	51

The implementation of the MCDC land use scenario will result in severe congestion, irrespective of various road network links introduce. As a benchmark, a comparison was made with the current GPMC base year model, i.e. corresponding to 1996 land use and the 1998 road network. In this case, an acceptable average speed on the major network of 58km/h is attained, whilst 27 % of road links are at capacity (i.e. operating at unacceptable levels of service).

The introduction of the MCDC land use with trips assigned on the base network results in a decrease of the average travel speed to 12km/h, while the number of links at capacity more than doubles. These figures slightly improve with various road network links added to the base network. However, even in the best case (PWV9 network no-toll) the average speed is only 34 km/h while approximately 44 % of all major road network links are at capacity.

4.3.2 *Evaluation of the strategic transportation projects.*

PWV9 Mobility Spine. The need for the southwards extension of the PWV9, as continuation of the mobility spine, is clear if one considers the assigned volumes on the southern links of the PWV9. The peak hour assigned volumes on the link where the PWV9 crosses the Witwatersberg Ridge for the two PWV9 scenarios range between 5 000 vph and 7 000 vph (both directions) in 2010. Already this equates to a demand of three lanes per direction.

Benefit-cost estimates were calculated for the three road network scenarios. The benefits calculated refer to transport user benefits arising from a reduction in vehicle kilometres travelled on the network. The costs were calculated considering the proposed road network improvements within the study area. The calculated benefit-cost ratios were larger than one in all cases, thus confirming the need and importance of construction of the PWV9.

Witwatersrand Link. Although no detailed modelling of the linkage with the Ben Schoeman corridor was done, a high demand on possible alternative routes within the desire band was observed.

Activity Spine. The assignment results show a clear demand for the proposed activity spine from a capacity point of view. This is especially true in the north western part of the study area, where the activity spine is shown to be at capacity.

Public transport assessment. The demand modelling confirmed the dire need for an adequate public transport system within the corridor. A distinct public transport strategy was not developed in the course of establishing the demand. This is mostly due to external factors influencing such a strategy which needs to be in place prior to formalising a MCDC public transport strategy.

Urban Port Development. The densification at the Urban Port was included in the demand modelling process. Subsequently, trips with an origin or destination in the Urban Port were established and can be used as input to more detailed analyses of the said area.

4.3.3 *The impact of tolling the PWV9*

Even though sections of the PWV9 were tolled in the demand modelling exercise, assigned volumes on the section remains high. It was recognized that through tolling sections of the existing freeway towards the north, one could actually stimulate development by forcing users onto the activity spine. However, the toll strategy for the larger area still needs to be firmed up within the next year, resulting in any discussions in this regard being of a preliminary nature.

5 ACCESSIBILITY / MOBILITY CONSIDERATIONS

5.1 *Background*

A key objective of the MCDC strategy is, as indicated in the first section of this paper, to reduce travel times or distances between residence and place of work. Although this aspect is dealt with implicitly in the four step process, the output of the transportation demand modelling is not presented at a micro level for one to ascertain whether these objectives have been met through transportation infrastructure improvements. An accessibility analysis (also implying mobility in the regional sense) is performed to determine whether the relative accessibility within the study area has improved given the proposed transportation framework.

Accessibility has generally been defined as some measure of spatial separation of human acivities. An accessibility index is generally devised by utilizing distance, travel time or travel cost between trip origin and destination.

5.2 *Accessibility analyses results*

An extract of results of the accessibility analyses are provided in Table 2. A comparison between various network scenarios is given by, as an example, comparing accessibility measures between the same residential zones (Soshanguve, Klip/Kruisfontein, Atteridgeville, etc.) to a major employment zone (Rosslyn). The second part of the table shows the accessibility measures between the same residential zones and the average of all destinations.

The results show a clear improvement in the accessibility index (measured by equilibrium travel time) through road network improvements. The accessibility of Rosslyn – probably the most important employment node within the MCDC – is drastically improved. If one considers the cell value to be the equilibrium travel time from one of the residential zones to Rosslyn, the figure (post network improvements) ranges between 25 % - 50 % of the original. For the base case, the cell values appear to be too high to represent average travel times between the zones; however, one must bear in mind that these figures represent severe congestion. The PWV9 No-toll network generally provides the best accessibility.

Similarly, if one considers the equilibrium travel time from the residential zones to all destination zones, a clear reduction in travel times for the various network improvements are shown. Furthermore, if one considers all origins and all destinations within the larger study area, average travel time has approximately been halved through the introduction of various network improvements and the PWV9 extension. These results confirm the importance of implementing the various network scenarios, especially the PWV9, in order to ensure a proper level of accessibility along the MCDC. If implemented, increased accessibility will contribute to successful implementation of the MCDC.

6 TOWARDS IMPLEMENTATION

6.1 *The Integrated Growth and Development Implementation Strategy*

Since the approval of the Integrated Growth and Development Implementation Strategy (IGDIS) for the MCDC, fourteen strategic projects that will contribute to the success of the MCDC

Table 2 : Results of Accessibility Analysis

Equilibrium travel times	**ROSSLYN**				**Average of All destinations**			
	Base Network 1998	2010 Commited Network	PWV9 Network No toll	PWV9 Network Toll	Base Network 1998	2010 Commited Network	PWV9 Network No toll	PWV9 Network Toll
Soshanguve	256.9	80.1	59.1	58.7	353.1	130.7	99.1	115.2
Klip/Kruisfontein	229.8	63.2	37.1	37.6	326.5	106.6	73.4	86
Atteridgeville	105.8	63.2	47.5	58.4	55.3	48.8	43.5	50.4
Lotus Gardens	90.5	53.7	35.8	46.0	39.9	35.4	30.1	35.5
All origins	222.5	64.8	40.1	41.6	177.8	75.4	57.5	67

development initiative were identified. Three task teams (i.e. the Spatial Development Task Team, the Business Development Task Team & the Social Development Task Team) were established to facilitate implementation of these strategic projects. Good overall progress is being made on the strategic projects, although shortage of funds is a major concern.

6.2 *Lessons learnt*

In the course of current planning initiatives and steps towards implementation, several valuable lessons have been learnt. These lessons, as listed below, need to be borne in mind as one moves forward to practical implementation of the MCDC:

- the overall vision of the MCDC needs to be communicated regularly
- all major roleplayers and/or stakeholders needs to share this vision
- a clear and focused development framework need to be established to provide broad guidelines for development initiatives
- the framework needs to be robust
- development proposals need to be communicated between the various disciplines to ensure coordination of activities
- forums need to be established where applicable activities can be discussed
- all spheres of government need to be partners in this development, thus taking ownership at all levels
- implementation of projects should only follow once proper planning is in place and consultation with affected parties has been undertaken
- an individual is required as a driving force to ensure the ultimate success of the project. Individuals within the main disciplines, who strongly support the principles of the MCDC, need to continuously support the project manager
- there should be a proper funding strategy for implementation of developmental projects within the MCDC
- political commitment at all three spheres of government to ensure implementation
- complexity of public transport leader to back of focus and direction
- a proper framework for public transport needs to be established to ensure focus and direction in implementing such projects

7 CONCLUSIONS

The paper gave a brief background on the development of the MCDC and then focused on transportation aspects. The main emphasis of transportation aspects within the corridor is on the improvement of accessibility and to provide an integrated transportation framework that will support and strengthen the development potential of the MCDC. Integration with land use aspects is also essential to ensure that the ultimate objective of reducing trip lengths and times within the corridor is achieved.

The importance of the various strategic projects was underlined through demand modelling using the GPMC Emme/2 model. Specifically, the need for construction of the southern link of the PWV9 was clear. Furthermore, results show a serious lack of capacity for the future road networks, thus underlining the importance of a comprehensive and efficient public transport strategy for the MCDC. Accessibility analyses show a vast improvement in reduction of travel times between major residential zones and zones of employment, considering the various improvements to the transportation network.

Finally, an overview of current initiatives with respect to strategic projects within the MCDC is provided. It is clear that the continuous "buy in" from all spheres of government and the willingness to provide funds to enhance the corridor principles on an ongoing basis is of paramount importance to secure the MCDC's position as a success story in urban redevelopment.

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Transportation – Communication network planning for the city of Taj-Agra

Prem Prakash V.
Electrical Engineering, Dayalbagh, Agra, India

Vivek Kumar
Faculty of Engineering, DEI, Agra, India

Prem S. Satsangi
DEI, Agra, India

ABSTRACT: System Scientists have begun to evince considerable interest in large scale socio-economic systems which profoundly influence the environment in which man lives. The living conditions of major/medium sized cities of India have deteriorated under the pressure of exploding population, rapid urbanisation and industrialization .To sustain the pace of urbanisation and industrialisation, there has to be a commensurate growth in the urban infrastructure. In this context transportation is the most important single component unstructured in shaping urban development and urban living.

In this paper, we present a comprehensive transportation/ communication network planning using the celebrated Lowry's model for the city of TAJ, AGRA. This work also highlights the effect of communication links on the transport-energy environment scenario.

1 INTRODUCTION

In the present day world any attempt to solve one problem results in aggravating other problems. For example an attempt to solve the problem of transportation results in various other problems viz., deterioration of environment and excessive pollution and also it has an adverse effect on the energy scenario. Physical system theory with graph theoretic approach, analogies and modeling techniques has emerged as a potential tool for solving large-scale real world problems.

Agra, the city of Taj has its unique identity on the world platform. Agra enjoys a big stack in tourism and hospitality sector but its importance is growing as a center of education, banking, industry and commerce. The city, is viewed as a set of activities that interact and generating flows. Activities and flows take place in adapted space and channel space respectively. The location of activities of each type depends on factors taking place elsewhere i.e., at regional scale. The city can thus be considered in terms of migration movements, simulated by employment opportunities.

Against such a backdrop this work examines the celebrated Lowry's model for strategic planning and provides useful insights by offering a graph theoretic interpretation to it. Besides empirical implementation of an operational version of the Lowry's model in the form of an inter-constrained gravity model, the work also examines the activity allocation and transport demand implications of a range of developmental concepts as a case study of strategic planning for Agra, a medium sized city, which was not properly planned in the past and growing fast without any controlled planning. The present work addresses the problem of strong interactions between the communication and transportation. In this context, it is also shown that incorporating communication links produces a dramatic change in the efficient use of transport as well as corresponding improvements in environmental conditions and energy saving. Further, this work assumes utmost importance in view of the proposal of Taj Trapezium and *Varadarajan* Committee report which recommended shifting of all non eco-friendly industries within a radius of 50 Km with Taj as centre.

The introduction of incumbent parameters requires rigorous and structured efforts to develop a realistic model of a major/ medium class city. Specially, those cities, which are not properly planned in past and growing fast without any controlled planning.

System approach and high-speed electronic computers do the fundamental modeling for urban & metropolitan planning and decision making. It provides the necessary capacity for handling large amount of statistical information and also step-wise refinement of the model response using repetitive procedures; (Hutchison.1990), to predict residential development based on proportionality uses:

i. Between accessibility of one point and size of activity of another point.
ii. Function of distance separating one point from another point. This model predicts the level of residential development of a zone.

The celebrated Lowry's Model of metropolis, which has attracted the attention of a large number of planners, allocates residential population around a work place in proportion to the potential of accessibility to employment. Its simplicity, operationality, adaptability, modest data requirements, comprehensiveness and the implied integrated land-use and transportation planning are adequate justifications for the selection of the Lowry's model of metropolis out of the various land-use models for strategic transportation planning studies of the city of Taj, Agra (Rajkumar.1979).

2 SYSTEM OF EQUATIONS OF LOWRY'S MODEL OF METROPOLIS

With the Lowry's model of metropolis, the spatial distribution of basic employment is allocated exogeneously to the model, and the spatial distribution of households and population serving employment are calculated by the model. The zonal allocation rules for both households and population serving employment are specified within the number of households for any zone and the minimum population serving employment thresholds for any zone are specified.(Rajkumar.1979), (Satsangi.1970)

The structure of the Lowry's model of metropolis is expressed by the following system of equations:

$$p = e\,A \qquad (1)$$
$$e^s = p\,B \qquad (2)$$
$$e = e^b + e^s \qquad (3)$$

where p = a row vector of the population or households within each of the n zones; e = a row vector of the total employment in each zone; e^s = a row vector of the population serving employment in each zone; e^b = a row vector of the basic employment in each zone; A= an nxn matrix of work place to household accessibilities and B = an nxn matrix of the household to service center accessibilities.

The accessibilities matrix A may be expanded as follows:

$$A = [a'_{ij}]\,.[a_j] \qquad (4)$$

where a'_{ij} = an nxn square matrix of probabilities of an employee working in i and living in j and a_j = an nxn diagonal matrix of the inverses of the labour participation rates, expressed either as population per employee or house holds per employee.

The accessibility matrix B may be expanded as follows:

$$B = [b'_{ij}]\,.[b_{ij}] \qquad (5)$$

Where b'_{ij} = an nxn square matrix of probabilities that the population in j will be serviced by population serving employment in i; and b_i = an nxn diagonal matrix of the population serving employment to population ratios.

The zonal Constraints:
The distribution of activities produced by the above set of equations should be such that following constraint equations are satisfied:

$$p \le p^c \text{ and } e^s \ge e^{smin} \qquad (6)$$

Where p^c = a row vector of the population holding capacities of each of the n zones; e^{smin} = a row vector of the population serving employment thresholds.

2.1 *Lowry's model of Metropolis as an inter-constrained Gravity model*

Any gravity model is based on the hypothesis that the interaction, t_{ij} , between an origin zone i and destination zone j for a particular flow is :
i. Directly proportional to demand requirement generated at the origin zone i, denoted by P_i,
ii. Directly proportional to number of size of the opportunity (or attraction) in zone j as implied by P_j.
iii. Proportional to some function of distance or cost of travelling from i to j, *dij* say a function decreasing or increasing.

In these models, the number of trips produced or attracted by each zone can be used as the mass variable instead of the measure of relative attractiveness. Therefore, certain constraint must be introduced to ensure internal consistency within the model between estimated trip distribution and externally derived trips.

2.1.1 *Production Constrained Gravity Model*

The model is an interaction between a population distribution and a large number of shopping centers

Pi = The expenditure power available at zone i.

P_j = Attraction power of the shopping centers (number of shops, number of retail employees, shopping floor space and retail sales themselves) (Lowry,1964).

The constraint is that the sum of retail expenditure made by the residents of zone i over all the shopping centers considered must equal to the total expenditure of the residents in zone i.

2.1.2 *Attraction Constrained Gravity Model*

This model is similar to the residential part of Lowry's model of metropolis in that it allocates residences, or residential population, around workplace by using a distance deterrence distribution function, but zonal attraction power is also introduced. According to the model

$$T_{ij} = B_j\, a_j\, P_i\, f(c_{ij}) \qquad (7)$$

Where, P_i = 'attraction power' of zone i as a place of residence; A_j = 'attraction power' of zone j as a place of employment (number of jobs in zone j)
There is only constraint that the sum of the number

of people living in i and working in j can not exceed the number employed in j. (Lowry,1964)

$1/B_j$ now represents the expenditure of residential zones for residents constrained by attractions(Jobs), or the accessibility of employment zone j to residential opportunities.

2.1.3 *Inter-constrained Gravity Model & Lowry's Model*

The inter-constrained gravity model combines the features of both the production and attraction constrained gravity models such that the output of a gravity model becomes the input of another. The basic employment available at all the zone is distributed among these zones by means of the attraction constrained gravity model. The activity rate for the study area helps in population distribution, which is used to estimate the distribution of service trips and there by service employment, using production constrained gravity model. The allocation of service employment generates estimates of resident population using attraction constrained gravity model. The extra service workers are located in different zones depending upon the relative accessibility and attractivity of each zone. The iterative procedure is continued till equilibrium is achieved.

The general process of calculation involved in the Lowry's Model can be expressed more precisely by a series of equations beginning with the attraction constrained gravity model which is used to find the distribution of residence of the workers, (Lowry,1964).

From the distribution of residential population the distribution of service trips can be calculated by a production constrained gravity model. (The Equations of Lowry's Model and various gravity models are not shown here for the want of space. Please refer (Lowry,1964) for more details).

2.2 *Agra, The context city*

2.2.1 *Empirical Implementation*

In the present study, the entire region of the Agra Urban has been divided into 13 sub-zones. The basic employment in each zone, land area of each zone, total population of Agra urban area, total employment of Agra urban area, maximum population constraints, minimum population serving employment threshold constraints, Average inter-zonal movement., average intra-zonal movement. surface area of each zone and overall attractivity factor for the Agra urban area is calculated using the following steps.

The dis-aggregation of the total employment into employment in basic industries and deployment in population serving industries is achieved through the import-export statistics of Agra as revealed through the survey of inter-state goods traffic by road of Agra.

For the each zones of Agra, as a measure of rough classification, the employment in industries of major group (as per NIC 1970), whose exports (quantity/value) exceed imports (quantity/value) and categories of service which are of national/international relevance is taken as constituting employment in basic industries while the rest is assigned as employment in population serving industries.

The surface area for each zone is computed on the basis of number of workers employed in major and minor organizations and average surface occupied per employee as per the master plan of Agra. Area is computed by master plan by using land-use sample survey done by the Agra Development Authority.

The intra-zonal movement is computed by determining the centroids of these irregulars shaped zones. The attraction centers are concentrated and assuming the production centers (residence) to be located on the periphery of these zones (agreement with the development plan of Agra urban area) and then averaging the movements from attraction center to production centers and vice-versa. The inter-zonal movement on the average is taken as a distance from the centroids of a particular zone to the centroids of all other zones in the study area.

2.2.2 *Projection Methodology*

For the year 1971, data regarding population, population serving employment and basic employment is available. However, Lowry's model was used to simulate these parameters to validate the model. Simulated data and existing data were compared for various attractivity factors. For the least percentage error, best attractivity factor was chosen for different zones. It should be noted that one important aspect of this study is that by using Lowry's model, these parameters were simulated and projected for the years 1981 and 1991 also for least error. There by validating this model for 1971, 1981 and 1991 for which data was available. The simulated results are very close to the available data, thus showing the, robustness of the model.

Projection of various parameters using Lowry's Model for years 1999, 2001, 2010,2020 is done with the help data of years 1971,1981 and 1991 using non-linear analysis and by performing regression analysis.

Computation and projection for successive years requires projection of its parameters like (Population, Area, inter-zonal distances, House Holds, Houses, Basic Employment etc.). The growth is exponential. The projected values are extrapolated from initial values. Extrapolation increases or decreases the values by a constant value that is based on the difference between starting value and extrapolated value. To extend complex and non-linear data, the function is programmed for predicting future values based on a linear regression of a range of known data. It returns expected values for future target years. Further, the function is programmed for extrapolating future val-

Table 1. Projection of Population for target years 1999, 2001, 2010, 2020 in various zones using Lowry's model

Zones	1999	2001	2010	2020
I	49,349	52,700	60,785	69,768
II	92,113	95,112	113,230	133,361
III	28,996	30,997	36,559	42,739
IV	48,756	50,843	59,695	69,531
V	136,456	140,841	157,871	176,794
VI	119,978	125,604	134,714	144,836
VII	146,314	151,515	167,887	186,078
VIII	163,305	168,909	193,488	220,798
IX	89,095	95,098	109,366	125,219
X	140,568	142,929	162,157	183,521
XI	173,567	183,968	209,876	238,662
XII	243,566	260,084	317,150	380,556
XIII	61,567	65,566	75,261	86,033
XIV	1,495,629	1,551,144	1,798,041	2,057,900

Table 2. Projection of Service Employment for target years in various zones of Agra.

Zones	1999	2001	2010	2020
I	8,745	9,432	11,018	12,779
II	12,345	13,547	15,869	18,449
III	5,475	6,016	7,389	8,915
IV	2,475	3,125	3,100	3,073
V	13,976	14,122	15,143	16,278
VI	18,457	19,747	23,093	26,811
VII	22,565	23,658	27,136	31,001
VIII	31,987	33,217	39,176	45,797
IX	7,695	8,745	9,926	11,239
X	27,657	29,458	35,944	43,150
XI	24,474	25,050	28,226	31,756
XII	12,456	10,711	9,129	7,371
XIII	7,587	8,341	9,778	11,375
XIV	197,893	205,167	234,927	267,993

Table 3. Projection of Basic Employment for target years.

Zones	1999	2001	2010	2020
I	4,321	4,096	3,879	3,638
II	7,531	7,694	7,973	8,282
III	1,994	1,839	1,678	1,499
IV	8,584	9,063	10,971	13,091
V	27,564	28,008	33,468	39,534
VI	21,453	22,775	26,368	30,360
VII	26,574	28,751	33,333	38,424
VIII	23,475	24,100	26,204	28,543
IX	8,234	8,711	9,626	10,644
X	11,437	10,407	9,616	8,737
XI	28,943	30,274	35,682	41,691
XII	55,697	57,474	72,352	88,883
XIII	12,493	11,268	13,328	15,616
XIV	240,299	244,460	284,478	328,942

ues of parameters that extend a straight line or exponential curve that best describes the existing data.

Table 4. Projection of Best Vβ for target years.

Name & Zones	1999	2001	2010	2020
Foundry Nagar, I	.155	0.198	0.243	0.293
Rambaugh, II	.170	0.198	0.243	0.293
Industrial Area, III	.155	0.195	0.238	0.285
Etmaddolla, IV	.155	0.195	0.238	0.285
Sultan Ganj, V	.155	0.195	0.238	0.285
Hospital Road, VI	.155	0.192	0.234	0.282
Nai ki Mandi, VII	.170	0.198	0.243	0.293
Bodla, VIII	.170	0.192	0.234	0.282
Sikandra Urban, IX	.170	0.195	0.238	0.285
Trade site, X	.155	0.198	0.243	0.293
Tajganj, XI	.170	0.198	0.246	0.298
New Agra, XII	.155	0.195	0.240	0.290
Lohamandi, XIII	.170	0.202	0.249	0.301

2.2.3 *Working Rule*

- Projections for the various factors were calculated for 1999,2001, 2010, 2020 with help of nonlinear intrapolation method for different zones of Agra.
- Attractivity Factor for different zones is different. Before actual projection, best fitted attractivity factor (Vβ) was chosen for least percentage error for different years and for all zones. Percentage error is calculated by (Simulated value - actual value) * 0.01.
- Intra zonal distances are also intrapolated.

Lowry's model was simulated for service employment and population for targeted years by using a computer program developed in Visual C++. Tables 1 through 4 show various simulated data of various parameters.

3 EFFECT OF ADDING TELE-COMMUNICATION LINKS IN TRANSPORTATION PLANNING:

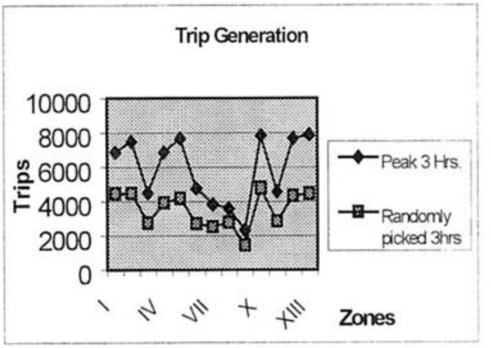
Telecommunication has emerged as an important factor in socio-economic development of a region. Telecommunication links between zones are having great potential to reduce a large number of trips between zones. Due to incumbent technologies like Internet, WAN, faxes, Teleconferences, virtual reality, multimedia and Hypermedia exchange of information from the source to destination, can be effectively achieved. These technologies have given birth to E-commerce, E-business, Tele-education, Teleshopping, Home Shopping, Mobile, Small and distributed offices etc. In the present study reduction of trips with the introduction of telecommunication links has been incorporated, which will ease traffic congestion in Agra. The city of Taj has muti-modal

Table 5. Number of Links between zones, various calls made in various zones. Trip reduction calls for 1999

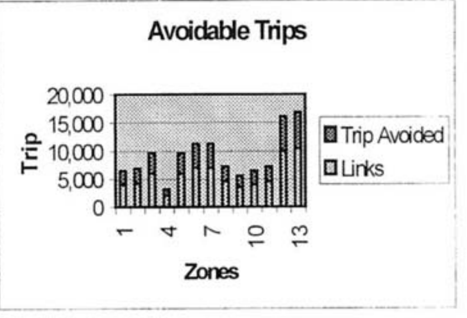
Zones	Capacity Links	Average Calls made in 3hrs (Peak Hrs.)	Trip Avoidable Calls 3 hrs (peak hrs.)
I	4,000	4,931	2,404
II	4,250	5,240	2,622
III	6,000	7,397	3,606
IV	2,000	2,466	1,202
V	6,000	7,397	3,606
VI	7,050	8,640	4,212
VII	7,000	8,630	4,207
VIII	4,500	5,548	2,705
IX	3,500	4,315	2,104
X	4,000	4,931	2,404
XI	4,500	5,548	2,705
XII	10,000	12,328	6,010
XIII	10,500	12,945	6,311
XIV	73,300	90,305	44,024

transportation system depending on various income groups of the society. A pilot survey was carried out to know the average inter-zonal and intrazonal trips (Leblanc.1992), (ALI.1988) and average trip lengths were calculated for the entire city for the year 1999. Two time slots were chosen for pilot survey i.e., Peak 3 Hrs and any other three hrs. A sample survey of 300 population was carried out by questionnaire and also by observations of traffic pattern on various zone junctions. This sample was exponentially projected over simulated population of Lowry's model, service employment and basic employment for the year 1999. The results of survey and projections regarding trips in various zones for year 1999 are represented in the form of Graph 1.

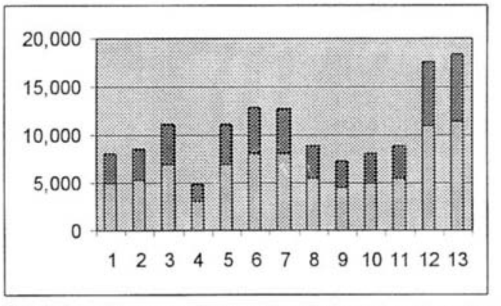
Table 5 shows the projected results of pilot survey and it also shows the present status of trip avoidable calls with respect to the available communication links. A number of suitable locations in each zone have been identified where, if more communication links are installed then larger number of trips can be avoided. The results of the study are shown in graph 2 and graph 3. Thus, The study clearly reveals that by adding communication links between zones, the transportation pattern of the city can be tremendously changed, number of trips reduced.



Graph 1. Existing trips patterns in various zones for year 1999 (The sequence of squares in the graph pertains to zones)



Graph 2. Existing links and trip reduction in various zones for year 1999.

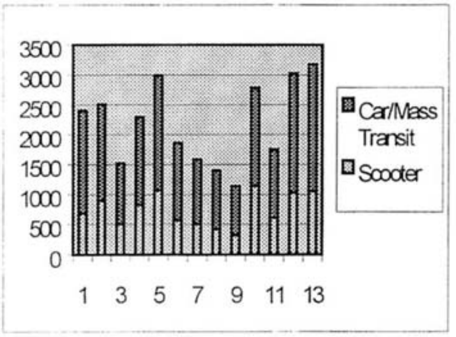


Graph 3. Adding more links and projection of number of trip reduction in various zones for year 1999.

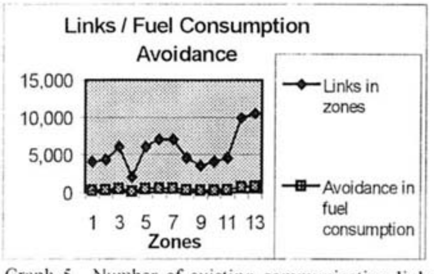
4 POLLUTION REDUCTION AND ENERGY SAVING DUE TO ADDITION OF COMMUNICATION LINKS

Transportation of a city is one of the major influencing factors in environmental pollution. Further, the rate of fuel consumption may be treated as one of the parameters, which causes pollution. It is very obvious that if we add communication links as illustrated in previous section (3), the number of trips made by various modes of transportation will be greatly reduced and thereby, reducing pollution and energy consumption. For working out the details of reduction of pollution levels and thereby, reducing energy consumption, a survey was carried out for calculating number of trips made by various modes of transportation. Study shows that 35% of modal split is motorized vehicles, which causes pollution.

The study identifies that if more number of telecommunication links is installed between zones then a



Graph 4. Number of Trips at various zones calculated by different modes of Transportation for year 1999.



Graph 5. Number of existing communication links and fuel saving projected for year 1999.

Table 6. Study of Telecommunication links and fuel saving for year 1999. (3 peak Hrs.)

Zones	Capacity	Fuel saving (Liter)
I	4,000	281
II	4,250	306
III	6,000	421
IV	2,000	140
V	6,000	421
VI	7,050	492
VII	7,000	491
VIII	4,500	316
IX	3,500	246
X	4,000	281
XI	4,500	316
XII	10,000	702
XIII	10,500	737

large number of trips can be avoided (Section 3). This avoidance can result in fuel conservation, which is a parameter for pollution reduction.

Following section of the paper is a method of calculating reduction of fuel consumption due to addition of communication links in a zone.

Fuel saving = Sum (number of trips avoided with added links by motorised vehicles * Average Trip length * Consumption rate) (8)

The survey reveals the following,
The average trip length by motorized vehicle = 6.67 Km.
The average trip made in peak 3 hrs from one zone to another by different motorized modes is shown in Graphs 4.

The above study clearly reveals the effect of adding communication links results in saving a large number of trips, thereby reducing pollution and saving in energy consumption.

5 CONCLUSION

In the present study, Lowry's model of metropolis has been implemented for the city of Taj, Agra for predicting the growth and transport pattern for a number of Target years upto 2020 based on Master plan of Agra. It has also been shown that adding telecommunication links at appropriate locations in various zones results in reducing a large number of trips which are avoidable by if these links are provided. Further, It has been shown that adding of communication links results not only in easing traffic congestion and hazards on the roads but it also reduces environmental pollution due to motorized vehicles and saving in energy.

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The role of land use planning in transportation planning and effective implementation: A case of Managua, Nicaragua

Takashi Shoyama
ALMEC Corporation, Tokyo, Japan

Kazuaki Miyamoto
Center for Northeast Asian Studies, Tohoku University, Sendai, Japan

ABSTRACT: This paper introduces the "Comprehensive Transportation Plan in Managua in the Republic of Nicaragua" conducted in 1998 by Japan International Cooperation Agency (JICA) with an emphasis on the interaction between land use and transportation planning. In the JICA Study, land use plan was explicitly formulated after a quantitative comparison of several alternative scenarios of urban development in terms of road traffic volume and investment cost for transportation infrastructure and urban redevelopment.

1 FORMULATION OF THE MODEL

Japan International Cooperation Agency (JICA) has conducted a number of urban transportation planning studies in large cities of many developing countries. Long-term transportation planning should always be carried out in parallel to or in conjunction with, land use planning because large cities in developing countries are characterized usually by rapid urbanization. However, in the JICA Studies, land use planning has been done in a limited manner such as projection of population, employment and car ownership by zone. Namely, land use planning was not done in the real sense of the word. The situation is the same also for other studies conducted by other donor organizations. The reasons are threefold:

1 Land use plan is sometimes existing though it is often ineffective.
2 Land use plan should not be prepared merely based on transportation aspects. It requires huge inputs and efforts of various fields to work out an effective land use plan.
3 There is often no guarantee for a newly prepared land use plan to be implemented and followed due to deficient administrative systems.

In Managua, however, the situation was different on the following points:

1 Land use plan was not existing excluding the former Central Business District (CBD), which was seriously destroyed by the earthquake in 1972.
2 Managua is a compact city with a population of 1.2 million as of 1998, and maps of current land use were readily available.
3 Urbanization of Managua is apparently led by road development. Land use control was considered essential to construct an environmentally sustainable city.
4 The city government of Managua intended to authorize and enforce the land use plan.

Thus, in the "Comprehensive Transportation Plan in Managua" conducted by JICA in 1998, the Study Team has decided to work out a land use plan explicitly in the form of zoning maps. This paper aims mainly to introduce the process of this land use planning.

2 SOCIO-ECONOMIC CHARACTERISTICS OF MANAGUA CASE STUDY

Managua with an area of about 3,465 square kilometers, is the capital of Nicaragua. It is located along the southern shore of the Managua Lake and its urbanized area is approximately 250 square kilometers.

A devastating earthquake hit and destroyed Managua in 1972. Since then, disorderly urbanization of low rise buildings went on towards the suburbs and the damaged city center was left untouched. Furthermore, a civil war occurred in 1979 between the Sandinista government and the Contras supported by the US government and it continued until the cease-fire in 1990. During this period, Nicaragua's economy was strangled and its negative growth continued until 1993. Nicaragua's social and economic recuperation has started only a few years ago. Population of Managua was estimated at 1.2 million in 1998. Per Capita GDP in Managua is about US$ 620, 50% higher than the national average (US$ 420). Nicaragua is one of the least developed countries in Central and South America. However, its car ownership is relatively high at about 20%.

In 1998, the total number of trips generated in a weekday in Managua was about 2.5 million in which 95.8% were made by residents in Managua and the remaining 4.2% by non-residents. In Managua, private mode shares 36.5% and public mode 35.1%. The remaining 28.4% is by non-motorized modes such as walk and bicycle. Of the private mode, cars share nearly 80%, and the bus is the only choice of the public mode. Namely, the modal choice in Managua is simple, i.e. car or bus.

The total road length in Managua is estimated at approximately 1,100 km at present. It is composed of 4-lane and 2-lane roads. Most of major arteries are of 4 lanes in urban areas but there are still many 2-lane road sections that should constitute the basic network.

The most heavily trafficked road section is the Pan-American Highway with a traffic volume of about 55 thousand vehicles per day. Some other roads also show a large traffic volume of about 30 to 45 thousand vehicles. In a few sections, volume/capacity ratio exceeds 1.0.

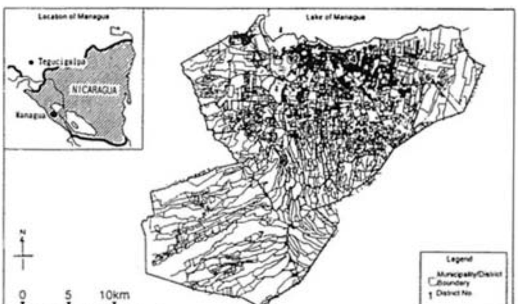

Figure 1. Study Area

Figure 1. Traffic Volume on Major Roads, 1998 (24 h

Table 1. Socio-Economic Profile of Managua

Indicators	Managua	
Population: 000	1,200	
No. of Viviendas: 000		
Average Vivienda Size	6.25	
Employment: 000 (%)	349.3	(100.0)
Primary	4.1	(1.2)
Secondary	73.5	(21.0)
Tertiary	271.7	(77.8)
No. of Students/Pupils: 000	413.3	
Average Income/Viviendas: C$/month	2,470	
Car Ownership		
Car Owning Vivienda: %	19.9	
No. of Registered Vehicles (inc. motorcycle): 000	51.5	
Ownership Rate: No. /000 pop.	43	

Source: Person-trip survey (1998) and various official statistics

Note: Employment and school attendance are at workplace and school place, respectively. US$ 1= C$ 10.

3 CURRENT LAND USE PLANNING IN MANAGUA

At present, there is no legal basis with regard to land use planning at the national level. At the city level, however, some regulations are existing. In the case of Managua, they are:

1 Master Plan of Central Area of Managua (1994)
This plan was authorized in 1994 for the former CBD destroyed by the earthquake in 1972. The planning area is 520 ha. Following this plan, major construction works have not been implemented until recently.

2 Regulatory Plan of Managua (1982 and 1984)
This plan includes regulatory guidelines on zoning, land use, construction permit, road structure, parking and so on. However, no actual regulation in the form of maps is not shown.

3 General Plan of Urban Development of Managua
The city of Managua is currently conducting this planning study. The result of the JICA Study is expected to form part of this plan since close discussions were held between the city and the study team.

At the time of the JICA Study, the only effective land use plan was for the former CBD of Managua. The fact that the city intended to legalize a land use plan for the entire area of Managua was one of the major incentives for the JICA Study Team to work out a land use plan.

4 ISSUES ON LAND USE PLANNING

4.1 *Strenghtenign of Land Use Control*

As stated earlier, disorderly urbanization is ongoing outward along major arterial roads in the absence of effective land use control. One of the outstanding characteristics of Managua's land use is the relatively low population density of about 100 persons per ha in the built up areas. This can be attributed partly to the complexity of land ownership due to the claim to recover land ownership of expatriates who fled from the country during the civil war. However, the major reasons are the high land price in the built-up areas and the availability of cheap land in the suburbs. If effective land use is not implemented, low-density urbanization will further expand towards the suburbs and requirement for urban infrastructure development and vulnerability against environmental hazards will increase enormously.

The population of Managua was projected to grow from 1.2 million in 1998 to 1.4 million in 2003, 1.6 million in 2008 and 2.0 million in 2018. Per Capita GNP will also grow from US$ 620 in 1998 to US$ 1,150 in 2018.

Therefore, the major objectives of the study were, a) to determine the size of the city to accommodate the projected population, and b) to determine realistically the use and the density of the planned urban area.

4.2 *Needs for Transportation Infrastructure Development*

Car ownership in Managua was projected to grow from 20% in 1998 to 41% in 2018. Coupled with the population increase, transportation demand will grow very rapidly, and it was forecast that chronic traffic congestion would occur in a few years. To cope with the increasing transportation demand, it is imperative to promote road development. However, the problem of traffic congestion has never been solved in the world merely by increasing road infrastructure. Moreover, it is uneconomical and environmentally undesirable to rely heavily on road development. Severe financial constraints inevitably require a combination of various countermeasures, such as:

- Restriction of car use
- Enhancement of public transportation system
- Transportation demand management

These countermeasures however require in depth planning before implementation. Particularly in relation to the enhancement of public transportation system, land use planning plays a vital role. In the JICA Study, the concept of "Public Transportation Corridor" was highlighted in providing quality public transportation service as well as in guiding future land use properly to create urban axes for business and commercial activities.

4.3 *Limited Financial Resources*

The investment for the transportation sector of Managua in 1999 was US$ 7.4 million, of which US$ 1.5 million was grant aids from foreign organizations. At present, Nicaragua is restricted by a guideline set by IMF to prohibit the arrangement of new loans with international funding sources. Although the budget envelope for Nicaragua is expected to increase significantly in the future, investment requirement is far greater than the budget envelope.

Thus, it has become one of the major tasks for the Study Team to recommend new fund sources, and, more realistically, to prepare an economical investment program implementable on the balance of transportation and land use planning.

Table 3. Comparison of Traffic Situation of Development Scenarios

Indicator (on 1998 network)	1998	2018		
		Scenario I	Scenario II	Scenario III
Average Trip Length (km)	3.16	4.15	5.94	5.13
Ratio	100	131	188	162
Passenger-km (000/day)	5,818	16,645	23,735	20,483
Ratio	100	286	408	352

Table 2. Future Socio-Economic Framework of Managua

	1998	2003	2008	2018	Growth Rate (% p.a.)		
					98-03	03-08	08-18
Population (000)	1,200	1,384	1,574	1,964	2.9	2.6	2.2
No. of Viviendas (000)	192	221	252	314	2.9	2.6	2.2
GRDP (US$ million)	745	977	1,287	2,250	5.6	5.7	5.7
GRDP per Capita (US$)	620	710	820	1,150	2.7	2.9	3.4
Economically Active Population(000)	454	547	645	864	3.8	3.4	3.4
Unemployment Rate (%)	21.2	19.4	15.9	6.1	-	-	-
No. of Students/Pupils (000)	413	501	594	800	3.9	3.5	3.0
Car Ownership (%)	19.9	23.9	27.5	40.5	-	-	-
Average Vivienda Income							

5 POSSIBLE SCENARIOS FOR URBAN DEVELOPMENT

If the city size becomes compact, the efficiency of urban activities becomes high, while the cost of urban redevelopment and vulnerability against earthquakes will increase. On the other hand, if urbanization expands without control, the cost of developing urban infrastructure will be enormous, while existing built-up areas will be left untouched. In the JICA Study, the following three (3) scenarios with different urban areas and population density were compared in terms of transportation network performance using the models developed for this purpose:

- Scenario I: Mono-Polar High-Density Development which assumes a compact city with the present CBD and a large-scale redevelopment in the existing built-up area.
- Scenario II: Extended Low-Density Development, which is actually the extension of current urbanization with scattered functional distribution.
- Scenario III: Corridor Controlled Development which assumes a planned urbanization with determined urban axes and urban redevelopment in critical areas.

Scenario I requires a very high government capability in land use control and enforcement, and Scenario III assumes a careful planning of land use control and public transportation development. For Scenario III, two routes of east-west segregated busways of 30 km were assumed. (Existing 4-lane road will be widened to 6-lane road using existing right of way and the central 2 lanes will be used as exclusive busway. Upgrading of this busway to rail transit becomes possible in the future.)

These scenarios were evaluated from the transportation points of view using demand forecast models.

1 Average trip length and passenger-km on the road network is the smallest in Scenario I. If road development is conducted in proportion to passenger-km, development requirement of Scenario II and III becomes higher than Scenario I by 65% and 35%, respectively.
2 The requirement for urban redevelopment is about 4,000 ha for Scenario I, 900 ha for Scenario II and 1,200 ha for Scenario III. The cost of urban redevelopment is enormous in Scenario I although most of the cost is needed in the latter half of the planning period (2009-2018).
3 High density development and redevelopment assumed in Scenario I may be vulnerable to possible earthquakes.

Based on the discussion above, Scenario III was selected as the most realistic development scenario

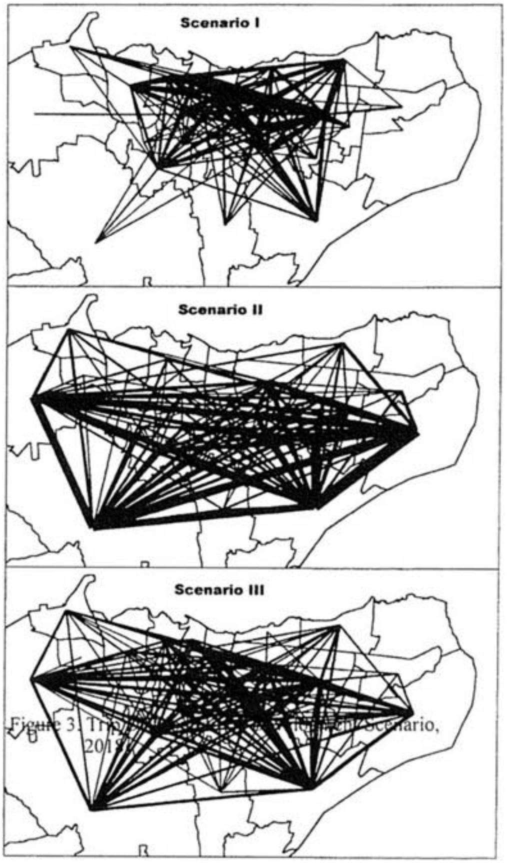

Figure 3. Tr[illegible]ario, 2018

Table 4. Land Use Comparison of Alternative Scenarios, 2018

	1998			Scenario I			Scenario II			Scenario III		
	Area (ha)	Population (000)	Population Density (pers/ha)	Area (ha)	Population (000)	Population Density (pers/ha)	Area (ha)	Population (000)	Population Density (pers/ha)	Area (ha)	Population (000)	Population Density (pers/ha)
1. Urban Area	12,972	1,118.4	86.2	15,341	1,87.,8	122.0	22,956	1,912.8	83.3	19,447	1,902.8	97.8
1.1 Existing Urban Area	12,358	1,116.6	90.4	12,358	1,814.4	256.8	12,358	1,204.6	97.5	12,358	1,402.7	113.5
- Central	8,581	913.6	106.5	8,581	1,423.4	146.8	8,581	813.6	84.8	8,581	1,011.7	117.9
- Peripheral	3,777	203.0	53.7	3,777	391.0	103.5	3,777	391.0	103.5	3,777	391.0	103.5
1.2 New Urbanization	614	1.8	2.9	2,983	57.4	19.2	10,598	708.2	66.8	7,089	500.1	70.5
- Residential	-	-	-	326	41.3	126.7	7,122	686.4	96.4	3,713	478.3	128.8
- Industrial	-	-	-	350	-	-	500	-	-	350	-	-
- Academic	-	-	-	-	-	-	150	-	-	-	-	-
- Airport	614	1.8	2.9	614	1.8	2.9	614	1.8	2.9	614	1.8	2.9
- Others	-	-	-	1,693	14.3	8.4	2,212	20.0	9.0	2,412	20.0	8.3
2. Rural Area	41,724	81.9	2.0	39,255	92.0	2.3	31,640	51,000	1.6	35,149	61.0	1.7
TOTAL	54,596	1,200.3	22.0	54,596	1,963.8	36.0	54,596	1,963.8	36.0	54,596	1,963.8	36.0

for the long-term (2018). The scenario assumes an ample space for the increasing population, poly-centric structure with urban axes and coordinated control on land use. Due, however, to the excellent performance of Scenario I, its concept was taken in the short-term and medium-term when population increase is not so remarkable

For the selected urban development scenario, future traffic demand was projected. Total number of trips will increase from 1998 by 34% in 2003, by 58% in 2008 and by 119% in 2018. The modal share of private mode will increase continuously. Public transportation will lose its share from 50% in 1998 to 40% in 2018 by 10%.

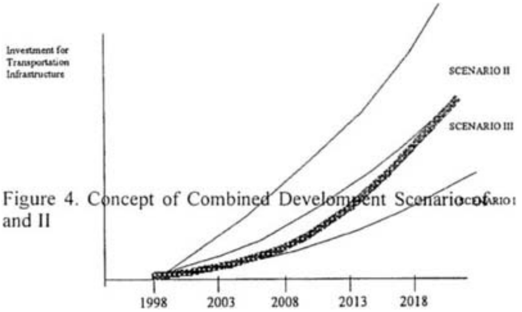

Figure 4. Concept of Combined Development Scenario I and II

Table 5. Future Traffic Demand (excluding Walk Trips)

	1998	2003	2008	2018
No trips (000/day)				
- Private	871.3	1,200.7	1,485.9	2,323.7
- Public	880.0	1,138.7	1,277.8	1,514.2
- Total	1,751.3	2,339.4	2,763.7	3,837.9
Modal Share (%)				
- Private	49.8	51.3	53.8	60.5
- Public	50.2	48.7	46.2	39.5

6 STRATEGIES FOR FUTURE LAND USE

In Managua, road development has always been followed by urbanization. A vicious cirle tends to be created between urban sprawl and road development. The development of roads in Managua thus should be strictly controlled in a well-planned manner in accordance with the land use plan. This, however, requires an enhanced planning capacity and a strong enforcement capability in the City's administration. In the JICA study, a series of discussions were held between the city staff and the study team in order to work out a desirable and implementable land use plan. Various land use alternatives were checked not only from the viewpoint of city planning but from the viewpoint of road and public transportation development. Particularly for road development, its implementation program was prepared strictly in accordance with the land use plan. Actually the study process was an iteration of land use planning, traffic simulation and road and public transportation planning.

The strategies of land use plan in Managua can be summarized as follows:

1 Short-term (2003)

- Taking into account the existing developments and currently ongoing projects, the basis for creating urban axes should be formed in terms of land use and transportation infrastructure development.
- Urbanization should be confined in the existing urban area to make maximum use of the existing resources.

2 Medium-Term (2008)

- A clearly defined structure for urban axes of Managua should be constructed.
- Similar to the short-term strategies, the existing resources should be utilized to the maximum extent. However, controlled expansion of urbanization mainly towards the east and the west could be admitted.

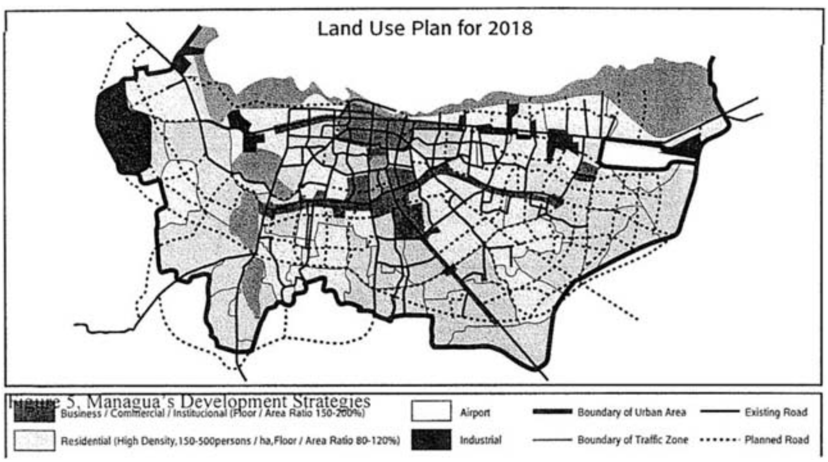

Figure 5. Managua's Development Strategies

	Area (ha)	Population	Density (psn/ha)	Area (ha)	Population	Density (psn/ha)	Area (ha)	Population	Density (psn/ha)	Area (ha)	Population	Density (psn/ha)
1. Urban Area	12,35	1,116,57	90.	12,35	1,285,90	104.1	15,536	1,493,700	96.1	19,447	1,902,800	97.8
1.1 Existing Urban Area	12,35	1,116,57	90.	12,35	1,285,90	104.1	12,358	1,402,700	113.5	12,358	1,402,700	113.5
• Central	8,58	913,56	106.	8,58	962,60	112.2	8,581	1,011,700	117.9	8,581	1,011,700	117.9
• Residential/Others	7,58			7,49			7,311			7,281		
• Commercial/Service	63			72			910			940		
• Industrial	36			36			360			360		
• Peripheral	3,77	203,00	53.	3,77	323,30	85.6	3,777	391,000	103.5	3,777	391,000	103.5
• Residential/Others	3,77			3,76			3,754			3,732		
• Commercial/Service							23			45		
1.2 New Urbanization							3,178	91,000	28.6	7,089	500,100	70.5
• Residential/Others							602	78,500	130.4	3,713	478,300	128.8
• Commercial/Service							3			30		
• Industrial							168			350		
• Others							2,405	12,500	5.2	2,996	21,800	7.3
2. Rural Area	42,33	83,71	2.	42,33	97,70	2.3	39,060	80,100	2.1	35,149	61,000	1.7
Managua Total	54,59	1,200,28	22.	54,59	1,383,60	25.3	54,596	1,573,800	28.8	54,596	1,963,800	36.0

3 Long - Term (2018)

- Urbanization will be expanded considerably. It must be controlled in the defined urban area, and roads should not be developed outside the urban area with a few exceptions that were necessarily proposed to avoid anticipated traffic congestion of the urban road network.
- Urban axes should be extended to the newly urbanized area by creating urban activity centers.

7 LAND USE PLAN

Managua's land use plan was prepared for the short-term (2003), medium-term (2008) and long-term (2018) in consistency with the transportation master plan and city planning requirements of the City. Moreover, urban axes are clearly identified in the plan considering the existing development initiatives, enhancement of public transportation service and economic revitalization of the City. When busways are implemented as proposed, the modal share of public transportation is forecast to grow by 2% for short and medium-term and by 6% for long-term. This will bring about huge economic and environmental benefits to the City.

In relation to land use control, the following points were incorporated in the land use plan.

- In the planned business/commercial/institutional area to be created as the urban axes, low-density residential use should be restricted. For this purpose, a relatively high floor/area ration (FAR) of about 150 to 200% should be specified. In the application of this restriction, the base FAR should be the minimum at 150%. Then the bonus FAR of up to 200% is given to the developer depending on the land provided for public use in the frontage area of the site. In any case, however, the building structure should be controlled to be earthquake-resistant.
- There are two types of residential areas: high-density and low-density. High-density residential area allows an FAR of 80-120%, which is suitable for two-story structure. The population density of this area is 150 to 500 persons/ha. Low-density residential area allows an FAR of

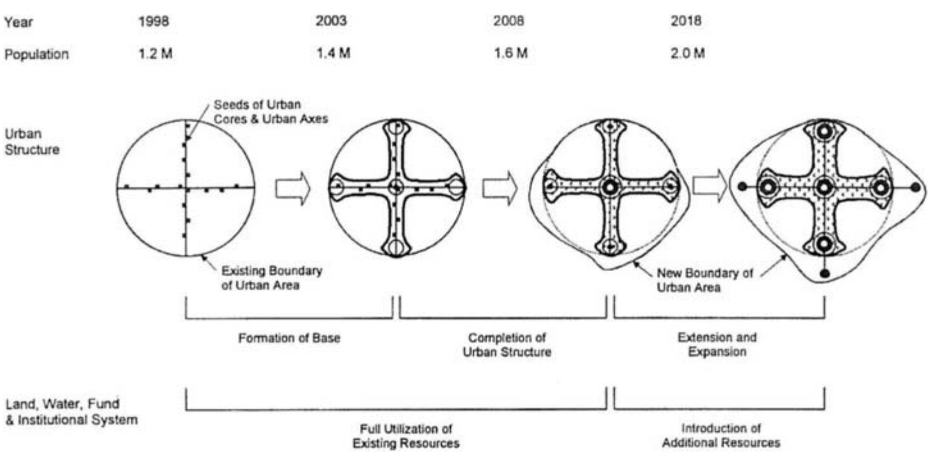

Figure 6. Land Use Plan for 2018

30-60% assuming one-story structure and a population density of 50 to 150 persons/ha. Considering the possibility of earthquakes, high-rise structure of more than three stories is not recommendable unless the structure is earthquake-resistant.

– Outside the planned urbanization, a strict land use control should be imposed to prohibit disorderly urban sprawl towards suburban areas.

8 CONCLUSION

In Managua, a land use plan up to the year 2018 was formulated by the JICA sponsored "Comprehensive Transportation Plan in Managua" in consistency with the transportation master plan and the City's planning requirements. The important feature of the study is that the land use plan was worked out explicitly (i.e. in the form of maps) unlike other usual transportation studies. Considering the planning and enforcement capacity of the City, the plan is expected to be soon authorized for implementation. Unfortunately, however, Nicaragua was hit by a series of natural disaster after the completion of the Study (Hurricane "Mitch" in 1998 and flooding in 1999). Due to the damage of the disasters, Managua's socio-economic and financial situation may have changed considerably. However, the land use plan worked out by the JICA study looks over for a long period. The plan would desirably be authorized and implemented at the earliest possible.

Lastly, acknowledgements are extended to Managua's counterpart staff, members of JICA and its advisory committee and the members of the Study Team for their valuable cooperation and advice during the study.

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A Review of land use model applications in transportation demand forecasting

Kazuaki Miyamoto & Varameth Vichiensan
Center for Northeast Asian Studies, Tohoku University, Sendai, Japan

ABSTRACT: This paper investigates the current state-of-practice of land-use model applications to transportation demand forecasting. The overview of application is briefed and the interaction structure between land-use and transportation is discussed. An alternative way to consider the integrated land-use and transportation models is proposed. Four example cases from UK and US are presented to illustrate the way in which land-use and transportation interactions are modeled in practices. The paper concludes with some emerging situation in land-use transportation modeling, and further study direction.

1 INTRODUCTION

Travel demand forecasting is one of the most essential steps in comprehensive transportation planning and individual transportation infrastructure development projects as well. However, the forecast has not been always so satisfactory when it is compared with the observed travel volumes after the implementation of the plan/project. In addition, emerging concern on the environment of air pollution and global warming, travel demand forecasting procedures are requested to have a higher ability to respond to changing lifestyles and social concerns as well as a wide range of policies and policy measures.

To respond to the social requirements to begin with the above-mentioned situations, the Department of Transportation, in cooperation with the Environmental Protection Agency, has embarked on Travel Model Improvement Program (TMIP) in U.S.A. with a variety fields in travel demand forecasting methods including land-use issues.

Also in Japan, with a similar motivation, the Ministry of Construction, which is in charge of road transportation plan and the implementation, has initiated a research and development project to improve the forecasting system in Japan. The research project covers all the processes in transportation planning and the plan implementation. One of the topics of the research project is to improve the application of land-use models to travel forecasting procedures.

The present paper is the first report of the ongoing study on the topic. This paper describes the first results of a review of the existing applications of land-use models in the travel demand forecasting procedure. Before the comparison of existing applications of the models, a scheme is introduced to classify the type of model structure with respect to interaction between land-use and transportation.

2 OVERVIEW OF THE APPLICATION OF LAND-USE MODELS TO TRANSPORTATION PLANNING

A number of land-use models have been developed since the Lowry Model in 1964, in spite of having such a criticism as Lee's requiem for large Scale models, and some 17 modern models are currently counted up in the world as reviewed by Wegener (1999). However, most of them are developed in the course of academic research and a few of them have been actually applied to practical transportation planning (Webster, Bly and Neil 1988 and Wegener 1994).

In the case of Japan, CALUTAS (Nakamura, Hayashi and Miyamoto 1983) has been applied to some real big transportation development projects but few other applications have been identified. Even in Europe, few applications other than those of MEPLAN (Marcial Echenique and Partners 1995) and DELTA (Simmonds 1999) have been found so far in this investigation. On the contrary, many Metropolitan Planning Organizations in the U.S.A. have been introducing land-use models in their transportation planning processes (Travel Model Improvement Program 1997).

In this paper, four model applications are selected for discussion based on a scheme for comparison proposed in this study. The selection was made mainly based on the availability of information.

3 INTERACTION STRUCTURE OF LAND-USE AND TRANSPORTATION IN SIMULATION MODELS

3.1 *Modeling structure*

In the transportation demand modeling, land use is modeled within different modeling frameworks; it can be the land-use model, the land-use module, or the unified framework of land-use and transportation. This variety treatment of land use result in three general configurations urban model of land use and transportation, Figure 1.

- A-type model is the sequential system of independent land-use model and transportation model. Land-use model represents land-use only, and transportation model deals transportation only. Land-use modeling framework ranges widely from the traditional conventional Lowry-type to the state-of-the-art disaggregated simulation framework. However, transportation modeling framework is usually based on conventional four-step model. The interactions between land use and transportation are modeled by external interfaces of the two models. Land-use model output is the input to transportation model, and vice versa. Examples of this kind of system include the DRAM/EMPAL land-use model with four-step-type models as in many US MPOs, UrbanSim land-use model with EMM/2 transportation model, DELTA land-use model with START transportation model, etc.
- B-type model is the interaction/composite system comprising of land-use module and transportation module interconnected to each other. Land-use module determines land use and sometimes implies transportation, and output to transportation module. The interactions between land use and transportation can be considered more integrated comparing with A-type model. B-type and A-type model structure are similar in that they both comprises of sub-model interacting by interface, but they are different in the integration extent of land-use and transportation. Example of this type of model include MEPLAN or TRANUS
- C-type model is the *unified/integrated system* of land-use and transportation. Land use and transportation are highly integrated modeled in a single framework. The model determines land use and transportation simultaneously, rather than a sequential determination of land-use and transportation separately as A-type or B-type model. The models of this type include MEPLAN, TRANUS, and ITLUP. And, those of the unified/truly-integrated-type include RURBAN (Miyamoto & Udomsri 1995), MUSSA (Martinez 1996).

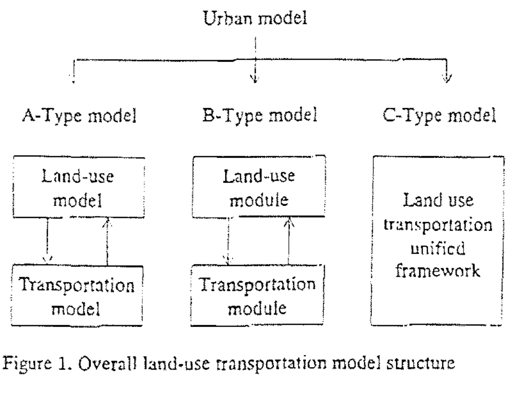

Figure 1. Overall land-use transportation model structure

However, in the past, some attempted to classify urban models into two categories by structure, which conforms to B-type and C-type models in this paper. Generally speaking, they are sometimes called as the integrated land-use and transportation models despite of different extent of land use and transportation modeling integration.

Wegener (1994) described the most common division of an urban system into eight subsystems: land use, networks, population, etc. Two groups of models were distinguished in reference to these subsystems. The unified models are those being formulated within a unifying principle and linking all subsystems into tightly integrated modeling system. And, the composite models are those being formulated as the independent subsystems interconnecting with each other.

Miyamoto & Sathyaprasad (1995) described the modeling interactions between land use and transportation, and distinguished the land-use transportation models into two groups. The interaction models have land use and transportation subsystems interacting each other through input and output. And, the integrated models simultaneously determine land use and transportation pattern as the outcome of the same choice process.

The concept of Wegener (1994) and Miyamoto & Sathyaprasad (1995) are similar in considering the model structure. This study builds upon those two, and further takes the integration extent of land use and transportation interactions into account.

3.2 *Representation of land use and transportation interactions*

Land use and transportation interactions may be observed in two directions: land use to transportation direction and the reverse direction. The above three types of model represent these interactions in different ways as shown in Figure 2.

In the land use to transportation direction, both A-type and B-type models, land-use effect to transportation is mainly represented by the land use variable attributes such as population, employment, in-

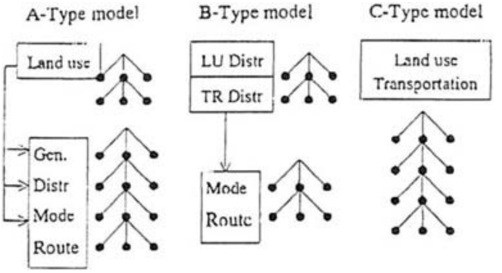

Figure 2. Land use and transportation interactions representation in three types of model

come, etc. These are input to the conventional four-step type transportation model or module either in the trip generation, trip distribution, or mode choice parts. The extent to which land-use data being used in the transportation models vary case by case (Purvis 1997, Oregon Department of Transportation 1995, San Diego Association of Government 1995.)

However, in some B-type models, the activity distributions from land-use module also imply the transportation demand distribution. This means the activity module already synthesizes trip generation and trip distribution. The resulting land-use and transportation are then input to the deducted transportation model for mode choice and route assignment.

In the C-type models, the land-use and transportation patterns are outcome of the same choice process; in the same choice hierarchy, location is a higher choice level and travel behavior is a lower choice level. Both land-use and transportation patterns are therefore determined simultaneously as one lump solution. Hence the effect of land use to transportation is then of the overall choice process.

Next, in the transportation to land use direction, different models have different representations but there is consensus in considering time lag effect of land use to transportation, i.e., transportation affects the land use and activity locations in the next time interval. The effect is the results of four-choice process: origin choice, destination choice, mode choice, and route choice, and it is fundamentally the resulting travel time. To better represent the travel time effect, a variety of derivations of travel time are often used such as accessibility measure, which is the opportunity of each location in accessing to different activities in other locations. In some models, the transportation effect is represented in terms of transportation monetary cost that is added to the production cost at a certain location, and affects the allocation of production activity.

In the A-type and some B-type models, the effect is input to location model which is itself a process of location choice and destination choice. There might lead to inconsistencies between origin-destination choice in transportation model/module and location-destination choice in land-use model/ module. There is no guarantee that the travel condition which land-use model uses is consistent with that the transportation model outputs.

In contrast, in the C-type model, the mobility disutility resulting from the lower choice is feedback to the higher choice of activity location because the transportation is the lower-level choice process. Since location and transportation choices are obtained under the unique choice process, this does not lead to any inconsistencies.

3.3 *Extent of land use and transportation interactions in modeling*

Based on the modeling structure, a land-use transportation model system may be considered as the interaction/composite (A-type and B-type) model or the truly integrated/unified (C-type) model. However, different levels of inconsistencies in the modeling framework may exist depending on how land-use and transportation interaction is modeled. Some B-type models may be considered an integrated models to some extent because the output from land-use are both activity distribution and travel demand distribution, conforming to the behavioral theory. Likewise, the A-type model may be considered more or less the same as the B-type model because the transportation and land use effect are represented in very similar way despite of separate modeling framework.

To classify the model into two discrete types of model either by modeling framework or land-use transportation interaction alone may not be sufficient. This study proposes a rather continuous range of modeling essences, Figure 3. Two extreme cases are of the left and the right end of the axis respectively. Two points of view are considered. From modeling structure point of view, the left end represents the model that comprises of the interacting independent land-use and transportation subsystems and determines land use and transportation separately. The right end represents the model that de-

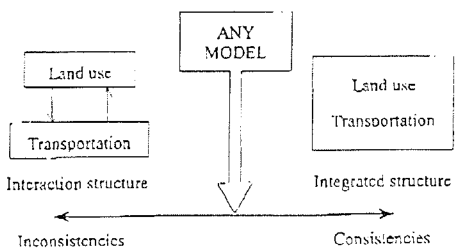

Figure 3. An axis representing land use and transportation integration extent

termines land use and transportation into one unique framework.

Next, from the consistency point of view, the left end represents the model having large inconsistencies between land use and transportation, whereas the right end represents the model having very consistent land use and transportation.

Comparing to Wegener (1994) and Miyamoto & Sathyaprasad (1995), the composite/interaction model is approaching the left end, whereas the unified /integrated model is approaching the right end. The proximity to each end depends on what extent land-use and transportation are integrated in interactions modeling. If it is so tightly integrated that it does not lead to any inconsistency, it will be the right most, and if it is so loosely interacted that inconsistencies explicitly exist, it will be the left most. A model of integrating structure but appears some possible inconsistencies, as well as a model of interacting structure but prove relatively high consistency

4 EXAMPLE OF MODELS

Four models, which are actually applied to practical travel forecasting, are selected to illustrate the discussion above: two of them are the recent practices in US, and another two in UK. For the two US cases, one falls on the left axis and another on the right axis, and this is also similar for the two UK cases. The main features of these four cases are shown in Table 1.

4.1 *Model structures*

Among the four models, the modeling framework varies case by case. San Diego model and Trans-Pennine model are of A-type. The San Diego model uses DRAM/EMPAL for activity location with the in-house developed four-step-type transportation model. The Trans-Pennine model uses DELTA land use model with the START strategic transportation model. The Oregon statewide model and the LASER model are of B-type, i.e., TRANUS and MEPLAN frameworks respectively.

4.2 *Time dimension*

Every model make forecast with a similar length of time, say 20 to 30 years. Time dimension is modeled as shown in Figure 4. The typical time step for both runs of land use and transportation models/modules is 5 years. However, the Trans-Pennine model runs DELTA land-use model every year and runs START transportation model every 5 years.

4.3 *Zone system*

In most models, the land-use zones are concurrent with the transportation zones except for the San Diego that has more detailed transportation zones.

Table 1. Summary of four model applications

	San Diego	LASER	Oregon Statewide	Trans-Pennine
Study area	San Diego MPO, US	London, UK	Oregon State, US	North England, UK
Forecast year	1995-2020	1991-2011	1990-2020	1991-2021
Land-use and transportation models	A-type	B-type	B-type	A-type
Time step	5	5	5	1 for land use 5 for transportation
Land use				
Land-use model	DRAM/EMPAL	MEPLAN	TRANUS	DELTA
Scale of application	Metropolitan	Metropolitan	Regional	Regional
Number of zone	208	84	145	109
Land category	Type of land	Type of floorspace	Type of regional land	Type of floorspace
Household category	By family structure	By employment type	By income level	By structure/ life stage
Transportation effect of	Travel time	Trade disutility	Trade disutility	Accessibility
Transportation effect in	Location choice	Location choice	Location choice	Area utility
Transportation				
Transportation model	In-house developed	MEPLAN	TRANUS	START
Essence of model	4-step	Deducted 4-step	Deducted 4-step	4-step
Number of zone	4,545	84	145	109
Public transportation	y	y	y	y
Non-motorized mode	y	y	n	y
Goods transportation	n	y	y	y
Transfer from land-use model	Activity location	Activity location, Trip matrix	Activity location, Trip matrix	Activity location
Effect of land-use in	Trip generation Mode choice	Trip generation Trip distribution	Trip generation Trip distribution	Trip generation
Interaction				
Time lag effect	y	y	y	y
Land use to transportation	Activity distribution	Trip OD	Trip OD	Activity distribution
Transportation to land use	Travel time	Travel time, Money transportation cost	Travel time, Money transportation cost	Accessibility
Transportation Policy Capability				
Investment and services	y	y	Project ongoing	y
Regulatory	y	y		y
Pricing	y	y		y

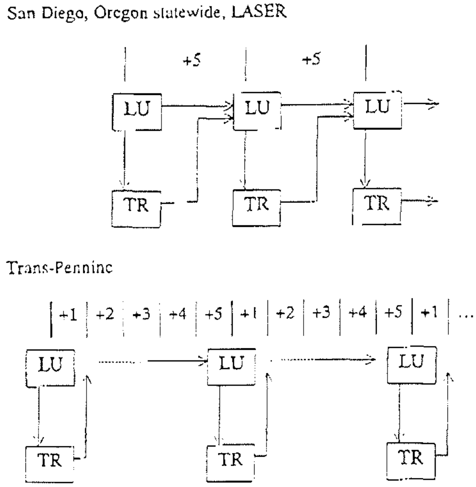

Figure 4. Time dimension

4.4 *Market segmentation*

In the land-use market, land-use category is based on floorspace type and availability in the urban models, however, other non-urban land type is also considered in some regional models. Households are usually crossclassified by household structure and employment status. In the transportation market, other modes than cars such as transits, walk, and cycling modes are considered in all models. Goods transportation is considered in the regional models and also in some urban models.

4.5 *Land use effect to transportation*

In the San Diego model and the Trans-Pennine model, land-use data from land-use model are the numbers of household, employment, land area, etc., and they are used calculating transportation demand in the transportation model. In addition to the trip generation that uses land-use data, the mode choice step of the San Diego model also uses income as one factor in modal split.

In the Oregon statewide model and the LASER model, land-use distribution is determined from land-use module, and this implies the transportation demand. Therefore, multiplying the land-use (activity) distribution with some factors gives transportation demand distribution.

4.6 *Transportation effect to land use*

As discussed in Section 3, the land use effect to transportation is the travel time in principle, but its representation varies case by case. The San Diego model directly uses travel time in the employment allocation. The LASER model and the Oregon statewide model incorporate travel time and monetary transportation costs in activity allocation. The Trans-Pennine model calculates area accessibility and secondary environmental value.

4.7 *Extent of land use and transportation interactions in modeling*

On the axis of integration level, the four models may stand in different positions, as shown in Figure 5.

The San Diego model, of A-type, comprises of separated land use and transportation models and its land use and transportation interactions are relatively loose and conventional. It is essentially on left axis and relatively close to the end.

The Trans-Pennine model is comparably similar to the San Diego model in the sense that it comprises of different framework models, however, the land use and transportation interactions are more substantially considered. Although it may be on left axis but tends to move rightward.

The LASER model and the Oregon statewide model have very similar structures; B-type. Furthermore MEPLAN and TRANUS are very similar in theoretical framework. Since the model structure comprises of land-use and transportation modules rather than unique simulation module, in this sense, they fall on the left axis. However, the activity location distribution and the transportation demand distribution are determined at the same time which indicates lower consistencies, in this sense, they can be on the right axis. Then compromising these two considerations, these two models are moderate between completely interaction model and completely integrated model, and may be somewhere between Trans-Pennine model and the rightmost-model.

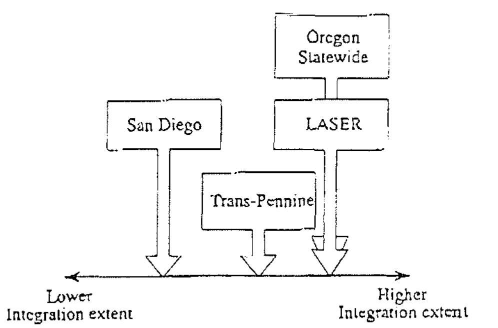

Figure 5. Four example models on the axis representing extent of land use and transportation integration

5 CONCLUDING REMARKS

A number of urban models are reviewed and compared from the additional viewpoint of land-use transportation integration extent. The effort in linking land-use model with existing transportation model (falling in the A-type model) are increasingly popular in practices due to less implementation effort required. However, the extent to which the two models are integrated is different matter because the inconsistencies of land use and transportation may exist. Therefore, the extensive consideration is required to minimize any possible inconsistencies. These ongoing attempts include the UrbanSim land-use model linked with Emme/2 transportation model, the MENTOR model (based on MEPLAN) linked with SATURN model, etc. In practical transportation planning, still there are not many truly integrated land-use transportation models (rightmost model) being widely and efficiently used. This study seeks the ways to approach such truly integrated system and at the same time operationally feasible. A larger numbers of models, in addition to the four models presented in this paper, are being reviewed from several points of consideration and will be presented in subsequent reports

The authors would like to express their sincere gratitude to Prof. Michael Wegener, Professor Roger Mackett, Prof. Anthony May and Dr. David Simmonds for their valuable comments at the start point of this study. In addition, they also extend their hearty thanks to the model builders and users for providing them with important information for the study.

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Integrating development and transport planning in the new South Africa

L'integration du développement avec la planification des projets de transport en Afrique du Sud

La planificación integrada del desarrollo y del transporte en Sud África

Kostas Rontiris
Independent Consulting Engineering, Johannesburg, South Africa

Mike Krynauw
Land Use and Planning Directorate, Greater Pretoria Metropolitan Council, South Africa

ABSTRACT: Recent local government legislation in South Africa calls for the preparation of Integrated Development Plans. At the same time, land transport legislation calls for the preparation of Integrated Transport Plans. Transportation is one of the fundamental elements of the Integrated Development Plan, specifically in terms of its spatial development framework. This paper examines the strong functional relationship between the two planning processes and explains the difficulties encountered in trying to integrate them.

RÉSUMÉ: La legislation recente des government locals en Afrique du Sud demande la preparation des "plans" de development integré. En meme temps la legislation pour transport terrestre a besoin de la planification integré de transport. La transportation est un des elements fundamentales pour la politique developmentale integré particulierment en termes du cadre du development spasiale. Cette presentation ci examine la forte relation functionale entre les deux projects examinants et explique le difficultés rencontré avec les efforts pour l'integration.

RESUMEN: Legislacirn promulgada recientemente en Sud Africa, respeto al gobierno local, manda la preparacirn de Planes Integrales de Desarrollo. Aslmismo, legislacirn respeto a transportes terrestres manda la preparacirn de Planes Integrales de Transportes. La transportacirn es uno de los elementos fundamentales del Plan Integral de Desarrollo, especificamente en thrminos de su marco espacial de desarrollo. Este papel investiga la poderosa relacirn funcional entre los dos procesos de planificacirn y explica las dificultades encontradas en su integracirn.

1 THE LEGAL FRAMEWORK

Since the demise of apartheid in 1994, the South African government has started with a process of fundamental restructuring on the laws regulating firstly the structure, powers and functions of municipalities and secondly the land transport system in the country. During the apartheid era, planning laws and legislation used to translate apartheid ideology into physical and spatial reality. This generated local policies that promoted sprawl, class and racial separation and enormous disparities in the quality of services. To address the legacy of the past distortions within the context of scarce resources and limited capacity, it was imperative to introduce new planning approaches and to rationalise apartheid planning legislation.

The new planning approach requires a shift from the traditional understanding of preparing structure plans to guide land use control and regulation and transport plans to guide public infrastructure investment. A key factor of the new planning approach is the recognition that development is a dynamic and ever-changing process and needs to be accommodated in an appropriate planning system.

Notable among the new planning legislation are the Local Government Transition Act of 1993 and the Development Facilitation Act of 1995. The first piece of legislation sets the parameters within which the municipalities could operate and initiate the integrated development planning process. The second piece of legislation establishes mechanisms to fast track land development based on a framework and principles that promote integration and redistribution. Of particular importance to the subject of this paper are two new pieces of draft legislation, namely the Municipal Systems Bill, 1999 and the National Land Transport Transition

Bill, 1999. Both are in the process of being promulgated and will become the law of the country early in the year 2000.

1.1 Municipal Systems Bill

This Bill provides for the core principles, mechanisms and processes that are necessary to enable municipalities (including metropolitan authorities) to move progressively towards the social and economic upliftment of communities and ensure universal services that are affordable to all. The Bill also provides for the preparation of Integrated Development Plans. These provide a framework for support, monitoring and standard setting by other spheres of government in order to progressively build local government into an efficient, frontline development agency capable of integrating the activities of all spheres of government for the overall social and economic upliftment of our communities.

1.2 National Land Transport Transition Bill

The National Land Transport Transition Bill provides for the transformation and restructuring of the land transport system. A key element of this Bill is the preparation of Integrated Transport Plans by planning authorities (municipalities). These plans will be developed to enhance the effective functioning of cities through integrated planning of transport infrastructure and facilities, transport operations, including freight movement and public transport services within the context of the Integrated Development Plans for their area. The Integrated Transport Plans must also be able to direct employment opportunities and activities, mixed land uses and high density residential development into high demand public transport corridors interconnected through development nodes within the corridors, and discourage urban sprawl.

2 THE INTEGRATED DEVELOPMENT PLAN

2.1 Definition

An Integrated Development Plan is a plan aimed at the integration of development and management of the area of jurisdiction of a municipality. This plan is a complex action plan, which requires the integration and linking of complicated urban elements and processes. It is a single, all inclusive plan that links, integrates and coordinates other plans and proposals, forms the policy framework and general basis on which annual budgets are based and aligns resources and capacity of the municipality for the implementation of the plans.

2.2 Contents of Integrated Development Plans

An Integrated Development Plan reflects:

- the municipal council's vision for long term development of the municipality with special emphasis on the municipality's most critical development and internal transformation needs;
- an assessment of the existing level of development in the municipality across all sectors, which must include an identification of communities which do not have access to basic municipal services;
- the council's development priorities and objectives;
- the council's development strategies spanning across the sectors of social and community services, transport, infrastructure, housing, public safety, emergency services, environmental management, etc.;
- a spatial development framework;
- operational strategies;
- financial plan; and
- the core components of the municipality's performance management system.

3 THE INTEGRATED TRANSPORT PLAN

3.1 Definition

An Integrated Transport Plan is a plan aimed at the integration of the transport system by providing for the regulation, provision, use and management of transport infrastructure, operations and services by operators of public transport, freight and private travellers.

3.2 Contents of Integrated Transport Plans

The Integrated Transport Plan must formulate the municipality's official vision, policy and objectives for land transport and must give due regard to the relevant Integrated Development Plan. The plan must at least:

- specify any changes to the municipality's land transport policies and strategies since the previous plan;
- include a list showing, in order to precedence, the projects to be carried out and the cost of each. This list must be prepared with due regard to the relevant Integrated Development Plan;
- include all modes of transport and infrastructure, including new or amended roads, airports, harbours (where applicable) and commercial developments having an impact on the land transport system;

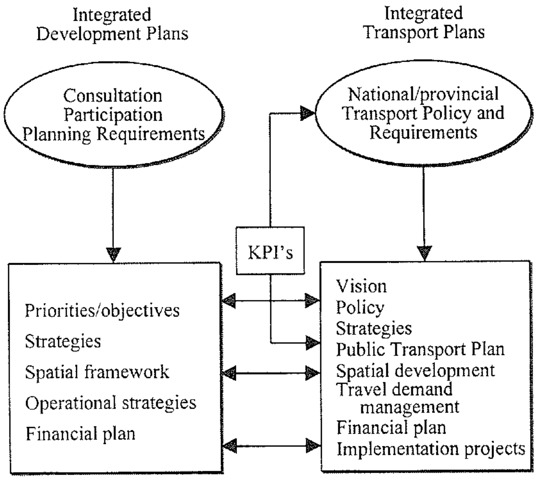

Figure 1 : Functional interrelationship of planning processes

- include the municipality's transport budget, including funding sources with regard to land transport for the relevant financial year;
- include the municipality's public transport plan;
- set out a general strategy for travel demand management;
- set out a road and transport infrastructure provision, improvement and maintenance strategy, and
- set out a general strategy or plan for the movement of hazardous substances by road along designated routes.

4 RELATIONSHIP OF TRANSPORT WITH DEVELOPMENT PLANNING

It is the clear intention of government that land transport planning must be integrated with the land development process. As prescribed in transport legislation the Integrated Transport Plan must form the transport component of the Integrated Development Plan. The functional interrelationship of the two planning processes is shown in Figure 1.

5 THE CHALLENGE IS REAL INTEGRATION

In order to achieve real integration of the planning processes into a single process, the Greater Pretoria Metropolitan Council has developed the Single Planning process depicted in Figure 2.
As it can be seen this process integrates all the elements of the development planning process with the transport planning process elements.

6 PROBLEMS AND ISSUES

Whilst the enabling legislation on both the municipal and transport arenas is calling for the integration of development and transport plans, the road to achieve this ideal situation has not been easy. A number of problems have been encountered, the most important ones being:

i) institutional arrangements: The plans are the responsibility of different municipal departments with differing line functions.

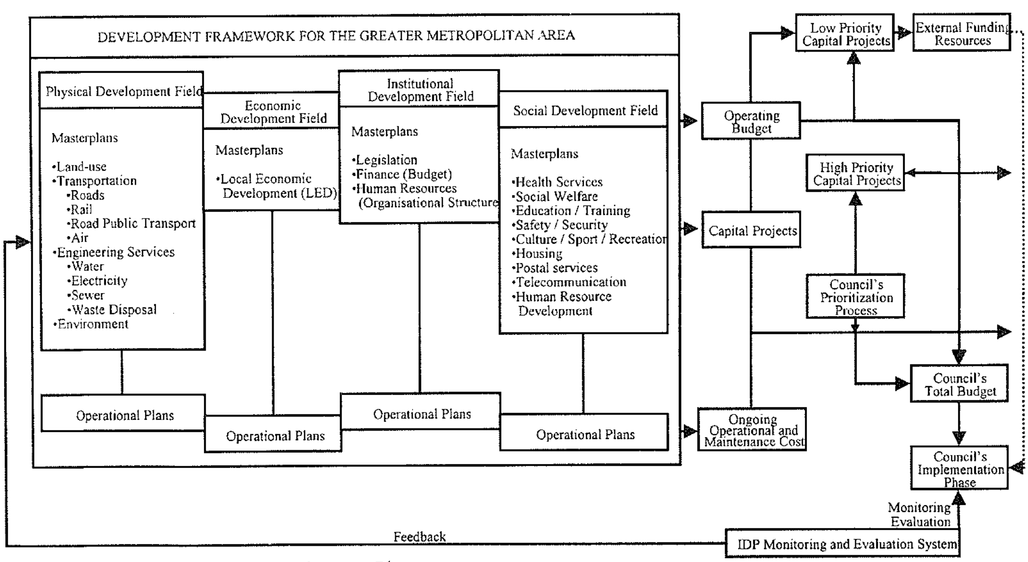

Figure 2 : The Single Integrated Development Plan

Coordinating mechanisms are necessary in order to achieve the alignment of the two processes. This proved to be time consuming and has added to the myriad of meetings, sub-committees and puts additional strain to the human resources of municipalities.

ii) time frames: The preparation of the plans has not been synchronised yet. Budgetary constraints and council procedures for initiating the plans has resulted in most cases that the one process is more advanced than the other. This makes coordination difficult and delays the completion of the process.

iii) public participation and consultation: The public participation is an important aspect of both processes and the integration of the two processes resulted in confusion over "who is doing what and when". This means that the public participation channels and participative forums had to be restructured on the basis of the integrated process. When such changes occur, credibility of the planning process always becomes an issue.

iv) Availability of skills: The core planning skills of facilitation and strategic planning necessary for the integration of the planning processes are not adequately conceptualised. Private sector planners are required to fulfill roles and provide skills and experience which depart from those which have generally characterised the practice of their profession. The physical planning skills of the traditional town and regional planner are not the central skills required to manage integrated development planning. IDP requires management skills, sectoral and technical expertise, multidisciplinary coordination, interpersonal abilities, teambuilding and motivational capacities.

7 CONCLUSIONS

South Africa is promulgating legislation that will result in the "single" development planning process, by which future development is achieved in an orderly, sustainable manner, and in which the necessary financial resources for such development are allocated in a disciplined and responsible manner.

Such planning incorporates transport as a key element and attempts to establish what resources exist, what people's skills are, what institutional strengths exist and what results are expected within any given period of time. Translated into the language of local government and despite the problems experienced, this can be simplified to the process of establishing a specific development programme and allowing for an ongoing process of change, adaptation and refinement to the benefit of all the people of South Africa.

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Barriers to cost-effective transport

Barrières aux mesures pour le transport qui sont rentables

Barreras que previenen rentable transporte

Geoff Gardner
Transport Research Laboratory, Crowthorne, UK

Derek Quinn
Leeds City Council, UK

ABSTRACT: Medium sized cities in developing countries need to be able to identify their main transport problems as quickly and cheaply as possible. A brief city-audit using a comprehensive inspection framework can highlight the key issues and provide initial guidance on suitable cost-effective solutions. Such an inspection manual has been developed and trialled in several cities, and the results of this work are reported here.

RÉSUMÉ: Les villes moyennes dans les pays en voie de développement doivent pouvoir identifier leurs problèmes principaux de transport en tant que rapidement et à bon marché que possible. Un bref ville-audit utilisant un cadre complet d'inspection peut mettre en valeur les questions clés et fournir des conseils initiaux sur les solutions rentables appropriées. Un tel manuel d'inspection a été développé et trialled dans plusieurs villes, et les résultats de ceci fonctionnent, financé par le gouvernement britannique sont enregistrés ici.

RESUMEN: Las ciudades de tamaño mediano en países en vías de desarrollo necesitan poder identificar sus problemas principales del transporte como rápidamente y barato como posible. Una ciudad-intervención abreviada que usa un marco comprensivo del examen puede destacar las cuestiones claves y proporcionar a la dirección inicial en soluciones rentables convenientes. Tal manual del examen se ha desarrollado y trialled en varias ciudades, y los resultados de esto trabajan, financiado por el gobierno británico están señalados aquí.

1 INTRODUCTION

This paper describes a project funded by the UK Department for International Development to develop a low-cost means of improving cost-effective transport in developing cities. The output of the research takes the form of a manual that can be given to practitioners for use in the field.

1.1 *AIMS*

The main aim of the project is to improve the availability of cost-effective transport for the rural and urban poor, including public transport and non-motorised modes. A further aim is to increase the ability of developing city governments to introduce energy efficient transport systems.

In pursuance of this aim the objectives are to help developing cities to identify as quickly and as cheaply as possible the main problems that exist in the field of transport. This is achieved through the production of guidelines for a cost-effective audit of performance and, during the project itself, by direct contact between the project team and ten developing city transport authorities.

The beneficiaries should comprise all urban travellers including women and the urban poor. In addition, efforts will be made to reduce wasteful expenditure on prestigious but inappropriate schemes. Monies thus freed will be available for investment in the social and welfare sector.

1.2 *BACKGROUND*

Almost all research into urban transport problems has taken place in developed countries. Traffic characteristics in developing cities can be very different. As car ownership levels rise dramatically, many of the World's cities are facing unprecedented levels of traffic congestion. Resulting time delays, pollution and road accidents are a major concern. A third of the global energy consumption and associated pollution arises from transport activities. Air and noise pollution is particularly severe in cities of developing countries whose streets are prone to traffic congestion. Contrary to popular belief, these problems are not inevitable. Techniques exist today that can help to minimise congestion and improve the environment.

An audit can provide clear evidence of the improvements that could, and should, be made. It is important that developing city leaders should recognise that change is possible.

Work by White(1994) and Crafer (1995) and others has shown the importance of road safety audits in the UK. In areas where there are no centrally prescribed road design standards, the need for an independent expert scrutiny is likely to be even greater.

The history of externally-funded traffic and transport projects in developing cities is a sorry tale of good ideas that have failed to come to fruition (Barrett, 1984). Work in Jakarta, Bangkok, Cairo, Abidjan and Nairobi have all failed to deliver and sustain the expected benefits. One common approach to a transport study is to use a large transport-planning model. These face particular problems: the software used may not have continuing local support - especially if the project over-runs, as is common. Study teams might break up if local staff get better offers based on their new-found computer and language skills. Often a study will take so long that a new administration might take over and may be unwilling to ratify the findings of a study not sponsored by them. Whatever the reason, there is a very good chance that the results of a large transport study imposed upon a city will be unsustainable (and indeed may well end up in a dustbin). Rather than a detailed study of one particular city, therefore, this research sets out to cover a wide large number of cities in the hope that seeds will be sown in some that will come to fruition.

In recognition of the difficulties of identifying problem areas in Developing Cities, the UN, World Bank and others are attempting to establish indicators of a city's performance, with particular reference to issues of sustainability. Strenuous efforts are made to ensure that these indicators are objective, measurable, and replicable. This is a very valuable activity and good worldwide collaboration is being achieved, in part thanks to the Internet. (UN, 1999)

The research described here, therefore, aims not to duplicate the collection of factual indicators, but to derive a means of incorporating subjective data into an appraisal process.

2 METHODOLOGY

An Urban Transport Audit methodology has been created to rapidly assess a city's ability to introduce cost-effective transport systems. An audit being 'a searching examination by an official body.'[1] The method attempts to enable the determination of where blockages are occurring that prevent the implementation of low-cost, appropriate, traffic and safety measures.

The research borrows heavily from a procedure developed in the UK to assist in the inspection of schools. Faced with the task of giving funding authorities and parents good quality information on more than 7000 schools within the target four years required a considered approach. The Office for Standards in Education (OFSTED) established a methodology that is based upon a detailed framework prepared centrally which is used by small teams visiting schools for less than one week. During the visit the team, working to a set plan, is able to make a guided judgement on the performance of the management and teaching standards. Substantial work has been done to ensure that the framework for assessment is clear, concise, and comprehensive. The aim of the present research is to produce the first version of such a framework for a city's performance in the transport sector.

The linking of judgement to evidence is a key principle of this approach. The existence of sound evidence can help turn an imprecise view into a measurement that, although still unquantifiable, is scientifically valid.

2.1 *CAVEATS*

It is recognised from the outset of the study that subjective decisions are, by definition, imperfect ones. In the field of road safety for example, a road that looks 'obviously' dangerous to a Western observer may have had no actual accidents. It is also recognised that there are substantial 'grey areas' in which two experts of equal experience may disagree. Those from North America, for example, will be accustomed to seeing far more traffic signals per linear mile than someone from the UK. Some indication of the experience and background of the inspectors should therefore be included in the evidence base and used in interpreting the results.

However, it is not the intention of the research to investigate the subtle differences that exist between similar cities. It is a sad fact that many of the World's developing cities have traffic and transport conditions that are on the point of collapse. For many years to come the problems will be very large and very obvious to anyone who is looking in the right place.

It is not the intention of this research to substitute for the detailed work going on in very large cities. These will often be full of political intrigue, which can negate the implementation of advice, no matter how appropriate. Instead, a typical target would be a city of around one million people. This will be large enough to have hundreds of thousands each day who are affected by the negative impacts of traffic, and this can be a major barrier to local development. If they have recently reached such a size as a result of rapid urbanisation, then these cities are unlikely to have a large contingent of transport professionals. Around the world, there may be hundreds, if not thousands, of such cities. Unlikely to merit large transport studies, they would be eminently suited for a short transport audit or inspection to help guide local strategies and prioritise any external input.

It is intended that, for a city of around one million, a professional inspector, using suitable guidelines, could produce a preliminary audit for around ten thousand dollars inclusive of all fees, travel and subsistence. This means that for the price of one kilometre of underground metro railway track (one hundred million dollars) an audit could be done in ten thousand cities. This low-cost grass-roots approach to development fits very well into the aims of the UK development agency DfID.

3 CONTENT

The range of inputs has been chosen to allow for the uncertainty and limitations that any project in a developing city is subject to. The team will be equipped with a book of around 50 pages, each page covering a different component or sub-component.

The main areas to be looked at are as follows

1) Long term planning and infrastructure investment. Land-use & new development
2) Traffic Management and the organisation of the road network
3) Public Transport

Table 1: An extract from the Inspection Manual

26	POLICE PERFORMANCE AND ROAD SAFETY ENFORCEMENT	The activities of the police should have a purpose. The control of traffic regulations and driver behaviour is essential for reasons of safety and congestion. Police performance should therefore be judged according to how well they increase safety and reduce congestion.			
<<<Current Status		Efforts being made >>			
VH	Police follow a clear plan to improve safety exactly where needed and intervene in automatic traffic control only in cases of emergency. Enforcement presence is sufficient to deter most traffic offences.	The extent to which this is an issue or a problem in the city is		The assessment of how well the authorities are dealing with this is	
H	Police make attempts to control speed where this is thought to be a problem (as opposed to where accident reports prove it). Enforcement of other offences is conducted at similar locations.	H The Evidence on which this Judgement is based is:			
M	position exactly between conditions above and below (not to be used as 'don't know')				
L	Police do link ticket issuing to speeds and real offences, but are as likely to do this where it will be easy, rather than where it will be effective. Most drivers do not fear breaking rules as they expect little effective enforcement, or know that an inducement will work.				
VL	Uncontrolled, ineffective, corrupt policing.	Recommendations:			

4) Environmental impact of transport and Road Safety
5) Access to transport for disadvantaged groups and non-motorised transport
6) Institutional arrangements for transport in the city

These, together with the situational baseline details are evaluated using a set of guided judgements that break down each of these general areas into component parts that can be judged in turn.

In order to guide the judgements being made, a set of descriptors is provided. Reference to these, even though an exact match may not be possible, helps the inspection team to reach a conclusion. A five-point scale is used ranging from Very Low (VL) indicating performance significantly below requirements up to Very High (VH). As an example of this approach, table 1 gives an example.

Note that a key part of the structure of the method is that judgements such as the one illustrated above are preceded by a review of the relevant background conditions. In this case, the conditions of service and employment of the officers and the budget and equipment levels of the force will be reviewed and will ultimately be taken into consideration before judging the performance on the ground.

The five-point scale evaluation enables a measured judgement to be made of the situation as it currently is. As a further refinement, some assessment can be made of the efforts being made. For convenience the same five point scales is used, though in this case it runs from VL representing no effort (or even obstruction) up to VH for significant positive effort.

An important part of the process is the collection of evidence. This may not (during a short inspection) be quantified, but it should, as far as possible be able to be proven. For example, "considered opinion" is not a good example of evidence, whereas "footpath blockages are common" is, as even though unquantifiable, it could be tested by a short survey with photographic proof. All comments made should be able to tested against the question "could somebody argue with this statement? And if so, how would I justify my opinion". Quotations from local professionals are admissible evidence, though this has confidentiality implications.

Although again to be used with care, it is considered instructional (for both parties) to add a recommendation for each topic. Amongst other things, this helps test understanding of the issues. These will need to be graded, since most cities cannot usually afford to do everything all at once. As far as possible general (and obvious) recommendations (such as "ask central government for more money") should be avoided. Similarly, emphasis should be given to recommendations that (like the evidence) can be described and monitored, even where direct quantification is not always possible

3.1 *OUTPUTS*

The aim of this process is NOT to produce a total score for a city, though this would theoretically be possible. Rather the aim will be to assist in the decision-making process. The use of a method such as the one presented here provides a structured means of working through a large and unstructured problem. It brings the shared language of a logical approach to enable those with different viewpoints, either from different institutions or even different countries, to discuss the real essence of a problem. Its comprehensive nature also ensures that by the time the process is complete, there is unlikely to be any components of the traffic and transport problem that have not been dealt with in a systematic way.

The benefits for the city are that, for the smallest possible expenditure, the following are made available:

1) The biggest overall problem is identified
2) Relative importance of other problem areas is highlighted
3) An immediate action plan can be prepared to solve worst problems
4) Terms of Reference can be produced to tackle other deficiencies

The target for the project is that 80% of the benefits of a more comprehensive study can be achieved for around 20% of the cost.

4 PRELIMINARY FINDINGS

So far the audit has taken place in around a dozen cities to a varying degree of detail. It is proving to be highly effective as a means of generating interest in the subject area and has stimulated debate internally within almost all of the cities visited. The method has evolved, with the final version of the inspection manual being version 11.

A full review of individual city performance is outside of the scope of this paper, but a summary of the main barriers to cost-effective transport can be given, as follows:

Planning: Where there are plans at all, these are rarely updated, and may incorporate ideas from previous decades such as zone plans and 'predict and provide' road building. Unfortunately, even though they are out of date, there is still reluctance from 'junior' staff to question the validity of a master plan.

Traffic Management: There are few cities that have an effective hierarchy of roads. As a result main through routes are congested and minor roads have environmental problems. Traffic signals are seen as a dominant solution and little use is made of lower cost measures such as road markings.

Road Safety: Some specialist education is common in most cities visited. Most even collect some form of accident data. This is, however, rarely used as a means of actually implementing remedial measures (except in Tunis).

Public Transport: Few cities (outside of Brazil) have optimised the use of competitive private bus operations with considered route planning and social back up. Many cities face increasing pressure and problems from uncontrolled and unrestrictable paratransit.

Enforcement: There are financial and bureaucratic reasons why there is a long lag time between an offence being committed and a fine being administered. This means that there is no corrective effect and traffic police are seen as an unwelcome burden on drivers. Traffic policing is rarely a desirable or honourable profession.

Sustainable Transport: Few cities have even thought of reducing car dependence. Ironically as the West tries to encourage walking and cycling these are already important modes in low-income countries. Cycling is commonly in decline as motorcycling grows. Walking is the majority transport for all short trips but this is despite appalling conditions in every city visited. Footpaths everywhere are neglected, blocked by cars and hence failing to serve pedestrians, with severe safety and quality of life implications.

Institutional: The main drawback to improvement in cost-effective transport would appear to be that the agencies that have some ability to improve the situation rarely work together to good effect. Even a 25-dollar barrier outside a school can take months of argument and decision ratification at a very senior level. In deference to superiors, and fearful of their jobs, few junior staff are willing to take initiatives and to actually implement. Instead, discussion, study and deliberation take place, while blame is passed around for problems on the street.

5 CONCLUSIONS AND RECOMMENDATIONS

It has been shown to be possible to create a method for a short audit or inspection of a city's traffic transport and road safety. The method has many advantages, not least in that it draws together interested parties and can ensure that every element of a transport system is given attention fairly and without omissions.

Cities visited provide a good cross section of size, income and car usage. It is possible therefore to draw some recommendations that may have universal value in order that other cities can avoid making the same mistakes as many of those visited.

1. The number of transport professionals employed in a city should be linked to the number of vehicles. Car ownership is rising throughout the world and it must be recognised that this growth can be managed but only if the efforts made to control car use grow at the same rate.

2. Somebody, somewhere, should take a consumer viewpoint of public transport. If run for the sole benefit of operators, entrepreneurs or city bureaucrats, the service will deteriorate and the inevitable consequence will be that people will want to switch to private or semi-private modes as soon as they possibly can.

3. The ability of countermeasures to reduce road accidents at cluster sites should be recognised. Collection and use of accident data for remedial works should take priority over more general administrative use of figures.

4. The link between land use and transport must be appreciated. It is certain that a large building will generate both trips and parking. These need to be managed, in advance of the future worst case.

Other recommendations exist, but these are either of a very general nature (such as agencies should work together) or very specific (such as allocation of funding relative to other budgets).

Overall, the problems of motorised transport in low-income countries appear almost certain to increase. In some capital cities this may eventually be tackled, though solutions will require lengthy institutional negotiation based on intimate knowledge of local priorities. In smaller (though still large) cities there will be few people who have either the knowledge or the institutional capacity to control the worst excesses of unrestrained car growth. In such situations, nine times out of ten institutional blockages may still block implementation of progress. Frequently, however, the use of a short audit using a comprehensive inspection framework may provide the initial guidance that can offer a beginning towards a more cost-effective approach.

ACKNOWLEDGEMENTS

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La influencia del 'Metro' en el desarrollo urbano de la Ciudad de México
Influence of the 'Metro' in the urban development of Mexico City
L'influence du 'Métro' dans le développement urbain de la Ville de Méxique

R.R.Orrego, P.A.Torres & S.G.Estrada
Sistema de Transporte Colectivo, México D.F., México

ABSTRACT: The following work is a qualitative analysis of the influence that the introduction and operation of the Metro net in the Metropolitan Area of Mexico City (AMCM) within the scope of the following surroundings: the big Urban Corridors, the Metropolitan Area and the Central Region.

RÉSUMÉ: Cést travail étude l'influence que dans le développment urbaine a provoqué la construction et l'operation du métro de la ville du Méxique au niveau de la region centre du pays, la zone métropolitaine et des routes urbaines plus importantes.

RESUMEN: El presente trabajo analiza cualitativamente la influencia en el desarrollo urbano que ha generado la construcción y operación de la Red de Metro en el Area Metropolitana de la ciudad de México en el ámbito de los siguientes entornos: los grandes Corredores Urbanos; el Área Metropolitana y la Región Centro.

1. PRESENTACIÓN

El análisis de la influencia generada por la operación de una línea de Metro, a pesar de ser un fenómeno poco estudiado, no debe ser visto únicamente como producto de una relación aislada, Metro - Desarrollo Urbano, sino debe estar inmerso en un ambiente que influye en el crecimiento y desarrollo de toda la red del Metro y de la Metrópoli en todos sus aspectos que la componen.

El presente trabajo analiza cualitativamente la influencia en el desarrollo urbano que ha generado la implantación y operación de la Red de Metro en el Area Metropolitana de la ciudad de México (AMCM) en el ámbito de los siguientes entornos:

- Los grandes Corredores Urbanos
- El Área Metropolitana.
- La Región Centro

2. DIAGNÓSTICO SITUACIONAL

Actualmente el Área Metropolitana de la ciudad de México es una de las metrópolis más grandes del mundo, conformada por 16 delegaciones del Distrito Federal y 34 Municipios conurbados del Estado de México, cuenta con una población estimada en 17.2 millones de habitantes, de los cuales; el 51% corresponde al Distrito Federal y el 49% restante a los municipios referidos. Estas localidades se asientan en una superficie del orden de 1600 Km^2 y en la que se desplazan 3 millones setecientos mil vehículos automotores.

Figura 1. Zona centro de la ciudad de México

Sta metrópoli, al igual que todas las grandes urbes del mundo, creció bajo un esquema radial, con base en el origen de sus accesos carreteros, por lo que la movilidad de su población se presenta hacia el centro de la ciudad de la misma.

Por su magnitud, la Metrópoli tiene entre otros, graves problemas de transporte a los que se enfrentan tanto las autoridades competentes de ambas jurisdicciones como los consultores de la planeación urbana y de movilidad.

La encuesta de Origen y Destino de los viajes de la población residente del AMCM realizada para 1994, arrojó 30.8 millones de tramos de viajes, que se distribuyen en un 52% en transporte concesionado a base de Microbuses; 16% en Automóvil particular; 15% en el Metro; 9% en Autobuses Urbanos; 3% en Autobuses Suburbanos; 3% en Taxis Libres y el resto en otros modos de transporte individual.

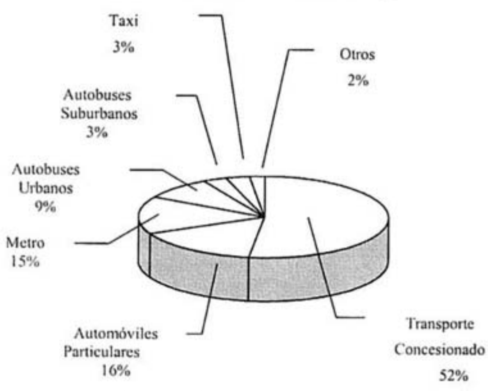

Figura 2. Distribución Modal

Para atender los traslados masivos, la población la ciudad de México cuenta con una infraestructura de 11 líneas de Metro, en una red de 191.5 kilómetros de longitud de operación y 167 estaciones, a través de la cual se transportan en promedio por día laborable 4.5 millones de personas, sin contar con los transbordos que se dan en las estaciones de correspondencia con que cuenta la red.

2.1 Los Grandes Corredores Urbanos

Aceptemos que las vías de comunicación impulsan y generan cierto tipo de uso y desarrollo urbano, ya que normalmente el comercio y los servicios se concentran a lo largo de las avenidas importantes de las zonas céntricas o núcleos de población, provocando un incremento natural de la carga vehicular en vías de acceso y en la propia infraestructura vial.

El Metro llegó tardíamente a la ciudad de México, cuando ésta ya contaba con una población de 7 millones de habitantes, y el mismo se instrumentaba para coadyuvar en la solución de la problemática de congestión vehicular que se generaba por la gran actividad socioeconómica que cotidianamente se daba en el centro, mas que como parte de un desarrollo integral armónico de la ciudad.

En ese entonces, las mayores concentraciones mercantiles de la ciudad se localizaban en zonas donde históricamente ha existido comercio tales como: los ejes de Mixcalco - Merced – Jamaica; el Centro Histórico – Tacuba – Tacubaya, Mixcoac y San Angel; la Villa de Guadalupe y su entorno, etc. y sobre las avenidas importantes como la Calzada México - Tacuba, Av. Chapultepec, Fray Servando Teresa de Mier, José María Izazaga, Calz. Zaragoza y Tlalpan entre otras.

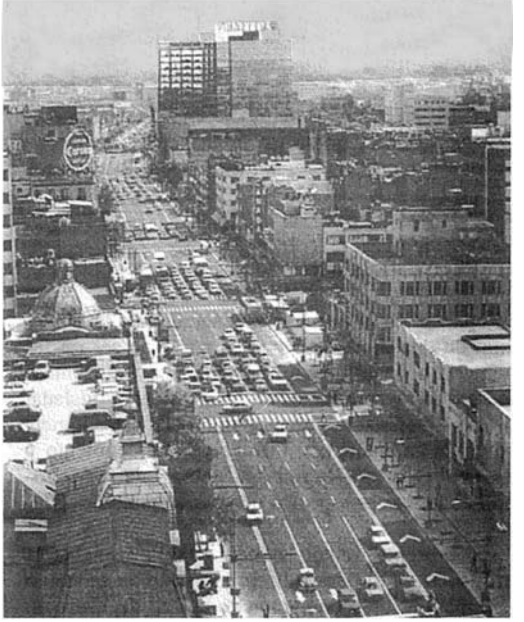
Figura 3. Corredor urbano Eje Central

Para la zona centro la presencia del Metro en los años setenta facilitó la movilidad de la población, pero a su vez incrementó el sector de comercio y servicios de la zona, lo que dio origen a importantes cambios en el uso del suelo, y a la emigración de gran número de habitantes hacia la periferia del Área Metropolitana. Como parte de este fenómeno se observa que tan sólo la Delegación Cuauhtémoc, disminuyó su población en más de 350 mil personas en un periodo de 30 años.

Este caso ejemplifica claramente como la presencia del Metro fue muy relevante en la transformación que se generó en el Centro Histórico de la ciudad.

Por otra parte, fue en esta misma época con la realización y actualización del Programa General de Desarrollo Urbano del Distrito Federal, cuando propuso la creación de corredores urbanos, como concentradores de servicios y usos habitacionales de alta densidad, los cuales conectarían los centros y subcentros urbanos de administración, empleo, servicios y vivienda y de activos socioeconómicos de ése entonces; así, vías importantes fueron propuestas para convertirse en corredores de este tipo.

Para este programa de corredores, el transporte masivo fue concebido para atender los viajes que generarían los mismos, fue entonces cuando la planeación del Metro tomó otra vertiente, ya no enfocada a resolver problemas de tránsito, sino a apoyar la estructuración urbana y su desarrollo a corto y largo plazo basado en sectores territoriales que respetaban las divisiones delegacionales y corredores urbanos, a fin de distribuir la actividad económica en el territorio capitalino y acercar el empleo a la vivienda para disminuir la complejidad de la movilidad.

En la actualidad se observa que existe una "malla" que se extiende principalmente por la zona del centro histórico, la avenida Paseo de la Reforma Poniente, Insurgentes sur, Periférico sur, Av. Revolución y la Calz. de Tlalpan. Esta malla representa la centralidad y aglutina la mayoría de los centros de atracción de viajes, mismos que emplean al mayor número de trabajadores y que concentra gran cantidad de empresas como son: talleres artesanales, pequeñas industrias, oficinas de empresas transnacionales, restaurantes, bares y similares entre otros.

Esta estructura se ha venido generando por la dinámica del mercado inmobiliario, la carencia de instrumentos que fomentan los programas de acción efectivos para articular la participación de la inversión privada, con la regulación de los usos del suelo y con acciones directas en materia de transporte colectivo, estacionamientos, equipamiento y vivienda.

El surgimiento de megaproyectos de renovación y modernización urbana, realizados por promotores inmobiliarios, abocados fundamentalmente a establecimientos comerciales para el mercado medio y alto, al sur y al poniente del Distrito Federal, aprovechando terrenos baldíos o con edificaciones de escaso valor, han venido proliferando en las vías primarias de comunicación dependientes principalmente del transporte privado. De ello se pueden mencionar el centro Coyoacán, Galerías Insurgentes, Perisur, Pabellón Altavista, World Trade Center, Plaza Satélite, Bosques de las Lomas y el Centro Santa Fe, entre los más importantes.

Figura 4. Corredor Urbano Calzada Zaragoza

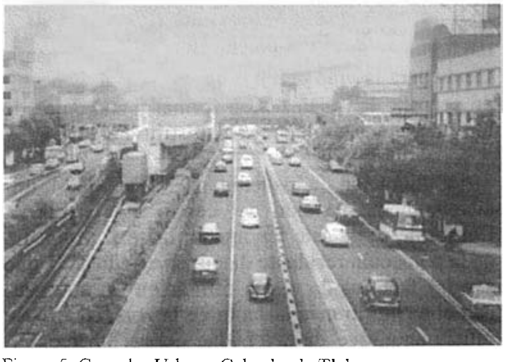

Figura 5. Corredor Urbano Calzada de Tlalpan

Analizando el perfil del usuario cotidiano del Metro, en su gran mayoría esta compuesto por empleados y estudiantes, con un sueldo promedio de 2 veces el salario mínimo; en este caso, el Metro no participó en tan importantes desarrollos.

El desarrollo urbano de los corredores no ha tenido trascendencia debido a que no se han consolidado; ello requiere más que la presencia de un sistema de transporte de alta capacidad, como lo es el Metro, lo cual se ejemplifica con las líneas 4, 5, 6 y 7, caracterizadas por ser de "baja afluencia", encontrarse incompleta su construcción y por su trazo tangencial a través de corredores urbanos que libran el Centro Histórico de la ciudad.

2.2. El Área Metropolitana

El inicio de la metropolización de la ciudad de México, se sitúa en la década de los cuarenta, siendo el municipio de Naucalpan, localizado al norponiente de la ciudad, el primero en ser considerado como conurbado. Para 1950 entre el D.F. y los municipios de Naucalpan y Tlalnepantla existía ya continuidad urbana, y estos se urbanizaron rápidamente, estimulados por la política de promoción de instalación de industrias definido por el Gobierno del Estado de México.

Paralelamente, y a raíz del crecimiento demográfico espectacular que se dio en éste siglo, el Gobierno capitalino limitó la expansión formal del área urbanizada dando como resultado que el crecimiento urbano en pleno desarrollo fuese insuficiente para la gran demanda habitacional, generando con ello la urbanización formal y anárquica de los municipios colindantes al Distrito Federal.

La migración de los habitantes del AMCM, tradicionalmente ha sido del centro a la periferia. Conforme se da este fenómeno, la edad promedio de la población residente disminuye, indicando que son las familias de nueva formación las que ocupan el territorio más distante de la zona centro. Se infiere aquí, que la diversidad del sector terciario (escuelas, comercio al menudeo y mayoreo, transporte, etc.) deben proveerse en función de este importante cambio demográfico, los cuales son escasos en la periferia y abundantes en el centro.

Un elemento que incide de manera directa en la consolidación de los asentamientos humanos es sin duda la disponibilidad de servicios urbanos elementales, como agua potable, drenaje y transporte, necesarios para escalar hacia el sector terciario. Estos y otros servicios de los sectores de la educación y salud, beneficiaron mayoritariamente a las delegaciones centrales del Distrito Federal, sobreofertando los mismos en la zona centro y desprotegiendo las delegaciones y municipios de la periferia.

Figura 6. Estación Pantitlán Línea A en hora de máxima demanda

Figura 7. Servicios urbanos complementarios a la Línea de Metro

Adicionalmente a estos factores, es necesario agregar los asociados a la pérdida de dinamismo económico, la caída del empleo, la descentralización de empresas, así como los atribuibles a los desequilibrios ambientales, ya que todos ellos han incidido en la transformación del Area Metropolitana.

Por otra parte los fenómenos naturales a que está expuesta la ciudad de México, también incurrieron en su transformación, a raíz de la contingencia de los sismos de septiembre de 1985, se hicieron ajustes a la normatividad de planeación de la ciudad, destacando las modificaciones al reglamento de construcciones y a la eliminación de un 65% de los corredores urbanos autorizados en 1982.

Con relación a los impactos que en el entorno de las estaciones, líneas y la propia red del Metro se reflejan en el contexto urbano. El Metro de la ciudad de México ha influido en la expansión de la mancha urbana de esta metrópoli por el fenómeno de acercamiento de las distancias en el tiempo de traslado, y en el resultado de sus efectos a corto, mediano y largo plazo.

Corto plazo

- Reducción en Tiempos de viaje
- Incremento en pasajeros transportados
- Substitución de modos de transporte de baja capacidad
- Reducción del tránsito vehicular
- Reordenamiento del transporte
- Generación de áreas peatonales y jardinadas
- Mayor seguridad en el tránsito vehicular y peatonal
- Menor contaminación ambiental
- Incremento de la plusvalía
- Mejoras en la infraestructura vial y de servicios

Mediano plazo

- Renovación de áreas urbanas
- Cambio en la estructura de negocios
- Mayor y mejor calidad de vida
- Mayor nivel de pasajeros transportados
- Ordenador urbano, vial y del transporte
- Mayor cobertura y facilidades de desplazamiento conforme crece la red.
- Mejoras en el entorno urbano

Largo plazo

- Cambio en la distribución modal hacia el transporte masivo eléctrico
- Renovación de áreas habitacionales en el centro
- Cambios de uso del suelo en la zona centro y núcleos del AMCM
- Concentración de edificios habitables en el entorno de las estaciones del Metro

2.3. La Región Centro

En la década de los sesenta, la extraordinaria expansión y el desarrollo urbano del Área Metropolitana y la Región Centro del País, generó una intensa actividad socioeconómica de los sectores secundarios y terciarios, emprendida por las administraciones del Distrito Federal, del Estado del México y de las Ciudades de Toluca, Puebla, Querétaro, Cuernavaca y Pachuca.

Esta expansión fue coadyuvada asimismo, por las grandes inversiones que paralelamente llevó a cabo el Gobierno Federal para la construcción de las autopistas que comunicaron a la capital del país con las principales ciudades de la región centro. Situación que fue el atractivo para muchos habitantes de las ciudades centrales, que aún trasladándose cotidianamente hacia la misma, intentan mejorar sus ingresos.

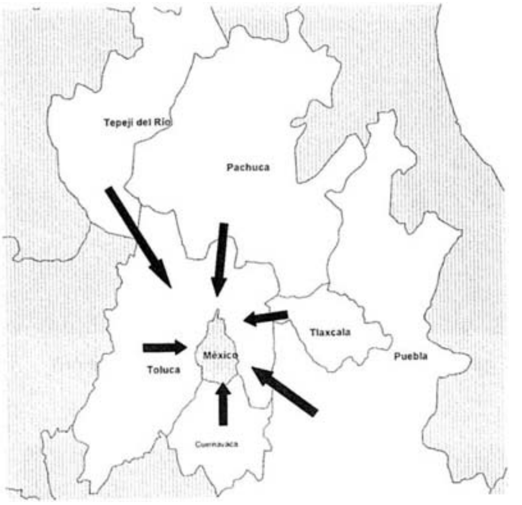

Figura 8. El Metro de la ciudad de México influye en la Región Centro del país.

Es por ello, que es común observar que las estaciones periféricas de las líneas del Metro, atienden satisfactoriamente los desplazamientos de esta población trabajadora y flotante, procedente de las ciudades de Toluca, Puebla, Pachuca y Cuernavaca principalmente, lo cual puede observarse con los resultados de la Encuesta de Origen y Destino que realizó el Instituto Nacional de Estadística, Geografía e Informática (INEGI) en 1994.

3. CONCLUSIONES

El Metro llegó tarde a la ciudad de México, sin participar en la implantación del desarrollo urbano inicial, ya que este se encontraba consolidado. El impacto que han producido sus líneas, ha coadyuvado en la movilidad de la población establecida; ha favorecido los centros de actividad socioeconómica; y propiciado el crecimiento urbano horizontal debido al incremento de la oferta de transporte.

Contrario a esto, las líneas que se apartaron de la zona centro, no atienden corredores y centros urbanos proyectados en los años setenta y ochenta,

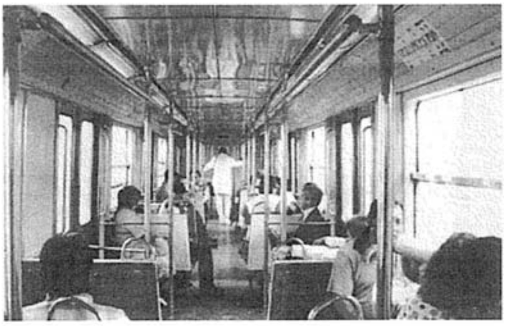

Figura 9. El Metro, modo de transporte de alta capacidad

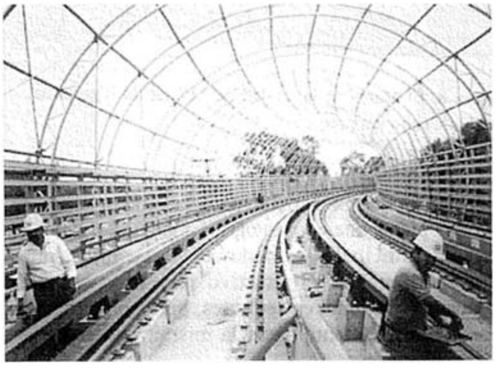

Figura 10. El Metro debe seguir creciendo ahora con una visión metropolitana

los cuales se ubican en el sur y poniente de la ciudad como son: Perisur, Santa Fe y Pabellón Altavista entre otros, lo que se traduce en una nula influencia en el desarrollo urbano de dichos corredores.

Para que una línea de Metro tenga incidencia positiva en el desarrollo urbano, esta debe acompañarse invariablemente de la instrumentación de otros servicios urbanos y de la implantación de políticas para impulsar o atender corredores urbanos que justifiquen dichas líneas.

En conclusión, el Metro de la ciudad de México, como prestador de un servicio eficiente, ha sido uno de los principales generadores y detonadores de la evolución de la zona centro de la misma, debido principalmente al excelente servicio que ofrece al disminuir considerablemente los tiempos de desplazamiento, mayor capacidad vehicular en su infraestructura vial, menor contaminación ambiental, seguridad y economía para los usuarios del sistema.

Cabe enfatizar que por la magnitud y la actividad socioeconómica de nuestra metrópoli, se hace imprescindible que institucionalmente, se continúe ampliando la Red del Metro, ahora con una cobertura metropolitana.

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Programa sectorial de vialidad regional y primaria de la zona metropolitana de Querétaro 2015

Primary and regional road sectorial program for Queretaro 2015 metropolitan zone

Programme sectoriel de voirie régionale et primaire de la communauté urbaine de Querétaro 2015

E. Jiménez del Prado Carranza & S.A. Damián Hernández

Desarrollo Urbano y Obras Públicas del Gobierno del Estado de Querétaro, Mexico

ABSTRACT: The 2015 Primary and Regional Sectorial Program for Queretaro Metropolitan Zone pretends to be a leading instrument in the road designing subject. Such subject is based on an integral sight that structures a net which is able to satisfy the society's present and future necessities of traffic flow. This program is divided into three periods: On the short-term (2000), on the medium-term(2003), and on the long-term (2015).

The methodology used to accomplish such projects war the planning of an initial road scheme which was firstly analyzed and discussed by all federal, state and municipal dependencies along with the demanding society to obtain the road's required characteristics.

Thirteen road axis with a 5 kilometer length as minimum, one metropolitan ring, and two freeways have been proposed. The existing roads have been included in this project. Now, we are looking for their interconnection with low budget projects. Such scheme avoids the extreme usage of specific roads that result in excess of traffic in the city of Queretaro.

RÉSUMÉ: L e Programme Sectoriel de Voirie Régionales el Primarie de la Cummunauté Urbaine de Querétaro 2015 cherche à être une ligne directrice des actions en matière de coirie, avec à sa base une vision intégrale qui structure un réseau routier capable de répondre aux nécéssités de transport présentes el futures de la société, et ceci en trois temps: à court terme (2000), à moyen terme (2003) et à long terme (2015).

La méthodologie employée pour la réalisation des travaux a été la mise en place d'un schéma routier initial qui a été discuté et analysé par tous les départements concernés au niveau fédéral, municipal ainsi qu'au niveau de l'Etat et de la société afin d'en assurer sa viabilité.

Sonts proposés: 13 Axes Routiers de 5 Km minimum, un Anneau Métropolitain et 2 Axes parallèles; leur construction serait effectuée en utilisant les voies existentes et en essayant de réaliser leur connexion, ceci avec des travaux à un moindre coût. Ce schéma éviterait que nous dépendions de quelques voies comme c'est le cas actuellement dans la Cummunauté Urbaine de Querétaro.

RESUMEN: El Programa Sectorial de Vialidad Regional y Primaria de la Zona Metropolitana de Querétaro 2015, pretende ser un instrumento rector de las acciones en materia de vialidad, con base en una visión integral que estructura una red vial capaz de satisfacer las necesidades de movilidad presentes y futuras de la sociedad, en tres escenarios: corto (2000), mediano (2003) y largo plazo (2015).

La metodología empleada para la realización de los trabajos fue el planteamiento de un esquema vial inicial, el cual fue discutido y analizado con todas las dependencias federales, estatales, municipales y la sociedad para asegurar su viabilidad.

Se proponen 13 Ejes Viales con longitud mínima de 5 Km, 1 Anillo Metropolitano y 2 Libramientos, aprovechando las vialidades existentes y buscando su interconexión con obras del menor costo posible. Este esquema evita la dependencia de unas cuantas vialidades, como sucede hasta ahora en la Zona Metropolitana de Querétaro.

1 INTRODUCCIÓN

La Zona Metropolitana de la Ciudad de Querétaro (ZMCQ) alberga a más del 70% de la población estatal y está conformada por cuatro Municipios: Querétaro, Corregidora, El Marqués y Huimilpan, cada uno de ellos con características distintas entre sí, políticas diferentes y capacidad de respuesta heterogénea.

El hecho de que la vialidad sea uno de los elementos de integración de la ZMCQ, hace imprescindible la conformación de una sola red vial, que responda a los requerimientos cada vez más demandantes de la población.

Todo lo anterior hace necesario el contar con un instrumento rector en materia vial, que permita coadyuvar al desarrollo sustentable de la ZMCQ, facilitando la realización de las diversas actividades propias de cualquier metrópoli, que sirva como un elemento ordenador del crecimiento urbano y haga segura y expedita la comunicación entre los distintos orígenes y destinos. En forma interestatal, intermunicipal e interdelegacional; comunicando la Zona Metropolitana de la Ciudad de Querétaro. en escenarios a corto, mediano y largo plazo (proponiendo una revisión intermedia del programa al año 2005).

El Programa Sectorial de Vialidad Regional y Primaria de la Ciudad de Querétaro 2015, pretende ser un instrumento ordenador y regulador de la movilidad y coadyuvar al desarrollo urbano, con base en una visión integral y acciones que estructuren una red vial capaz de satisfacer las necesidades de movilidad presentes y futuras de la sociedad.

Como punto de partida se tomó al Plan Estatal de Desarrollo 1998 – 2003, que considera a la vialidad como un elementos estructurador del crecimiento urbano; el Estudio Integral de Vialidad y Transporte Urbano elaborado entre 1993 y 1994, el cual plantea una serie de políticas y lineamientos en materia vial y por último, los planes parciales de desarrollo de cada uno de los municipio conurbados.

2 METODOLOGÍA DE TRABAJO

La metodología empleada para la realización de los trabajos estuvo basada en una serie de condiciones primordiales de ser tomadas en cuenta:

La primera se refiere a un planteamiento previo de un esquema vial para la Zona Metropolitana, cuya finalidad fue la de tener una orientación sobre la movilidad que pudiera ofrecerse a nivel metropolitano, esto es; predeterminar las arterias que servirán para el movimiento ininterrumpido de vehículos, destinados a recorrer grandes distancias dentro del área de estudio y cuya finalidad es la de distribuir en forma radial el tránsito, de tal suerte que la utilización de vías primarias se concentre a recorridos de cortos a medios (no mayores de 5 Km.).

Una segunda condicionante fue el nivel de profundidad establecido para el Programa Sectorial, en donde se incluye a la Vialidad Regional y Primaria con la finalidad de fortalecer a la movilidad entre centros productores y atractores de viajes, buscando sea expedita y en condiciones seguras.

Las vialidades secundarias y locales, por sus propias características fueron analizadas superficialmente y solo se incluyeron aquéllas cuya relevancia resultase importante dentro del esquema global final.

3 VIALIDAD REGIONAL

Se define a la vialidad como la franja de terreno acondicionada específicamente para el tránsito de vehículos a nivel urbano, suburbano e interurbano, que sirve para atender las necesidades de movilidad de personas y sus mercancías; de una manera rápida, confortable y segura y acorde a las necesidades de accesibilidad, a las distintas propiedades y usos del área colindante.

La Vialidad Regional, es aquélla que facilita el movimiento vehicular expedito de grandes volúmenes de tránsito en forma interestatal, intermunicipal o interdelegacional, a través o alrededor del área metropolitana, son vialidades colectoras y distribuidoras del tránsito urbano y suburbano, para el caso de Querétaro, las vías regionales fueron las carreteras federales y estatales que llegan a la Zona Metropolitana..

Tabla1. Vialidad Regional por Delegación y Municipio

N	Delegación o Municipio	Long. Kms.
1	Santa Rosa Jáuregui	**16.403**
2	Félix Osores Sotomayor	**9.015**
3	Felipe Carrillo Puerto	**11.138**
4	Centro Histórico	**18.049**
5	Epigmenio González	**11.142**
6	Josefa Vergara Hernández	**15.955**
7	Villa Cayetano Rubio	**12.574**
	Subtotal Delegaciones	**94.276**
A	**MUNICIPIO QUERÉTARO**	**94.276**
B	**MUNICIPIO CORREGIDORA**	**23.253**
C	**MUNICIPIO EL MARQUÉS**	**58.902**
D	**MUNICIPIO HUIMILPAN**	**0.000**
	TOTAL VIALIDAD REGIONAL	**176.431**

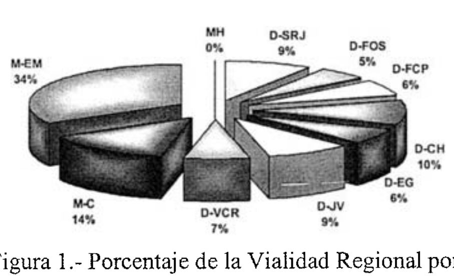

Figura 1.- Porcentaje de la Vialidad Regional por Delegaciones y Municipios

Uno de los principales problemas que se presenta en la actualidad para modernizar, prolongar o construir la Vialidad Regional, principalmente caminos y carreteras; es la liberación del espacio considerado como derecho de vía. Por lo general esta vialidad en Querétaro, cuenta con ese espacio; considerado en 20.00 Mts. a cada lado del centro de la sección y por consiguiente no se requiere pagar afectaciones, por ser todas; autopistas o caminos existentes; sin embargo en el futuro será necesario ampliar el derecho de vía, dados los requerimientos del crecimiento poblacional y las características del tránsito urbano.

La Vialidad Regional debe caracterizarse por no tener intersecciones a nivel, topes, su velocidad de proyecto superior a 60.00 Kms./Hora, anchos de carril apropiados, mínimo de 3.30 Mts., el transporte público de pasajeros no debe circular por los carriles centrales, debe contar con carriles de aceleración y desceleración, preferentemente debe tener dos cuerpos de circulación, con un mínimo de dos carriles por cuerpo con características de vialidades colectoras y distribuidoras.

En la Tabla 1 y Figura 1, se muestra la distribución de la Vialidad Regional de la ciudad de Querétaro, clasificada por Delegación y Municipio, en donde se aprecia que el Municipio de Querétaro tiene la mayor porporción, seguido de los municipios de El Marqués y Corregidora; para el Municipio de Huimilpan no se encontraron este tipo de vialidades dentro de la Zona Metropolitana.

De acuerdo a las acciones planteadas, en las Figuras 2 y 3 se presentan la magnitud de las mismas para cada uno de los horizontes de estudio, así como el crecimiento acumulado para el corto, mediano y largo plazo.

4 VIALIDAD PRIMARIA

Si la vialidad es la franja de terreno acondicionada para el tránsito de vehiculos a nivel urbano, que sirve para atender las necesidades de movilidad, de personas y mercancías; de una manera rápida, confortable y segura y a las necesidades de accesibilidad, a las distintas propiedades o usos del área colindante.

La vialidad primaria es la que permite el movimiento expedito del tránsito, en forma interdelegacional e intermunicipal, dando servicio directo a los generadores primarios del tránsito (centros comerciales, escuelas, oficinas gubernamentales, bancos, etc.) y se combinan entre si para formar un sistema colector y distribuidor, que mueve al tránsito en toda el área Metropolitana y en todas direcciones, auxiliando a la Vialidad Regional.

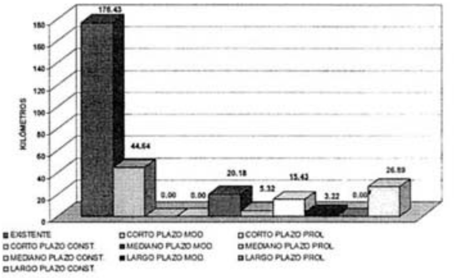

Figura 2. Propuesta de Acciones de la Vialidad Regional

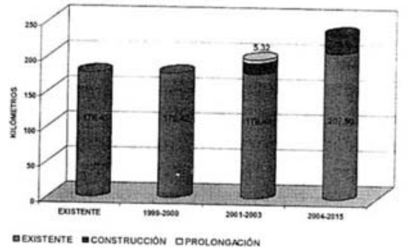

Figura 3. Crecimiento de la Vialidad Regional

Tabla 2. Vialidad Primaria existente, clasificada por Delegación y Municipio

N	Delegación o Municipio	Long Kms.
1	Santa Rosa Jauregui	**21.545**
2	Felix Osores Sotomayor	**35.255**
3	Felipe Carrillo Puerto	**12.606**
4	Centro Histórico	**43.789**
5	Epigmenio Gonzalez	**31.830**
6	Josefa Vergara y Hernández	**31.140**
7	Villa Cayetano Rubio	**14.788**
	Subtotal Delegaciones	**190.953**
A	MUNICIPIO QUERÉTARO	**190.953**
B	**MUNICIPIO CORREGIDORA**	**18.365**
C	**MUNICIPIO EL MARQUES**	**6.932**
D	**MUNICIPIO HUMILPAN**	**0.000**
	TOTAL VIALIDAD PRIMARIA	**216.250**

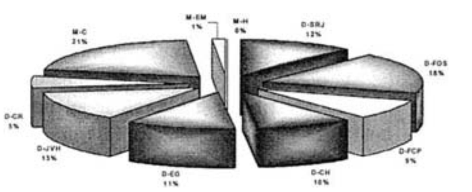

Figura 4. Porcentaje de la Vialidad Primaria por Delegación y Municipio

El principal problema de la Vialidad Primaria es su falta de continuidad, lo que provoca que el tránsito se concentre en unas cuantas vías llegando a su saturación en las horas de máxima demanda generando con ello mayor consumo de combustible, incremento en la contaminación ambiental, perdida de horas hombre productivas, etc.

El área Metropolitana de Querétaro cuenta con 156 Vialidades Primarias, con una longitud total de 216.25 Kms. lo que representa una longitud promedio de 1.39 Kms. de longitud por vialidad. Esto comprueba la falta de continuidad citada, por lo que se debe de tender a formar ejes de longitud considerable (superior a los 5.00 Kms.), que permitan una adecuada distribución del tránsito entre la Red Metropolitana y la Red Primaria.

La actual propuesta esta encaminada fundamentalmente a proporcionar esa continuidad, aprovechando al máximo lo existente, reduciendo al mínimo las afectaciones, a fin de prolongar los ejes existentes.

En la Tabla 2 y Figura 4 se muestra la longitud de la Vialidad Primaria por delegaciones, que conforman el Municipio de Querétaro y los Municipios de Corregidora, El Marques y Huimilpan; conurbados en el Área Metropolitana. de Querétaro.

Las Figuras 5 y 6 muestran las cpropuestas de acciones de acuerdo a los distintos horizontes de planeación, así como el crecimiento de la vialidad primaria.

5 ANILLO METROPOLITANO

Como se ha citado, uno de los principales problemas viales que padece la Zona Metropolitana de Querétaro es la mezcla del tránsito de largo itinerario con el urbano, especialmente peligroso en la Carretera México – Querétaro en el tramo Cuesta China – Plaza de Toros, en la Av. 5 de Febrero desde su entronque con esa carretera hasta el acceso a Juriquilla; y en la Carretera Libre a Celaya desde la Av. 5 de Febrero hasta la cabecera municipal de Corregidora.

En este orden de ideas, una solución factible de implementarse en el mediano plazo (2003), es la conformación de un Anillo Metropolitano que permita reorientar los flujos vehiculares urbanos de tal suerte que se reduzca la mezcla de tránsitos y al mismo tiempo, contribuya a eficientar la movilidad interna mediante una reasignación natural de los flujos. Esquemáticamente, el Anillo Metropolitano se muestra en la Figura 7.

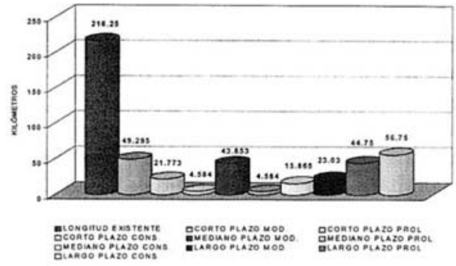

Figura 5. Propuesta de Acciones de la Vialidad Primaria

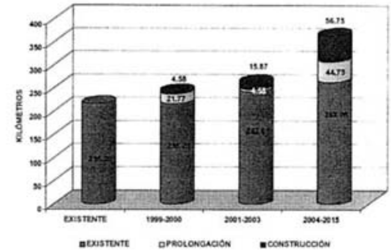

Figura 6. Crecimiento de la Vialidad Primaria

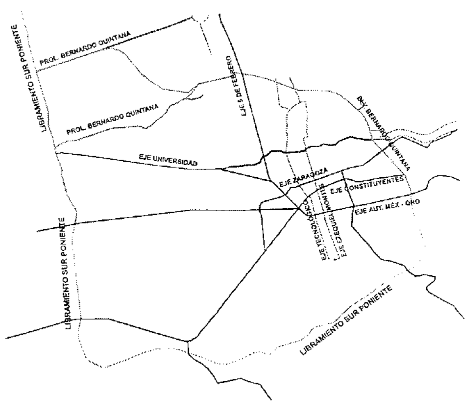

Figura 7. Esquema del Anillo Metropolitano

6 EJES VIALES

El concepto de Eje Vial debe entenderse como aquella vialidad primaria que cuenta con las características físicas y operacionales necesarias para convertirse en un apoyo al Anillo Metropolitano y sea una opción para comunicarse en los sentidos Norte – Sur u Oriente Poniente.

Los Ejes Viales están concebidos como las vías de conexión interdelegacionales e intermunicipales dentro de la Zona Metropolitana, así como vías alternas cuando por alguna razón se vea interrumpida la circulación de otra vialidad primaria.

Dentro del Programa Sectorial se constituyen 13 nuevos Ejes Viales, que se complementan con los existentes y aprovechan al máximo las vialidades primarias actuales, proponiendo algunas continuaciones para enlazarlas y dar un sentido de red lo más reticular posible.

La premisa con mayor relevancia para formar un Eje, fue la de poder integrar una vialidad de al menos 5 kilómetros de longitud (el promedio de la longitud de una vialidad primaria actualmente es de 1.69 Km). Adicionalmente se buscó que se unieran con las vialidades metropolitanas, para poder ampliar las posibilidades de rutas para un recorrido determinado.

En la Figura 8 se presenta el esquema global de la vialidad primaria y regional en donde se puede apreciar la amplia gama de opciones que el ususario teien para desplazarse dentro de los distintos sectores de la Zona Metropolitana. Las áreas que se ven sin vialidades, son zonas agrícolas de alta productividad o de recarga de mantos acuíferos y a solicitud expresa de las autoridades municipales se optó por dejar exclusivamente vías de acceso de bajas especificaciones para evitar la especulación del valor de la tierra y el crecimiento de la mancha urbana hacia esos lugares.

Este es en términos generales el planteamiento que se tiene para la Zona Metropolitana de Querétaro. Se reconoce la necesidad de continuar con estos trabajos para el resto de las vialidades y su complementación con estudios de movilidad para las principales áreas generadoras de viajes.

Cabe resaltar el hecho de que se trata de un esfuerzo conjunto entre las autoridades locales, la opinión de expertos en planeación urbana y de la sociedad en su conjunto.

7 COSTOS DEL PROGRAMA

Los costos del Programa Sectorial se calcularon con base en el tabulador establecido en el Gobierno del Estado de Querétaro para junio de 1999 e incluyen la estructura del pavimento, guarniciones, banquetas, señalamiento horizontal y vertical, así como un porcentaje para la el pago de afectaciones.

Los anchos de las secciones para la vialidad regional fueron de 40 y 60 m, para la vialidad primaria de doble sentido de circulación de 20 y 25 m, y para ejes de un solo sentido de circulación de 20 y 14.85 y m, respectivamente.

Se estimaron costos para 14 vialidades regionales y 216 vialidades primarias, en las Tablas 3 y 4 se presentan las cifras alcanzadas para cada uno de los horizontes de planeación, así como de acuerdo al tipo de vialidad.

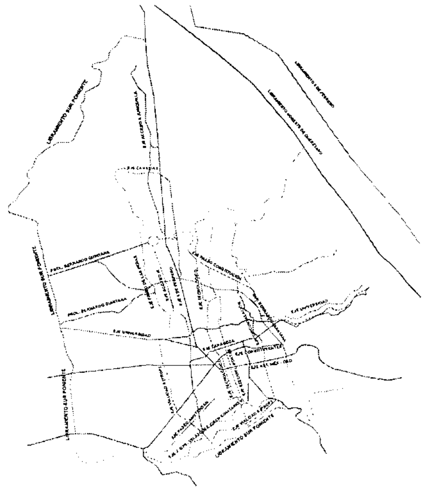

Figura 8. Ejes Viales

Tabla 4. Costos por Horizonte de Planeación

VIALIDAD REGIONAL	COSTO (USD)
Corto plazo	$ 7'171,452.6
Mediano plazo	$ 27'129,033.8
Largo plazo	$ 9'089,091.5
Total Vialidad Regional	**$ 43'389,577.9**
VIALIDAD PRIMARIA	**COSTO (USD)**
Corto plazo	$ 25'033,874.4
Mediano plazo	$ 40'498,203.7
Largo plazo	$ 46'927,012.3
Total Vialidad Primaria	**$ 112'459,090.4**
COSTO DEL PROGRAMA	**$ 155'848,671.3**

Tabla 5. Costos por Tipo de Vialidad.

VIALIDAD REGIONAL	COSTO (USD)
Libramientos	$ 19'195,020.0
Anillo Metropolitano	$ 20'141,820.2
Otras	$ 4'052,739.7
Total Vialidad Regional	**$ 43'389,577.9**
VIALIDAD PRIMARIA	**COSTO (USD)**
Ejes Viales	$ 60'479,047.8
Otras	$ 51'980,042.6
Total Vialidad Primaria	**$ 112'459,090.4**
COSTO DEL PROGRAMA	**$ 155'848,671.3**

8 CONCLUSIONES

Los principales problemas detectados a lo largo del estudio fueron los siguientes:
El tránsito de carga de largo itinerario y el que transporta sustancias peligrosas que cruzan la Zona Metropolitana, se mezcla con el tránsito urbano provocando congestionamiento, contaminación y alta peligrosidad en la circulación.

Existe una falta de comunicación entre delegaciones y municipios ya sea en la dirección Norte – Sur o en la Oriente – Poniente, dependiendo de su ubicación, a excepción del Centro Histórico.
No hay continuidad en la vialidad primaria, lo que reduce su potencial de utilización y concentra el tránsito en aquellas vías que tienen una longitud adecuada.
Es notoria la diferencia existente entre el crecimiento del tránsito y la construcción de vialidades con capacidad suficiente y especificaciones acordes a las necesidades presentes y futuras.

Las premisas con que se basó el Programa Sectorial de Vialidad Regional y Primaria de la Zona Metropolitana de Querétaro 2015 son:
Crear un documento rector que oriente los esfuerzos de las distintas autoridades involucradas en la construcción de vialidades, evitando duplicidad de esfuerzos y eficientando la utilización de los recursos en este rubro.
El Programa busca la consolidación de la mancha urbana, por lo que la mayor parte de las acciones son la modernización y prolongación de las vialidades existentes.
La propuesta asegura una comunicación permanente entre todas las áreas, al dotar de al menos dos entradas y dos salidas para cada una de las delegaciones y municipios dentro de la Zona Metropolitana.
Para los viajes que requieren recorrer grandes distancias dentro de la mancha urbana, se crea un primer anillo metropolitano que permitirá reorientar el tránsito, reduciendo la dependencia de vialidades como la Av. 5 de Febrero y la autopista México – Queretaro, ademas de reducir el tiempo de recorrido por ser una vía sin semáforos, intersecciones a nivel y libre de transporte público en los carriles centrales, por lo que se convertirá en colectora y distribuidora.
Con las acciones propuestas dentro del programa Sectorial se conforma una red vial primaria, por medio de ejes viales, que son opciones reales de movilidad, además de permitir una comunicación adecuada Norte – Sur y Oriente – Poniente con secciones capaces de albergar el tránsito presente y futuro.
La red vial propuesta, cuenta con las características físicas y operacionales que permiten una reordenación del transporte público de pasajeros, sin necesidad de crear nuevas vías o realizar adecuaciones geométricas.

La propuesta del programa, consiste fundamentalmente:
a.- Para la Vialidad Regional, en la conformación de: un Anillo Metropolitano y Dos Libramientos, entendiendo por conformación la Modernización, Prolongación o Construcción de las vialidades que los conforman.
b.- Para la vialidad Primaria, en la consolidación de 13 Ejes Viales, entendiendo por consolidación, la Modernización, Prolongación o Construcción de las vialidades con que se integran estos 13 ejes.
Si bien el costo del programa requiere de una inversión cuantiosa se debe sin duda al rezago en la construcción de vialidades con relación al crecimiento de la Zona Metropolitana de Querétaro. Es necesario recalcar que el Programa Sectorial únicamente incluye a la vialidad regional y primaria, siendo necesario desarrollar programas similares para la vialidad secundaria, el equipamiento urbano, estacionamiento, el transporte público y la legislación sobre el uso del suelo. etc.

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Meeting the transportation challenges of Bangalore in the year 2010

D.V.Guruprasad
Karnakata State Road Transport Corporation, Bangalore, India

ABSTRACT : This paper presents the transportation challenges of Bangalore for the next ten years

Bangalore is the 5[th] largest city in India, with a population of about 5 million. The urban agglomeration covers an area of 272 Sq. Kms. Unike other metropolitan cities of India, public transport in Bangalore has been confined to road transport. Though major rail lines criss-cross the city, there has been no concept of suburban railway transport. Decades ago the railways had introduced a push-pull train between Bangalore and Yelhanka but due to poor response this train is now non-operational. There is no scope for having an underground railway in Bangalore. Therefore even to this day transport need of Bangaloreans is met only by road transport.

As a policy the Government of Karnataka has decided that the metropolitan area of Bangalore be a nationalised area for road transport. This means that the public road transport service in Bangalore will be the monopoly of the State Road Transport Corporation, a Governmental agency. Till the year 1997 the needs of Bangalore was met by the BTS Divisions of the Karnataka State Road Transport Corporation. In the year 1997 a new public sector road transport agency called Bangalore Metropolitan Transport Corporation (BMTC) was carved out of KSRTC to exclusively cater to road transport needs of Bangaloreans.

There has been a phenomenal rise in the population of Bangalore especially during the 80's and early part of 90's. The population, which was less than 30 lakhs in 1981, touched almost 42 lakhs in 1991. This steep rise in population put severe strains on the city bus services. The State run transport organisation was unable to increase its fleet strength due to financial constraints. The gap in supply was therefore filled by privately owned vehicles. Tables I shows the growth of two, three and four wheeler vehicles during the decade 1988 to 1998.

Table 1

(In thousands)

No.		wheelers	wheelers	wheelers
1	1988-89	357.4	15.7	69.0
2	1989-90	415.9	15.8	74.2
3	1990-91	458.9	17.9	82.8
4	1991-92	500.6	23.1	90.9
5	1992-93	525.3	25.5	89.9
6	1993-94	517.2	29.8	91.7
7	1994-95	574.6	33.2	105.1
8	1995-96	641.3	37.9	117.1
9	1996-97	723.6	46.2	133.1
10	1997-98	837.1	54.1	152.0

One of the peculiar phenomenon of Bangalore is the steep rise in the number of three wheeler autorickshaws. Tough autorickshaws are found in almost all cities India, their growth in Bangalore is something unnatural. In the year 1990 the number of autorickshaws in Bangalore was 15, 800. In the year 1998 this number has grown to over 50, 000 and it is reported that another 15, 000 autos will hit the roads of Bangalore very soon.

The increase in the number of autos can be directly attributed to the marked preference of Bangaloreans for this mode of transport which is economical and fast. The autorickshaws can easily wade through city traffic carrying three persons. Hence they have become a preferred mode of transport.

It is pertinent to mention here that till the early 80's there was no concept of maxi-cabs in Bangalore city. Maxi-cabs by definition are large vans capable of carrying 12 passengers. During the latter half of 80's maxi-cabs mushroomed all over the State of Karnataka and in Bangalore also they started plying in the outskirts of city carrying people from the suburbs to various industrial units lying outside the city. It the State of Karnataka alone about 15, 000 maxi-cabs have been registered and the number of maxi-cabs in the State is higher than the number of buses in the public sector. In Bangalore, there are over 3500 maxi-cabs.

Bangaloreans by nature do not prefer to travel by cabs (taxies) which carry 4 to 5 people. The number of metered cabs in Bangalore is meagre and if at all people. The number of metered cabs in Bangalore

The increase of the number of motor vehicles on the road has also contributed to air pollution as well as noise pollution. Bangalore has been known to be a city which induces diseases like Asthama. With the deterioration of air quality in Bangalore, various diseases seem to have increased. The pollution due to motor is meagre and if at all people use cabs they are private taxies which do not have meters. These taxies are normally used on contract basis or used for long distance travel.

The large number of vehicles on Bangalore roads has resulted in the number of road accidents increasing by leaps and bounds. Table II below gives the statistics of road accidents both fatal and non-fatal over the years. This table also shows the contribution of autos and maxi-cabs in increasing the accident statistics of Bangalore.

Table 2

Statistics of road accidents both fatal and non-fatal in Bangalore roads

Year	Fatal	No.of persons killed	Non-fatal	No.of persons injured
1980	295	316	3920	3429
1985	403	419	4402	3892
1990	537	562	6192	5677
1995	642	678	8035	6966
1998	685	726	7675	6358

Statement showing number of accidents in which auto rickshaws, two wheelers and maxi-cabs(Tempos) are involved.

Year	Autorickshaws	Two wheelers	Maxi-cabs(Tempos)
1996	1063	1869	1209
1997	1039	1860	1238
1998	1015	1944	1173
1999(Up to 31.8.99)	566	1255	696

The increase of the number of motor vehicles on the road has also contributed to air pollution as well as noise pollution. Bangalore has been known to be a city which induces diseases like Asthama. With the deterioration of air quality in Bangalore, various diseases seem to have increased. The pollution due to motor vehicles in Bangalore city is given at Table III.

Table 3

	CO g/km	HC g/km	Nox g/km	PM g/km	Sox g/km	Lead g/km	CO2 kg/km
Motorcycle	10	5*	0.1	5*	0.2	0.03	0.1
Rickshaw	9	5*	0.15	5*	0.2	0.03	0.1
Car, petrol(cat**)	10(0.2)	2(0.3)	6(2)	8(0.5)	0.5(0.01)	0.08	0.3
Car, diesel	1	2	8	5	1	-	0.2
Tractor	2	6	31	18	3	-	0.9
Bus BMTC	2	7	24	16	3	-	0.7
Bus non BMTC	2	6	24	16	3	-	0.7
Truck, trailer	2	6	24	17	3	-	0.9
Maxi-cab	15(0.3)	5(0.4)	10(3)	11(0.6)	0.8(0.01)	0.08	0.4

CO = Carbon Oxide, HC = Hydrocarbon Nox = Nitrous Oxide, PM = Particulate Matters
Sox = Sulfur Oxides, CO2 = Carbon dioxide.

The increased number of vehicles on Bangalore roads has put severe strain on the roads of Bangalore. Unlike other metropolitan cities Bangalore has not grown in a vertical manner. High rise residential complexes are restricted to very few areas.

It is seen that the land use in Bangalore presents a low density and low rise profile. Almost 35 percent of the land available is used for residential purpose and 31 percent is available for transportation. However the roads of Bangalore are not very wide enough. Bangalore has two separate city centres traditionally know as city area and cantonment area, both areas being divided by a green patch called Cubbon Park. The city centre for the city area is Kempegowda Road/Avenue Road/Krishnaraja Market

Table 4

Land use category	1990 Area (hectares)	1990 %	2010 Area (hectares)	2010 %
Residential	9878	34.8	24369	43.2
Commercial	675	2.4	1644	2.9
Industrial	2039	7.2	3844	6.8
Public, semi-public	2616	9.2	4909	8.7
Parks, open space	2132	7.5	7788	13.8
Transportation	8946	31.5	11697	20.7
Unclassified	2114	7.4	2214	3.9
TOTAL	28400	100.0	56465	100.0

areas and the city centre for the cantonment is Mahatma Gandhi Road/Brigade Road/Commercial Street/Shivajinagar areas. The land use of Bangalore is given in Table IV.

As can be seen from the above the traffic situation in Bangalore is not comfortable. Tough the traffic congestion is high during peak hours, there is no cause for alarm as of now. However the traffic scenario is slowly moving towards unmanageable levels and the situation will drastically alter in the year 2010.

TRAFFIC SCENARIO IN 2010.

The land use in 1990 and 2010 is shown in Table IV. It is seen that the land available for transportation needs will shrink by more than 10 percent during the year 2010 and this will naturally cause very heavy strain on the roads of Bangalore. In the year 2010 the population of Bangalore is expected to be more than 70 lakhs. It is estimated that in the year 2010 the number of BMTC buses plying on the roads of Bangalore will be less than 3000. However, due to rise in population, the demand for BMTC buses would be about 5000. This gap in demand and supply would again give rise to increase in privately owned vehicles.

It is estimated that in the year 2010 the number of private vehicles will grow three fold and is expected to touch the figure of 3.53 million. With such a phenomenal rise in the number of vehicles and with the depletion of land space for transportation the situation in Bangalore will become alarming and will be akin to the situation faced by Bangkok today. If no remedial measure is taken now itself the situation will go out of control.

Urban Planners are already aware of this problem and have prepared various plans. Some of these plans and some suggestions which I propose to venture are detailed below :

TACKLING THE PROBLEMS ENVISAGED IN 2010 :

(a) Adding more land for public transport : During the past 3 years efforts have been made to build ring roads around Bangalore city. Two stretches of ring road from Domlur to Koramangala and Kanakapura Road to Hosur Road are already in operation. The third stretch from Hebbal to Cantonment has now been open for traffic. When completed these ring roads will add more area for transportation.

At present a number of flyovers are being built in Bangalore. These, will no doubt, add more land for transport use but it is pertinent to mention that these flyovers will not help in easing the congestion at city centres.

Sometime ago some planners mooted the idea of covering the existing open storm water drain which criss-crosses Bangalore. The existing storm water drains connect the periphery of Bangalore to the central areas (Please see the map). The width of these drains are 2.5 metres on an average and at some places they are between 7.5 and 10 metres wide. Since at present the drains are not covered they have become a health hazard and an ugly sight. If these drains are covered we would be able to get suitable space that could be used to meet the transportation needs of the city. The covered drains can be made both as dedicated tramway or dedicated bus lane.

Since drains are situated in highly populated areas the covered space would considerably ease the strain on existing roads.

Without making heavy investments it would thus be possible to increase the land space in Bangalore.

(b) Improving existing road transport system : After the operations of Bangalore City were removed from the purview of KSRTC consequent to the formation of BMTC in 1997 there has been significant improvment in the bus operations within the city of Bangalore. A comparison of operations in Bangalore city before and after the formation of new Corporation is given in Table V.

Table 5

87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99
1428	1555	1640	1614	1664	1702	1808	1822	1774	1912	2088	2079

As on 31.8.1999 = 2126 buses

Even with the improved operations BMTC will be unable to generate enough surplus funds to invest on infrastructure developments. As stated already the number of buses required to meet the needs of Bangalore population in 2010 will be 5, 000. Within the next 10 years BMTC will not be able to generate Rs. 250 crore to invest on purchasing 3000 new buses. Since the need is to put more buses on the road BMTC like many other transport corporations in the country has envisaged a scheme of hiring private buses to run under its supervision. In this scheme BMTC will take on hire private buses along with the driver, put a conductor on these buses and run these buses on the notified route of BMTC. Under the scheme the BMTC will avoid cost on the buses, the bus driver, the fuel and other peripherals. BMTC will meet the cost of the conductor and bus owner will be paid about 8 to 9 rupees per Km. Run by his bus. It is seen under this scheme the cost of operation per Km. Is between Re.1.50 to Rs.2.00 less than the cost of operation of buses owned by BMTC. At present over 100 buses are operating on Bangalore routes under the scheme. If the scheme is expanded and if more than 700 buses are added to BMTC through this scheme there would be significant improvement in the road transport scene in Bangalore.

It is to be mentioned here that even though the scheme has generated interest it will not be possible for BMTC to have almost 50 percent of its fleet through privately owned buses. In fact such a scheme in Delhi was a big failure.

It can therefore be concluded that BMTC will not be able to meet the challenges of 2010.

Metro bus concept : The metro bus concept envisages running of huge buses having very high carrying capacity (almost three times the capacity of present bus) to ply on trunk routes. The trunk routes will be roads from city centres to important suburban centres in various directions. At these places terminals will be built. The trunk routes will be fed by feeder routes. These feeder routes will be located in the outskirts, 4 to 5 Kms. Away from the city centres. The feeder routes will connect all the suburban centres. In the terminals transfer between trunk routes and feeder routes will take place. In other words this is a hub and spoke concept.

Consequent to the successful experiment in Curitiba, a city in Brazil, planners thought that the concept of introducing metro buses should be tried in Bangalore too. A feasibility study, funded by Swedish International Developmental Agency, SIDA, has been completed in this regard and the team of consultants have already produced the report. The Consultants feel that Bangalore has all the ideal conditions for introduction of metro buses.

The trunk road has to ideally be dedicated bus lanes where large articulated buses can ply at high speeds. At present in India buses are built on truck chassis and bus designs are quite old. The bus floor is quite high from the ground level resulting in uncomfortable entry and exit at bus stops. The buses in India cannot carry more than 60 passengers.

The metro bus, on the other hand, is 3 axle single articulated bus having a length of 18 metres and width of 2.55 metre. This bus which can run at a maximum speed of 70 Km. Per hour can carry up to 215 passengers.

In the metro bus concept, trunk routes will be serviced by the metro buses and feeder routes will be serviced by other existing standard buses or high capacity buses which carry up to 120 passengers.

The existing wide roads in Bangalore can be used as trunk routes. In the trunk routes the metro bus will ply either on the kerb side or they can ply on the middle of the road or they can go on contra flow lanes. Contra flow lanes means buses moving in one way street against the traffic flow.

Since the metro buses on the trunk routes have to necessarily move at high speeds it is necessary to have dedicated lanes for the same. With some adjustment it is possible to have dedicated lanes in Bangalore city. But while making dedicated lanes it has to be presuled that introduction of metro buses will result in reduction of other type of vehicles likes two wheelers, maxicabs and autorickshaws.

It is felt that the metro bus system implementation will take about 5 to 6 years. Even though the trunk routes can be identified it is necessary to have new depots for new type of buses. Also way side bus stations as well as terminals for transfer of commuters from feeder lines to trunk lines have to be built. It is estimated that even if 25 articulated buses are introduced on only one or two trunk routes to begin with, the project would cost about Rs. 35 Crores. The amount of Rs. Crores is not very high but as stated earlier BMTC will not be in a position to invest this amount and one has to go for borrowings from financial institutions.

On the other hand, the Government can set up a separate transport corporation to run metro buses in Bangalore and give all the feeder routes to BMTC for its operation. This way the metro bus project would fructify early.

Elevated light rail transit system : The planners in Bangalore have already moved in the direction of having ELRTS for Bangalore. Compared to the buses which are plying on the roads of Bangalore the elevated light rail has better passenger carrying capacity as can be seen from the Table below :

System	Hourly passenger carrying capacity
Private vehicle	4,000
Omni bus	15,000
Light Rail Transit	25,000
Suburban Rail	45,000
Underground Rail	75,000

Since Bangalore cannot have an underground rail system, in the year 1994 the Government of Karnataka thought that light rail transit would ideally suit the needs of Bangalore city. The Government thus constituted Bangalore Mass Rapid Transit Limited, an organisation to implement the mass rapid transit system in Bangalore. This company signed an agreement with U.B. Group Consortium in 1997 to set up elevated light rail transit system under build, own, operate and transfer arrangement.

The ELRTS proposed for Bangalore will cover about 100 Kms. , and will comprise of 4 major lines viz. , red, green, blue and yellow. The red line is from Yeshwanthupur to Marthally, the green line is from West of Chord Road to

Kanakapura Raod, the blue line is from Yeshwanthpur to Kanakapura Road and Yellow line is from Hebbal to J.P. Nagar. The proposal is to complete the entire system in two or three phases in a total period of about 10 years.

The UB Group Consortium proposes to have LRT trains consisting of four light rail vehicles. Each vehicle will accommodate 60 sitting and 180 standing passengers and will have an average speed of 40 Kms. Per hour. The Consortium proposes to levy a fare of Re.1.10 per Km., and wants to make use of automatic fare collection system. The fare structure proposed by the Consortium matches the fares levied by autorickshaws in the city at present.

The ELRTS will comprise of about 87 stations and each station will be at distance of about one Km., on an average, from each other. The estimated project cost will be around Rs. 5, 000 Crores. Though the first phase of the project was to commence in 1999 itself, so far no progress seems to have been made.

Suburban Railway : At present 3 major railway lines run through Bangalore city. They are (1) Bangalore-Mysore line which connects the suburbs of Kengeri and Nagarabhavi to the city centre, (2) Bangalore-Guntakal line which can connects Bangalore cantonment, Frazer Town, etc., (3) Bangalore-Madras line which can connect Krishnarajapuram and White Field to the city centre and (4) Bangalore-Miraj line which can connect Malleswaram, Yeshwanthpur, HMT Colony and other areas. If these lines can be interlinked it will be possible to run suburban trains on the existing railway tracks. Though this will not fully solve the problem of congestion the new suburban services will at least ease the congestion during the peak hours.

For meeting peak hour demand of a city like Bangalore it is not correct to depend on only one type of system as is being done now. All over world the thinking is towards having an integrated public transport system so that the traffic can be cleared expeditiously. The integrated public transport system will be a complement for metro bus, other type of bus, light rail transit and suburban train system. All these 4 systems will complement each other and help ease the traffic.

Any improvement in public transport system should ideally result in curbing the number of personalised vehicles. A study has shown that in Bangalore 22 percent of the traffic comprises of two wheelers going from various directions to the city centres, 12 percent of the total traffic are cars and 10 percent are two-wheelers. Thus almost 50 percent of the traffic flow during peak hours is towards city centres. If public transport system is improved it will be possible to have 75 percent of the road use by buses and 25 percent by other vehicles. Since the Bangalore commuters are used to the freedom afforded by personalised vehicles it is necessary to device ways and means of curbing road use by private vehicles. This can be done in the following manner :

(a) Ban on registration of auto rickshaws. Auto rickshaws are contributing to noise and air pollution and unless their number is limited the traffic cannot be controlled. It is therefore necessary to limit the registration of auto rickshaws to the present levels and at least for 10 years from years 2000 to 2010 no new auto rickshaws should be registered.

(b) Limiting maxi-cabs : The maxi-cabs which are already registered are operating as public carriers clandestinely. The State Government has taken a correct policy in increasing the tax structure for these vehicles which will no doubt limit their number in future. However if as a policy registration of these vehicles is stopped for 5 years there will be less such vehicles on the roads.

(c) Control the numbers of two wheelers : If the public transport system improves the number of two wheelers coming on the road will automatically decrease. We can also think of levying higher tax for these two wheelers so that people are encouraged to use the public transport.

(d) Increasing of parking fees : At present in Bangalore, parking fees in collected in very few places. Like in western countries people must be made to pay for parking their vehicles on the roads. We should consider banning parking in major roads like Brigade Road, Commercial Street etc. In roads like M.G. Road and J.C. Road very stiff parking fees are to be prescribed so as to discourage shop keepers and businessmen occupying the parking place and also discourage others coming into city centres.

Apart from the above city planners can also think of introducing electronic road pricing system, a system by which toll is collected for road use by a vehicle electronically.

In order to introduce this system it is necessary that each and every vehicle should have an electronic instrument. The owner of the vehicle will pay the pre-determined amount and get the instrument loaded. The moment the vehicle crosses the toll collection Gantry, the cameras at the gantry and the antennae regiter the vehicle and automatically deduct the toll amount from the vehicle. In Italy the system is called Easy Card and in America it is also known as E-Z Card. In Singapore however the system has been modified as an Electronic Road Pricing system. In this system the roads of Singapore has been divided into two zones viz., Inner Zone and the Outer Zone. The CBD comes under the Inner Zone. Any vehicle coming into the Inner Zone has to pay a very high toll for using the road. The toll is prescribed based on entry times. Supposing a vehicle enters the Inner Zone. Any vehicle coming into the Inner Zone has to pay a very high toll for using the road. The toll is prescribed based on entry times. Supposing a vehicle enters the Inner Zone during peak office hours the toll will de high whereas the toll will be less during non-peak hours. At many roads Gantry cameras have been fixed and once the vehicles cross the Gantry the toll is automatically deducted. This will prevent vehicle users from bringing their vehicle into the city during peak hours and those who want to enter the city will enter and amount collected will be used for improvement of the traffic.

CONCLUSION : Though the traffic situation in Bangalore during the year 2010 would cause alarm, by curbing the number of private vehicles in the city and by having an integrated public transport system the situation can be effectively managed.

3 Transport demand management measures
Demande de transport et mesures de gestion
Medidas para la administración de la demanda de transporte

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Traffic management and road designs for improving traffic flow: A case for bus priority lanes with segregated cycle tracks

Geetam Tiwari
Transportation Research and Injury Prevention Programme, Indian Institute of Technology, Delhi, India

ABSTRACT :Detailed field studies in Delhi show that since bicycles and other non-motorized vehicles use the left side of the road, buses are unable to use the designated bus lanes and are forced to stop in the middle lane at bus stops. This disrupts the smooth flow of traffic in all lanes and makes bicycling more hazardous. Motorized traffic does not use the curbside lane even when bicycle densities are low. All modes of transport move in sub-optimal conditions in the absence of facilities for non-motorized vehicles. In this paper we illustrate that pedestrians, bicyclists and non-motorized rickshaws are the most critical elements in mixed traffic. If the infrastructure design does not meet the requirements of these elements all modes of transport operate in sub-optimal conditions. It is possible to redesign the existing roads to provide safe and convenient environment to non-motorized modes. This also results in improved efficiency of bus transport vehicles and enhanced capacity of the corridor when measured in number of passengers per hour per lane. The paper illustrates that the capacity achieved in a corridor by redesigning the road cross section, which includes segregated cycle tracks, and exclusive bus lanes compares favorably to capital intensive option like MRTS.

BUSES: MAJOR MEANS OF TRANSPORT IN ASIAN COUNTRIES

Most cities in low income countries[i] rely heavily on the use of buses. It is the major means of mobility, particularly for the low-income population[ii]. The share of public transport trips even in the high-income Asian countries is much higher compared to the European countries. (Table 1).

In LICs walking and non-motorised vehicles are the predominant travel modes in most cities. Public transport is the predominant mode of motorized travel in most cities Walking and non-motorized modes are less significant in middle-income countries. In most cities in these countries, bus use predominates.

Table 1 Modal split of Passenger Traffic in Selected European and Asian Countries (1996)

	% Public road transport	% Private transport	% Rail transport
Europe			
France	5.4	86.4	8.1
Germany	8.7	84.0	7.2
United Kingdom	6.3	89.0	4.6
Spain	12.1	81.5	6.32
Asia			
Japan	6.9	61.9	31.1
Hong-Kong	64.9	28.2	32.1
Korea	36.3	40.0	23.6

Source: International Road Federation, 98[iii]

The travel characteristics of large cities in high-income countries are differentiated from such cities in low and middle-income countries by the use of mass rapid transit (MRT) and commuter rail systems. Buses form the backbone of urban public transport services throughout Asia. However, over crowding, increased incidence of breakdowns and poor service frequency has resulted in decline in general levels of service and comfort.

Consequently, a large number of IDVs are operating as paratransit modes in Asia cities. This service is mostly provided by the informal sector. Paratransit operations provide an important service in cities throughout the region with the notable exceptions of China and high-income countries such as Australia, Japan and Singapore[iv].

Vehicle Ownership in Asian Countries

Economic growth, urbanization and population trends in Asian cities indicate that the urban population of Asian cities will have to depend heavily upon public transport for their travel need, unlike the European cities, which are heavily dependent on private transport. Though the average income levels of people in Asian countries are expected to rise, these countries would still have 53 percent of the world's poor people by the year 2000[v]. Thus, travel demand would increase in low income Asian countries having 50 percent of the world's poor. Vehicle ownership of private vehicles and availability of public transport vehicles would continue to be low despite increase in the number of vehicles.As evident in high-income Asian countries, the existence of large public transport demand on the main travel corridors of large urban areas leads necessarily to the implementation of high capacity systems. These have been successfully operating in cities of high-income countries. Since most Asian countries have scarcity of resources and low-income levels, operating bus based public transport system is the only option, which is economically and financially viable.

TRAFFIC PATTERN ON URBAN ROADS

Since bicycles and other NMVs use the left most lane of the road, buses are unable to use the designated bus lanes and are forced to stop in the middle lane at bus stops. All modes of transport move in sub-optimal conditions in the absence of facilities for NMVs. This disrupts the smooth flow of traffic in all lanes and makes bicycling more hazardous. Therefore, providing a separate bicycle track/ lane for NMVs would make more space available for motorised modes and make bicycling less hazardous. It is also obvious that in the absence of segregated NMV lanes on arterial roads, it is not possible to provide designated lanes for buses.

Pedestrians, bicyclists and non-motorised rickshaws are the most critical elements in mixed traffic. If the infrastructure design does not meet the requirements of these elements all modes of transport operate in sub-optimal conditions. It is possible to redesign the existing roads to provide safe and convenient environment to non-motorised modes especially if the right of way is 30m or more[vii]. This also a prerequisite for achieving improved efficiency of public transport vehicles and enhanced capacity of the corridor when measured in number of passengers per hour per lane.

Segregated bus lanes are necessary to meet the increasing travel demand and to improve the public transport service. Except in some urban corridors where the centre of the road is reserved for buses, in many cities around the world, the curbside lane is reserved for buses. The latter has been attempted in Delhi, but with no success. In the absence of segregated bicycle lanes bicyclists use the curbside lane. This makes it impossible for buses to use the left-most lane in spite of repeated attempts at enforcement by the Delhi Police. If separate lanes were available then all bicyclists would use them and this would make the curbside lane available for buses. As a matter of fact, the presence of segregated bicycle lanes is a necessary pre-condition for establishing bus lanes.

ROAD SECTON PLANNING FOR EXCLUSIVE BUS LANE

Our studies show that on urban arterials the curbside lane (3.5 m) is used primarily by bicycle and other non motorized traffic. Because of the presence of bicycles and NMVs in the far-left lane, buses are unable to use thes lane and are forced to stop in the middle lane at bus stops. Motorized traffic does not use the curbside lane even when bicycle/NMV densities are low. A segregated bicycle lane needs only 2.5 m and since most of the major arterials in Delhi as well other Indian cities where planned development has taken place after 1960s, have a service road, the existing road space is wide enough to accommodate a bicycle track. This would not require additional right of way for road. A detailed study completed in Delhi, India shows how existing roads can be redesigned within the given right of way to provide for an exclusive lane for NMT modes (bicycles and three wheeled rickshaws).[viii]

Detailed designs for road cross section and intersections have been prepared in Delhi on the basis of following criteria:

1. Physically segregated bicycle tracks on routes which have >30m ROW.
2. Recommended lane width on main carriageway 3m (minimum).
3. Recommended lane width for buses 3.3 m (minimum).
4. Recommended lane width for bicycles 2.5 m (minimum).
5. Separate service lane and footpath.
6. Intersection modification to include the following:
    - Restrict free left turns
    - Modify traffic signal cycle
    - Roadside furniture to ensure safe bicycle movement and minimise interference from motorised two wheelers

Exclusive bus lanes can be provided either as curbside bus lane (Figure1) or central two lanes physically segregated from rest of the traffic (Figure2). Table 2 lists critiria that should be adopted for chosing one of the two options. Figure 1 and 2 show detailed designs where two lanes of 3m each are proposed for the main carriageway in

Table 2. Criteria for site specific choice between a central bus-lane layout and a curb-side bus-lane layout

Sl. No.	Central Bus Lane	Curb-Side Bus Lane
1.	**Excessive side-entries for vehicles into service lanes or individual plots.**	**Limited access to service lanes or widely spaced entry points into adjoining area.**
Rationale	The high volume of turning traffic interferes with the through movement of bus traffic if the bus uses the same curb-side lane as the turning vehicles.	
2.	**Closely placed traffic lights for vehicles.**	**Traffic lights at larger intervals.**
Rationale	Buses using the curb-side lane are forced to stop at every red signal with other vehicles reducing throughput and encouraging passengers to board and alight in unsafe areas.	
3.	**Low frequency of bus-stops**	**Higher Frequency of bus-stops**
Rationale	If the frequency of bus-stops is higher a central bus-lane will create too many pedestrian crossings defeating the its purpose while a curb-side bus lane will provide safer and more efficient bus-stops.	
4.	**Higher volume of two-wheeler and three-wheeler vehicles**	**Lower volume of two-wheeler and three-wheeler vehicles**
Rationale	High volumes of two-wheeler and three-wheeler vehicles interfere with the movement of buses in the curb-side lane especially at the bus-stops where buses often cannot approach the designated bus-bays due to the three-wheelers parked there and the two-wheelers trying to overtake from the left-side. Also, the difference in sizes of these vehicles sharing the curb-side lane makes the situation unsafe for the smaller vehicles.	
Eg.	**Arterials through heavy commercial landuse areas like Vikas Marg**	**Highways through large institutional areas like stretch of Ring Road in ITO area.**

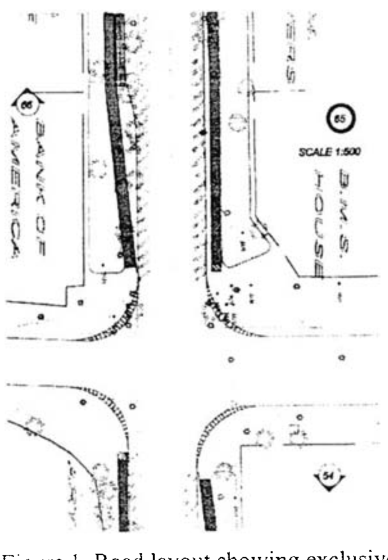

Figure 1. Road layout showing exclusive curbside buslane

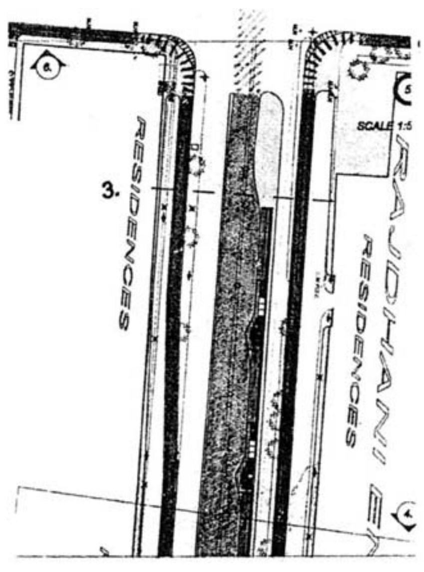

Figure 2 Road layout showing central bus lane

addition to the 3.3m wide central/curbside bus-lane. In the case of the central bus lane stretches the two 3.3m wide lanes combine to form a 6.6m wide undivided two way road. A 2.5 m wide cycle track is proposed throughout the length of the corridor running adjacent to the main carriageway (separated by a 0.4m wide divider on either side) A service lane is proposed between the cycle track and the peripheral footpaths all along the stretch with a minimum specified width of 3m.

The flow, speed and direction of traffic is controlled by the design of the junctions and road surfaces. The design, of course, differs completely in the case of Curbside bus Lane and Central Bus Lanes options.

Intersection with Curb-side Bus Lane:

- An extra bay is provided for right turning traffic at junction.
- The bus lane before and after the junction are streamlined.

The Minimum left turning radius according to which the curve of the intersection is plotted is (a) In case of buses not turning left : 7.5m with a sloped leeway of 1.5m for larger vehicles, (b) In case of buses turning left : 14m. with a sloped leeway of 1.5m. This case specific designing allows for control of left-turning speeds thus ensuring safety and the speed transition between an arterial and residential road.

Intersection with Central Bus Lane :

Three lanes - straight, left-turning and right-turning are provided for the vehicles before the intersection and only one after it due to dispersal of traffic. However the single lane after the intersection is 4.5m. wide to allow for necessary leeway. The central bus stretch becomes 3-lane wide before the junction to allow for a left-turning lane.

The bus lane before and after the junction are streamlined.

The Minimum left turning radius according to which the curve of the intersection is plotted is 7.5m with a sloped leeway of 1.5m for larger vehicles. This case specific designing allows for control of left-turning speeds thus ensuring safety and the speed transition between an arterial and residential road.

Criteria for Locating Bus Stops

Interchange should be close to their users. Bus and paratransit stops should be near to residences to minimize walking distance, and major interchanges should have direct pedestrian links segregated from motorized traffic.

Public transport routes should generally follow main traffic routes and boarding points should be adjacent to and beyond intersections and linked with other parts of the general traffic network - particularly footpaths. Measures should be taken to remove cyclist from the main carriageway, cause they prevent the buses from parking close to the bus stops or interchange points.

Bus and paratransit stops should be placed at points where pedestrian routes to and from major generators converge (example: major commercial, institutional centres or next to major intersections). Avoid locations where road safety or congestion problems are likely.

Wherever possible public transport vehicles should be provided with clearly marked passenger pick up points or bus stops, preferably off the main carriageway (i.e. bus stops should preferably be located on a lay by.

Lay-bys should be positioned on straight, level sections of road and should be visible from a good distance in both directions.

Access to a lay-by should be convenient and safe for both, vehicles and pedestrians.

Advance warning signs should be erected to alert the drivers of the approach to lay-bys and, the possible presence of pedestrians ahead.

Special facilities should be used in order to give greater priority to buses and hence to make public transport more attractive to potential passengers. These generally set aside a portion of the road for the exclusive use of buses, where they can maintain reasonable speeds or reach the head of the queues at intersections

If buses stop on the opposite side of the same road, stops should be located tail to tail as these are safer. Pedestrians will tend to cross behind the buses where approaching vehicles on the same side of the road can see them more carefully.

Bus stops should be located beyond pedestrian crossings and after intersections to avoid stopped vehicles masking pedestrian and other crossing activities.

Bus Stops should be placed such, around an intersection, so that the walking distance from the crossing reduces for the commuters. The walkable distance in each direction can be reduced to as low as 50m.'s by removing all free left turns and placing the bus stops after the crossing (in each direction of traffic flow).

Criteria for Redesigning Bus Stops

Bus stops have 2.8 m wide bus bay, 2.5 m wide bus stop and 1 m wide foot path.

Hawkers have been provided space at the bus stop to minimize disturbance to the regular flow of pedestrian and cyclist traffic.

The cycle track is diverted behind the bus stop in a gentle horizontal curve to reduce conflicts of cyclists with buses. This diverted path is raised to the footpath level and can be used by pedestrians too hence is widened from 2.5 m to 3 m.

CAPACITY ESTIMATES:

If a separate segregated lane is constructed for bicycles, the curbside lane, which is currently used by bicyclists will become available to motorised traffic. This relatively small investment in bicycle lanes can increase the road space for motorised traffic by 50 percent on 3 lane roads. Bicycle lanes also result in better space utilisation. For instance a 3.5m lane has a carrying capacity of 1,800 cars per hour whereas it can carry 5,400 bicycles per hour[IX]. Average occupancy of a car is 1.15 persons and bicycle carries one person. This implies that in order to move the same number of people we would need 2.6 times the road area that would be required for bicyclists. Given the fact that there is not much space available to expand existing roads, the future mobility needs and projected trips can only be met by increasing the capacity of the existing road network. This can only be achieved **by encouraging modes, wich are more efficient in terms of space untilisation.**

Most of the major corridors in Delhi are 6 lane divided carriageways. We have estimated the capacity of a 6 lane divided carriageway in the peak direction. Various combinations of modal shares and road space assignments were compared to evaluate their impact on the road capacity. Following options were considered.

Base case(Mixed traffic). The existing road space utilization pattern was taken as the base case. Capacity of a typical 6-lane corridor in Delhi corridor in persons per hour is estimated on the basis of average occupancy of each vehicle (Table 3).

Table 3: Capacity Estimation in different scenario

Current				Exclusive Cycle track provided			Cycle track and HCBS		
Vehicles/h		Persons/h			Persons/h	Persons/h		Persons/h	Persons/h
		Bus=40	bus=80	Veh./h	bus=40	Bus=80	Veh./h	bus=40	bus=80
Cars	1404	1614.6	1614.6	1404	1614.6	1614.6	1404	1614.6	1614.6
MTW	1652	3634.4	3634.4	1652	3634.4	3634.4	1652	3634.4	3634.4
BUS	248	9920	19840	324	12960	25920	486	19440	38880
TSR	454	799.04	799.04	454	799.04	799.04	454	799.04	799.04
Cycle	338	354.9	354.9	338	354.9	354.9	4500	4725	4725
Total	4096	16322.94	26242.94	4172	19362.94	32322.94	8496	30213.04	49653.04
	~	**16000**	**26000**		**19000**	**32000**		**30000**	**49000**

1 Current mixed traffic is observed modal shares on Delhi streets.

2 Cycle track provided scenario includes exclusive cycle track for bicycles where max. 4500 bicycles can travel.
Space occupied by 338 bicycles in the mixed scenario becomes available for other vehicles. This is equialent to 338x1/2 = 169 cars = 169/2.2 = 76.8 buses. Since bicycles share the left Side lane with buses, therefore bicycle space is given to 76 additional buses.
However, the maximum capacity of this lane as per IRC standard is 1800 PCU or 1800/3.7= 486 buses. If we replace 338 bicycles with additional 76 buses then the existing level of congestion and speeds will be maintained.

3 Cycle track filled to capacity ~ 4500 bicycles,and left lane filled to capacity by buses ~ 486 buses Along with existing number of vehicles on the road gives the total capacity of the corridor.

Table4: Capacity in persons/h in three MV lanes(excluding bicycles)

	Bus=40		Bus=80	
	ExclusiveCycle Track	Exclusive cycle track and HCBS	ExclusiveCycle Track	Exclusive cycle track and HCBS
Car	1614.6	1614.6	1614.6	1614.6
MTW	3634.4	3634.4	3634.4	3634.4
Bus	12960	25920	19440	38880
TSR	799.04	799.04	799.04	799.04
Total	19008.04	31968.04	25488.04	44928.04
~	**19000**	**32000**	**25000**	**45000**

Dedicated cycle lane. The right-of-way on a 6-lane carriageway is reallocated to provide for a separate 2.5-3 m wide bicycle track. The exclusive bicycle track can carry 4500 bicycles per hour. This still leaves enough space for six lanes on the main carriageway. All the lanes of the main carriageway are used by all motorised modes. If the space released by exclusive bicycle track (equivalent of 338 bicycles ~ 169 PCU~76 buses as per Table 3) is used by additional 76 buses the congestion level and corridor speed will not have significant changes. Table 7 shows increase in corridor capacity from 16000 to 19000. Number of bicycles and other vehicles remain same as the base case. Buses increase by 76 additional vehicles.

Dedicated bicycle lane and high capacity bus system (HCBS). A dedicated lane is provided for bicycles and the curbside lane is exclusively reserved for buses operating as HCBS. Other two lanes are used by all other motorized traffic. A dedicated 3 m wide bicycle lane can carry 4500 bicycles (maximum capacity of an urban lane is 1800 PCU ~ 4500 bicycles). Exclusive bicycle lane releases space on left most lane for buses. Therefore the maximum capacity of the left most lane is 1800 PCU ~ 486 buses (Table 3).

The results of the capacity estimation show that with the corridor capacity measured in terms of persons/ hour in existing patterns of mixed traffic, capacity can be improved by 19% by providing exclusive bicycle tracks. If the bus occupancy is taken as 80 persons/bus then 23% improvement in capacity can be realised by providing exclusive bicycle tracks. Not only does extra space on the main carriageway become available to other modes, the dedicated bicycle track also provides a higher capacity for bicyclists. Provision of exclusive bicycle track also provides an oppurtunity to develop left lane as an exclusive bus lane. Table 4shows 88% improvement in capacity from 16000(40 persons/bus) and 26000(80 persons/bus) to 30000 persons and 49000 persons respectively. This is achieved by running 486 buses in the exclusive bus lane and 4500 cycles in the exclusive cycle lane.

Table 4 shows capacity of the main carriageway(three lanes used by motorised vehicles). This does not include capacity provided by the cycle track. Corridor capacity improves by 19-23% by providing exclusive cycle track. However, utilizing the full capacity of the corridor i.e. provision of high capacity bus system in the left most lane can lead to capacity improvement by 56-73%.

It is clear that, if Delhi and other similar cities can have major improvement in public transport capacity if facilities for non-motorized transport are considered as an integral part of a programme to enhance road capacity. Not only are lanes designed for bicycle traffic less expensive to build than roadways, but they also will divert pedestrians and slow-moving vehicles from the roadway, increasing the efficiency of car and bus transport.

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Transport demand management in developing countries: The São Paulo car share programme

Le gestion de la demande de transport dans les pays en voie de développement: Le programme de co-voiturage à São Paulo

La gestión de la demanda de transporte en los países en vías de desarrollo: El programa de coche compartido en São Paulo

P.Câmara
Leicester City Council, UK

M.L.R.Freire
CETESB, São Paulo Environmental Secretary, Brazil

ABSTRACT: The paper presents transport demand management programmes in developed countries as a way forward to tackle growth in car use and car dependency and the scope, if any, for the development of such programmes in developing countries. It also presents an overview of how car-clubs are progressing in Europe and focuses on a car-share programme 'Programa Transporte Solidário' being developed in the city of São Paulo, Brazil, as an attempt to reduce car dependency, ease congestion and ultimately to improve air quality.

RÉSUMÉ: Cet article présente des programmes de gestion de la demande de transport réalisés dans les pays développés qui visent à réduire la croissance de l'usage du véhicule particulier et sa dépendance, afin de développer des programmes similaires dans les pays en voie de développement. Il comprend un aperçu de comment le 'car-clubs' a progressé en Europe et se centre sur le programme de co-voiturage 'Programa de Transporte Solidário' qui a été développé dans la ville de Sao Paulo au Brésil, qui tente de réduire la dépendence de la voiture, la congestion et finalement améliorer la qualité de l'air.

RESUMEN: Este artículo presenta programas de gestión de la demanda de transporte realizados en paises desarrollados para reducir el crecimiento del uso del coche y la dependencia del mismo, a fin de desarrollar programas similares en paises en vias de desarrollo. Integra un enfoque sobre cómo el 'car-clubs' ha evolucionado en Europa y se centra en el programa de coche compartido, desarrollado en la cuidad de Sao Paulo, Brazil - 'Programa Transporte Solidário' - que intenta reducir la dependencia del coche, la congestión y finalmente mejorar la calidad del aire.

1 INTRODUCTION

The negative effects of transport such as congestion, pollution, high accident rates, noise, delays, health hazards are most felt in urban areas. Increasingly peak hours are expanding and in some cities inter-peak periods are ceasing to exist. This is mostly the case of São Paulo, Brazil, where car ownership levels are comparable to those in developed countries (476 vehicles per 1,000 people) and are still at increase. Modal share is also high favouring car journeys – 26.2% of all trips are made by car including walking journeys and if only motorised modes are considered the car accounts for 41.1% of all trips (CET, 1997).

Car use/dependency must be reviewed. Innovative transport demand management approaches must be developed not only to discourage cars' indiscriminate use but also to encourage alternative modes of transport and a more efficiently use of private cars and the road network. The car will always play a key role in modern societies, people's mobility and in fulfilling their travel needs.

Several strategies aiming at reducing car use and car dependency have already been implemented in both developed and developing countries. Most of the well known comprise a combination of pedestrianization of central areas in cities and towns, improvements in public transport, improvements for cyclists, traffic management, traffic calming, etc. Of special interest to this paper are the examples of traffic ban strategies already attempted in Rome, Athens, Mexico City and most recently in São Paulo. What lessons were learned, if any, from these experiences? What benefits, if any, resulted from such schemes?

The authors believe that the magnitude of the problem is very complex and that there is no single solution to high car dependency, congestion and pollution in such cities as São Paulo, Rio de Janeiro, Buenos Aires, Mexico City as in many others that still grow at a fast pace. A combination of different strategies and measures, especially at the demand side, will eventually avoid these problems aggravating and, may well slow down the rate at which traffic is steadily increasing.

Transport demand management has become a common approach in transport planning in developed countries. Both, the US and many European countries have a wide experience in Transport Demand Management (TDM) and Mobility Management (MM) programmes with great rate of success in reducing car dependency, thus congestion and pollution. It has also become clear that the way forward to plan transport is no longer tackling the supply side but demand. Transport demand management will definitely play a key role in shaping traffic and transport in developing country metropolises. Brazil for instance, had a fleet of 1 million vehicles in 1958, 25 million in 1998 and it is estimated that in 2010 this figure will rise to 50 million vehicles. Where and how will these vehicles circulate? Average journey speeds for motorized individual traffic are already almost down to those of pedestrians.

This paper will look at some European initiatives, mainly 'car-club' schemes and will present a very interesting and innovative experience in the city of São Paulo, where a 'car-share' programme scheme has been initiated.

2 THE EUROPEAN MODEL – MOBILITY MANAGEMENT

Many developments have been flourished in Europe in recent years to tackle car dependency. In the UK as in most EU member states, it is clear that the way forward is to tackle (transport) demand and no longer (transport) supply, including road building and infrastructure. The more roads are built, the more traffic will be generated and more roads will be necessary to be built - an endless cycle that needs to be broken.

Mobility management has been recently defined by two major projects funded by the European Commission as being 'primarily a demand oriented approach to passenger and freight transport that involves new partnerships and a set of tools to support and encourage changes of attitude and behaviour towards sustainable modes of transport'. These tools are usually (but not solely) based on information, communication, organisation and co-ordination (MOMENTUM/MOSAIC, 1999).

Mobility management also advocates that the programmes should be 'voluntary' based as far as possible. Mobility management introduces many incentives to 'persuade' modal shift from the car to other modes of transport and it is being developed and promoted differently within member states in Europe (Câmara, 1999). These may include:

- strategies led by employers to discourage car commuting and business trips (e.g. Green Transport Plans in the UK);
- new working practices such as 'teleworking';
- 'car-club' initiatives promoting car sharing programmes (Switzerland, Germany and Holland and mostly recently in the UK);
- setting up mobility centres to provide information and consultancy on transport alternatives (e.g. Graz, Coimbra, Bologna, Münster, Wuppertal);
- new legislation on the environment – carbon monoxide tax and other decrees (Italy);
- fiscal incentives to promote alternatives to the car (Holland, Belgium and most recently the UK); and
- promotion of cycling and walking as well as public transport.

Car sharing schemes are detailed below as the paper focuses on a 'car share' programme being developed in the city of São Paulo, Brazil, known as Programa Transporte Solidário.

2.1 Car sharing/car clubs

In Britain the term 'car sharing' has been often understood as one driver giving lifts to others, usually to and from a workplace. This is being now called 'ride sharing'. In continental Europe 'car sharing' refers to clubs and schemes, often with hundreds or even thousands of member-drivers, who use (share) a number of cars individually for all sorts of private and business journeys. In simple terms, 'car-clubs' is a convenient form of short-term car hire that enables its members to use a car without actually owning one. The aim is to provide access to a car when walking, cycling and/or public transport are not viable alternatives.

It is argued that cars usually sit in garages, parking designated areas and streets for most of their lifetime. In Holland it was found that this figure mounts to 23 hours a day, on average. This is not a very efficient or economic use of the car neither of the land. In addition, owning a car is a costly business. Car clubs are initiatives well known in

Europe, in which vehicles can be shared by up to 20 households in a neighbourhood. The concept of 'car-clubs' seeks to divorce car use from car ownership to improve car utilisation rate and ultimately to reduce over dependence on the car as a means of transport. Therefore its use becomes hugely maximised and trips are carefully planned in advanced, so unnecessary trips are not undertaken and significant car miles are saved.

Switzerland now has a single 'car sharing' organisation called Mobility, which has over 25,000 members who share 1,200 vehicles throughout the country. Mobility is expected to double its membership to 50,000 within the next 12 to 18 months. A 1995 survey of Swiss car sharers found that for every 5 people who joined the club one gives up their car, accounting savings of 28,000 car miles. Switzerland's good quality public transport system has played a vital role in encouraging drivers to decide to become Mobility members.

The German Club, StattAuto, in Berlin, has now more than 5,000 members and about 150 vehicles around the city. StattAuto membership is cheaper than running a private car for those driving less than 6,000 miles a year. Research has found that as people get used to being members of StattAuto, their 'travel awareness' increases and they drive fewer miles. Before joining StattAuto, members were travelling an average of 5,425 miles/year by car and after joining this figure dropped to an average of 2,560 miles/year in StattAutos and other cars - a reduction of 53%. This reduction in car use led to a 28% increase in walking and cycling and a 35% increase public transport use.

The advantages of 'car-clubs' are many fold, they:

- allow people to use cars without necessarily owning one;
- allow users access to cars for short periods from convenient neighbourhood or workplace locations;
- encourage combining the use of other means of transport, including walking, cycling and taxis and so help the environment both locally and globally;
- are already successful in several European countries and are growing significantly every year.

Members and the community alike benefit from Car Clubs schemes:

- access to a range of vehicles at reasonable rates;
- cars can be hired for as little as one hour at a time;
- the cars are based within walking distance of where the members live;
- payments for car use are spread over the year;
- none of the hassle that goes with buying and selling cars privately;
- servicing, repairs, and maintenance are the club's responsibility;
- improved health through more walking and cycling;
- better air quality and less noise pollution, enhancing overall quality of life for all.

Some key questions often asked are:

How does the club work?
Through a membership fee anyone can become a member of these clubs. Membership fees vary from country to country.

What does the club offer to its members?
The club offers its members a wide range of vehicles, available through a 24-hour booking system, vehicle's insurance, maintenance and repairs.

Who should become a member?
Anyone who drives less than 10,000 km is better off becoming a member of such schemes. As well as anyone concerned with their and the community's environment and health. Finally those who want to reduce their car mileage and dependency.

The European schemes have demonstrated that significant environmental benefits can be derived from city car clubs, including lower individual car mileage, higher vehicle occupancy rates, and a significant modal shift to 'greener' transport modes (Armitage, 1999). Car clubs can really help reduce congestion and air pollution, whilst at the same time improving energy efficiency. Would such schemes be a viable option in developing countries to alleviate traffic congestion and relieve pollution?

3 THE BRAZILIAN EXPERIENCE - THE CAR SHARE PROGRAMME IN SÃO PAULO

São Paulo is the biggest city in Brazil. It has a population of nearly 11 million inhabitants, its metropolitan region nearly 17 million, while the State of São Paulo 32 million. The city has a fleet of 4.7 million vehicles, of which 3.8 million are private cars. Car ownership levels are very high – 2.18 people per vehicle - comparable to those in developed countries. Due to this number of vehicles, congestion is part of São Paulo's life besides air pollution, air quality is very poor. Individual car trips are the most inefficient way of using cars.

Consequently, São Paulo's metropolitan area population has been constantly exposed to high levels of congestion and air pollution, mainly during the winter (from May to September). Health statistics show an alarming situation. In the winter mortality caused by heart and lung diseases increases by 13% among children and the elderly. Between 1990-1991 lung diseases accounted for 36% of all deaths among children under the age of five years old.

Therefore, it is crucial to set up policies to reduce and keep air pollution in the city of São Paulo at lower levels and at a later stage to apply a similar approach to other fast growing cities within the State of São Paulo.

One of the major priorities in the municipality is to implement a strategy to reduce and keep pollution caused by urban traffic at lower levels. Although budget is limited the municipality is working very hard, trying to find solutions envisaging benefits to the community, in both short and long terms.

In the 1970s due to the oil crisis Brazil adopted some strategies to tackle the lack of petrol supply. The main ones were rationing the times when petrol stations were opened (including closing them down on Sundays), price mechanisms (constant increases of petrol prices) and also promotion of 'car sharing' schemes, similarly to the ones being developed now, but these mainly addressed commuting trips. In addition to public campaigns urging people to travel less by car and/or to use their cars more efficiently and wisely.

More recently two 'demand management' experiences took place in the city of São Paulo. The first one being car access restriction strategies - Rodízio, similar to the one in Athens, Daktilos, in the eighties; the Rome Targhe Alternative (1993) and the Mexico City, Hoy no Circula (No Driving Day) from the late 1970s (Macedo, 1998).

In 1997, the State Secretariat for the Environment of São Paulo (the regional authority SMA) implemented a car ban strategy, lasting from May to September aimed at air pollution reduction due to vehicle emissions during the winter period. In October of the same year, the city of São Paulo introduced a permanent peak hour car ban scheme, according to number plates endings, aiming at reducing congestion in the city of São Paulo (Macedo, op.cit).

The second demand management strategy, developed to support the 'Operação Rodízio' is the pioneering Car Share Programme called 'Programa Transporte Solidário'. Unlike the European schemes, the programme in São Paulo is more like a 'ride share' scheme that means, people sharing the use of their private cars with others. The aim of such programme is to encourage 'shared' transportation among people who travel to the same destination, such as the same school, work in the same place or area, and/or live in de same neighbourhood.

This programme suggests that if more people travel together in the same vehicle they will be contributing to reduce the number of vehicles in the streets, save fuel, reduce pollution and less car parking spaces at the destination will be required. These gains will benefit both, the individual and the community as a whole, and will eventually lead to a change of attitude and behaviour with regard to the use of the automobile and its dependency.

The Programme started in 1996, when its first software was developed and made available at no cost to those interested in taking part in the scheme. The programme allowed the registration of people in the same community who might wish to join the 'car-share' schemes. It crossed data such as journeys itineraries, destination and hours at which the journeys would take place in an attempt to find compatible routes and potential ride 'sharers'. The software also provided description of passengers' profiles in details such as whether they were smokers or non-smokers, gender, their hobbies, etc. Each registered person was given a list containing all this information of potential ride matchers. It was up to each of them individually to organise their travelling arrangements in carpools, with the advantage of sharing the burden of driving, parking the vehicle and all the costs involved for any particular 'shared' journeys they might make.

This first version of the car-share programme software aimed initially at enterprises and it was distributed amongst nearly 1,300 organisations of both the private and the public sectors, including independent and state schools, local authorities, shopping centres and housing estates. Although results from a follow-up telephone survey with 20% of such organisations suggested that 99% of the interviewed supported the idea of the car share project, in reality the take-up was not satisfactory. The reasons being lack of better publicity and marketing among the communities, some compatibility problems were identified, for example, the software was not compatible to schools and individuals, not enough time since the programme launch among others.

In 1997 the software was updated taking into account the problems identified in the first version. Thus it was developed aiming at three distinct target groups, enterprises, schools and housing estates. In addition to that, it was produced in two formats, disk and CD-ROM. In parallel a marketing campaign was launched to promote and disseminate the concepts of the 'car-share' programme. This included, publishing the application form for the software in a national newspaper with a readership of over 1.2 million, launching the CD-ROM of the campaign 'Breath São Paulo - Car Share' ('Respira São Paulo-Transporte Solidário'). Several talks and presentations were also held culminating in a distribution of more than 10.000 copies of the software in 1997 to institutions all over the country and a kit which included a poster, a 'T' shirt and further dissemination material. The types of organisations who requested the software included private enterprises, schools, local authorities, hospitals, housing estates, banks, trade unions etc.

So far 13.000 copies of the software have been distributed, of which 34% to the city of São Paulo, 33% to the rest of the state of São Paulo and 23% to other states in Brazil and some to Argentina and Paraguay. These requests were made mostly by enterprises (44%), schools (22%), housing estates (15%) and unions (10%).

The total cost of the programme was US$537.000 of which one fifth was paid by CETESB/SMA while the remaining four fifths through sponsorship. It covered the production of the second version of the software (25.000 copies were produced at a total cost of US$35.000); the CD-ROM cost US$32.000. The most expensive item was the distribution of the promotional material and of the software (US$354.000) totally paid by Fôlha de São Paulo newspaper, one of the main sponsors of the programme. Other less expensive items included promotional events and the production of 15.000 posters. Finally the first version of the software was totally produced (and financed) by the CETESB programming team.

In 1997 a survey among those individuals and institutions that had received the software was planned for 1998. However the surveys did not go ahead for funding and sponsorship problems. As a result of that the team involved in the programme was reduced.

Some car-share pilot projects were, however, started at main traffic generation points in the city and elsewhere. The sites were selected on the grounds of their previous interest in receiving a copy of the car-share programme software.

The first pilot project was carried out at the São Paulo University Campus, which attracts over 50.000 people including lecturers, members of staff and students. The initial plan was to involve the whole community and to promote the programme with posters, banners and leaflets and finally to establish strategic points for the distribution of the software. Unfortunately the director of the university left and the new one plus his team delayed the process of implementing the project and did not comply to the commitments of the previous director. The project was not successful, for lack of support within the organisation and the only 130 students who enrolled in the programme did not own a car. In addition buses are not allowed in the campus neither vans making it even more difficult any car reduction scheme to succeed.

The second pilot took place in the city of São Paulo in an area which houses several enterprises and employs over 7.000 people, including CETESB, known as 'Quadrilátero', of which 1.638 enrolled to take part in the 'car-share' scheme. Successfully 208 of these (13%) in fact started sharing their cars with others. The riding share arrangements took different forms. Some shared their car every second day (probably due to the car ban restrictions). Others left their cars home and chartered a bus. Some car shared on a regular basis thus shared the running costs of the vehicles while others car-shared only on the days they were not allowed driving their cars into town due to the 'Rodízio' and finally few 'car shared' on an occasional basis.

For the third pilot in the city of Rio Claro, in São Paulo State, the software was updated to cater for postal code discrepancies. In Rio Claro the project intended to promote car share and bicycle. Unfortunately the project was not successful for political and administrative reasons. The transport team at the city council was developing totally opposite strategies to those advocated by the 'car-share' programme and they were instead expanding car parking in the city centre and removing existing cycle lanes.

4 CONCLUSIONS

It is clear that transport demand management strategies are the only way forward to tackle traffic growth and its negative impacts such as congestion, pollution, delays, high noise levels exposure in order to improve life quality in our cities and the health of its inhabitants.

Europe has shown that mobility management strategies can be a very successful tool in tackling such problems, by encouraging alternative modes of transport to the 'solo' driving. In addition to public transport, cycling, walking and teleworking, another innovative alternative is 'car-sharing' or 'car-clubs' programmes. Such schemes are flourishing at rapid pace in Europe and practice has shown that significant environmental benefits can be achieved, such as car mileage reduction, higher vehicle occupancy rates and modal shift to 'greener' alternatives.

In Brazil the first attempts in travel demand management dates from the 1970's due to the oil crisis. In the 1990's the city of São Paulo launched two major transport demand management schemes, the 'Rodízio' car ban restriction programme and a pilot 'car-sharing' programme.

Unfortunately the 'car-share' programme - Programa Transporte Solidário - has not been as successful as it could have been anticipated. The main reasons being the lack of funding to continue the work started, plus the fact that in 1998 there were elections in the State of São Paulo culminating in the change of all those in key decision making posts. In 1999 the new elected team reassessed the on-going projects and tried to adjust them to new guidelines and to the new budget. The team responsible for the car-share programme is still working internally and arguing the importance to continue to develop it even further. The team is working on its year 2000 version and is preparing a new budget for the programme as well as trying to identify the reason for its poor performance in its previous versions.

As a matter of fact it became clear that some of the current 'car-sharers' are taking part in the scheme on the days they are banned of driving their cars. Thus it is clear that the two programmes – the car ban strategy and the 'car-share' can complement each other really well. Maybe the 2000 version should highlight the 'car-share' as a viable alternative to the car on days people are not allowed to drive their cars into town due to the 'Rodízio'.

Other reason for the poor performance of the Programa Transporte Solidário in São Paulo may well have been cultural factors that can act as barriers in such programmes. The UK for instance is legging behind in Europe in car sharing programmes, car-clubs and vanpool schemes for this same reason.

These poor results observed in the Transporte Solidário Programme should not discourage the city of São Paulo to continue to pursue demand management strategies to tackle traffic congestion and pollution such as their 'car-share' programme neither should discourage other cities to follow São Paulo's programme example.

Maybe the next step of the car-share programme in São Paulo should be to undertake a qualitative survey with those 208 from the 'Quadrilátero' who are currently 'car-sharing'. This would allow learning from their practical experiences of 'car-sharing', for what trip purposes they share their journeys, how they feel about it, what the main benefits or constraints of 'car sharing' are and finally what it could be done to improve future programmes even further and gain more adepts.

Sooner or later politicians will realise that the only plausible way to tackle transport growth is by managing current (transport) demand and supply more efficiently and effectively. The population must also realise that they have their part to play in this process. 'Car-sharing' can be a good travel alternative to the 'solo' driver and a very effective and efficient way to move around cities.

Although 'car-sharing' schemes or 'car clubs' are not the only solution to traffic congestion or pollution, they can be one of the several possible solutions to minimise their impacts due to the increase in both, car ownership levels and car use, and ultimately its high dependency. In Europe such programmes have shown that they can be part of the solution and to contribute to enhance the quality of life and the health of individuals/communities alike.

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Is it worth while organizing the taxi drivers from the Federal District of Mexico?

Est-ce qu'il vaut la peine d'organiser les chauffeurs de taxi du District Fédéral du Mexico?

¿Vale la pena organizar a los choferes de taxi del Distrito Federal de México?

A. R. Nava Cardona
Universidad Nacional Autónoma de México, Mexico

ABSTRACT: The analysis that is developed in this paper make emphasis to the human part involve at the transport service. To talk about of improvement at the work condition of drivers in public transport it is a taboo; but we have to face up and to accept that this human part not only have obligations, but it have too to enjoy the right that going more than an stupendous income. The taxis from the Federal District of Mexico are located at the firs place of pollution from the point of view of number of travel made and number of people transported. In this paper, I present my humble answer to this problem.

RÉSUMÉ: L'analyse qu'on developpe dans cette contribution fait attention à la part humain impliqué dans le service de transport. Parler à propos l'amélioration des conditions du travail des chauffeurs du transport publique de passagers, c'est tout un tabou; mais il faut leur faire face et il faut reconnaître que ce partie humain n'a pas seulement des obligations, mais aussi elle doit jouir des droits qui doivent aller plus loin d'un excellent salaire. Les taxis aux District Fédéral du México occupent la première place dans la pollution cosiderée du point de vue de nombre de voyages effectué et nombre des personne transportée. Cette contribution c'est à mon humble avis une possibilité de solution.

RESUMEN: El análisis que se desarrolla en la presente ponencia hace énfasis en la parte humana implicada en el servicio de transporte. Hablar de mejoras en las condiciones laborales de los choferes del transporte público de pasajeros, es todo un tabú; pero debemos enfrentarlos y reconocer que esta parte humana no solo tiene obligaciones, sino también debe de gozar de derechos que vayan más allá de un estupendo sueldo. Los taxis en el Distrito Federal de México ocupan el primer lugar en contaminación ambiental considerado desde el punto de vista de número de viajes efectuados y número de personas transportadas. Esta es mi humilde contribución para su solución.

1 INTRODUCCIÓN.

Nos encontramos en una época en que el autoempleo tiene un peso importante en nuestra economía. El sector transporte no es la excepción, más bien al contrario se trata del sector que en mayor medida y con mayor antigüedad se ha beneficiado de la labor de personas que ofrecen sus servicios a manera de autoempleo; y en menor medida se cuenta con servicios provenientes de empresas propiamente establecidas.

Esto ha provocado que se tenga poca experiencia en la manera correcta de manejar las relaciones laborales con servidores del transporte. Así mismo, las experiencias con trabajadores debidamente organizados en empresas públicas o privadas, en este sector, han sido amargas, provocando en la actualidad gran apatía del tema, entre autoridades, empresarios e incluso los mismos trabajadores. Tal es el caso del transporte público de pasajeros en el Distrito Federal de México.

En el presente trabajo se analiza el servicio de transporte público individual caracterizado por los taxis.

Existiendo una marcada tendencia a analizar los problemas del transporte desde el punto de vista del usuario y sus necesidades, o desde el punto de vista financiero para la adquisición y reposición de las unidades del transporte, incluidos los estudios de contaminación de las mismas y otros enfoques. Ha sido de especial interés analizar este problema enfocando la parte humana del transporte, el prestador directo del servicio, el chofer del taxi.

2 EL SERVICIO PUBLICO DE TAXIS.

Los taxis como una forma de autoempleo.

En la evolución de los medios de transporte público, de acuerdo a Molinero Molinero & Sánchez Arellano (1998), los taxis ocupan el tercer lugar, luego del peatón y del automóvil particular.

Sin embargo pese a su temprana aparición entre los medios de transporte público, es difícil encontrar información sobre los mismos, la bibliografía existente es reducida.

El servicio de taxi, se ha caracterizado por ser un servicio particular que nunca ha sido llevado a cabo por una instancia gubernamental son una fuente de trabajo importante para aquellas personas que cuentan con un capital para invertir en una unidad factible de convertirse en taxi, su placas, permisos necesarios para prestar el servicio público de taxis, pago del seguro de responsabilidad civil, así como el acondicionamiento del mismo en caso de ser necesario. Para fungir como conductor del taxi basta obtener la licencia-tarjetón expedida por la Secretaría de Transportes y Vialidad del Distrito Federal que cuenta con los requisitos de una licencia tipo B, con vigencia de un año y válida para conducir taxis libres y de sitio, patrullas, ambulancias y automotores de carga pública cuyo peso máximo no exceda de 35 toneladas. Bajo tales condiciones es factible lograr autoemplearse.

Esta forma de entrar al negocio de los taxis ha producido individualización y polarización en el servicio; ya que cada propietario de taxi, lo conduce, le da mantenimiento y limpieza ocupándose de los gastos que genere el negocio Además de proveerse así mismo las condiciones laborales que más le convengan.

En un inicio los propietarios de taxis preferían no exponer la unidad a probables accidentes por lo que no solían rentar la unidad a un tercero para que la trabajara; pero en la actualidad se ha proletarizado ampliamente el servicio. Así existen permisionarios que trabajan su unidad a la par que existen choferes que trabajan el vehículo logrando una retribución económica sin ser propietarios del vehículo.

Condiciones laborales de los choferes de taxi.

Con el fin de analizar las condiciones laborales de los choferes de taxi se entrevistaron a 43 choferes de taxi en distintos puntos del Distrito Federal.

El 72% indicó que solo trabaja el taxi sin ser dueño. La mayoría de éstos identifican al dueño del taxi como el patrón y solo una pequeña proporción lo identifican como una persona que les alquila la unidad para trabajar. Se maneja el concepto de cuenta, referido a una cantidad fija que se entrega al dueño del vehículo por cada jornada laboral.

El número de horas por jornada laboral fue superior a 8 horas y hasta 16 horas para el 93% de los entrevistados, siendo el valor modal 12 horas, 51%.

El número de años realizando la labor de chofer de taxi fue declarada entre 7 y 20 años para más del 50% de los entrevistados.

El 70% de los entrevistados indicó que en este trabajo no es posible tomar vacaciones, el 26% indicó poder tomar entre 2 y 8 días de vacaciones al año y solo el 5% indicó poder tomar 15 o más días de vacaciones.

Respecto al servicio médico sólo el 23% indicó asistir a servicios del seguro social debido a que gozaban de dicho servicio por tener otro empleo o gracias a la cobertura a través de algún familiar. El 33% señaló la utilización de los servicios médicos de salubridad o del gobierno y el 40% señaló el uso de servicios médicos privados. El resto señaló que dependía de la urgencia, mencionando el uso de la automedicación.

Respecto a sus datos personales, el 51% señaló su edad en el rango de 23 a 38 años, el rango restante se encontró entre los 39 y 63 años de edad.

El máximo nivel de estudios para el 77% de los entrevistados fue primaria o secundaria, un 2% declaró no tener estudios y el 21% declaró tener bachillerato o universidad.

Siendo requisito para obtener la licencia-tarjetón el tomar un curso diseñado especialmente para ellos, se les preguntó su opinión al respecto y se encontró una amplia aceptación ya que el 42% contesto que el curso era bueno o muy bueno, 26% indicó que era regular y un 16% señaló que era malo, estos últimos sin embargo señalaron que era un buen curso para los choferes de taxi principiantes. El restante 16% señaló no haber tomado ningún curso.

3 ANÁLISIS DEL MARCO JURÍDICO.

El chofer de taxi es un trabajador.

Las leyes y reglamentos existentes en materia de transporte público, se abocan principalmente a regular a los usuarios, las concesiones para prestación del servicio, la prestación misma del servicio, los vehículos, tarifas, verificación y vigilancia.

Desde un punto de vista laboral, solo se menciona la capacitación y una serie de obligaciones referidas a la prestación del servicio de transporte ofrecido.

Respecto a las garantías otorgadas por la constitución a través del artículo 123 los choferes de taxi por las condiciones de trabajo, surgen los primeros intentos de conformar organizaciones sindicales independientes para luchar por sus derechos, pero hasta la fecha no han fructificado. El principal obstáculo son las primeras agrupaciones creadas y los propios permisionarios que impiden cualquier intento de sindicalización, pues implicaría establecer un contrato que mermaría significativamente sus ganancias.

Dadas estas dificultades, en mi particular punto de vista, vislumbro una solución distinta. Si se considera a los permisionarios o dueños del taxi, como simples alquiladores de un medio laboral, como ya lo empiezan a señalar los choferes mismos.

Entonces lo que debe de realizarse es una organización de trabajadores, tal que en ellos mismos sea en quienes recaiga el interés por afiliarse a la seguridad social. Otra manera sería buscar medios para asegurarse al menos el acceso a servicios médicos particulares a través de un gremio de choferes de taxi. Sin que esto los obligue a conformar una organización empresarial o sindical que los coarte, sino mas bien que les permita continuar su labor de manera independiente.

Ejemplos importantes de organización de trabajadores autónomos e independientes a la vez, los tenemos en la misma ciudad. Tal es el caso de la Organización de Boceadores de México, quienes a lo largo de los años, han logrado proveerse de servicio médico particular, así como de créditos para la adquisición de vivienda, entre otros. Sin embargo cada uno de ellos desarrolla su labor productiva de manera personal e independiente.

Así los trabajadores mexicanos que desarrollan su labor a manera de autoempleo merecen también verse favorecidos por los medios que proveen y fomentan el desarrollo social de los pueblos.

El sector transporte tiene mucho que aprender a este respecto. Tanto permisionarios, como choferes, usuarios y autoridades del transporte público deben beneficiares de una organización adecuada para unos y otros.

Si se dice que el transporte es generador de progreso, este progreso debe alcanzar a todos y cada uno de los que intervienen en el proceso.

4 BONDADES DE LA ORGANIZACIÓN.

Lograr organizar a los choferes de taxi, ya sea en una sola organización general, o en varias organizaciones con el mismo propósito; les proporcionaría, además de lo expuesto en la sección anterior, la oportunidad de aprender a relacionarse, a comunicarse y convivir, fortaleciendo sus propias capacidades de atencion y solución de sus problemas comunes.

Logrando recuperar valores como el respeto, la tolerancia y la solidaridad entre ellos, hacia los permisionarios, los usuarios y las autoridades.

Podrían desarrollar sistemas de capacitación en que los choferes con más antigüedad transmitieran sus conocimientos a los de nuevo ingreso.

Con lo cual el usuario se vería beneficiado, pues se lograría otorgar un mejor servicio, con mayor calidad.

La experiencia desarrollada por los radiotaxis, vislumbra que organizar a los taxistas en una o varias centralitas, lograría ordenar la circulación incesante de taxis vacíos en busca de cliente. Los viajes con clientes a bordo impactaría en una significante disminución de la contaminación ambiental derivada por los viajes sin clientes o en busca de los mismos.

Un buen servicio de taxis comité con el uso del automóvil particular por lo que su optimización desalentaría el uso continuo del automóvil, a favor del uso de taxi.

Así en lo que respecta a los choferes de taxi, despertar en ellos el deseo de beneficiarse de las bondades de organizarse, impactaría en la reestructuración del transporte. Disminuiría la existencia de taxis pirata o fuera de reglamento. Pues no es lo mismo obedecer por obligación que obedecer porque se aspira a un bien.

La situación mencionada por Legorreta (1989) respecto a que las primeras organizaciones de taxistas se convirtieron en asociaciones de permisionarios. Nos anticipan que el bienestar acompaña a toda organización. Un mejor servicio, produce bonanza en el empleo del mismo y repercute de manera directa en la economía de sus integrantes.

Esto es un reto para las autoridades correspondientes; quienes deben estar consciente de este hecho y pensar si el servicio de taxi debe de continuar sujeto a 5 unidades máximas por permisionario.

En cuyo caso se trata de un negocio en que al llegar a un progreso de 5 unidades, con todo y la experiencia que este hecho les signifique, deben de estar dispuestos a dedicarse a otra cosa. Es decir es un extraño negocio que tiene límites en un determinado punto de su desarrollo. El análisis de este problema no se realizó, pero suena de gran interés para un economista o un administrador, ya que dicho límite tiene que ver con el tema de los monopolios.

5 CONCLUSION.

Es inevitable el desarrollo de formas organizacionales para lograr mejorar la situación en que laboran los servidores del transporte.

Para el caso de los choferes de taxi, lograr hacerlo es un sueño largamente acariciado. Corresponde al gobierno, a los permisionarios e incluso a la sociedad misma el dar su voto aprobatorio para que este sueño se lleve a cabo.

Es inadmisible fingir que todo va bien. Considerar el desarrollo social de los trabajadores, es muy importante aún cuando se trate de trabajadores que no dependen de un patrón sino más bien hacen uso del autoempleo; el cual, ha sido altamente promovido a través de diversas políticas de gobierno.

Este debe de ser un trabajo en equipo. El Instituto Mexicano del Seguro Social, no debe de quedarse tranquilo expresando tan solo que ya cuenta con el seguro voluntario y esperar sentado la llegada de los clientes. La iniciativa privada debe sentir que esta es una invitación para participar en el proceso de ofrecimiento de soluciones a este sector de la población. Las autoridades en transporte deben tomar conciencia de su papel ante este problema, y no centrar su atención exclusivamente en el usuario y soluciones a la comunidad en lo referente al transporte; pues existe el prestador del servicio que se trata de todo un trabajador que a su vez es un ser humano. Además prestarles la debida atención impacta con seguridad en el servicio.

El trabajo de encontrar cada vez mas y mejores soluciones, es arduo para todos; pero, estemos felices de tener trabajo por hacer.

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Análisis del uso de colectivos en la Ciudad de México

Analysis of minibus use in Mexico City

Analyse de l'utilisation des transports en commun dans la Ville de Mexico

E. Mar-Juárez
Instituto de Ingenería, UNAM, México D.F., Mexico

N. Domínguez
Subdirección de Protección Ambiental, Instituto Mexicano del Petróleo, Eje Central Lázaro Cárdenas, México, D.F., Mexico

RESUMEN: Se analiza la dinámica del crecimiento de la Zona Metropolitana de la Ciudad de México (ZMCM) y los cambios en la estructura modal del transporte en la que se han visto favorecidos los minibuses (colectivos) o transporte concesionado con una consecuente proliferación excesiva de estos vehículos y su impacto al medio ambiente. Y se proponen líneas de acción para disminuir los problemas que causa este medio de transporte.

ABSTRACT: Urban growth dynamics of Mexico City are analyzed alongside changes in the transport mode structure in which minibuses or "colectivos" have proliferated over the transport demand needs and its environmental impact. Action lines are proposed to diminish the problems this mode causes.

RÉSUMÉ: La dynamique de coissance de la zone métropolitaine de Mexico ainsi que les changements de structure du transport dans laquelle les mini-bus ou transports concessionnés entrainant une prolifération excessive de ces véhicules polluants sont analysés. Des plans d'action sont aussi proposés pour réduire les problèmes causés par ce type de moyens de transport.

1 INTRODUCCIÓN

El incremento demográfico y urbano que la ciudad de México ha registrado en los últimos 35 años ha provocado importantes cambios en su fisonomía. Ya que de ser un asentamiento humano de 316 km^2, con 5 millones de habitantes, se convirtió en una verdadera Zona Metropolitana, donde se localizan y aglomeran el mayor número de actividades económicas del país, con una población de aproximadamente 20 millones de habitantes en una superficie urbanizada de 1,700 km^2, abarcando actualmente 16 Delegaciones Políticas del D.F., 53 municipios del Estado de México y uno del Estado de Hidalgo[INEGI, 1999].

Es lógico que la demanda de servicios urbanos haya crecido en igual forma. En cuanto al transporte, en 1995 se realizaron 37 millones de viajes/persona/día (vpd), y se estima que por el año 2020 se realizarán 53 millones de vpd[DDF,1996], lo que agudizaría los problemas de movilidad. El incremento del parque vehicular tiene tasas anuales muy elevadas, incrementandose de 248 mil vehículos automotores registrados en 1960 a 3.5 millones en 1995 [SCT, 1997]. Esta situación exige identificar estrategias concretas que afronten de manera integral las demandas futuras de transporte.

El presente trabajo examina el origen, evolución y consolidación de un sistema poco eficiente de transporte denominado "colectivo" que contribuye con aproximadamente el 40% de los vpd [PROAIRE,1994].

El trabajo se encuentra dividido en tres partes, en la primera se plantea el marco histórico de este modo de transporte, resaltando su importancia en las diferentes actividades de la ZMCM y los problemas ambientales que originado con su crecimiento.

La segunda parte presenta las variables que permiten visualizar cual es el impacto de este modo de transporte en la sociedad y cuáles son las variables que inciden en su desarrollo. Finalmente se indicará las líneas a seguir para disminuir su impacto al medio ambiente y a la sociedad.

2 MARCO HISTÓRICO

Los sistemas de transporte han jugado un papel muy importante en el desarrollo, magnitud y crecimiento de la ZMCM. A principios del presente siglo el transporte urbano adquirió una nueva dinámica con la aparición de los tranvías movidos por energía eléctrica, que se convirtieron en el principal sistema de comunicación de los habitantes de la ciudad.

sistema por tranvía resultaba insuficiente, dando origen al servicio de autobuses que se caracterizaba por la operación de camiones de carga adaptados con carrocerías para diez personas. No se tenían horarios ni rutas fijas, el propietario elegía a criterio tanto el periodo de operación como el itinerario en función de la demanda local existente. En general, los primeros trayectos siguieron las rutas más rentables de los tranvías [Ward, 1991].

Este servicio operó en 29 líneas con un total de 1,457 autobuses. Para 1945 se llegó aun total de 1,957 unidades; cinco años después se habían incorporado a este sistema 1,400 unidades más y para 1982 el total de autobuses ascendia a más de 16,000 unidades cifra referida al número de concesiones otorgadas por el Departamento del Distrito Federal (DDF) en los años mencionados. El crecimiento de la Ciudad continuaba, la tasa de motorización con respecto a autobuses en los últimos 40 años indica que existen más de 600 personas por autobús[DDF, 1983-1996].

El transporte basado en autobuses que se ofrecía en la Ciudad fue incapaz de cubrir la demanda y cobertura. La falta de una respuesta del gobierno de absorber esta necesidad permite la entrada de nuevos agentes en la prestación del servicio de transporte.

Es así como el transporte conocido como "colectivos" inicia su desarrollo en la ciudad, el taxi como modo de transporte colectivo adicional apareció en la segunda década del siglo actual. Al principio operó sin itinerario fijo, y posteriormente quedó adaptado a la modalidad de "pesero", es decir, de ruta fija. En 1935 el total de taxis llegó a 4,538; para 1945 había 4,560; cinco años después su número era de 5,109 y para 1980 operaban en la Ciudad de México cerca de 60 mil taxis. Casi todos los viejos automóviles conocidos como "taxis colectivos" fueron sustituidos por Combis y posteriormente, se modificaron para tener mayor capacidad y poder transportar unas 15 personas, para que finalmente aparecieran los famosos microbuses que transportan aproximadamente 25-30 personas[Legorreta, 1994].

Este modo de transporte presenta una adaptación tal a las condiciones de la demanda de transporte en la ciudad que mientras en 1980 circulaban 2,000 unidades en 143 rutas, para 1994 se tenían registrados 200 mil unidades en toda la ZMCM con una extensión del servicio en 38 mil km [Legorreta, 1994].

Este crecimiento del 140% anualizado en 15 años, se convierte en un hecho sin precedente en la historia del transporte a nivel mundial [Molinero,1998]. Estos cubren prácticamente toda la extensión de la ZMCM: zonas recién urbanizadas en la periferia, las vialidades no atendidas por otros modos de transporte, las arterias principales, donde compiten con transporte operado por el gobierno (trolebuses, metro, etc.) por la ventaja de la flexibili-

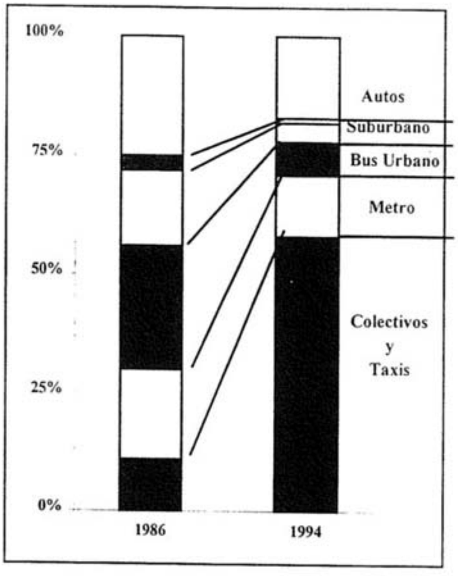

Figura 1. Evolución del Reparto Modal (COMETRAVI, 1997)

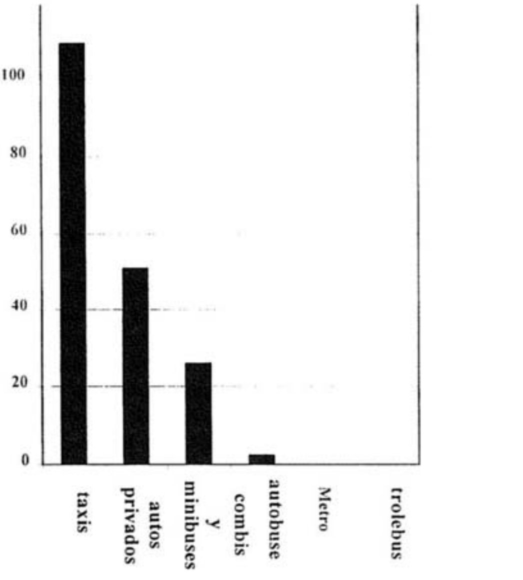

Figura 2. Emisiones contaminantes por tipo de transporte (g / pasajero*km).

asentamiento de población o de trabajo.

A pesar de representar el 4% del total del parque vehicular que circula por la Ciudad de México, este medio se constituye en el principal servicio de transporte para alrededor de 16 millones de personas, su influencia ha sido tal, que ha desplazado en importancia al METRO y a los autobuses foráneos, es por lo tanto, un medio indispensable para el funcionamiento de la ZMCM.

De forma paralela a su desarrollo, han surgido diversos problemas como son su impacto al medio ambiente, mayor saturación de la superficie vial, y la falta de vigilancia para hacer respetar reglamentos de transito y desintegración del transporte de uno de los mayores asentamientos humanos del mundo [Brosthaus, 1995].

En cuanto a emisiones el inventario de 1994 señala un estimado de poco más de 4 millones de toneladas de contaminantes emitido al año a la atmósfera, correspondiendo 75% de éstos al sector transporte, 13% a la industria y servicios, 12% a vegetación y suelos. El transporte es responsable de la mayor emisión de monóxido de carbono (99.5%), óxidos de nitrógeno (71.3%) e hidrocarburos (54.1%) a la atmósfera. Dentro de este sector, los microbuses, taxis y automóviles particulares tienen los factores más altos de emisiones y, por lo tanto, ocupan los niveles más altos de contaminación (Fig. 2).

3 VARIABLES DE UNA MEGACIUDAD

Para tener una panorámica del dimensionamiento del problema de transporte y del desarrollo urbano, deben considerarse los siguientes datos:

3.1 *Demografía*

En 1940 la Cd. de México contaba con 1.6 millones habitantes esta cifra se triplico para 1960, en los siguientes 20 años crece 8 veces y en los 15 que siguen prácticamente se mantiene. Entre 1990 y 1995 la ZMCM ha disminuido su crecimiento (1.8% anual) respecto a periodos anteriores; sin embargo, aún concentra casi la quinta parte de la población nacional, en un espacio que representa el 0.3% de territorio nacional, alcanzando las mayores densidades de población que van de 13,000 y 18,000 habitantes por km^2.

Se estima que para el 2020 la población en la ZMCM puede llegar a 23 millones de habitantes, consecuencia de una tasa de crecimiento anual del 0.2% en el DF y 2.2% en los municipios conurbados, previéndose un incremento del 37% en el número de viajes.

3.2 *Estructura Física*

El proceso de crecimiento físico de la ciudad se inicia entre los años 1970 y 1980 cuando la Cd. de México incorpora a 17 municipios del Estado de México, lo que se denominó Area Metropolitana. Entre Metropolitana, esta integración se ve facilitada por la extensión del Sistema de Transporte Metropolitano.

La infraestructura de transporte terrestre del DF cuenta con 198 km de vialidades primarias, 310 km de ejes viales y 8 mil km de vialidades secundarias. Los municipios conurbados por su parte cuentan con 47 km de vías urbanas rápidas, 616.5 km de vías primarias, 94.3 km de autopistas interurbanas y 258.2 km de carreteras interurbanas.

3.3 *Población Económicamente Activa*

La ocupación predominante de la Población Económicamente Activa (PEA) de la ZMCM es en los servicios, que representan un 66.7% de la PEA; de éstos el 42.2% se localizan en el DF, mientras que en los municipios conurbados se ubica el resto. La actividad industrial concentra al 32.2% de la PEA, de este porcentaje el 16.6% se localiza en el Edo. de México y el resto en el DF. La actividad agrícola sólo representa el 1.1% del empleo en la ZMCM.

La estructura del ingreso de la población indica que el 79% percibe ingresos inferiores a 3 salarios mínimos, lo que indica que los empleos existentes son de una baja remuneración, a los que se tiene que dotar de infraestructura de transporte y servicios a bajo precio.

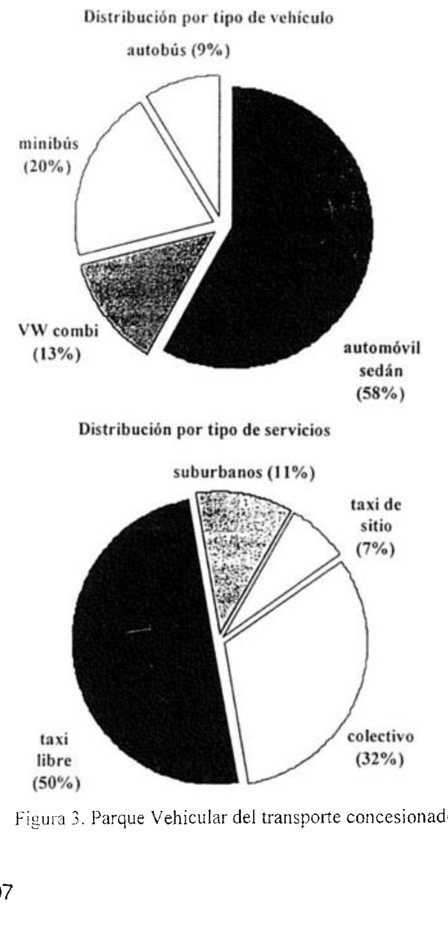

Figura 3. Parque Vehicular del transporte concesionado

3.4 *Distribución modal*

Uno de los insumos más importante para planear el transporte, es analizar los diferentes modos que la integran para planear su desarrollo: en la ZMCM se encuentran registrados más de 3 millones de vehículos, de los cuales 87.5% circulan en el DF y sólo 13.5% lo hacen en la zona conurbada (Fig. 3).

El modo de transporte que mayor crecimiento ha manifestado es el de microbuses, combis y taxis que en el año de 1975 transportaban el 12% de los viajes y en 1994 el 55.3%. Con respecto al parque en circulación y edad de éstos, factores claves para las emisiones contaminantes, casi el 24% corresponde a modelos posteriores a 1990, más del 75% a modelos entre 1980-1990 y menos del 1% a modelos anteriores a 1980, lo que refleja un parque obsoleto, ya que el transporte que circula en el DF tiene en promedio 5.8 años y en el Edo. de México de 9.3 años.

Esta cantidad de vehículos automotores tiende a hacer ineficiente el traslado de personas y mercancías, además de producir un incremento en los tiempos de viaje promedio que le toma a una persona para transportarse internamente en el DF o el Edo de méxico y al atravesar la ZMCM. Por ello las velocidades promedio en horas de máxima demanda para autobuses y trolebuses son 16 km/h, para microbuses (colectivos) es de 21 km/h, para autos particulares de 27 km/h y para el Metro de 35 km/h [INEGI, 1999].

3.5 *Evolución de la Línea de Deseo*

Los estudios de origen y destino realizados en la ZMCM demostraron una modificación importante de las rutas de viajes de personas. En 1983, las líneas de deseo de movimiento se caracterizaron por dirigirse al centro de la Ciudad. Para 1994, los movimientos eran en distancias menores y disminuyeron los viajes al centro, por lo que se generaron más desplazamientos entre puntos de la periferia y aumentó el número de recorridos en la propia localidad.

Del total de tramos de viaje contabilizados por día (37 millones), 82.4% se realizaba en el transporte público, mientras que el restante 17.6% lo hacían en transporte privado. Dentro del transporte público participaba mayoritariamente los colectivos (55.3%) seguidos por el metro. En cuanto al número de viajes que se realizan al día y que asciende a 37 millones vpd, el DF concentra el 66.5% y la zona conurbada el 33.5% [INEGI, 1999].

4 LÍNEAS DE ACCIÓN

Debido a que el ritmo de crecimiento poblacional ha evolucionado más rápido que el de transporte público y no logrando abastecer las necesidades de transporte, ha originado un aumento desmesurado de los colectivos, provocando así un deterioro de la calidad ambiental de la zona metropolitana.

En base al análisis de las variables presentadas en este artículo, se propone mitigar su efecto al medio ambiente por medio de una oferta de servicio controlada por la demanda de mercado, es decir, un nuevo reordenamiento de la flota de colectivos de acuerdo al crecimiento poblacional, líneas de deseo y eficiencia operativa bajo un marco de competencia real. Bajo este mismo esquema establecer paradas consensadas con el usuario de acuerdo a sus necesidades, capacitar a los operadores del servicio y una renovación del parque en el mediano plazo tanto de unidades como de combustibles.

5 CONCLUSIONES

El ritmo de crecimiento de la ciudad impide la prestación de servicios y regulación adecuados, así los colectivos se presenten en la mayoría de nuevos asentamientos como la única respuesta a la demanda de transporte. Si bien estos responden a sistemas locales de demanda al generalizarse como modo de transporte para la zona metropolitana trae graves problemas debido a su limitada capacidad, ineficiencia y al incremento del caos vial, todo esto genera una disminución de la calidad del aire, por ello se propone una planeación urbana y la creación de una oferta de transporte seguro, eficiente y confiable.

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Physical mobility and lifestyle changes: Commenting policies of transport

Mobilité et changements de style de vie: une analyse des politiques de transport

Análisis de cambios en estilos de vida y movilidad física, su impacto sobre políticas de transporte

M.Thynell

Department of Peace and Development Research, Göteborg University, Sweden

ABSTRACT: The concept of sustainable transport was soon followed by discussions about lifestyle as an active part of transport policies. The aim of this article is to clarify the role of lifestyle changes and its relation to transport.

RÉSUMÉ: La notion de durabilite dans le transport provoque des debats sur le style de vie comme partie integrante des politiques de transports. Le but de l'article est de clarifier et de debattre de l'impact des evolutions du style de vie et de leur role potentiel dans les politiques de transport.

RESUMEN: El articúlo introduce criterios de sustentabilidad seguidos por una discusíon de como los cambios de estilo de vida representan factores activos, cambiantes ante todas las políticas de transporte. El articúlo aporta elementos a la discusíon sobre las implicaciones que estos cambios, en especial los pertinentes a la movilidad física, pueden tener sobre políticas de transporte.

1 INTRODUCTION

"Which politician would dare to take their cars, their new found toy, away from the Polish people?"

The question was put by the Minister of Transport, Mr Liberacki in Poland in a debate on eco-friendly car technology and possible price rices. Of course, no one could advise the Minister on how to deal with restrictions on car use either in Poland, or in any other country exposed to dramatic increases in the number of motorized vehicles.

The automotive industry was the first globalized industry. The phenomena of automobility was gradually integrated to the economic and social life. Changes in patterns of consumption followed, and the emergence of a lifestyle suitable to the properties of cars. The existence of cars and car culture is a fact in today's world community. The private car is highly attractive as a symbol of social progress. This is seen *e.g.* in the emerging middle class in areas where traditional socio-economic systems have been modernized and relativized by macro-regional or/and global change in political and economic structures. On the political level the nation-state system is being relativized and weakened by regional entities, through the development of political and economic relations linked together by such phenomena as the evolution of a new techno-economic paradigm, and automobility as a means of globalization.

The background to the question is the outspoken desire for more cars. The rapid increase in the number of cars entails a variety of problems which confront the democratic authorities with new kinds of difficulties, since they have not dealt with issues of massmobility until recently. By posing his question the Minister put forth the complex relations between states, markets, consumers and development which interact in today's pattern of social changes and how the dramatic increase in physical mobility interplays with these relations. Cars and other modes of transport are both economic markets and necessary infrastructure. Consequently, any national policy of transport is operationalized within the framework of the prevailing strategy for development. As such, transport policies reflect concerns with external relations and with national relations between the state and the market.

The expansion of physical mobility is a global mega-trend forecast to increase substantially in most countries. The ongoing globalization of automobility is adding yet another burden to local and global environmental systems. The progress of automobility began one hundred years ago; however, no attractive examples of restrictions in motorized transport have been developed. In today's debate on means and aims of development, economic and environmental sustainability are crucial issues. These two kinds of sustainability are difficult to combine and the modern lifestyle, depending on extensive use of cars is subject to critical examination (Thynell 1998).

1.1 Facts and Concepts

In 1946 there were 46 million cars in the world; 75 per cent of those were registered in the U.S. In 1995 there were 495 million cars registered. According to an OECD-forecast there will be 561 million in the year 2000, and 707 million cars by 2010. The numbers of cars in developing countries today are rapidly increasing and overall car density has increased from 30 to 70 cars/1000 persons from 1970 to 1990. This figure can be compared with statistics from the U.S. where the corresponding number in 1995 was 769 cars/1000, indicating the huge difference between the various regions (WEC 1995:10). Approximately 9 per cent of the global population are car owners.

Data concerning the consumption of transport energy show that the U.S., *i.e.* 5 per cent of the global population consumes 36 per cent of all transport energy, while the NOECD countries, hosting 81 per cent of the population, consume 20 per cent of all transport energy. As soon as people can afford it they tend to prefer to go by car wherever they live. At the same time most politicians officially recognise that it is no longer feasible for every family in the world to have their own car. The global inequality highlights the huge difference in access to physical mobility between the various regions of the world. Average numbers mask the very large variations between rich and poor areas.

Transport and automobility are societal phenomena mainly produced by technical and economic expertise. The attractiveness of privately-owned cars and the increase in the vehicle fleet have created problems and policy instruments and concrete measures in use so far have proven to be inadequate and insufficient. By this I am referring to transport policies and local traffic campaigns in general. Technological development also appears to be an insufficient and inadequate means of controlling traffic growth. The problems associated with motorized transport can be divided into four main categories:

a) the congestion and other problems in densely populated areas related to the capacity of local road-infrastructures,
b) the tremendous number of people killed and injured. "In its first century the automobile has claimed 30 million people's lives". In Poland car accidents are a main cause of death for young men between 18 and 24 years old (Thynell 1999),
c) the local, regional and global pressures on the ecological systems are far above sustainable levels,
d) the fuel supply required by the rapidly increasing fleet of motor vehicles is still an issue in urgent need of a solution.

2 TRANSPORT POLICIES

The aim of transport policies has been to create good conditions and more specifically a sound vehicle-road-system. In order to deal with the inconveniences a range of fixes emerged. The political instruments employed in traditional transport policies are divided into three groups:

Planning fixes: Improved infrastructure such as bridges, tunnels and highway systems are often implemented hand in hand with political measures of different kinds. The effects of these measures are rarely thoroughly analysed. Regional planning and city planning are seen as ways of reducing the need for commuting. The physical planning of cities, urban areas and regions could improve their efforts to diminish the need to commute.

So far increase in travel demand has been controlled by means of traffic management. The achieved reductions in everyday trips have been eaten up by the overall increase in physical mobility, *e.g.* leisure travelling and the increase in long-distance travelling. Motorized mobility will increase substantially in most countries.

Technical fixes: these are also expressed as complementary techniques aiming at making cars and roads more efficient and safe. Many good examples of additional and/or improved techniques can be given, *e.g.* safety belts and seats for small children. Alternative technology is exemplified by vehicles driven by alternative fuel; electricity or fuel cells. Smart cars and smart roads have also raised expectations of safer and less congested roads.

The catalysator and the decrease of fuel - per tkm or pkm - are measures underlining the role of technology in problem-solving and putting a stress on the role of technical expertise in the highly developed countries. Technical fixes do not bring about solutions to the wide range of difficulties in today's transport system. The faith in the capacity inherent in technological achievement to solve problems has strongly emphasized the necessity of various sorts of technical fixes; however, the consequences of radical technology on the problems of sustainability are still not known.

Behavioural fixes: are other kinds of traditional measures applied to improve drivers' behaviour. Laws and regulations dealing with restriction of speed, parking behaviours and various kinds of tolls and circulation restrictions in big cities have been used. Economic adjusments: taxes, fees, subsidies and road pricing are negotiated politically and enforced in order to influence drivers' behaviour. It is difficult to evaluate the outcome of these measures. For instance, a well-known fact is that the doubling of gasoline prices does not lead to a 50% reduction of pkm, due to the elasticity amongst the consumers in their response to raised prices and taxes.

Information campaigns are also measures dealing with individual behaviour. Information can influence road-users and passenger behaviour towards changes in mobility patterns and reduce mobility only when that information offers a possible and positive alternative. Information campaigns need to have a clear-cut message since blurry or/and contradictory information or big-brother attitudes tend to be neglected by the users. The long term consequences of information are much debated in Social Science and can be said to be by and large unknown.

2.1 New elements in transport policy

The non-traditional aspect of 'lifestyle' was introduced when an integrated view on transport appeared. This recent and more complex understanding of the societal role of transport emerged at the same time as problems in transport became obvious. The fact that less than 10% of the global population owns a car and that the real problem for many people is the lack of access to physical and motorized mobility are examples of the kind of problems involved in this sector.

Changes in lifestyle as an active feature of transportation policy is of a different character than behavioural fixes because of its social and cultural embeddedness. The lifestyle of a person is closely connected with individual desires, dreams and cultural values inherent in Western culture. The way of life linked with prevailing modern values of the mainstream development in the sector of transport have been operationalized by means of the modern lifestyle. The car culture is a part of a western and modern culture. Current societal needs are in conflict with efforts to come to grips with global environmental deterioration. So far overall economic growth has been the salient factor setting the framework in which production, ownership and car use have expanded. It could be argued that the research agenda in the field of transport and automobility - to a considerable extent - have been set by the direct outcome of dominant agents in the world economy and not by the needs required to develop social and community life as such.

2.2 Background. The appropriation of cars on micro-level

The social and cultural embeddedness of the car in Western culture has been established by studies in sociology, anthropology, psychology and by a number of transport researchers *e.g.* Flink, 1975, Sachs, 1984, Freund and Martin, 1993. Issues on automobility and social change at household and individual levels have been surveyed by means of sociological methods. These kinds of studies have contributed with knowledge of how structural conditions are perceived at this micro level and how individuals in their daily life respond to changes in the larger structures. The previous studies at this level have contributed information about values and current trends in physical mobility. One interesting theoretical point of departure for a scientific approach was described by two psychologists focusing on transport and behaviour:

"The basic assumption is that individual transport behaviour is embedded in, and significantly directed by, the institutions, organisations and generally adopted lifestyles in society" (Vlek & Steg, 1996:50).

These 'adopted lifestyles' have often been viewed as if they were 'black boxes' in Economics and Technology, and their relations to political economy have also been neglected by Social Science. The way physical mobility is related to the progress of individual emancipation and the desire to be able to move freely at any time twenty-four hours a day have to be analysed in relation to the individually designed lifestyle. Changes of lifestyle in the area of transport have to do with mobility patterns, the preferred modal choice *e.g.* car, bike, public transport or other ways of travelling *i. e.* the prevailing behaviour in transport.

Western man has adopted the car physically and mentally. Car use has been given both a social and cultural meaning which cannot easily be replaced by other transport modes. What could be called a post-modern lifestyle, including alternative mobility patterns has not yet emerged on a large scale. This is the reason why transport behaviour is discussed in terms of lifestyle changes, and not only in terms of changed behaviour.

2.3 The debate about lifestyle changes and transport policy

A new perception on the unsustainable character of modern transport started to appear in the 1980's and the notion of lifestyles was integrated into *e.g.* an OECD report "Urban Transport and Sustainable Development" (1995:19) in following terms:

"lifestyles and technology of Western countries and the direction of the development in the rest of the world will have to change. The logical place in which to start promoting such changes is in cities".

Lifestyle is understood as a complex set of activities, and when brought together they constitute an entity. Mobility patterns and transport behaviour are closely connected to the underlying cultural values which found the values and attitudes of each individual. These values and attitudes are expressed and objectified in activities and through individual consumption. The car as a consumer object has given rise to a complete lifestyle. I find it relevant to use the definition given by Lööv & Miegel, Swedish cultural sociologists, in an article: *The Notion of Lifestyle - Some Theoretical Considerations:*

"[L]ifestyles must be viewed as potential forces of social and cultural change. In order to understand these processes it is necessary to account for the way in which culture flows from the macro level to the micro

level. Socialization is the generic term for this process" (1989:17).

According to these authors, the concept of lifestyle should be related to three different levels:

the structural level: this is the macro-level involving differences in cultures and societies that can be expressed in terms of differences in lifestyles. On the structural level focus is directed towards different features distinguishing Asian societies from the Islamic World, or the Occidental region. These features are *e.g.,* religious laws, secular legislation, traditional modes of production, modern ways of production and cultural values. Images about the character of other cultures relate to this level; the American way of life, the Shiá-Muslim lifestyle or the Japanese way of making a car.

the positional level: refers to the concept of lifestyle and is divided into categories: men and women, children and adults, *i.e.* groups with different social status. The inherent differences are related to the position of the group in the social stratification in a defined society. The differences are operationalised in daily life by means of the lifestyle of a person; accordingly the various social groups carry out different lifestyles.

the individual level: this is the micro-level in which there is an ideal and a real individual lifestyle. Questions like: how do persons with different lifestyles perceive their reality; how is identity created; how is a personality developed, how is the lifestyle expressed? These are aspects of relevance to the shaping of individual lifestyles. Of interest here is also the way in which individuals communicate and relate to other persons/groups. It is possible to study the lifestyle of a person through the various activities she/he is involved in. According to Lööv & Miegel, lifestyles are founded in four kinds of values:

material values: these are the basis for taste and preferences. Material values help us to make decisions about what to eat, where we wish to live, what kind of leisure activities we prefer and so on. These values are easy to detect and possible the most explored ones.

religious and metaphysical values: these are the basic foundation for our view of the world and the way we perceive reality. They are useful for solving existential issues: what is important in life, the meaning of life and death. The religious and metaphysical values are of fundamental importance to the individual and provide us with the necessary orientation related to our identity. Metaphysical values also give important information about social change.

aesthetic values: these tell us what to think about art, film, literatur, theatre etc.

ethical or moral values: these orient and help us with moral dilemmas and in personal conflicts. Ethical values are basic to our way of being, our morality. They provide the person with a guide to making judgements about what is right or wrong. Ethical and moral values help us to survive as individuals and to make our society sustainable. These values are culturally determined. Ethical values are a part of the social surroundings and we are not able to change these values as easily as we buy a new car. The morality of a person is not visible and not easily detected, as is the case with aesthetic or material values. They are none the less important determinants in the shaping of an actual lifestyle. Moral values are an important source of information on social change.

The significance of the car in the shaping of lifestyles has been studied by the Norwegian transportation researchers Berge & Nondal. The car often has the capacity to make the lifestyle of a person more obvious and visible, an assertation, which they define as follows:

"In recognising collective and individual lifestyles, the role of the automobile is important. It is a well-known fact that a material product can be used to communicate messages to other people. To do so, it has to have three properties (Berge 1995): i) It has to be visible in use, ii) It has to show variability (refering to its differentiating function), iii) It has to have personalizability (refering to the extent to which a product denotes a stereotypical or standardised image of the average user). The automobile has all these properties" (1995:711-724).

The lifestyle of a person codes and transmits social signals about changes in the patterns of trips and travels. The ways of transmitting these codified signals are constantly altered and closely related to changes in social structures at meso- and macro-levels. Of course, we are not able to identify a direct correlation between changes at macro and micro-levels in the lifestyle of Ms N. or in her pattern of mobility. It is, however, possible to analyse the relation between existing levels by connecting structural data at the various levels with knowledge gained from the application of lifestyle studies. In my view, studies of lifestyles need to include the construction of identity in two ways: the real person in its existing version and in the ideal version *i.e.* an imagined person.

When analysing potential changes of lifestyles and car use the groupings made by Lööv & Miegel are suitable tools. The car makes its owner visible and can tell us something about the socio-economic position of the owner. It can also provide additional information about the owner's identity. To demonstrate a person's lifestyle at the positional level by means of a car requires only visibility and the differentiating function belonging to the car in its symbolic role, *e.g.* the high economic value of the car. The collective way of life in a society can be illustrated by means of the differentiating function. In Phoenix, Arizona *e.g.* a person without a car is probably both economically and politically marginalized, either a drop-out or a foreigner.

Most lifestyle studies focus on the material and aesthetic aspects of consumption, aiming at prediction of trends in taste. The consumer's preferences are parts of a complex reality which comprises socio-technical change, economic change, cultural change, moral change and changes in ethical codes. Structural conditions *i.e.* location of domicile, degree of occupation, working hours, location of work and access to public transport, and the structural dependency of cars are the kinds of aspects I consider essential to integrate into discussions on the potential of change within a specific lifestyle.

2.4 The concept of lifestyle changes

With this framework I am able to come to grips with non-stable social elements in order to continue to elaborate the non-traditional aspects of transport policies which aim at approaching sustainable transport. Lifestyles are believed to be transferred mainly through imitation (Lindén, 1994). This transfer takes place vertically from well-to-do people with status, power and money to less privileged people and horizontally, from men to women of the same social class. This is the top-down transfer. Lifestyles are also transferred between generation from elderly people to young people and nota bene, vice versa.

The globalization of car use can be explained by these mechanisms (Lindén, 1994). This means that lifestyle changes take place at all levels in society as described by Lööv & Miegel. A whole society may imitate foreign lifestyles based on car use, *e.g.* Japan; see Plath, 1990 and Maruo, 1992. Individuals may imitate the lifestyles of other people, *e.g.* when women started to drive cars they acquired a certain masculine image through imitation.

Lifestyle changes are also natural parts of the life span. A Swedish study treated car use as a materialised expression of different lifestyles varying over time in the life of a single person and between the sexes. Ownership and car use may be seen as expressions of adult identity and the basis of a highly mobile lifestyle in developed countries.

The lifestyle of a person is the result of a rational choice and thus the lifestyle provides information about ongoing social change such as *e.g.* access to transport modes. Through studies of lifestyles we are able to see how a person orients and re-orients her/himself in the modern world. Lifestyles can tell us how changes are perceived by people in a city and how people form the base for changes of personal choices in e.g. transport. Individual choices have a profound meaning which is transferred into meaningful social activities. In this perspective lifestyles are useful in order to identify which are the carriers expressing social meanings in the sense of personal life meaning. The car has proven to be a meaningful artifact for a number of reasons. It is a part of a large technological system and thus the whole system has been integrated into modern societies. Macro-economic events contirbute to the establishing of a framework in which expansion of automobility and behavioural changes together with lifestyle changes occur. According to Giddens structuration in society takes place through the ordinary daily events and in the life planning of the individual. Modern men and women have to construct and reconstruct their life-meaning permanently. Some modes of mobility increase while others decrease and new modes are reinforced, creating new patterns of mobility. Giddens states "Life politics is related to political economy through the different aspects we incorporate in our lifestyle".

3 CONCLUDING SUMMARY

It has been established that transport policies are unable to deal efficiently with growing automobility.

Present curative responses to the problems are to be found in changes of lifestyle. These changes are based on individual values and behaviour related to transport. The appropriation of cars at the individual level has made it necessary to include changes of lifestyle in the agenda for transport policies, especially since Agenda 21 and the protocol on climate.

At the same time more than 90 per cent of the global population do not have a car. A huge number of people do not have a modern lifestyle - and they need to improve their possibilities of making journeys and of having access to health care and education.

Several aspects of modernization have had unforeseen consequences, *e.g.* there is a lack of knowledge of how to reduce the need for transport and even of reducing number of journeys made by cars. The highly developed countries have not yet discovered how to deal with the negative consequences of modernity, *i.e.* the specific characteristics related to development during the last few decades. It is time to integrate the side effects of transport into research in Social Science. This means a shift in focus from the practical aspects of economic growth and technical solutions towards the needs inherent in human beings and nature. The time has come to adapt visions of development to reality and not the other way around. Research on the influence of automobility in society is scanty and knowledge of this kind is needed to develop adequate visions related to the overall development of communal life.

The political economics of social change can approach issues of environment, democracy and relate them to social change. This method is suitable for exploring the dynamics of late modernity. The UNCED declarationen of Rio 1992 represents an effort in this direction but as was recognised by the UN Conference in New York in 1997 the Rio-declaration has not had the desired impact.

Economic and technological change is always possible and in fact it takes place daily. Social and political change is also possible however. I would claim that a qualititive outcome when discussing personal transport depends on the ability of the public to play an active part in the design of transport systems corresponding to their needs. Whenever a down-up approach is not taken seriously too many people will continue to suffer, not only from the consequences of poorly analysed strategies for development, but also from lack of transport since they are excluded from the community of car owners in the world.

The following conclusions may be drawn:

For a start: So far the only means in use when dealing with the need to increase the sustainability in the sector of transport have been the traditional tools of transport policies. The lifestyle fixe is a non-traditional aspect and so far less explored than the three kinds of traditional fixes, as commented upon above. Lifestyle changes can be included in transport policies and support traditional tools to help achieve sustainability in the area of transport.

Secondly: The debate on lifestyle changes emanates from the difference between changes in behaviour and lifestyle as a point of departure. The concept of lifestyle is manageable when linked to the three different levels as presented above, *i.e.* when it is obvious that the choice of lifestyle expresses prevailing values.

Thirdly: Lifestyle changes are a part of modern individual change and linked with ongoing social change. There is a lack of ethical values on which a sustainable society can be based. The prevailing values immanent in modern Western culture and today's built-in system of transport do not take into account the constraints immanent in the natural environment.

Finally: When lifestyles are based on ethical and metaphysical values and to a lesser degree on material and aestethic values it is easier to design systems of transportation and individual mobility in coherence with sustainable development.

In democratic societies the civil sector plays a role in the designing of transport policies. Whenever lifestyle changes are included in transport policies, the civil sector of society *i.e.* the ordinary road- and car user participate in these kinds of policies and in the formation of national sector policies.

The processes of economic growth, modernization and development are dependent on the overall development of sectors such as health, education and transportation in order to improve the conditions of life. Changes of values together with ways of evaluating development are needed to achieve a higher degree of sustainability. A large number of countries have financial difficulties due to infrastructural projects and increases in fuel and energy demand. The problems are universal, but they call for local solutions adapted to specific social and environmental needs.

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Development of a parking model metro system

Anil Madhugiri
RITES, New Delhi, India

ABSTRACT : The integration of various modes of transport is vital to the viability of the project because a large number of people using MRTS will not be living and destined within the generally acceptable walking distance of MRST station. Large proportion of MRST users will come and disperse to and from the station by public, hired and private modes, for which it is necessary to provide integration facilities at stations to ensure quick and convenient transfer. The various modes of transport are required to be integrated in such a way that each mode supplements the other. Assessment of parking requirement for the commuter demand at the MRT is a difficult and sensitive job. Difficult, because getting to estimate the modal split of the feeder trips requires very detailed analysis and sensitive because the acquisition of land will be based on the demand estimated. Delhi where the population is growing at a fast pace and there being scarcity of land, acquiring land for the purpose of traffic integration requires justification on the basis of a mathematical model. Thus a need to develop a parking model was felt. The interchange mode depends on the distance of the interchange trip and availability of modes. The distribution of interchange trips is an output of the assignement model developed to get the ridership on the MRTS. The relationship between distance and mode of the interchange trip was worked out. One of the most critical estimates is the proportion of walk, especially when it is a high proportion. The allocation between other modes is less critical, as parking requirements partly compensate. The data from Stated Preferences Survey revealed that only 6 % of travellers found it acceptable to walk more that, 1, 000 meters. This distribution was used for further analysis. Availability of modes depends on the trip end and station locality. Private modes are only available at the production trip end (i.e. home). Certain hired modes are not available at all stations, and this was also been taken into account. The commuters were divide into vehicle owning and non-vehicle owning. The vehicle owning decision tree is only available to travellers from non-vehicle owning households and to all trip attractions. The hired modes are further split between taxi, auto rickshaw and cycle rickshaw. While the split is based on estimated ratios, it may be noted that the area requirement is not particularly sensitive to the exact ratios, as an increase in the area a the area requirement of one mode is partly offset by a decrease of trips on road over the day to obtain a value for each hour. It was also disaggregated by two purposes - work/education and other. Distributions of parking times (between outward and return trips) were also assigned by trip purpose, with work/education having a longer average stay than other. The model performed a Furness-type procedure to obtain agreement between the arrival/departure profiles and the parking times. Vehicle occupancy and area required per mode further formed

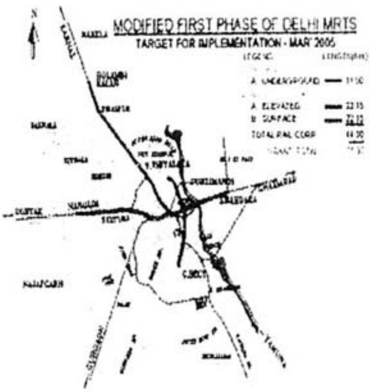
input to the model. The area rates include an allowance for circulation, but in some cases different areas may be needed, depending on the specific site layout. For buses, in particular, the type of operation will affect the area requirement. Turn-round time will depend on the passenger and driver facilities, the number of services using a bay, intensity of operation, provision of pedestrian bridges or underpasses to stances, etc.

1 INTRODUCTION

The integration of various modes of transport is vital to the viability of the project because a large number of people using MRST will not be living and destined within the generally acceptable walking distance of MRST station. Large proportion of MRST users will come and disperse to and from the station by public, hired and private modes, for which it is necessary to provide integration facilities at stations to ensure quick and convenient transfer. The various modes of transport are required to be integrated in such a way that each mode supplements the other.
Assessment of parking requirement for the commuter demand at the MRT is a difficult and sensitive job. Difficult, because getting to estimate the modal split of he feeder trips requires very detailed analysis and sensitive because the acquisition of land will be based on the demand estimated.

2 MASS RAPID TRANSPORT SYSTEM FOR DELHI - MODIFIED FIRST PHASE.

Delhi, the capital of India has a population of about twelve million in 1999, which is likely to increase to thirteen million by the year 2001. The city is dependent on means of buses only as mass transport. Surveys conducted in 1994 indicated that buses are catering to around 62 % of the total vehicular trips and the residual 38 % trips are catered by private modes. The Government of India has recently approved implementation of a Mass Rapid Transport System for the city. The Modified First Phase of the system consist of a network of 55.3 km as shown in figure 1.



Delhi where the population is growing at a fast pace and there being scarcity of land, acquiring land for the purpose of traffic integration requires justification on the basis of a mathematical model. Thus a need to develop a parking model was felt.

3 CONCEPT OF TRANSPORT INTEGRATION

The integration of various modes of transport is vital to the viability of the project because a large number of people using MRTS will not be living and destined within the generally acceptable walking distance of MRTS station. Large proportion of MRTS users will come and disperse to and from the station by public, hired and private modes, for which it is necessary to provide integration facilities at stations to ensure quick and convenient transfer. The various modes of transport are required to be integrated in such a way that each mode supplements the other.

3.1 Types Of Trips.

Two types of trips have been considered :

a) Walk Trip

Those commuters who would walk from their origin to the station and walk from the station to the destination fall under this category. An percentage of the total trips that would walk to and from the station have been assumed for each station, based on the catchment area and the landuse. Necessary pedestrian path and circulation area is required to be planned for these commuters.

b) Feeder Trip

Those commuters who would avail feeder/on line buses, hired or private mode to and from the nearest MRTS station fall under this category. The modal split for each station has been worked for these trips, based on the existing modal choice and landuse. Parking and circulation space is required to be planned for these modes.

3.2 Planning Parameter

Planning of station area varies from location to location depending upon the site conditions, landuse, access facilities etc. However in order to arrive at realistic parking area requirement at each station, an

Table 1 Interchange Mode Distribution, Vehicle-owning, Slow & Fast Modes

Interchange Mode	Trip Productions				Trip Attractions			
	0 -500m	500 -1000m	1000 -5000m	>5000 m	0 -500m	500 -1000m	1000 -5000m	>5000 m
Walk	100%	70%	0%	0%	100%	90%	20%	0%
Cycle	0%	15%	15%	0%	0%	0%	0%	0%
Cycle Rickshaw	0%	10%	13%	0%	0%	10%	20%	0%
Auto Rickshaw	0%	0%	5%	0%	0%	0%	20%	20%
Taxi	0%	0%	0%	0%	0%	0%	0%	10%
Car	0%	0%	2%	10%	0%	0%	0%	0%
M/cycle	0%	5%	15%	30%	0%	0%	0%	0%
Bus	0%	0%	50%	60%	0%	0%	40%	70%

Notes
Table shows modes used to access MRT station, distributed by interchange distance, for trips made by travellers from vehicle owning households.
All interchange modes available.

Table 2 Interchange Mode Distribution, Non-Vehicle-owning, Slow & Fast Modes

Interchange Mode	Trip Productions				Trip Attractions			
	0 -500m	500 -1000m	1000 -5000m	>5000m	0 500m	500 -1000m	1000 -5000m	>5000m
Walk	100%	90%	5%	0%	100%	97%	10%	0%
Cycle	0%	0%	0%	0%	0%	0%	0%	0%
Cycle Rickshaw	0%	10%	10%	0%	0%	3%	15%	0%
Auto Rickshaw	0%	0%	5%	10%	0%	0%	10%	5%
Taxi	0%	0%	0%	5%	0%	0%	5%	0%
Car	0%	0%	0%	0%	0%	0%	0%	0%
M/cycle	0%	0%	0%	0%	0%	0%	0%	0%
Bus	0%	0%	80%	85%	0%	0%	60%	95%

Notes
Table shows modes used to access MRT station, distributed by interchange distance, for trips made by travellers from non-vehicle owning households.
All interchange modes available.

Table 3 Interchange Mode Distribution, Vehicle owning, Fast Modes

Interchange Mode	Trip Productions				Trip Attractions			
	0 -500m	500 -1000m	1000 5000m	>5000m	0 500m	500 -1000m	1000 -5000m	>5000m
Walk	100%	90%	0%	0%	100%	90%	20%	0%
Cycle	0%	0%	0%	0%	0%	0%	0%	0%
Cycle Rickshaw	0%	0%	0%	0%	0%	0%	0%	0%
Auto Rickshaw	0%	0%	5%	0%	0%	10%	10%	20%
Taxi	0%	0%	0%	0%	0%	0%	5%	10%
Car	0%	0%	5%	10%	0%	0%	0%	0%
M/cycle	0%	10%	30%	20%	0%	0%	0%	0%
Bus	0%	0%	60%	70%	0%	0%	65%	70%

Notes
Table shows modes used to access MRT station, distributed by interchange distance, for trips made by travellers from vehicle owning households.
Slow interchange modes not available

Table 4 Interchange Mode Distribution, Non-Vehicle-owning, Fast Modes

Interchange Mode	Trip Productions				Trip Attractions			
	0 500m	500 -1000m	1000 5000m	>5000m	0 -500m	500 -1000m	1000 -5000m	>5000m
Walk	100%	100%	5%	0%	100%	100%	30%	0%
Cycle	0%	0%	0%	0%	0%	0%	0%	0%
Cycle Rickshaw	0%	0%	0%	0%	0%	0%	0%	0%
Auto Rickshaw	0%	0%	5%	10%	0%	0%	5%	5%
Taxi	0%	0%	0%	0%	0%	0%	0%	0%
Car	0%	0%	0%	0%	0%	0%	0%	0%
M/cycle	0%	0%	0%	0%	0%	0%	0%	0%
Bus	0%	0%	90%	90%	0%	0%	65%	95%

Notes
Table shows modes used to access MRT station, distributed by interchange distance, for trips made by travellers from non-vehicle owning households.
Slow interchange modes not available.

effort has been made to evolve a set of assumptions. [Reference 1].

The assumptions are based on past studies, field studies undertaken and by discussion amongst various planners. The number of vehicles and parking area requirement is very sensitive to these planning parameters, particularly when high proportion of walk trips are assumed.

The various planning parameters used for the present analysis are :

a) Modal Split
b) Parking Duration / Turnaround Time
c) Passenger Occupancy
d) Parking Standards (including circulation).

3.3 Modal Split

3.3.1 The interchange mode depends on the distance of the interchange trip and availability of modes. The distribution of interchange trips was taken directly from the assignment model.

3.3.2 The relationship between distance and mode of the interchange trip is set out in Table 1 to Table 4. One of the most critical estimates is the proportion of walk, especially when it is a high proportion. The allocation between other modes is less critical, as parking requirements partly compensate. The Stated Preference Survey (1998) revealed that only 6 % of travellers found it acceptable to walk more that 1, 000 meters. The cut-off at 1, 000 meters in the Figures is an approximation.

3.3.3 Availability of modes depends on the trip end and station locality. Private modes are only available at the production trip end (i.e. home). Certain hired modes are not available at all stations, and this has also been taken into account.

3.3.4 Figure 2 indicates the mode decision tree. The vehicle owning decision tree is only available to travellers from vehicle owning households and to all trip attractions.

3.3.5 The hired modes are further split between taxi, auto rickshaw and cycle rickshaw. While the split is based on estimated ratios, it may be noted that the area requirement is not particularly sensitive to the exact ratios, as an increase in the area requirement of one mode is partly offset by a decrease in that of another mode.

3.3.6 The arrival/departure profile was obtained from the survey conducted by RITES and disaggregated where necessary to obtain a value for each hour, as in Table 5. It was first disaggregated into two purposes -

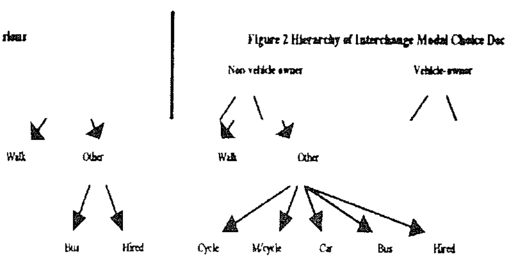


Figure 2 Hierarchy of Interchange Modal Choice Dec

Table 5 Arrive+Depart Profiles at MRT Stations

Time Start	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
Work/Educ	1	2	3	7	8	5	3	2	3	2	3	4	6	7	5	3	2	1	1	68
Other	0	0	0	0	2	3	3	3	2	3	3	2	2	2	2	2	1	1	1	32
Total	1	2	3	7	10	8	6	5	5	5	6	6	8	9	7	5	3	2	2	100

work/education and other - and then into separate arrival and departure profiles for each mode, using professional judgement.

3.4 Parking Duration

3.4.1 Distributions of parking times (between outward and return trips) were also assigned by trip purpose, with work/education having a longer average stay than other. These were again based on judgement and local experience. The distributions are given in Table 6 and 7. The model performed a Furness-type procedure to obtain agreement between the arrival/departure profiles and the parking times.

Table 6 Parking Duration of Public Modes

Mode	Parking Duration, mins
Cycle Rickshaw	5
Auto Rickshaw	10
Taxi	15
Bus	5

Table 7 Parking Duration of Private Modes

Parking Duration (hours)	Trip Distribution	
	Work	Other
1	0%	0%
2	0%	5%
3	0%	20%
4	5%	25%
5	5%	25%
6	5%	15%
7	10%	5%
8	15%	5%
9	40%	0%
10	20%	0%
Total	100%	100%

Note. These figures are only applicable to trip productions

3.5 Vehicle Occupancies for Interchange Trips.

3.5.1 In order to convert passenger trips to vehicle trips, occupancy rates were defined in Table 8. These were considered to be preferable to using traffic counts because the latter do not apply specifically to occupancies of interchanges trips.

3.6 Parking Standards

3.6.1 The area rates include an allowance for circulation, but in some cases different areas may be needed, depending on the specific site layout. These are shown in Table 9. For buses, in particular, the type of operation will affect the area requirement. Turn-round

Table 8 Vehicle Occupancies of Interchange Trips

Mode	Occupancy
Cycle	1.10
Cycle Rickshaw	1.20
M/Cycle	1.25
Auto Rickshaw	[illegible]
Taxi	3.00
Bus	60.00
Private Car	2.50

Table 9 Area Required by Mode for Parking and Circulation

Mode	Parking Area (Sq.m)
Cycle	1.5
Cycle Rickshaw	3.0
M/Cycle	2.5
Auto Rickshaw	5.0
Taxi	30
Bus	200
Private Car	20

Note: Figures apply to typical surface level parking time will depend on the passenger and driver facilities, the number of services using a bay, intensity of operation, provision of pedestrian bridges or underpasses to stances, etc.

4. RESULTS

4.1 The results for the Parking requirement show that for the Metro Corridor, Vishwa Vidyalaya and Patel Chowk stations are intended to be the interchange stations with area requirement of 22000 and 9000 sq.m respectively for the year 2021. Shahadara station of the rail corridor would require the maximum area of 43000 sq.m and ISBT, the interchange station, would need around 4300 sq.m of area for planning integration facility.

5 PRIORITIES

5.1 Private car requires considerably more time-space per passenger than any other mode, due partly to its long turn-round time. It is worth considering to what degree car should be catered for, especially when space is limited. Relief to the road network may also be small in some cases.

5.2 Where available land is less than that required, the following priority reductions are recommended (Table 10), unless local considerations dictate otherwise.

6 SUMMING UP

6.1 Provision of Integration facilities is vital for the success of any MRTS project.

Table 10 Parking Priority Allocation

Mode	Parking Provision
Bus	100%
Cycle	60%-100%
Motorcycle	60%-100%
Cycle Rickshaw	60%-100%
Auto Rickshaw	60%-100%
Car/Taxi	10%-50%

6.2 The requirement of area for integration facilities is sensitive to the modal split by which commuters would be approaching the stations.

6.3 As per the opinion of the commuters, the acceptable walking distance is between 500 to 1000 m.

6.4 Vehicle owners have a choice of private, hired modes and public transport mode at the origin end only hired and public transport at the destination end whereas non-vehicle owners have a choice of only hired modes and public transport mode at the both ends.

6.5 Model showed that maximum area of 22000 sq.m is required in 2021 at Shahadara station and on the metro corridor, Vishwa Vidyalaya, which would serve as main interchange station, would require 4300 sq.m in 2021.

6.6 As the area required for integration is a generally more that the supply, there is a need to prioritise the allocation, in which preference should be for public transport.

Acknowledgement.

The authors would like to thank, RITES management for letting them use their database for this paper.

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[Reference1] : RITES, Detailed Project Report On integration facility for the Modified First Phase of Delhi MRTS, August, 1995.

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Propuesta de política de estacionamiento en zonas residenciales de la Ciudad de Sancti Spíritus

Proposal of parking policy in residential areas of Sancti Spiritus

Proposition de politique de stationnement dans zones residentielles de la ville de Sancti Spiritus

René A.García Depestre

Cuartel s/n esq. Alfredo Hernández, Sancti Spíritus, Cuba

Resumen:

El índice de motorización crece cada día y la situación que presenta el estacionamiento techado en la mayoría de las ciudades es común, caracterizada por el déficit. Una acertada política de estacionamiento unido a medidas y regulaciones contribuirían a mejorar los efectos sobre el medio.

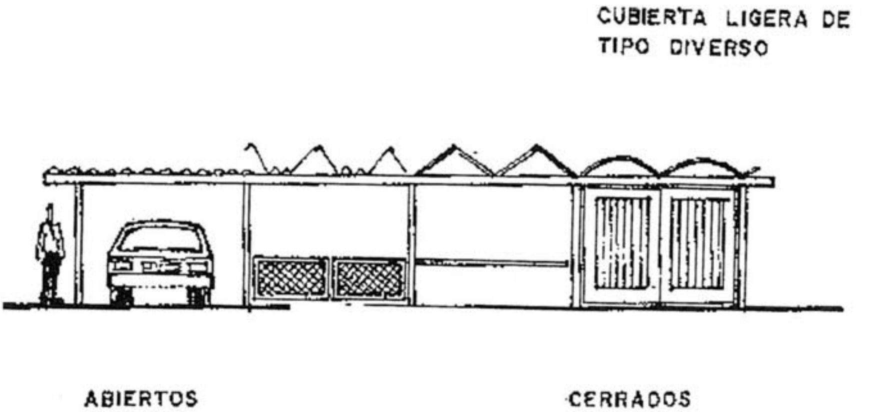
Summary:

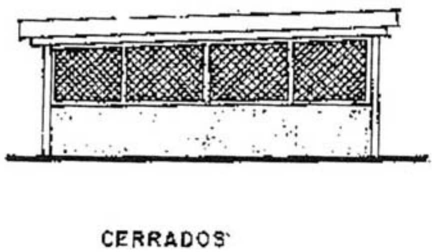
The rate motorization s in creasing every day and the situation that present parking indoors is common in most of ther cittes characterized by deficit. An fitted parking police joined to measures and regulations will contribute to decrase the consequense over environment.

Résumé:

Le indide de motorisation aumente tous les jours et la situation de stationnement coubert dans beacoups de villes est commun caractérisé par le déficit. Une politique opportune de stationnement avec arrangement et regularistation aide á faire meilleur les effects sur le environnement.

ESQUEMA DE SOLUCION





En el siglo XX nace con la presencia de un nuevo elemento que revoluciona en su totalidad el sistema de transporte terrestre "el vehículo automotor". Al principio eran escasas y sus velocidades no superaban las que desarrollaban los tirados por animales, pero su número creció vertiginosamente y con ello los conflictos y problemas, los que se agravan en la ciudades donde resulta más difícil modificar la estructura de las vías, así como de las instalaciones de apoyo al transporte y conviven vehículos y peatones.

Podemos asegurar que una de las dificultades que hoy presenta el transporte automotor es el estacionamiento dado su número creciente y la escasa construcción de estacionamientos techados.

La situación de los estacionamientos en general para todas las ciudades está caracterizada por una ausencia casi total de los mismos en los centros de ciudades y zonas netamente residenciales. Estando ubicado los mismos en áreas propias de viviendas o colindantes a ellas y en las vías (generalmente de servicio), el primer caso se ha afectado considerablemente por la problemática de la vivienda en el decursar de los años tales como cambios de uso de estacionamientos a viviendas, nuevas construcciones, ampliaciones u otros usos; en el segundo caso se mantiene y con el tiempo se incrementa su uso como estacionamiento con los riesgos que implica dejar vehículos en la vía pública y el deterioro por el intemperismo.

No se puede analizar el estacionamiento de vehículos en una ciudad sin analizar la motorización y luego de un análisis se comprueba que existe una fuerte tendencia al incremento a nivel mundial. En cuba esta curva presenta una fuerte disminución en la década del 60 resultados del proceso de transformación que genera grandes presiones económicas; a partir del año 70 comienza el ascenso a pesar de las serias restricciones y limitaciones el cual se detuvo en el año 92 y continua avanzando lentamente a partir del 96. La ciudad que analizamos no está ajena a lo explicado anteriormente y en la actualidad presenta un bajo índice de vehículos por cada mil habitantes.

Otros elemento de gran importancia en el presente estudio es la edad del parque automotor, el que luego de la recopilación de información se obtiene que el 49% de los vehículos tienen más de 30 años, el 7% del parque existente tiene entre 30 y 15 años de explotación y los enmarcados entre 15 y 5 años representan el 41% de los vehículos actuales, siendo el resto (3%) los que tienen hasta 5 años.

La situación de los estacionamientos en la ciudad de Sancti Spíritus no es distinta a lo comentado de forma general, pero es necesario detallar y luego de su estudio se detectó:

- Dentro de la trama tradicional y en zonas residenciales los estacionamientos techados se han transformado en nuevas viviendas o ampliaciones.
- Las edificaciones destinadas al estacionamiento han sido transformadas en almacenes, talleres y otros usos.
- Las nuevas instalaciones administrativas, sociales y comerciales carecen por lo general de áreas destinadas al estacionamiento.
- Los proyectos de edificios multifamiliares en ningún caso contemplan la construcción de estacionamientos en plantas bajas o sótanos.
- En las nuevas urbanizaciones se han utilizado bajos índices de motorización para prever el estacionamiento futuro.
- Se estaciona en las vías principales y de servicio al existir pocos estacionamientos en todas las zonas.
- Construcción de estacionamiento de variada tipología en las zonas residenciales de edificios multifamiliares por parte de los propietarios.
- En la zona del centro histórico urbano se transforman las edificaciones para facilitar estacionar los vehículos con la pérdida de los valores arquitectónicos que ello implica.

Todo lo anterior lleva a la conclusión de que existe un déficit de este servicio a nivel de ciudad, desarrollando cada propietario iniciativas en dependencia de la zona de residencia con la afectación del entorno y del medio, además de utilizar la vía pública para estacionar, con la afectación que esto genera a la corriente vehicular y a los peatones, con alta potencialidad para la ocurrencia de accidentes del tránsito especialmente con los peatones.

Como una muestra de lo anterior el por ciento de vehículos con estacionamiento en la zona, que incluye el centro histórico urbano, es de 14 y en la zona de edificios multifamiliares alcanza el 16. Estos datos nos indican que es necesario una acción que permita el incremento del estacionamiento, pero no de forma espontánea y anárquica como hasta la fecha, para dar mayor protección a los vehículos y mejorar el ambiente urbano donde vive el hombre.

El proyecto urbanístico de la zona residencial de edificios multifamiliares se trabajó con 40 vehículos por cada mil habitantes para estacionamientos fuera de la vía pero ninguno techado, hoy de ha superado este indicador existiendo un déficit y los propietarios han construido estacionamientos sin regulaciones urbanas y se propone en esta zona la construcción de baterías de estacionamiento en áreas libres anexando variantes de solución y unido a regulaciones y medidas contribuirían a disminuir los efectos de los vehículos sobre el medio y a la tranquilidad de los propietarios.
La situación en el centro histórico urbano es distinta a la analizada anteriormente al ser prácticamente nula la cantidad de áreas libres y donde se concentran los servicios que a su vez son generadores de estacionamientos, aunque en muchos casos de corta duración, estando también entre las causas del estacionamiento: trabajo, descanso y diversiones. En esta zona se estudió la posibilidad de crear estacionamientos que brinden servicio de forma colectiva, pudiendo dedicarse en horas laborales a prestar servicio a empresas e instituciones y durante el resto del día a los visitantes y usuarios de las instalaciones centrales, logrando incrementar el número de plazas de estacionamiento con el cambio de uso de edificaciones, pero aún no satisfacen la demanda y siempre tendremos que recurrir al estacionamiento en la vía.

Con el presente trabajo no se pretende agotar el tema tratado pero sí en la necesidad de pensar en este fenómeno con su problemática actual y dejar posibilidades para la solución del mismo a largo plazo.

Ejemplos negativos por falta de previsión con relación a los estacionamientos puede ser común en muchas ciudades y lograríamos resolver la problemática sobre la base de grandes afectaciones y soluciones complejas sobre vías en más de un carril, sobre isletas, aceras y parterres.

En el caso presentado tal situación se haría más compleja al no contar con secciones que soporten lo anterior; pero a nivel de ciudad no existen problemas con el estacionamiento al aire libre.

La solución presentada en ambas zonas llevan una inversión inicial pero la misma es recuperada en corto espacio de tiempo y permitirá ahorro de recursos en el mantenimiento del vehículo. Es necesario destacar que el resultado se puede extrapolar a otras zonas de la ciudad o territorio y se multiplicaría el efecto teniendo en cuenta la edad del parque automotor, mejorando también el hábitat.

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Urban transport and environment: Why have urban highways no service roads?

Transports urbains et l'environnement: un propos de réconsidérer le dessin géometrique des autoroutes urbaines

M.de Langen

Institute for Infrastructural, Hydraulic and Environmental Engineering, Delft, Netherlands

ABSTRACT: Effective instruments to reduce the growth of the environmental damage created by urban traffic, or to even roll it back, are in scarce supply. This is particularly so in the large cities of the developing world, among other reasons because of their seemingly uncontrollable expansion over vast areas. Is it possible that, rather than being a very welcome relief of urban traffic congestion, urban highway systems, by the way they are designed, fuel environmentally unsustainable transport system developments?

RÉSUMEE: Instruments effectieves pour réduir, ou même redresser, le détruit de l'environnement par le traffic urbain sont rare, en particulier dans les grandes villes des pays en dévelopement. Selon les causes, il semble que l'expansion mal controlée du territoire urbain joue un rôle important. Serait-il possible que, loin d'être un soulagement, les réseau d' autoroutes urbains, par leur dessin géometrique, pavent la route vers un système des transports urbains insupportable du point de vue de l'environnement?

1. INTRODUCTION

The negative impact of urban traffic on the environmental quality of large developing cities is impossible to ignore. The air pollution, noise and land-hunger of traffic has created adverse environmental conditions in many cities. Well documented and debated as the problem by now is, the search for effective instruments to control and then gradually undo the environmental degradation in our cities has so far been highly elusive. Partly because of the mere scale of the worst affected cities, such as the city that hosts this CODATU conference, Mexico city. But to a large extent also because the portfolio of feasible ánd effective instruments appears to be too small.

This paper contains a brief communication, concerning one simplified line of argument only. The purpose of the paper is to trigger reflection by colleagues, and reactions, concerning one simple question: why are urban highways (with vehicle entry/exit points via grade separated intersections only) almost invariably designed without service roads for plot access along their entire length, without parallel pedestrian (and where relevant cycling) tracks, and without parallel busways (or LRT) providing easy access by public transport along the entire road?

Urban highways without direct plot access and grade separated intersections are a quite recent development. They only became popular with the rise of private car use and "sub-urbanization" thirty years ago, and were in fact indispensable instruments to make it happen.

Without these highways, that type of development would not have been possible, and urban form totally different, as is still clear from looking at those urban areas where urban highways and ring roads were not built, and those that were largely formed before 1960.

Undoubtedly, urban freeways have great merits for efficient urban traffic circulation over longer distances within the same urban area. But there is an afterthought that becomes more and more prominent as cities change form, and urban activity location patterns and activity location choices become more and more dispersed: what about "generated traffic"? (Todd Litman, 1999).

By the way urban highways are now commonly designed they only function as a way of reducing travel time by car between origins and destinations that are increasingly further away from each other, and are conceived as a kind of "short-circuiting" (between separated locations), whereby the land in-between is jumped over and has no direct relation to the road.

However, in practice, "visibility" from an urban highway is becoming a more and more valued business location factor. But the actual access is only possible with significant detours, which are not so much of a problem for car trips, but completely spoil the accessibility by NMT and public transport.

2. A SEARCH FOR INSTRUMENTS THAT CREATE EFFICIENT CITY STRUCTURES, REQUIRING A MINIMUM AMOUNT OF TRAFFIC.

Urban corridors with service roads? - a thought experiment -
1. Negative environmental effects of urban traffic can be controlled by: (a) cleaner vehicle engines, (b) a modal shift to public transport or cycling, (c) reduced trip distances.
2. Focussing on reduced trip distances: land-use control through permits and regulations does not work in most cities, what else can be tried?
3. Urban form (the land-use market) does not develop towards an attractive long-term system configuration in response to "free market" choices of individual actors alone.
4. Current transport prices are wrong.
5. Traditional attempts to change those prices through taxes (e.g. on fuel) and subsidies (e.g. to public transport) have a disappointingly weak effect on urban form. Considering the implicit price policy of not supplying, or limiting the supply of, certain transport products may be much more effective.
6. The main urban road corridors are the most difficult, and influential, animals. How to use their supply?
7. Consider an urban corridor concept based on good direct access and business activity location along the entire length of the road, provided by means of separate service roads that also enable good NMT mobility, and combined with a separated busway network in the corridor.
8. Explain why the line of argument above is *wrong*, and investigate how sound the reasons why it is wrong are themselves.

The line of argument presented in the opposite table and further explained below may at some transitions surprise, and might upon further reflection require change. But let us first try to follow its sequence, as a thought experiment.

2.1. The main policy categories that are applicable to reduce the negative environmental effects of traffic are, in principle:
(i) a reduction of emissions per vehicle -better engines, cleaner fuel, more silent engines (partly also a change in the location of the environmental impact, e.g. electric vehicles),
(ii) a shift towards modes of transport with a lower pollution per personkm - urban cycling, walking, public transport vehicles with a high occupancy,
(iii) a change in land-use and activity-location patterns that leads to shorter trip distances and enables more pedestrian and cycle trips and more public transport trips in high occupancy corridors.

2.2. Concentrating on (iii) above: in practice, instruments that trigger more environmentally sustainable urban land-use and activity-location patterns appear to be either absent or ineffective in most countries. Most big cities grow in a largely uncontrolled manner, and controlling land-use developments through government regulations appears to be almost impossible, apart from in a few countries with highly professional and/or powerful public government administrations. Accepting the reality that land-use plan implementation through the traditional concept of regulated building/activity permits and public land development and land-pricing policies does not work in most places, what instruments are left?

2.3. In an attempt to find new public government instruments, maybe the issue has to be re-phrased first. It is inaccurate to state that land-use instruments are missing or ineffective. Many instruments are available to private parties, the most straight forward being to buy land and develop it. The collective problem is that urban expansion is a typical example of a market where the choices made by individual private parties (households, businesses, investors) may be logical from the point of view of the immediate effects for individual decision maker involved, but do not lead to a public (collective) optimum. Nor may they be in the best long-term interest of the individual decision makers. On the contrary, what results is an inferior urban transport system configuration. In many countries, despite reported government policies to one way or another achieve the opposite, the length of trips made in the urban area between all kinds of activity locations (home, work, schools, shops, markets, entertainment, family and friends) grows. As a result of and resulting in (both cause and effect) increasing trip distance the share of private car traffic and private motorscooter traffic increases more and more, supported by an increasing income.

The pressure to -as a government- build more and more roads to resolve the traffic jams is powerful and effective.

2.4. From an abstract economic policy point of view one could say that if market forces lead to non-optimal developments, the prices that steer that development are wrong. For a moment playing with the assumption that individual decision makers decide to do what is in their own immediate best interest, and that they make no big errors in that respect: which prices are wrong that brought urban transport on a collision course with the safeguarding of an attractive urban environment? A slightly less optimistic additional question is: what is the role of "push off" effects between population groups with unequal economic and social powers? Is there a problem of equal prices but grossly unequal purchasing power? (less optimistic since suggesting that there is no general public interest but winners and losers). Forgetting about the finesses of the answers to these questions, the ball-park is: transport prices are wrong.

2.5. Transport "prices" are broadly composed of three elements: (a) the financial cost (price of the vehicle, of the bus ticket, fuel, the bicycle, shoes), (b) the travel time, and (c) how pleasant or unpleasant the trip is (including the risks that one is exposed to).

Urban modal split studies have been carried out in large numbers during the last twenty-five years. What they seem to indicate is that the higher incomes are, the more transport costs become unimportant as a determinant of modal choice and the more the perceived attractiveness of the various modes of transport becomes decisive, more also than travel time. Moreover the percentage of the modal choice that can be explained by objectively measurable and predictable variables such as travel costs and time turned out to be disappointingly low in many models, which in a way confirmed the lack of traditional transport policy instruments to really influence the persistent shift towards longer travel distances and a higher share of private car traffic.

One feature also emerged clearly from the urban modal split studies: the most important explanatory variable is in fact the range of available alternatives to chose from. Unavailable alternatives cannot be selected. This sounds as a wide open door. But it can also be interpreted differently. The range of alternative "products" that a consumer can chose from is also an aspect of the price policy. The success of many commercial firms partly lies in eliminating the availability of alternative choices. Travel demand management is in fact just that. But so far the widely praised example of Singapore has not been seriously copied in many other cities, or enriched by new travel demand management concepts.

Yet it is an important field for reflection: what options does the government as supplier of transport infrastructure have to offer or not offer certain travel alternatives, by supplying or not supplying the corresponding infrastructure, in order to pursue wider public interests.

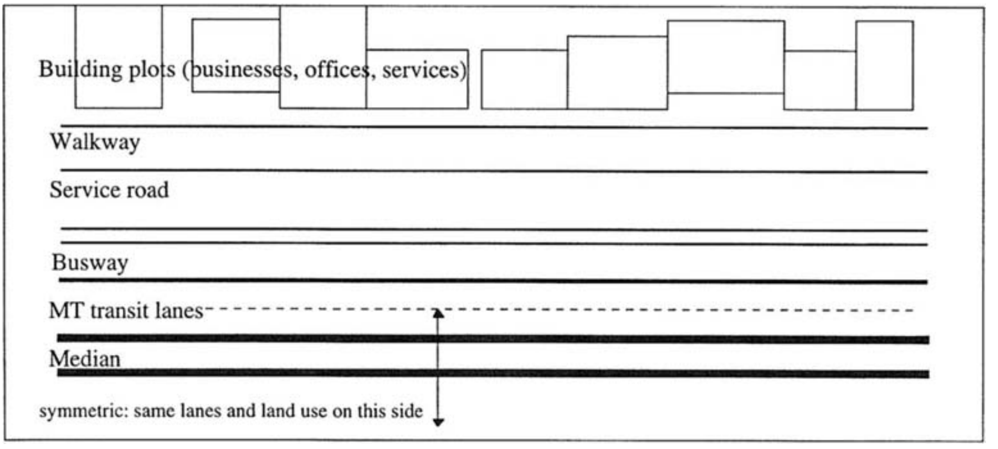
It is interesting to quote the example of India here. For three decades years the national government of India (its planning commission) has purposely minimized the growth of private car use in the country, by simply allocating very little money to the construction of roads that would allow massive urban and peri-urban car use. This policy only started to change a decade ago, and has now changed completely, accelerated by a change of government (the political parties in power). The recent change in urban transport policies in China is similar, although attempts are being made here and there to avoid the worst consequences (Zhenyao Chen, 1988).

2.6. Is it possible to adapt the supply of urban transport infrastructure in such a way that it only concentrates *on assuring the availability of travel alternatives that support a sustainable urban travel system*: a system that is in equilibrium with the financial, social and ecological carrying capacity of a city?

At a small scale initiatives of this type already have started to emerge. For example, in thinking about urban traffic safety there is, in some high income countries, a shift towards the idea of "intrinsically safe" road design, which means a geometric road design that even without speed humps and the like makes it practically impossible for motorvehicles to reach a speed of more than 20-40 km per hour without exposing themselves to a serious risk of damage, at those points in the road network where such a speed limitation deemed desirable. So far that approach is limited to local neighbourhood traffic plans. Could it also be applied to the main urban road corridors?

At the other side of the income spectrum, many very large low-income compounds in developing countries are intrinsically safe in a very low-cost manner: they have no paved roads for motor-vehicles inside. From a sound urban development point of view the challenge there seems more to strongly improve the *NMT* mobility within such areas and to enhance a better local activity balance (live, work, services, entertainment), than to "short-circuit" them to CBD's (de Langen, 1999; de Langen and Tembele, 2000).

But here as well as in high income urban areas, the main arterial corridors and ring-roads are the difficult problem. What can be done to shape those in such a manner that they support the development of a sustainable transport system, rather than the further growth of urban transport patterns that are increasingly unsustainable, economically, socially and environmentally.



2.7. This paper proposes to reflect on a urban road corridor design that has become more or less forgotten in the last decades: *an urban corridor with separate parallel service roads.*

In high income countries, urban highways have been designed instead, when new major urban roads were constructed. In developing countries, often the available space in existing urban corridor reserves has been converted entirely to extra motorvehicle lanes, with the result that these arterials are becoming more and more difficult for those that walk, make the thought of cycling ludicrous, and make them more and more unattractive as business location.

Could the redesign of the existing arterial road network into (less) motorvehicle transit lanes, dedicated public transport lanes (busways), and service roads (featuring wide walkways and a shared carriageway for low-speed motorvehicles -access to activities along the section only- and bicycles) work as an instrument to restore a better local balance between employment, services and residential housing throughout an urban area? The suggestion is based on the, casual, observation that parts of some cities where this road design can still be found ("boulevards") appear to support a more even activity balance, generate less traffic and have a better environmental quality.

The same casual observations suggest that currently old arterial city corridors with an intense activity mix are vulnerable to environmental degradation caused by transit traffic, because their original function receives no protection, but is often sacrificed to enable more long distance trips. In other words: to the supply of trip alternatives that are undesirable from a longer-term macro perspective. Sacrificing such roads to increased commuting by car triggers a loss of attraction for businesses and nearby residents, and thereby deteriorates the activity balance. This negative spiral has been at work in many large cities. Question: can the process also spiral in reverse?

3. CONCLUSION

The conversion of urban highway networks that the paper proposes to think about is:

(a) redesign a significant number of existing urban arterials or highways into "boulevards" with properly dimensioned service roads, busways, and a maximum design speed on the remaining MT transit lanes of 50 km/hr. Make them attractive as business location and for pedestrians -good access and an attractive environment- and unattractive for traffic that has no local origin or destination. And, simultaneously

(b) increase the transit capacity of a small number of other arterials that are maintained as a core highway network with a limited number of nodes, but constraining their total capacity to no more than 10-15% of the total peak trip demand in the urban area. By doing this, urban "islands" of 10-20 km2 will be created without significant transit traffic inside.

This paper is only a thought experiment. Contributions to a debate of its weaknesses and strengths are very welcome. The proposed most effective way of conducting such a debate is to list all the reasons why the whole idea and line of argument is *wrong*, followed by a critical investigation of how convincing all those reasons are themselves.

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Car parking policy issues and guidance information systems in Nigerian Cities: Case study of Metropolitan Lagos

Samuel Iyiola Oni
University of Lagos, Nigeria

ABSTRACT : It is the main objective of this paper, to formulate a framework, informed by a systematic appraisal of car parking policy issues concerning Nigeria's most densely populated, built - up and economic/industrial nerve center; and which is appropriate in terms of response to the dynamic interrelationship between demand for, and supply of parking facilities over time, in Lagos. In recognition of the fact that available information is characterized by a complex and multi-dimensional nature, the presentation proposes an integration of geographic/guidance information and artificial intelligence systems and mechanisms, as a decision support technology, designed to provide a means of automating certain reasoning types, associated with car parking systems' management.

Analytical results obtained and discussed in the paper indicate that the problems of car parking in metropolitan Lagos are best addressed through continuous estimation of parking needs based on artificial intelligence aided techniques. In addition, the optimum utilization of all existing parking facilities can be promoted through regular maintenance, efficient management legislation and conducive enforcement environment, coupled with enlightenment and traffic - issues - related – education.

1.0. INTRODUCTION

All over the world, the growth of private car use has brought in its trail, the need for more efficient uses of available road spaces, by both moving and parked vehicles. Indeed, as pointed out elsewhere, (Oni, 1992) the need to control the use of road space by vehicles parked on both long and short term basis, constitutes one of the earliest indicators of increased vehicle ownership and use. Invariably, the control of parked vehicles by imposing restrictions on how, when and where vehicles can be parked is often a complementary development. In addition, the costs, monetary and opportunities of being able to park, as well as where vehicles can be loaded and unloaded must be continuously taken into account. It is now a widely acknowledged fact, (Oni, 1998), that whilst control over the parking of vehicles can be applied in isolation of other policy matters, it is most effective as part of a comprehensive traffic management programme (Oni, 1998). Furthermore, although it is possible, in principle, to prohibit parking in one street or part of a street in isolation, parking control as an instrument of policy is best applied within a comprehensive scheme of parking restrictions over the entire extent of a city. When due recognition is therefore given to the fact that car parks are integrated and functional component parts of the urban landscape, it becomes evident, that the car parking policies presently in place in Lagos, Nigeria, which are characterized by apparent ad-hoc and piece-meal formulation and implementation, require a systematic and informed review, if the car problems in Lagos metropolis are to receive long term solutions. It is this problem which this presentation sets out to address, in the light of extensive surveys, whose results indicate that there is an undesirable level of limited coordination between the various agencies involved, at the different levels of Government, with car - parking policy issues; the surveys further revealed that hereto, investments in parking facilities were neither systematic nor coordinated, with the overall result that there is a complete absence of an articulate parking policy associated with metropolitan Lagos. To the identified end of this paper, attention is focused on a scheme, which proposes an integration of geographic/guidance information and artificial intelligence systems and mechanisms as the framework for the formulation of a comprehensive and effective car parking policy, designed to provide a long - term and flexible solution to the parking problems of Lagos Metropolis.

2.0 THE PROBLEM

In Metropolitan Lagos, the most critical problem faced by parking policy formulation and implementation is that concerning the excessive volume of parking-search-traffic. Problems of environmental degradation and traffic congestion caused by parking-search traffic have attracted little attention in metropolitan Lagos. It is consequently clear that there is a need for a system, designed to provide drivers with up-to-date information about the location of, and direction to available parking spaces, as a means of improving the efficiency of the use of the parking stock, occasioned in part, by associated reduction of the amount of parking search traffic. Parking guidance and information systems of the automatic/semi-automatic variety appears to be most suited, in that connection.

In Nigeria's former Federal capital, which is still the commercial and industrial nerve centre, as well as the most rapidly growing and densely populated state, there is hardly any clear definition of responsibilities between the various agencies responsible for the planning, development and management of parking facilities. Presently, they include the Federal Ministry of Transport, the Lagos State Ministry of Transport, Lagos State Parking Authority and the Lagos Island and Mainland Local Government Authorities. As a result, there exists a wide gap due to conflicting policy goals and objectives, and an undesirable, counterproductive overlap in some of their areas of responsibility.

3.0. PARKING POLICY IN METRO-LAGOS

In metro-Lagos, the local government authorities have always been neglected in the preparation of the redevelopment schemes. The observation here is that in metro-Lagos, the Parking policy is formulated on an ad-hoc basis by the Ministry of Works and Transport with inputs from other relevant bodies. The responsibility of implementing the parking policy rests with the State's Ministry of Public Transport, Parking Authority and Local Government Councils.

A general review of the existing policy/practice concerning the provision and planning of car parks shows the following features;

⇒ The policy and decision processes are treated as discrete decisions.

⇒ The existing policies appear to be formulated without a thorough understanding of the spatial parameters that bring about the need for parking. The policy issues are found in a piece-meal manner in different gazetteers and magazines. The related parking policy in metro-Lagos is contained in an haphazard manner in the following existing traffic and parking statutes and laws.

Results from questionnaire interview (1998) revealed the following:

1) It is not the sole responsibility of the car parking authority to control and manage the whole parking affairs in metropolitan Lagos, as parking problems have an ecclectic and multi-dimensional characteristics. Right now, there is no parking scheme for the disadvantaged group- disabled and elderly people and no special (all-day) concessional parking scheme for certain professionals to park their vehicles.

A better policy document on parking should focus on the following items:

⇒ Need for enforcement on parking provision for high rise buildings and high traffic generating land uses.

⇒ Proper management of the existing car parks.

⇒ Strict application of the stipulated car parking standard requirements.

⇒ Producing a comprehensive and updated car parking policy document.

4.0 PARKING GUIDANCE INFORMATION SYSTEMS IN NIGERIAN CITIES

The parking guidance information system provides drivers without local knowledge with the necessary information about one set of potential parking opportunities and drivers with nearly complete local knowledge with the information necessary to update their perceptions of current network conditions.

The imbalance between parking demand and capacity, the rapid increase in illegal parking, excessive volumes of parking search traffic and the amount of time wasted in a search have attracted the attention of the author of this thesis. The problems of environmental degradation and traffic congestion caused by parking search traffic is the focus of this section of the presentation, and could be addressed through the development and application of a new technology here referred to as parking guidance and information (PGI) systems.

PGI systems aim to provide drivers with information on the location of, direction to, and the availability of parking spaces; and thereby encourage a more efficient use of the parking stock as well as reduce the amount of parking search traffic within an urban area. The success of PGI systems depends upon their design being based on a sound understanding of parking behaviour and of the likely response of drivers to the new forms of information.

The concept of parking and of parking search strategy are crucial components for a fuller understanding of parking and its implications for travel behaviour. The scope of the empirical survey of PGI systems review in Nigerian Cities (Lagos) is confined to systems that provide parking information through roadside signs rather than by means of radio broadcasts, information boards and maps, or road markings.

It was observed that Parking Systems cannot work efficiently without appropriate information on the location, type and availability of parking space. This information can be presented in many ways; examples of these are maps, information boards, radio broadcasts, road design, road signs and pavement markings (Young 1986a, 1987a). It is the contention of this paper that majority of motorists will drive in an orderly and safe manner if they are provided with clear, reliable information and guidance.

Disrespect and lack of obedience to traffic control devices are due to the lack of attention given to the design, application, installation and maintenance of parking facilities.

5.0.CHARACTERISTICS OF PARKING INFORMATION SYSTEMS IN METRO-LAGOS

The main findings of the parking information characteristics in the study area of interest here may be itemised as follows:

(1) Information on the overall distribution of parking facilities are not provided; moreover the use of information boards is not common and where they are available, they are not placed at appropriate locations. These boards should normally be placed at the entrance to the area of interest and at strategic points throughout the area.

(2) Hand held maps showing the distribution of parking facilities and the street networks are not provided and, in addition, sign posts showing the routes to parking places are not common features.

(3) Comprehensive information on the location, cost and type of facilities as well as time restrictions are not made available.

(4) In metro-Lagos, the parking direction information signs tend not to be provided throughout the extent of the road system, but are usually only found near the entrance to the parking facility and, in some cases, at major intersections near the parking facility. In most instances, parking authorities provide information at the entrance to the parking station.

The main conclusion derivable from the Lagos Metro area survey relating to information requirements are : Oni, (1992)

Existing PGI systems in the study area, in broad terms, do not provide drivers with the following important and necessary types of information on parking facilities:- location or name of the car park, direction or route to the car, current occupancy status of the car park.

6.0.GEOGRAPHIC INFORMATION SYSTEMS (GIS)

Applications of geographic information systems assist in focusing user's data acquisition activities, provide a framework for improving data storage and provide tools that can facilitate data management. They can also provide these users with analytic and reporting capabilities (including graphic production tools) that were unheard of 20 years ago. Most users involved in geographic analysis want to see a map that contains information relevant to their application.With this increase in the volume of digital data, from a wide variety of agencies around the world, the issue of standard data formats becomes important. Intelligent acquisition, selective storage, manipulation, and analysis of these data will require advanced geographic information systems if we are not to drown in this sea of environmental data. In addition to advances in traditional computer technology, research groups around the world are looking at fields of artificial intelligence (.e.g. expert systems, natural language understanding and image understanding), to make geographic information systems more efficient and more friendly to users with limited comput literacy.

7.0 TOWARDS SUSTAINABLE PARKING POLICIES

Parking policies requires a multi-dimensional integrated effort. The paper therefore suggests that these other measures could be adopted; viz: Road users planning, Interactive planning ; Policy articulation – Self- designed, Self-determined, Self-renewing.

⇒ Obtaining the consent and goodwill of the governed/citizen participation.

⇒ In Lagos, there is a need to consider the use of demand management measures to supplement other control measures.

⇒ Enabling environment should be established for full private sector participation that sees parking as serious financial investment which generates income and as such bringing efficient integration of parking information systems,

⇒ Referenda, public hearings and drivers' meetings should be regular features of the system.

⇒ Safety of vehicles in parks and their maintenance should receive appropriate attention instead of the neglect they now suffer;

⇒ Data bank on parking facilities and effective monitoring is most desirable and should be established. Finally, proper inventory, efficient information systems, parking legislation, financing of parking facilities and adequate maintenance should be properly coordinated to give measures which will alleviate the parking problem.

8.0. THE WAY FORWARD – SUMMARIZED SUGGESTIONS

This paper suggests that the envisaged PGI systems can have an impact by :

- re-distributing parking demand between car parks
- alleviating queues at the most populated car parks

The available evidence, collated in this paper on the attitudes of Lagos drivers to parking guidance information (PGI), suggests that existing PGI systems:

- are recognised by a majority of drivers bus used by only a minority.
- have their greatest impact on innocent drivers and the least effect on experienced drivers.

We are therefore led to conclude that enough emphasis is not placed on the provision of parking signs and information systems in the entire study area. Prominent parking signs should therefore be mounted on overhead gantries at all entry points. Furthermore, there is the identified need for well designed and highly maintained parking control devices at inter-sections.

9.0. CONCLUSIONS

This paper has shown that there appears to be a lack of emphasis in existing land-use transport and traffic models on the assessment of metropolitan Lagos parking policies. This is unfortunate since parking policy and management are an integral element of both transport planning and traffic management.

A review has been carried out, on the parking policy development in metropolitan. Lagos following which the paper introduced the appreciation of computer knowledge for effective management decision making, and for managing as well providing parking guidance information system for a traffic-orderly urban society. Robotics, machine, artificial and computer-based intelligence systems are required and advocated in solving the problem of poor parking guidance information system in Lagos metropolis. This technique could also be adopted in other large Nigerian towns with complex transport/traffic arrangement. In addition, it has also helped in identifying specific recommendations regarding proper policy formulation in respect of the provision of suitable car parks in Lagos metropolitan areas.

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Actions for reducing traffic congestion in the urban cities of Latin American countries

Actions pour la réduction de la congestion du traffic urbain dans les villes de l'Amerique Latine

Acciones para reducir la congestión del tránsito urbano en ciudades de América Latina

L. I. Sánchez Arellano
Facultad de Ingeniería, Universidad Autónoma del Estado de México, Mexico

ABSTRACT: Traffic congestion in urban areas it's a problem that is not enougt considerred in the cities Latin Americain countries. The mesurements used against traffic congestion in developed countries are applied in societies that are different in economical, political and social aspects. We think that the accurate identification and diffusion on the successful measurements could help to solve this problem.

RÉSUMÉ La congestion du trafic dans les zones urbains est un probleme assez pue traité par les pays de l'Amérique latine. Les mesures utilisé pour combattre la congestion dans les pays développement est connu et applique pour sociétés qui ont caractéristiques différentes dans l'économique, culturel et politique. Sa efficience nous le connaissons assez mal, ce par le quel on pue pas les utilisé pour les cas latinoamericaine. Nous croissns que l'identification précise doivent permettre résoudre directement cet probléme.

RESUMEN: La congestión del tránsito en las áreas urbanas es un problema poco tratado en ciudades de países latinoamericanos. Las medidas utilizadas para combatir la congestión en países desarrollados se conciben y se aplican en sociedades que difieren en lo económico, cultural y político. Su efectividad no se conocen bien, por lo que no se puede determinar la necesidad de adoptarlos y adaptarlos al ambiente latinoamericano. Creemos que una identificación precisa y la difusión de las medidas exitosas en otras latitudes, podrá ayudar a resolver este problema.

1 INTRODUCCIÓN

El presente documento se inscribe dentro de una de las línea de trabajo del Centro de Investigación en Ingeniería del Transporte (CIITRA) organismo de la Facultad de Ingeniería de la Universidad Autónoma del Estado de México. El objetivo principal es el dar una descripción de la problemática que presentan algunas ciudades importantes de latinoamérica sobre la congestión del tránsito en sus áreas urbanas. Podemos decir que se desconocen bastante mal las medidas aplicadas por los países ricos, por lo que suponemos que algunas de las medidas utilizadas en estos países pueden ser éxitosas en ciudades de países en desarrollo.

La utilización de estas medidas, con las adaptaciones propias de cada ciudad, permitirán reducciones importantes en los consumos de combustibles y por lo tanto disminución de emisiones contaminantes a la atmósfera y otras molestias (ruidos y malos efectos visuales ligados con el transporte). Se trata entonces de responder a las siguientes cuestiones:

- Definición lo más preciso posible del problema.
- Difundir entre los países en desarrollo resultados que es posible obtener si se aplican ciertas medidas para reducir la congestión del tránsito.
- Identificar los diferentes estudios realizados en países desarrollados y sus procedimientos de solución.
- Llevar a cabo una recolección de información para crear un banco de datos y apoyo bibliográfico.

2 GENERALIDADES

En la operación y gestión de los sistemas viales, uno de los principales objetivos buscados es reducir las demoras en los desplazamientos de los usuarios de las vías, este problema se vuelve más complejo en las áreas urbanas que en las vías interurbanas.

Durante el día, en los periodos de máxima demanda, el movimiento de vehículos se va haciendo mas lento y deficiente, con las consecuentes pérdidas de velocidad, hasta que el sistema se satura llegando a niveles de congestionamiento, en donde se incrementan las demoras.

De manera general las demoras son ocasionadas por la variabilidad en los volúmenes de tránsito, puesto que existen momentos en que la demanda puede ser muy grande o bien se presenta porque la capacidad de las vías cambia con el tiempo. Entonces podemos definir técnicamente a la congestión del tránsito como la situación que se crea en uno o más puntos de una vía, cuando la demanda del tránsito excede el número máximo de vehículos que pueden pasar por ellos. Al ocurrir esto, muchos vehículos deben detenerse, formando colas que se irán poniendo en movimiento después de algún tiempo, que en muchos casos puede ser largo y de una forma continua o bien intermitente.

Para muchas otras personas, la congestión del tránsito, no solo ocurre cuando la demanda excede a al oferta, sino también en todo momento en que la interacción vehicular sea tan intensa que impida que los usuarios de una vía puedan circular por ella cómodamente y sin demoras excesivas.

Lo que si podemos asegurar es que cualquiera que sea el concepto de congestionamiento, lo cierto es que causa una serie de inconvenientes tales como:

- Prolongación de los tiempos de viaje.
- Aumentos en los costos de operación
- Degradación del ambiente (contaminación del aire y ruidos).
- Aumento en el número de accidentes.
- Sensación de frustración y fastidio por parte de los usuarios.
- En general, una degradación de la calidad de vida en el entorno de las vías congestionadas.

3 METODOLOGÍA

Se pueden distinguir dos tipos de congestionamientos: los sistemáticos, cuyo momento y lugar de ocurrencia es previsible (mismo lugar y misma hora del día) y los accidentales, que se dan por sucesos casuales (descomposturas, cierres eventuales de carriles o calles, manifestaciones y accidentes de tránsito).

Entre las causas que originan los congestionamientos sistemáticos tenemos las ocasionadas por la misma corriente vehicular en situaciones de flujo continuo, y los dispositivos de control del tránsito (semáforos y señalamientos) que interrumpen los flujos vehiculares. Una forma de caracterizar el fenómeno del congestionamiento de un sistema vial, es cuando se hace necesario responder a una serie de cuestiones como:

- ¿ A qué hora comienza y termina el congestionamiento?
- ¿Cuál es el número promedio de vehículos?.
- ¿Cuál es el tiempo promedio de la demora?
- ¿Cuál es la demora máxima?
- ¿Cuál es la demora total de todo el tránsito?
- ¿Cuál es la proporción del tiempo en que se utiliza el sistema?
- ¿Cual es la proporción del tiempo cuando el sistema permanece inactivo?.

Todas estas preguntas se deben responder para poder atacar el problema específico del congestionamiento.

La participación del Instituto Panamericano de Carreteras (IPC), con sede en la Ciudad de Washington, D.C. que ayudó con la realización de las encuestas, su recopilación y análisis. Con los resultados de los cuestionarios contestados por parte de los responsables del transporte en las ciudades latinoamericanas, por consultores y expertos, se pudo definir de manera aproximada la problemática que viven estas ciudades respecto al congestionamiento del tránsito.

El contenido del cuestionario tenía como objetivo conocer tres aspectos básicos:

- Información socioeconómica de las ciudades (población, Superficie, número de vehículos con su clasificación, etc.)
- Información sobre el tránsito (horas de máxima demanda, tipo de congestionamientos, sus causas y gravedad de la situación).
- Información general del encuestado (nombre, cargo, domicilio y experiencia que tiene en el tema).

El análisis sistemático de algunas medidas para la reducción de la congestión del tránsito, permitirá que las políticas sobre los desplazamientos urbanos tomen en cuenta otros factores asociados con el entorno que influyen en las condiciones de vida de los habitantes. También se buscó la manera para la puesta en operación de estas acciones y de cómo pueden organizarse junto con los diferentes actores como son autoridades, operadores, transportistas y usuarios, con el fin de asegurar una mejor calidad del servicio de transporte.

La preparación de un documento que presente las diferentes estrategias para la reducción de los congestionamientos de tránsito, como medio de difusión de procedimientos a seguir.

3.1 Acciones contra la congestión

La congestión del tránsito urbano es con frecuencia un problema de difícil de solución, que requiere de verdaderas estrategias para remediarlo. La naturaleza de las estrategias para la congestión es muy variada, por lo que deben ser seleccionadas, definidas y aplicadas por distintos tipos de profesionistas e instituciones. Por tal motivo la concepción e implantación de cualquier estrategia, requiere generalmente de la acción coordinada de funcionarios de las dependencias gubernamentales, consultores, transportistas , cuerpos de policías, académicos y de investigadores entre otros, así como del apoyo de los medios de información masiva (la radio, televisión y periódicos), de instituciones cívicas y de que el público en general las acepte.

Existen diversos remedios para hacer frente a la congestión, algunos de ellos se basan en principios de áreas como: ingeniería de tránsito, planificación del transporte urbano, sociología, urbanismo, economía, psicología y otras disciplinas más. Estas acciones pueden aplicarse al sistema de transporte existente (mejorándolo), a la demanda del transporte (reduciendo su magnitud o modificando su distribución temporal y espacial) a los usos del suelo (adaptándolo a las necesidades de transporte) o bien a todos los integrantes de la realidad urbana.

De acuerdo con el tiempo que necesitan para surtir sus efectos, los remedios se pueden clasificar en remedios al corto, mediano y largo plazo, según que los resultados se obtengan en periodos de menos de un año, de uno a cinco años y más de cinco años según sea el caso. La información a conductores sobre tramos de vía congestionadas, la aplicación efectiva de medidas para regular el tránsito y los cambios en los horarios de los trabajos, son acciones al corto plazo, las modificaciones físicas a las vías y las mejoras al transporte colectivo suelen ser remedios al mediano plazo; mientras que los esfuerzos por cambiar los usos del suelo y el comportamiento de los conductores y peatones son casos de proyectos al largo plazo.

4 ESTRATEGIAS PARA COMBATIR LA CONGESTIÓN DEL TRÁNSITO.

Decíamos que existen dos tipos de congestionamientos: los sistemáticos y los accidentales, cada uno de éstos tiene diferente tratamiento, que se menciona a continuación:

4.1 *Congestionamientos sistemáticos.*

Existen en general, tres tipos de acciones para combatir la congestión sistemática:

- impedir que ocurra.
- eliminarla, si es posible y
- mitigarla, en caso de no poderse eliminar.

El primer tipo de acción se aplica a muchos casos a autopistas urbanas, pues como tienen pocos accesos son fáciles de controlar el ingreso a esos y se puede restringir su uso cuando aumente peligrosamente la probabilidad de que ocurra congestión. Desde luego, este un remedio al corto plazo que puede llevar a trasladar el problema a otras vías, si no se van aplicando también otras acciones al corto, mediano y largo plazo de la red urbana afectada. Todos estos remedios no solo pueden prevenir la congestión a otras vías, sino también mejorar en todo momento la calidad del servicio que ofrecen las vías a sus usuarios.

Es posible tratar de aplicar la segunda acción en ciertas calles convencionales, donde existe congestión y no se esta utilizando toda su capacidad potencial. Para ello se pueden instituir medidas de ingeniería de tránsito, tales como prohibición de vueltas derechas o izquierdas, estacionamientos y paradas del transporte público, mejorar la programación de los semáforos y sentidos únicos de circulación, entre otros, o bien hacer cumplir, mediante acciones de vigilancia policiaca, medidas instituidas que no se estén cumpliendo.

El tercer tipo de estrategia o acción es la mitigación, se aplica cuando las del segundo tipo no han podido eliminar a corto plazo la congestión en algunos puntos críticos de las vías (por ejemplo, en intersecciones de vías con gran demanda de tránsito). Muchas veces esta estrategia utiliza acciones completamente distintas a los del segundo tipo, pues no trata de eliminar una congestión imposible de suprimir, sino evita que ésta se propague a vías donde no existe congestión. Así, una acción del segundo tipo de estrategia puede ser el aumento de la duración del ciclo de semáforos, buscando mayor capacidad, mientras que en el tercer tipo puede tratarse de reducir esa duración para acortar las colas de vehículos, a fin de que no obstruyan intersecciones corriente arriba. El uso de esta estrategia no excluye la aplicación concurrente de remedios a mediano y largo plazo propios del primer tipo de estrategias.

4.2 *Congestionamientos accidentales.*

Como lo indica su definición, no se puede predecir la ocurrencia de esta congestión, aunque a veces es posible conocer la probabilidad de que se produzca en ciertos puntos críticos de un sistema vial. En estos casos pudiera tratarse de aplicar estrategias del primer tipo a esos puntos críticos, aumentando su capacidad para reducir la probabilidad de congestión, pero la prioridad de esa medida es casi siempre muy baja en el presupuesto vial.

Por lo tanto, la estrategia para la congestión accidental se centra principalmente en acciones al corto plazo para tratar de reducir su duración, o bien hacer desvíos del tránsito por otras vías menos congestionadas. Esta congestión puede ser causada:

- Por accidentes que obstruyen total o parcialmente una vía, producen turbulencia en el tránsito, o al menos causan distracción o cohiben a los conductores.
- Por incidentes (vehículos descompuestos y cargas de transporte tiradas o derramadas, entre otras).
- Por causa inesperadas como son alteraciones del orden público, manifestaciones o incendios y en ocasiones la presencia de vehículos de tracción animal.

En el caso en que sea posible retirar las obstrucciones de la vía, conviene localizarlas inmediatamente por medio de vistas aéreas (desde helicóptero, un edificio alto o por otros medios) y enviar un equipo especializado para tratar de despejar la vía sin mayores pérdidas de tiempo. En cualquier caso se pueden reducir los perjuicios de una congestión local después de localizada, prevenir a los conductores que podrían pasar por la zona afectada, mediante transmisiones de radio, señales con mensajes variables, "Internet" y otros.

4.3 *Otro tipo de acciones*

Existen en la actualidad toda una serie de elementos que pueden ayudar a reducir los problemas de congestionamiento en áreas urbanas, desde luego algunas de estas acciones o medidas son demasiado sofisticadas para ser utilizadas en países en vías de desarrollo, pero que creemos conveniente se conozcan al menos.

Están en primer lugar los Sistemas de Información Inteligentes (SII) que pueden ser de dos tipos:

- acciones viales directas a los caminos.
- elementos electrónicos de viaje (IVIS)

Después tenemos otros sistemas como:

- Navegar con información continua
- Carreteras guiadas
- Servicios motorizados
- Información del tránsito en tiempo real
- Previsión de la seguridad en tiempo real
- Información de la regulación en tiempo real

Cualquiera que sea la medida a tomar se requiere que esta sea factible y no solamente la queramos aplicar porque sabemos que su puesta en operación trajo mejoras en otros puntos u otras ciudades.

Para el caso de nuestras ciudades latinoamericanas una de las acciones que ya se han explorado, pero que por algunas razones no se ha continuado su aplicación, es la de promover los transportes colectivos como una forma de reducir los congestionamientos en algunos puntos de las ciudades. Los resultados encontrados durante la ejecución el estudio, fue que hacer una inversión para mejorar la infraestructura vial, como lo es básicamente ampliar las vías, demostró que esto no siempre es la mejor opción, ya que si bien es cierto se aumenta su capacidad, lo que se produjo al final fue una mayor saturación de las vías y un aumento en los tiempos de recorrido para el transporte público. Esto nos lleva a decir que en ciertos casos particulares de congestionamientos y la concurrencia de los transportes colectivos, las posibles ventajas que pudieran aparecer aumentando la capacidad de las vías, aparecen como algo sin mucho efecto o más bien casi nulo, dado que la congestión sigue aumentando. Lo que nos debe llevar a cuidar mucho los estudios o cálculos de rentabilidad de proyectos de infraestructura vial para las vías congestionadas, en donde la existencia de sistemas de transporte público son muy importantes.

Esto también lleva al caso de que una supuesta reducción en la incomodidad de usar los transportes colectivos, por medio de las inversiones en infraestructura vail, no compensaria un posible aumento en las tarifas del transporte por las obras realizadas.

5 CONCLUSIONES

El problema de congestionamiento en las principales ciudades de los países latinoamericanos nos parece un tema muy importante que debe ser rápidamente estudiado y atacado por los responsables de la organización y gestión del transporte.

No es posible seguir soportando numerosas pérdidas de tiempo para los usuarios del transporte, excesivos consumos de combustible, mayores desgaste de los vehículos y por lo tanto aumentos en la contaminación ambiental, cuando tenemos otro tipo de carencias como educación y salud entre otras y donde los recursos económicos son cada vez más raros.

El caso del congestionamiento de los transportes en las áreas urbanas se presenta como un proceso complejo, el cual se tiene que ver como un todo, en donde cada elemento del sistema no debe ser tratado de manera independiente en el proceso de transferencia y adaptabilidad, sino como parte del mismo sistema. Un ejemplo puede ser la selección vehicular, que no podemos ver de manera aislada a la formación de conductores o a la del manejo de los talleres de mantenimiento, ni las medidas que faciliten la circulación de los transportes de superficie.

Efectos nefastos se observan en el campo de la seguridad y la economía de las ciudades, notándose que el incremento de los accidentes en las vías congestionadas deterioran el servicio y los equipos, además de las consecuentes pérdidas humanas y materiales. Por todo esto se recomienda atacar el problema del congestionamiento antes de que se agrave y sea más difícil su solución. Un agradecimiento muy especial al Dr. Guido Radelat quien colaboró en la redacción de este trabajo.

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4 Institutional strengthening
Renforcement institutionel
Fortalecimiento institucional

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The road traffic management process in South Africa with a Western Cape Province perspective

K.E.Chinnappen & J.S.Hugo
Cape Metropolitan Council, Cape Town, South Africa

ABSTRACT: Prior to 1994 road traffic management in South Africa was not undertaken in an integrated manner, with law enforcement agencies, engineers and administrators each doing in isolation what was thought to be best, with little effect on the country's appalling accident rate. After the election of the new government, liaison structures were set up along the lines of the 3-tier government system and traffic management was approached in a multi-disciplinary manner. Road traffic accident casualties have decreased by 7% over the past 2 years.

1. INTRODUCTION

Of a population of approximately 42 million people, there are more than 6 million licensed motor vehicle drivers and about 6.6 million registered vehicles travelling on more than 520 000 kilometres of road and street network in South Africa. As in most countries, traffic safety is considered to be an extremely serious problem, evoking urgent response from politicians, technocrats and the community at large. In 1998, the annual road traffic accident count was in excess of 415 000, of which 81 622 were fatal or resulted in serious and slight injuries, costing the country about US$ 2.7 billion (13.4 billion South African Rands).

The unacceptably high levels of injury and fatal accidents on South African roads require urgent attention. However, road traffic safety should not be seen to be an exclusive function on it's own. It is the product of integrated, effective and efficient land based transport and traffic management systems designed to harness road traffic operations and related functions, with the primary purpose of improving the quality of road traffic. In the ongoing quest to compete for limited funds to upgrade and expand the road infrastructure, traffic management is seen as a tool that is used to maximise the volume of road based traffic on the existing infrastructure in a safe, effective and efficient manner.

2. DEVELOPMENTS PRIOR TO 1994

Prior to the 1990's, traffic management processes were virtually non-existent at national, provincial, metropolitan and local levels. Although part of tertiary academic syllabi at that time, integrated traffic management practice was not taken seriously by all affected role-players. Traffic enforcement officers, through a process of uncontrolled evolution, were given that task to perform "whatever was necessary" to essentially control traffic and enforce road traffic acts, legislation and local by-laws in South Africa. Road engineers independently prepared guidelines and implemented certain aspects of traffic management within the road environment such as directional signs, route markings, traffic signal warrants, etc.

Although known to be one of the key factors in promoting the economy of a country, the pre-1994 governments did not view transport as an essential area of development. Government's dominant role in transport was that of a bureaucratic regulator, a provider of road infrastructure and a transport operator. With respect to traffic management, it was weak in overall management, strategic planning and policy formulation. It also operated relatively independently from international best practices and, at that time, was not a member of the Southern African Development Community.

The Committee of State Road Authorities (CSRA), comprising of road engineers from the National Department of Transport, South West

Africa (Namibia prior to its independence) and the then four provinces, coordinated national policies and prepared guidelines and warrants affecting the road environment. Unfortunately, the committee had little or no political support from all spheres of government and lacked any meaningfully focussed direction towards traffic management issues. Similarly, the Committee of Urban Transport Authorities (CUTA) was structured as a predominantly uni-disciplinary committee with the purpose of coordinating urban transport.

In the early 1990's, traffic enforcement officials decided to investigate the need for national forum on traffic enforcement and control. At that time, the then four provinces had traffic enforcement structures consisting of Coordinated Traffic Committees (CTC) at provincial and metropolitan level. The Committee for Road Traffic Law Enforcement (CRL) was established under the Road Traffic Act of 1989. Together with CSRA and CUTA, the CTC's and, later the CRL, could thus be considered as the few recognised traffic management structures in place.

Just prior to the first democratic election of the country in 1994, the need for some form of integrated traffic management process was realised. Traffic management projects, such as incident management began to be discussed in multidisciplinary forums.

3. DEVELOPMENT OF MULTIDISCIPLINARY TRAFFIC MANAGEMENT STRUCTURES

After the 1994 national election, the Minister of Transport decided to create a formal consultative and co-ordinated structure between first and second spheres of government to address policy and functions. The Ministerial Conference of Ministers of Transport (MINCOM) was tasked with setting transport policies in the country. It receives technical input and support from the Committee of Land Transport Officials (COLTO) on all aspects of land transport. MINCOM comprises of the national Minister of Transport and Provincial Ministers responsible for transport from all nine provinces. Similarly, senior transport officials from the National Department of Transport and the nine provinces are members of COLTO. The MINCOM / COLTO structure, which has been functional since the latter part of 1994, was considered to be the first step towards providing the institutional framework within which the national / provincial relationship has been managed and the integrated management of transport functions facilitated.

After MINCOM and COLTO became operational, four technical coordinating committees were introduced, which included the Road Traffic Management Coordinating Committee (RTMCC) and the Traffic Control Coordinating Committee (TCCC), the latter replacing the Committee for Road Traffic Law Enforcement. In 1998, the TCCC, in the interest of integrated management, was expectedly incorporated into the RTMCC. The MINCOM / COLTO structure, with the coordinating and traffic management technical committees, is shown in Figure 1.

4. ROAD TRAFFIC MANAGEMENT COORDINATION

4.1 *Coordination*

The membership of the RTMCC has representatives from all disciplines in the first and second spheres of government involved in road traffic management. Currently, the RTMCC membership consists of the following organisations:

- National Department of Transport;
- The nine provinces (engineering, education, traffic police and logistics);
- The Institute of Traffic Officers;
- The South African Police Services; and
- The Department of Justice.

The five large metropolitan areas are shortly expected to become part of the committee.

The RTMCC is structured to coordinate all aspects of road traffic management in the country. Various technical committees and, if deemed necessary, associated working groups, have therefore been established to support and assist RTMCC, as shown in figure 1. Working groups are formed to perform specific national projects and disband at the completion of that project. The RTMCC currently has the following technical committees:

- Traffic officer training and development.
- Traffic information systems.
- Driver training and testing.
- Road traffic education and communication.
- Road traffic legislation.
- National overloading and control.
- Guidelines and standards for
  - setting of speed limits,
  - incident management,
  - road traffic signs,
  - vehicle standards and roadworthiness,

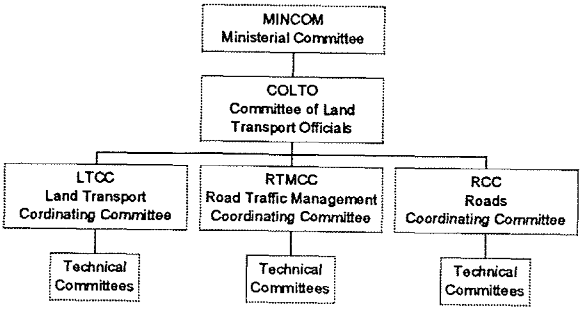

Figure 1: Transport structures in South Africa

- and inspectorate of vehicle testing centres.
- Road safety audits.
- Administrative adjudication of road traffic offences; and
- Special projects such as Arrive Alive, Credit Card Type Licenses, Accident Report Form, etc.

On the international front, national projects in particular generally tend to "piggy back" on lessons learnt from other countries, with the view to adopting the best practice in that project. As an example in traffic management, the State of Victoria in Australia shared their experiences in the processes and methodologies used to substantially improve road traffic safety.

Clearly, the country has embarked on a fully integrated and multidisciplinary approach, based on the so-called three E's (engineering, education and enforcement) as well as evaluation / monitoring, to address the issues affecting road traffic management. Technocrats are now jointly working together, strongly supported by the political structures. MINCOM has repeatedly expressed full political commitment by responding positively to initiatives proposed by COLTO and the coordinating committees.

4.2 *Results of effective coordination*

In the short time that the structures have been functional, key road traffic acts, regulations and special projects have been approved and implemented or are in the process of being implemented.

Notwithstanding the coordinated structures that that have been established, traffic management in South Africa can be described to be in a state of crisis because of the current high levels of lawlessness and exceptionally high death toll on the roads. The lack of past investment in equipment and human resources could be considered possible causes of the current unsatisfactory state of road traffic safety. Investigations highlighted the need to address the problems in all functional areas in all spheres of government. It was also found that the institutional arrangements were not conductive to coordination and rapid interventions. Due to the need to optimise limited resources and streamline institutional arrangements, an innovative concept of creating the Road Traffic Management Corporation (RTMC) was developed, which will collectively operate road traffic management "at arms length" from the government. The Road Traffic Management Corporation Act of 1998 *"will provide, in the public interest, for co-operative and co-ordinated planning and provision of advice, regulation, facilitation and law enforcement in respect of road traffic matters by the National, Provincial and Local spheres of Government and the private sector, and to that end, to provide for the establishment of the Road Traffic Management Corporation; and to matters contained therewith."*

Another recently promulgated act, the Administrative Adjudication of Road Traffic Offences Act, is designed to essentially change the culture of drivers committing traffic offences and not paying their fines, lessen the burden of the courts on minor infringements and promote the compliance of road traffic rules.

The successful Arrive Alive special project, now in it's fourth phase, is another illustration of using an innovative concept by obtaining joint funding from the Road Accident Fund Board, the government and to a lesser extent, the private sector to implement traffic management strategies and programmes to reduce fatal accidents. Coordination, cooperation and commitment amongst all road traffic related disciplines have been key factors that have contributed to the overwhelming success of the project. Since the start of the Arrive Alive traffic safety campaign, the total road traffic accident casualties dropped by 7% nationwide, which is estimated to amount to a saving of approximately US$ 80 million (R 475 million) to the country. Casualties in the urban areas dropped by 11%, but there was a slight increase of 2% in the rural areas.

5. TRAFFIC MANAGEMENT IN THE PROVINCE OF WESTERN CAPE

5.1 *Introduction*

The Western Cape Province comprises of an area of 129 370 square kilometres, with a population of some 4 million people representing 9.8% of the population of South Africa.

In 1998 there were 1.1 million registered vehicles and 1.0 million licensed drivers representing 16.9% and 16.6% of the figures in South Africa respectively. A total of 1 314 people died and a further 19 859 were injured in road traffic accidents in the Province, costing more than US$ 0.35 billion (R 2 billion). A total of 18% of all accidents and 16% of all fatal accidents in South Africa occurred in the Western Cape.

Approximately 68% of fatalities and 80% casualties occurred in the urban areas. More than 47% of all fatalities are pedestrians. In the Cape Metropolitan Area, about 60% of all road traffic accident deaths are pedestrian fatalities.

5.2 *Structures*

Historically, no single authority has had statutory responsibility at Local Authority, Metropolitan or Provincial level for traffic management. This has resulted in fragmented actions with no clear responsibility, authority or accountability for traffic management and, in particular, accident prevention measures.

In accordance with the RTMS, a consultative and coordinative transport structure similar to MINCOM and COLTO has been established in the Province. The structure consists of the Western Cape Provincial Transport Committee (PROVCOM) and the Western Cape Provincial Transport Technical Committee (PROVTECH), representing politicians and officials respectively. The latter has appointed a multidisciplinary committee that has been tasked to coordinate the management of road traffic management in the Province. This committee is called the Provincial Road Traffic Management Coordinating Committee (PRTMCC). Its main function is to take responsibility and accountability for the management of road traffic on all roads in the Province. In order to involve regional and local authorities and the community, the PRTMCC has established a Metropolitan and three Regional Road Traffic Management Coordinating Committees.

The terms of reference of these coordinating committees includes:

- Accountability and responsibility for road traffic in their respective areas.
- Development, implementation and management of road traffic plans based on National and Provincial road traffic plans.
- The establishment of RTMCC's at Local Authority levels.
- Involvement of the communities.

Figure 2 represents the transport structure, with the emphasis on road traffic management, in the Province.

5.3 *Planning*

A Provincial Road Traffic Management Plan has been formulated and was approved by PROVCOM on 15th September 1998. The Plan is based on the principles of Traffic Management System, enabling all affected role-players to work together in a holistic and integrated manner with the common aim to effectively promote orderly traffic and traffic safety. The Plan broadly outlines the framework for a strategy based on National and Provincial road traffic policies. The overall aim of the Plan is to reduce road traffic casualty accidents by 10% per annum.

The Plan is underpinned by a number of key principles, namely the need for:

- Political support and commitment.
- An integrated, multidisciplinary management approach continually striving for the highest standards of professionalism.
- Coordinated Local, Metropolitan and Regional plans, under the auspices of the National and Provincial policies.
- Community ownership.
- Focus on critical safety issues.
- Flexibility and realism.
- Regular monitoring and evaluation.

The overall strategy of the Plan is to adopt a multidisciplinary approach, coordinating the eleven functional areas within traffic to address certain identified critical issues. The functional areas are as follows:

- Engineering: Road environment.
- Education: Traffic safety education.
Driver training.
Marketing and mass communication.

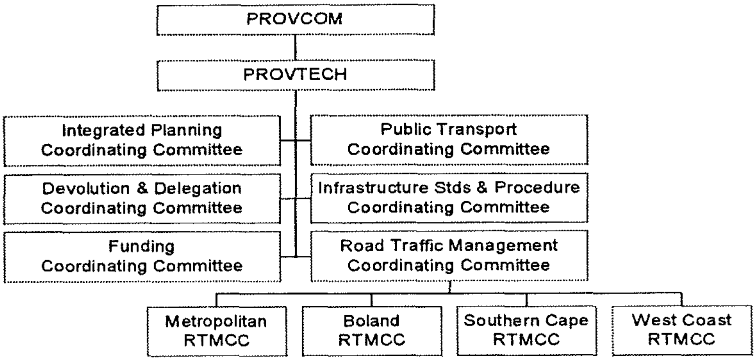

Figure 2: Transport management structure in the Western Cape Province

- Traffic law Enforcement: Legislation. Traffic Control and Policing. Adjudication.
- Logistics: Research, development and implementation. Registration and licensing. Traffic information. Emergency services

The critical issues that have been targeted for attention are the following:

- Traffic Safety: Alcohol and drugs. Speed. Fatigue. Seatbelts. Visibility. Intersection violations. Pedestrians.
- Management: Information and evaluation. Funding. Manpower. Organisational. Development. Training.

For each critical issue, objectives and the required approach have been determined.

The next step in the development of a holistic and fully integrated traffic plan for the Western Cape is the formulation of a Provincial Strategic Plan. The aim of this Plan is to provide strategies to which all the relevant parties can adhere. It aims to address two specific issues:

- What must be done to achieve the overall aim?
- What targets should be set?

The final draft of the Strategic Plan for the period 2000 to the year 2005 has just been completed. It details the strategies that must be adopted by the relevant functional areas to address the identified critical issues.

Furthermore, it will form the basis for the eventual implementation of projects and actions at Metropolitan / Regional / Local level, which is expected to ultimately reduce the number and severity of accidents on the Province's roads. The Strategic Plan is intended to substantially influence the Operations Plans that will be prepared at Metropolitan / Regional levels by the respective RTMCCs. The Operation Plans in turn will detail a course of action that should be implemented at District / Local level. Figure 3 illustrates this coordinated process.

6. CONCLUSION

This paper has reported on the ongoing progress towards achieving an effective and efficient traffic management system in the country.

All role-players have indicated their full commitment to the established structures and special projects. However, all spheres of government and, to an extent, the private sector need to demonstrate their support of the system by allocating funds and trained personnel to give effect to all the coordinated plans. Road safety results over the next few years will be used to evaluate the success of traffic management projects and plans coordinated by the established institutional structures.

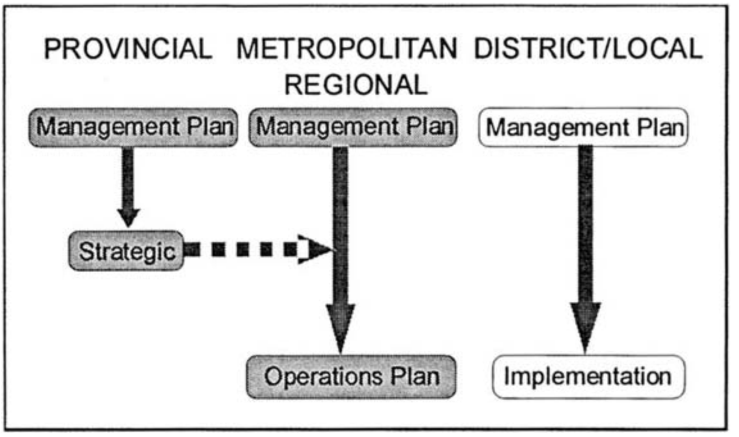

Figure 3 : Western Cape road traffic planning process

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The institutional framework for urban transport projects in developing countries: Case study of Mumbai, Bombay, India

J.T.Verghese
New Delhi, India

J.Jansky
Bombay, India

ABSTRACT: India has four mega cities - Bombay, Calcutta, Delhi and Madras - each with a population of about 10 million and still growing. Apart from these cities there are 26 cities which have a population of 1 million or more. The four mega cities are served by extensive surface heavy rail urban transport systems with the system in Bombay carrying more than 5 million passengers daily. Only Calcutta has an underground system and work has just started on a mass transit system for Delhi. Planning studies for expanding the mass transit system in Bombay have been on for several years now. However there has been very little expansion of the system. The authors have been closely involved in the conceptualization and studying the feasibility of providing a suitable rail based mass transit system for the Central Business District of Bombay. The institutional problems encountered and the approaches to resolve the various issues encountered is the basis of this paper. According to the Constitution of India the Railway comes under the Central Government, while the bus transport is with the control of the States. The Tramways and elevated light railways, though strictly speaking under the State control, have of late been subject to attempts to control by the Central Rail Ministry. To compound the problem, there are a plethora of ordinate the planning and implementation of new schemes.

The valuable lessons learnt and the unique solutions to the institutional problems will be of immense interest to developing countries in similar situations.

RESUMEN: 1. Mr. J T Verghese was formerly Executive Director in the Ministry of Railways in India and is presently a Management Consultant specializing in organizational and institutional issues. He was the institutional expert for the Feasibility Study for Bombay. Mr. Verghese has had extensive experience in Railways and had considerable exposure outside India having worked for five years as the Indian Railways' representation in France with responsibility for most of Europe. Mr. Verghese is a Mechanical Engineer with specialization in Management of Technological Change.

2. Mr. J Jansky is the Vice President of DE-Consult, which is a daughter company of the German Railways and is one of the largest transportation consultancy companies of the world. Mr. Jansky was responsible for the conceptualization of the scheme for the Central Business District of Bombay and played an active role in resolving the institutional issues. Mr. Jansky a Qualified Mechanical Engineer and Management Expert who has worked on several projects in Bombay for the last six years.

1 INTRODUCTION

Bombay is one of the world's largest metropolitan areas and its business activities play a major role in India's economy. Greater Bombay today covers an area of approximately 440 sq.kms., out of which 70 sq.kms. form the so-called Island City. Bombay Metropolitan Region occupies an area of about 4164 sq.kms, with a population well above 14 million. Three quarter of the population live in Greater Bombay, 30% in Island City.

Like many other world mega-cities, Bombay's economic development will be critically dependent on, and possibly constraint by, the ability to ensure the efficient transportation of its citizen and products. Recent studies have underlined the importance of public transport which today carries about 80% of all passenger trips in the Metropolitan Region with an almost equal share for rail and bus.

The Bombay suburban railway network, operated by the Central (CR) and Western (WR) Zonal Railways of Indian Railways (IR), is among the most intensively used in the world. The two suburban rail systems are presently connected through two links [Harbour Line (double track) and Vasai - Diva Line (single track)]. The third link, Bandra - Kurla, with a double track design has been planned already.

Each day, each of the railways operates more than 1,000 suburban passenger trains, accounting for a total of more than 5 million passenger trips. In addition, 70 trains carrying inter-city passenger, and 120 trains carrying freight use the same tracks.

Increasingly the passenger flow is shifting from a CBD related commuter pattern to a dispersed urban pattern as the city expands. The former regional operation is becoming a more and more complex urban operation. The regional rail system has to function as a surface Urban Mass Rapid Transit (MRT) system. It will form the backbone of an extended MRT system in the future which then might include subway-sections extending existing lines further down to the south into the Island City.

It is expected that the CBD will remain the financial centre of Bombay and the main centre of employment, even in contrast to the efforts to create a more polycentric city structure. Therefore, for the time being commuter services and inter modal passenger exchange at the two rail terminals (Churchgate and Victoria Station), and public transport within the CBD-area are of vital interest for the city and its surroundings.

The present situation is characterized by a series of weaknesses. Some of the most pressings are listed below:

Commuter services are unreliable due to frequent disturbances (by people living adjacent to the tracks, at level crossings with streets, inadequate infrastructure (e.g. switches etc.).

Services offer little comfort (low travel speed, partly because of track conditions and partly because of hutments/encroachments close to the track, which results in long travel times for passengers, long round-trip times of trains, and eventually, in overcrowding). With punctual improvement of the infrastructure as mentioned above, services can be enhanced without increasing the size of the fleet.

Bus based feeder and distributor services in downtown Bombay are insufficient to cope with passenger demand. Buses are hampered by the slow traffic flow in the Bombay CBD street network which results again in long round-trip times and inefficient use of the existing bus fleet, thus reducing the overall capacity of the bus system.

A study was commissioned in 1997 by the Maharashtra Government funded by German Government grants to look at the possibility of a mass transit system for the Central Business District (CBD) of Mumbai.

As the city grew and technology permitted newer forms of mass transport, a number of institutions were created. Some to install and operate transport system and others to regulate and mitigate the consequences of increased traffic. In large cities a number of autonomous institutions have now taken root and they play a crucial role in ensuring safe, efficient and adequate urban transport facilities. Many studies of Bombay have revealed that insufficient attention to institutional aspects have lead to poor planning and even poorer implementation standards. The lack of coordination between a number of agencies involved to different aspects of transportation planning, implementation and operation has resulted in projects with conflicting objectives and as in often the case, each vying for already scarce resources of land and money.

The existing institutions and their role at city level in influencing the planning and operation of urban transport may be seen in the Annexure I attached.

It is may be seen that all not only a number of institutions but they belong to different levels of government - city, State and Central. This makes coordination even more difficult since the political compulsions and orientation of these different levels could differ vastly. Urban transport being a politically sensitive subject, there would be a tendency among bureaucrats manning the institutions at the three levels to be influenced in their planning objectives by the political establishments.

While it is accepted that integration of transport development with the overall urban development plan is necessary and this would be best done by having a single responsibility agency, the facts remains that attempts to put in place such an agency with omnibus responsibility has always been threatened by existing institutions. In fact, wherever such attempts have been made, the total energies of institutions have been diverted from their assigned functions to defending their position. Projects to improve transport become the casualty.

There are, no doubts, difficulties in coordinating the roles of the Central, State and local government agencies. This often results in lack of clear responsibility and therefore accountability.

In Bombay, the Central and Western Railways belonging to the Union Government, provides the rail based mass transport system. The Ministry of Railways at the Centre which controls the budget, would prefer not to spend any money to improve the system since it is perceived to be loss-making activity. Thus tendency was reinforced with the declining central support to Railways and with the decision to transfer urban transport from Ministry of Railways to Ministry of Urban Development meant that the apathy to urban transport problems of Mumbai was near total.

Role of Government

Transport is a concurrent subject under the constitution implying thereby that both Central and State governments are to play their part. The fact remains that being a subject of daily importance for its citizens, particularly to the big city dwelling, the State to which the city belongs would clearly have to take the lead in planning and implementing transport projects

An analysis of the various functions related to putting in place a mass rapid system in the Central Business District of Mumbai lead to the framework given in Annexure - II.

Planning

There was broad understanding that planning covered considerations of issues under the following headings:

- Political
- Legal
- Technical
- Social
- Environmental
- Economic

One of the major problems which was encountered during the study was that there was not sufficient understanding among all the institutions involved regarding the different aspects of planning primarily with reference to the risks.

Regulation

There was also an area where there was considerable overlap between institutions. While there was some understanding of the standards which were to become guidelines for planning and operation, there was not much clarity regarding the roles to be played regarding compliance of plans with standards. This in effect meant that the approval processes were delayed. This at a considerably bearing since regulations covered:

- Building approval
- General regulation including safety and service requirements and the regulation of competition
- Environmental and cultural heritage regulations (which will be dealt with in a specific chapter)

There was also considerable lack of clarity regarding the role to be played by railways. The existing rail based commuter services are operated by railways. However, in the past when Mumbai had a tramway system, the operations were governed by the Tramway Act and continues to be theoretically so as long as the rail based system could be classified as tramway which indeed would be the case in the event that a light rail system was to be in place. In the past railways were attempting to get rid of the responsibility of providing commuter services in the large cities since it was apparently non-profitable. The subject of mass rapid systems was transferred to the Urban Development Ministry at the Centre. However, as soon as the State Governments begun to take the initiative in putting place rail based mass rapid systems, the Ministry of Railway have tried to exercise their control stating that rail based services were regulated. Some State Governments including that at Mumbai have taken the position that Light Rail Systems come under the definition of the Tramway Act as long as they are within the municipal area. The position has got further contentious because the VIIth Schedule to the Constitution of India contains three lists of matters. They are:

- The Union List: the power of legislation as regards all matters listed herein is vested in the Union Government.
- The State List: the power of legislation regards all matters listed herein is vested in all the State Governments.
- The Concurrent List: Both, the Union and State Governments have been invested with the power to legislate on all matters listed herein.

Railways are listed as Entry No.22 of the Union List, and Carriage of passengers and goods by railway, sea or air, or by national waterways in mechanically propelled vessels are covered by Entry 30 of the same list.

The List also contains a residuary entry, namely Entry No. 97, which bestows upon the Union Legislature the power to enact legislation on any other matter not enumerated in List I and List II including any tax not mentioned in either of those lists.

Entry 13 of List II covers Communications, that is to say, roads, bridges, ferries, and other means of communication not specified in List I; municipal tramways; ropeways; inland waterways and traffic thereon subject to the previsions of List I and List III with regard to such waterways; vehicles other than mechanically propelled vehicles. Entry 57 of the same List covers" taxes on vehicles, whether mechanically propelled or not, suitable for use on roads, including tramcars subject to the provisions of Entry 35 of List III.

Entry 35 of List III covers "mechanically propelled vehicles including the principles on which taxes on such vehicles are to be levied".

Whether the legislative power to enact suitable legislation for the proposed system lies with the Union or State Legislature or both, will depend on the entry under which the project would fall. This, in turn, as set out above, would depend on the precise nature of the system.

It would be clear that the situation is one in which there could be considerable scope for one or the other to either delay matters or take no initiative whatsoever using the ambiguity as an excuse. Keeping all these in mind it is decided to have a Project Review Committee consisting of representatives from the agencies of the Central, State and Municipal levels. One of the main objective of having a Review Committee was to ensure that on different stages of project there was agreement and once a stage have been crossed, it would not be possible for any of the agencies to back out from its earlier position. The Project Review Committee met at least 15 times over the two year period of the project and in-built safeguards were included in its working so that minutes of the meeting as issued by the study team would find automatic approval within a certain time period.

It was also recognized that among the many options of alignments possible, the political masters would have a say. In keeping this practical issue in mind it was decided to have a number of options studied in the preliminary phase and these would be presented to government for a decision of which two would be selected for further detailed study. This reduced the scope for irrational decisions since each options were presented together with the financial and economic returns. The Study Review Committee was also an excellent forum to convey to the various stakeholders the nature and extent of risks involved and which agency would take ownership. The Study Review Committee was therefore kept appraised of the following risks:

- Planning risk (the planning phase gets more expensive than expected and/or the results of the planning phase give rise to higher cost or less revenue of the project or the project gets killed altogether with the planning costs lost)
- Investment risk (construction of the infrastructure and/or procurement of the rolling stock is more expensive than planned)
- Financing risk (financing costs are above expectations or financing cannot be secured at all)
- Operating risk (operating the system is more expensive than planned)
- Revenue risk (revenue is below plan, i.e. fare and/or number of passengers and/or revenue from other sources like real estate development is below plan)

The Terms of Reference of the study had directed that the institutional arrangements should be directed towards public/private partnership. During the course of the study it was clear from the costs and rider-ship figures that a substantial government involvement would be necessary to make the project viable. This aspect was appreciated and both Government of Maharashtra and its institutions had concluded that it would be necessary to keep public participation in a minority position.

Taking into account the total risks involved, it was recommended that the planning risks should be taken by the government. The investment risk on the other hand was suggested to be split into its components. For the infrastructure, the risk of cost overruns is the same for government as for a private investor and therefore it could be taken by a private investor. However, the administrative risks associated with cost overruns due to administrative problems such as land acquisition and access is an area similar to planning for which the government should be the risk taker. The investment risk connected with rolling stock which can be dealt with by a well proven systems of guarantees, can also be taken by the private sector.

The financing risk would also be split into its components. The debt financing risk being high, since this is a long gestation project, will normally veer towards funding by multilateral and bilateral government agencies. This in turn will bring the Government of India as risk bearer since they would require to provide sovereign guarantees. The equity capital provider takes the prime risk and the private investor would expect a higher than normal return on investments which would go beyond 20% in the current situation.

It is also been suggested that a higher share of public equity capital in cash and or providing the private investor with real estate development rights could also be a substitute for reducing the equity capital in favour of guarantee debt capital. The alternatives to be considered are to have a large share of debt capital being guaranteed by the government which can be raised at low risk premium. Once this is done the risk for the equity holder in absolute terms became lower. This in turn would attract other interests to take up equity share particularly those having an interest in rolling stock or construction services.

The operating risks are not biased in favour or against government or private operator. The revenue risks is heavily influenced by the government regulation not only regarding the fares to be levied on the mass rapid system, but also fares for the competition - taxies and buses. It was recommended that the regulatory bodies should give a clear picture early in the project of the stability of the fare structure so as to obviate paying unnecessary risk premiums later on.

Conclusion

In conclusion it may state that the institutional arrangements to be in place at the planning stage where successful in reaching the study to a point where a certain higher than normal level of consensus was reached among the various institutions at different levels and resulted in project the proceeding with the clear understanding of the risks involved at different stages and also the possible allocation of risks.

Annexure - I

Function	Union Government			Maharashtra STATE						Thane Municipality	Municipal Corporation of Greater Bombay	
	Central Railways	Western Railways	Metropolitan Transport Project	MSRTC	Transport Commissionerate	Traffic Police	CIDCO	MMRDA	PWD		Road, Traffic Department	BEST
Urban Plan Formulation							☺	☺		☺	☺	
Development Control							☺	☺		☺	☺	
Urban Transport Plan Formulation							☺	☺		☺	☺	
Urban Transport Policy Coordination							☺	☺		☺	☺	
Land Reservation							☺	☺		☺	☺	
Right of Way Acquisition							☺	☺		☺	☺	
Traffic Management/Engineering						☺				☺	☺	
Traffic Signal Control						☺					☺	
Traffic Regulations					☺	☺						
Traffic Law Enforcement					☺	☺						
Traffic Accident Recording					☺	☺						
Traffic Safety Programme					☺	☺						
Vehicle Licensing					☺	☺						
Bus, Autorickshaw, Taxi, Tariffs					☺							
Bus Franchising Policy					☺							
Autorickshaw Franchising Policy					☺							
Taxi Franchising Policy												
Bus Investment Programme	☺									☺		☺
Bus Operators										☺		☺
Rail Operations	☺	☺										
Rail Tariffs	☺	☺										
Rail Major Projects			☺									

	1	2	3	4	5	6
	Planning	Regulation	Ownership	Financing	Operation	Maintenance
Government of India		⊕	⊕	⊕		
Government of Maharashtra	⊕	⊕	⊕	⊕		
MMRDA	⊕	⊕	⊕	⊕		
MMC	⊕	⊕	⊕	⊕		
BEST					⊕	⊕
Private owner	⊕		⊕	⊕	⊕	⊕
Private operator					⊕	⊕
Maintenance contractor						⊕

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National Urban Transport Policy for a sustainable development: The case of Brazil

Politique Nationale de Transport Urbain pour un développement soutenu: le cas du Brésil

Política Nacional de Transporte Urbano para un desarrollo sostenible: El caso de Brasil

E.A.Vasconcellos
Associação Nacional dos Transportes Públicos, São Paulo, Brazil

Actual public transportation conditions in Brazilian cities are inadequate, considering, service quality, efficiency and reliability. With decreasing investments and service quality, transit patronage has been decreasing, while private transportation use has been increasing, causing congestion, pollution and accidents. The problems were aggravated by the emergence of illegal public transportation by vans. The most important actions to overcome such problems are: the definition of a national policy for urban transport, with objectives, goals and resources, combining efforts from federal, regional and local authorities; the institutional arrangement among land use, transport and traffic policies; the organisation of high quality, regulated and integrated transit networks, under a new regulatory environment; the priority treatment of transit on roadways; the creation of transit alternatives for auto users; the more equitable use of public funds for roadways; the charging of automobile - related externalities; the promotion of new technologies to improve environmental quality.

Les conditions de transport publique au Brésil sont inadéquates par rapport à la qualité du service, son dégré de confiance et son efficacité. Etant donné la baisse des investissements et la perte de qualité du service, la demande pour le transport publique n'a cessé de diminuer; par contre, l'utilisation du transport individuel a augmenté, apportant de graves conséquences par rapport à la securité, la polution et les embouteillages. L'article propose: une politique d' intégration entre l'usage et occupation du sol, le transport et le traffic urbain; une estruturation intégrée des systèmes de transport public de haute qualité et avec des nouvelles régles de tutelle; la priorité aux transports publiques dans la circulation; des offres alternatives aux usagers d' automobiles dans le transport publique; l'usage de forme équitative des ressources publiques destinés à la voirie; l'imposition d'une contribution sur les côuts provoqués par les automobiles; la promotion les nouvelles technologies pour ammélioration des conditions de l'environment.

Las condiciones del transporte público en Brasil son inadecuadas, cuando se considera la calidad del sevicio, la eficiencia y la confiabilidad. Con la reducción en las inversiones y en la calidad del servicio, la demanda del transporte público disminuyó y el uso del transporte individual aumentó, con graves consecuencias para los congestionamientos, la seguridad del tránsito y la contaminación ambiental. El texto propone: la organización de las políticas de la utilización del suelo, transporte y tránsito; la organización de sistemas integrados de transporte público de alta calidad, dentro de un nuevo cuadro de reglamentación; la prioridad al transporte público en la circulación; la creación de alternativas de transporte público para los usuarios de automóviles; el uso más equitativo de los recursos públicos en el sistema vial; la recaudación de los costos causados por el uso de automóviles; la promoción del desarrollo tecnológico para mejorar la calidad ambiental.

1. URBAN AND TRANSPORT DEVELOPMENT IN BRAZIL

The Brazilian national transport system evolved from a large railway system in operation until the 40's to a large highway system that started to be built after WWII. While the former has been dismantled in face of diminishing investments and decreasing levels of service, the latter has been increased and improved, benefiting from road tax that was levied in the 50's (and terminated with the new 1998 federal Constitution). Consequently, bus and truck transportation on highways are responsible for most of the transport-related energy consumption and the diesel oil is the main source of energy.

At the urban scene, in the first decades of the century public transportation in main cities was provided by tramways, specially in important cities such as Rio de Janeiro and São Paulo. Small private bus operators then started to offer public transportation, as complimentary services and became the dominant mode from the WWII on, as long as tramway networks were not expanded to peripheral areas. In the 60s, all tramway systems were dismantled, as part of a political and ideological process that saw them as "old" technologies that caused traffic "congestion". As a consequence, in the 70's all middle and large cities in Brazil had their public transportation based on diesel buses, with few large cities having important railway and subway systems. In parallel, a steady increase in the use of automobiles – largely supported by public actions at all levels - started to change trip modal split, with decreasing use of public transportation modes and increased use of private transportation. Severe problems of congestion, traffic accidents and pollution begun to be experienced by larger cities.

At the institutional side, transportation issues are dealt with by technical agencies - either regional/state (metropolitan areas) or local Departments of Transportation (cities). With public transportation, unlike other Latin American countries, the market in Brazil is regulated, subjected to formal contracts defining routes, vehicles and fares, which demands a permanent relationship between the public and the private sector. Traffic issues are dealt with by state authorities (vehicle and drivers' licensing) and by local authorities (planning, signing and operation), a task division that has been mandated by the new Brazilian Traffic Code (as off January 1998). Beginning with the new Brazilian 1988 Constitution, the Federal government saw the urban transport issue as a local one, therefore reacting against its participation in the financing of even major systems such as railway and subways. A major privatisation program was launched, passing federal urban railway systems to either state authorities or private agents.

2. MAJOR CHALLENGES OF URBAN TRANSPORT

Urban transport in Brazil is facing major challenges related both to its internal deficiencies and to external economic and political factors. The main problem is how to ensure a high quality, sustainable public transportation system considering the uncontrolled urban growth, the persistent poverty of a large part of the population and the increasing use of private transportation. Main challenges are summarised below.

The first is policy uncoordinated actions: most agencies in charge of policies influencing transport conditions act by their own and are loosely tied by hierarchical or legal linkages. The problem is specially severe with respect to land use and its impacts on transport demand, and with respect to the relationship between agencies in charge of public transport and traffic. Urban, transport and traffic policies are seldom coordinated. Most cities have either a transport, a traffic or a roadway department but rarely an urban planning agency. Urban development occurs almost without control, under weak regulations, which leads to longer transport distances and energy inefficiency. At the metropolitan scale the problem is even worse, once state and local powers also conflict on how to manage common issues.

The second is the crisis of the state: the urban transport problem has been aggravated recently by the crisis of the state and the corresponding attempt to either deregulate or privatise transport services. At the institutional side, the state seems to be leaving apart its primary planning role, relying on the supposed capability of the private sector to assume financial risks and planning tasks. There is an implicit assumption that the market and the private sector can replace the state in ensuring adequate transport services. At the economic side, the fiscal crisis hinders the support to efficient public transportation systems and to distributive social policies. Large transport infrastructures, which rely on public investments, are becoming less feasible and subsidies to special groups are subjected to increasing opposition. The crisis is also related to the continued poverty of most of the population, which prevents people from paying public transportation fares. Both problems have sustaining a continuous crisis in the supply of adequate public transportation means and have consequently been supporting transport deregulation and privatisation proposals. However, the attempt to privatise public transportation infrastructure is facing problems, once many prospective private sectors are reluctant on giving their financial support As a consequence, overall public transportation conditions continue to be inadequate. Another financial issue further complicates the problem. Current federal norms, related to the tight control of fiscal deficits, prevent public agencies from borrowing money from the Brazilian Economic Development Bank (BNDES). Therefore, any investment on new public transportation infrastructure with public funds is officially prohibited unless a private agent accepts to borrow the money and to take the risk. As stressed before, few private agents are willing to do this in the case of public transportation investments.

The third is the poor access to public transportation by captive users: the persistent poverty of most people, coupled to an often rigid market approach to the supply of public transportation, generated a permanent conflict among accessibility, fare level and business profitability. Supply is permanently subjected to instability (White, 1990; Figueroa, 1991) and spatial and time coverage are often limited by the need to ensure a profitable operation. Other effect is the tendency to dilapidation of the fleet, with direct impacts on passengers' comfort and safety as well as on the availability of vehicles for daily operation.

The forth is the poor travel conditions for bus users: abusive consumption of street space by automobile users was directly supported by large resources directed to improve traffic overall conditions in the cities (Vasconcellos 1997a). Meanwhile, few effective priority measures were applied to bus operations, once most curbside bus lanes implemented in the 80's had little effect on average speeds (CET, 1982). Even important bus corridors - like the Santo Amaro/9 de Julho convoy system in São Paulo - were progressively abandoned, losing most of the initial benefits. Large resources were applied to increase road capacity for automobiles, while leaving buses to their own fate, struggling for road space. As a consequence, buses remained losing their reliability and patronage.

The fifth is the maintenance of poor transit service quality: railway services are extremely low-quality, with old equipment, unsafe traffic conditions, crowded trains and general unreliability. Bus services , to a lesser extent, are also inadequate: vehicles are a poor adaptation from truck structures, with little internal comfort, high internal noise levels and vibration, high entry steps (preventing many elderly from using the system) and poor information to users.

The sixth is the emergence of illegal public transportation: the deficiencies of bus operation and quality led to the increased use of illegal mini-vans for public transportation, mimicking the normal conditions in other Latin American countries. This shift received immediate support from part of the users, especially those living in the more remote areas, once it charges the same bus fare for a better service. Support also came from a large part of the media and the politicians as well, based on the supposed role of such vans to decrease unemployment. This initial marriage between providers and users now started to face problems, once the same negative consequences observed in other Latin American countries appeared: oversupply of services, leading to decreasing revenue for van operators and consequent lack of funds to provide adequate vehicle maintenance; occurrence of fatal accidents, without legal protection for those harmed; organisation of local "mafias" by some van operators, that preclude new van operators to enter the market; increased pollution and congestion; disrespect for routs and bus stops; increased unemployment of drivers and fare collectors of regular buses; use of illegal infant workers as fare collectors on vans. The problem is extremely serious, not only for its social consequences but also for the decrease in patronage of regular bus services, estimated in 20-30% in the last two years (NTU, 1998), with consequent pressures to increase bus fares.

The seventh is the support to private transportation: private transportation was made accessible to selected sectors - the new middle classes created by the income concentration process which characterised Brazilian economic development. The access was facilitated through bank credit and the organisation of vehicle consortiums, when people belonging to a group pay monthly instalments (up to 50) in order to have a car. The possession and use of the automobile was also facilitated by extremely low license and insurance taxes (about US$ 100 a year), plenty of free parking spaces on streets and often low gasoline prices (currently, about US$ 0.55 a litre).

3. ALTERNATIVE ACTIONS

The current crisis has to be treated by combining several actions pertaining to the three main fields of public policy that mostly interest to urban development in the sense analysed in this paper: urban, transport and traffic policies. The coordination among such policies is the core of the proposals that have been advanced by the ANTP – Brazilian National Public Transportation Association to improve quality of life, equity and efficiency in Brazilian towns, as part of a major project called "Projeto Transporte Humano" (Human Transport Project) (ANTP, 1996). The main proposals of such project are summarised below.

3.1 Organising a National Policy for Urban Transport

Despite the decentralisation objectives of the 1988 Constitution, Brazil needs a national policy for important national issues such as education, health, social security and transport. National policies do not harm democracy or political decentralisation targets and are needed as vital tools to support national broad objectives. Such policies have to work to join federal, regional and local resources, in a coordinated way, respecting the characteristics of each level of power. The main objective of such policy has to be the organisation of urban transport systems that are equitable, efficient and sustainable. Consequently, public transportation has to be seen as a priority, a vital tool to reorganise Brazilian cities. The national policy for urban transport has to define principles, objectives, goals, resources and control tools. It is suggested that goals are defined for the following areas: institutional capability; public transportation quality; traffic quality; traffic safety; energy use; environmental quality. Clear financial resource sources have to be defined, in order to cover the costs of the new transport systems.

3.2 Ensuring institutional coordination between transport and traffic

The overcome of unsustainability tendencies relies on major changes in institutional arrangement. The new Brazilian Traffic Code, issued in January 1998, assigns the responsibility for traffic planning and operation to city authorities. This is an excellent opportunity to organise local agencies that will deal both with traffic and public transportation, therefore overcoming some of the worst barriers to the provision of good public transportation. At the metropolitan level, if a better balance between regional and local power still remains to be reached in formal terms - once mayors still retain their legal powers over most local issues -, the reorganisation of public transport agencies has to be accomplished, through a political decision among mayors and state officials.

3.3 Organising land use vis a vis transport

To combine land use and transport policies is probably the long lasting and more deceiving objective in the field of urban planning. In developing countries, where democracy is fragile at best and profound social and political differences generate large bias in the decision making process, the problem is very serious. Cities should reorganise their agencies, by creating tighter linkages between urban, transportation and traffic policies. They should also create new spaces for interaction between governmental policies and society, around common goals of urban development that will lead to better solutions.

3.4 Organising public transportation networks

The Brazilian experience with bus corridors and service integration should be used to organise large, integrated public transportation systems, combining several technologies. Marketing efforts should be made to promote public transportation as a vital element for city sustainability. Political efforts have to be made to supersede current legal barriers, in order to invest public money in sound, efficient public transportation projects. The current regulatory environment has to be evaluated to be improved, in order to ensure high quality, efficient and sustainable public transportation services. Services by smaller vehicles may be very convenient in several cases and therefore may be treated as a special case to be included in the system whenever considered an important contribution to it. Otherwise, illegal transportation should be enforced and impeded.

3.5 Ensuring priority treatment for public transportation

Road space should be reorganised to ensure effective priority to buses. Considering the average city roadway structure, bus services could run from 20 km/h in dense central areas to 25-28 km/h in bus corridors representing major improvements over current levels. Proper signing, enforcement and operational resources should be used to ensure adequate daily operations, The new system should be monitored by special field personal and a special surveillance electronic system. A new, high quality public information system should be developed. New ways of purchasing and using tickets - specially for integrated trips - should be developed. Accordingly, proper quality indicators should be adopted as a basis to guide action and adopt corrective measures. The quality of daily bus operation should be placed on the highest point on the scale of importance of traffic department.

3.6 Creating alternatives for auto users

The historical support to automobile use and the importance of this technology to middle class economic and social life make the use of alternative public transportation very difficult (Vasconcellos, 1997b). However, many possibilities remain. First, if conventional bus services are reorganised at full efficiency, the lower income strata that shifted to the automobile may change back again. The same can be said of part of middle class young children in their school and leisure trips. Second, if new vehicles are developed, the service will be able to attract much more people. Especially relevant are internal comfort, low floor/low entry and, automatic suspension, in addition to modern communication devices for the users. Third, if high quality special bus services are organised, part of the automobile trips may shift to it. The new services already operating in some cities may be analysed.

3.7 Reassessing road expenditures

A large part of the economic resources that are supposed to lack for using on public transportation has been used in road investments, based on the myth that they correspond to overall public interest. This myth has to be opposed by reassessing investments on transport infrastructure. The questions that should follow any road investment is "who is going to profit" and "how public transportation will benefit"? These investments should be connected to urban planning decisions that enhance the importance of public transportation.

3.8 Charging for the automobile costs

Private transportation use should be reorganised, to minimise or eliminate its negative impacts. Among them, accidents and congestion are prime concerns. Traffic safety should be dealt with through physical, enforcement and educational actions. Road system should be redesigned or adapted at the neighbourhood level to appropriate space in favour of non-motorised and public transportation means, while subjecting the automobile to strict circulating rules. Enforcement should be reorganised by creating civilian police forces especial trained and by changing enforcement logistics towards the most dangerous and socially unacceptable traffic offenses, such as those threatening pedestrians and harming public transportation efficiency. Environmental impacts of automobile use should be strictly controlled, by permanently monitoring actual emission rates on streets.

3.9 Improving the environment

Air pollution problems can be minimised by reducing vehicle emissions, increasing the share of public transportation on total trips and reducing the need for motorised transport. In the first case, the use of electricity, new fuels (GNC) and new technologies for public transportation have to be supported and developed. In addition, periodic vehicle inspections should be organised, both for public and private vehicles. In the other cases, improvements may be made by combining several measures described above.

4. CONCLUSION

Actual public transportation conditions in Brazilian cities may be qualified as inadequate, considering spatial coverage, service quality, efficiency and reliability. With railways, current conditions are dramatically inadequate. In face of decreasing investments and service quality, public transportation patronage has experienced a sharp decrease, while the use of private transportation increased, causing congestion, pollution and accidents. This decrease was recently worsened by the use of mini vans to provide illegal public transportation in large cities, with support from users, the media and the politicians. All these problems combined have jeopardised the public transportation system to such an extreme that challenges its survival as an organised system. Brazilian cities cannot afford the dismantling of their public transportation services, once this would bring enormous social and economic problems, along with general unsustainability.

To overcome such challenges, major efforts have to be made. The most important are the definition of a national policy for urban transport, joining efforts of the federal, regional and local governments, with clear objectives, goals and financial sources; institutional arrangement between transport and traffic policies, both at local and regional levels; the control of land use and occupation and its organisation *vis a vis* transport requirements; the organisation of public transportation networks, with high quality and integrated services, under a new regulatory environment; the priority treatment of public transportation on the available roadways and the fighting against illegal public transportation; the creation of public transportation alternatives for auto users; the reassessment of road expenditures to use public funds in a more equitable way and the charging of the costs automobiles cause to society; finally, the promotion of new technologies and service organisation to decrease the need of motorised transportation and enhance environmental quality.

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Bus-transit innovations: Linking Curitiba, Brazil and Phoenix, Arizona

Les innovations dans le transport par autobus: relier Curitiba, Brésil et Phoenix, Arizona

Innovaciones en transporte masivo en buses: Comparando Curitiba, Brasil, y Fénix, Arizona

K.E. Kruckemeyer
Massachusetts Institute of Technology, Cambridge, Mass., USA

L.A. Nieri
Maricopa County Department of Transportation, Phoenix, Ariz., USA

ABSTRACT: The effectiveness of the bus-transit innovations in the Brazilian city of Curitiba, Paraná, has attracted considerable attention worldwide. In the United States Phoenix, Arizona, has, like Curitiba, grown quickly, but with the automobile as its primary mode of transportation. The authors explore the implications of applying successes from developing countries to glaring needs in the developed world, as well as the lessons that can provide guidance to meeting the extraordinary transportation and environmental challenges in the developing world.

RÉSUMÉ: L'efficacité des innovations dans le domaine des transports par autobus, dans la ville brésilienne de Curitiba en Parana, a suscité un intérêt mondial considérable. Aux Etats-Unis, la ville de Phoenix en Arizona a connu, comme Curitiba, une croissance rapide, mais toutefois avec la voiture comme mode de transport principale. Les auteurs explorent les implications de la mise en pratique des succès réalisés dans les pays en voie de développement afin de satisfaire les besoins pressants des pays développés. De plus, ils dégagent les leçons qui peuvent aider les pays en voie de développement à nelever les extraordinaires défis dans les domaines du transport et de l'environment.

RESUMEN: La efectividad de las innovaciones en materia de transporte masivo en buses en la ciudad brasileña de Curitiba, Paraná, ha atraido considerable atención a nivel mundial. En los Estados Unidos de América, la ciudad de Fénix, Arizona, ha, como Curitiba, crecido rápidamente, pero con el automóvil como principal medio de transporte. Los autores exploran las implicaciones de aplicar éxitos provenientes de paises en desarrollo a las mayúsculas necesidades que hay en los países desarrollados, lo mismo que las lecciones que pueden guiar la solución de las extraordinarias necesidades en materia de transporte y medio ambiente en los países en desarrollo.

1 INTRODUCTION

People around the world are caught in a transportation crisis. Whether for environmental, fiscal or social reasons, the automobile is no longer seen as the solution to this crisis. Transportation planners are looking to public transit to provide mobility and accessibility, and have begun to focus on the interaction between transportation and land use.

In the United States and other more developed nations, many medium sized cities are at a point where contemporary decisions will have an extraordinary impact on how the city will grow and change, and ultimately on the city's economic health and quality of life. While there may be some common perception of the problem, there is little agreement on the appropriate solution.

Cities in developing countries exhibit a wide variety of transportation problems, also in need of solution. In megacities like Mexico City \\it is difficult to change basic directions. Other growing cities, including many in Central America, are poised on the horns of a dilemma. Decisions today regarding public vs. private transport will greatly influence the development of the city and future quality of life. Making no decision will likely guarantee a vicious cycle of auto dependence, urban sprawl and economic distress.

1.1 *Common Questions*

People, planners and politicians all around the world are asking similar questions:

Why is traffic so congested?

Why is bus service so bad?

Is downtown deterioration, or peripheral sprawl, the source of the problem or a symptom of a deeper malaise?

Wouldn't building a rail transit line solve the problem?

If we do, where will the money come from?

Could a bus-transit system like Curitiba's be the answer to our transportation crisis?

1.2 *Possible Directions*

At the heart of the public transport dilemma is the question of mode. While throughout the world most transit riders are being served by bus, there is the widespread belief that bus transportation is insufficient in either quantity or quality to plan a city around. It seems there is hardly a city that is not considering a rail transit line; and European cities especially illustrate the remarkable urban vitality that can come from an urban rail transit system and connecting railroad network. Buses, however, fail to capture the imagination. They have an image problem.

Curitiba is a rare exception. Its bus-transit system is so effective that 75% of the population, both captive and choice riders, use it on a daily basis to get to work. Housing and commercial developers believe sufficiently in the bus system to locate new buildings along it, and bankers provide the financing. This is not just planning--it is a reality.

In the United States, the Federal Transportation Administration is promoting buses through their Bus Rapid Transit (BRT) program. This strategy might not only to save money on individual lines, but make it possible to develop more extensive citywide systems of public transportation.

The authors believe that by borrowing individual characteristics of the innovations that Curitiba has pioneered significant benefits to bus transportation can be achieved. However, creating a successful transit network with buses, one that will shape the development of a city, is likely to be illusive without an in-depth understanding of the complexities of Curitiba's system. There are still many times when rail transit will be an essential component of an integrated transit network.

1.3 *Definitions*

In this paper, Curitiba will be used to refer to the City of Curitiba and metropolitan Curitiba will mean the City and the urbanized portions of 11 surrounding towns. Phoenix will be used to refer to the City of Phoenix itself and Maricopa County will mean the urbanized area of metropolitan Phoenix, including incorporated cities and towns, and unincorporated but urbanizing parts of the county.

2 BACKGROUND

The population statistics of Curitiba and Phoenix bear remarkable similarities. In the 1930's, both of these cities had a population of around 100,000 people. Both were reasonably compact cities primarily served by public transportation.

In 1960, both cities had increased to 400,000 residents within metropolitan populations of approximately one-half million. By 1990, Curitiba's population had reached 1.6 million and Phoenix' 1.2 million, both within metropolitan areas totaling just over 2 million people.

The land use and transportation patterns of these two cities, however, have for many reasons taken quite different paths. In metropolitan Phoenix, public investment in roads and private investment in cars has gone hand in hand with low-density residential development and scattered commercial activity. In Curitiba, a carefully choreographed organization of the bus-transit network and zoning controls has resulted in more concentrated housing and commercial development focused on public transportation.

2.1 *Curitiba, Brazil*

Curitiba is well known for its bus-transit system and the critical role that the city's successful transportation network has played in the development of socially positive and environmentally friendly land use patterns. This network has been created and incrementally improved over the past thirty years, concurrent with the four-fold growth in the city's population.

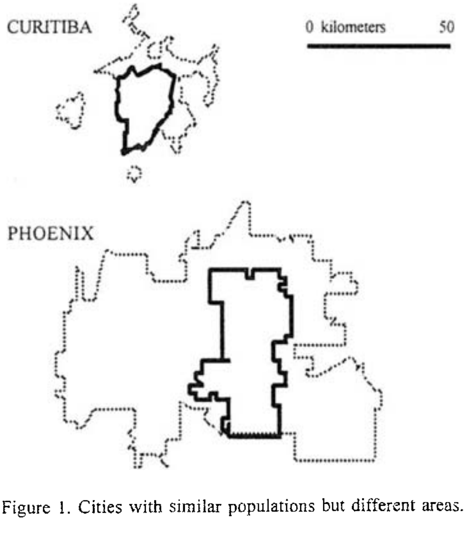

Figure 1. Cities with similar populations but different areas.

A more extensive description of the bus transit system in Curitiba can be found in the writings of Jonas Rabinovitch at the United Nations Development Programme and Robert Cervero at the University of California at Berkeley. Presentations on Curitiba by the authors of this paper will appear in the Proceedings of the American Society of Civil Engineers' March 1999 conference on Urban Public Transportation.

2.2 *Phoenix, Arizona*

Maricopa County (metropolitan Phoenix, Arizona) has also seen an exponential growth in population during this same period. Similar to most of the rest of the United States, this growth has primarily centered around the automobile. Transportation planning, infrastructure investment and commercial development have all assumed that the automobile was both desirable and appropriate.

The limitations of the car: congestion, air pollution, and reduced mobility for a substantial minority of citizens to name a few, were either not perceived or overlooked. The resulting urban sprawl and related traffic congestion has become exceedingly costly and highly inefficient. Current planning is attempting to find effective ways to reverse this trend.

2.3 *Comparisons*

A comparison the demographics of Phoenix and Curitiba illustrates how differently these two cities have developed. It also provides some background when one attempts to evaluate the potential for success of current planning efforts.

Figure 1 shows the plan of the City of Curitiba and the communities that make up its urbanized metropolitan area next to that of Phoenix and the surrounding municipalities and urbanized portions of Maricopa County. While the metropolitan populations, today at around 2 1/2 million, are nearly identical, the densities are quite different.

The density of the City of Curitiba is around 40 people per hectare (one hectare=2.5 acres), and the metropolitan density is 23. Along the transit spines, density is over 100 people per hectare. The City of Phoenix' density is approximately 11, and metropolitan density is in the low single digits. Because it has evolved with the automobile, commercial development in metropolitan Phoenix is much more widely dispersed than in Curitiba, where it has located along the bus-transit spines.

The transportation statistics are widely divergent. Auto ownership in Curitiba is 300 cars per thousand people and nearly double that number in Phoenix. Published figures for mode-split show that 75% of the work trips in Curitiba are made on public transit, while this number in Phoenix is 2%.

One surprising comparison is the personal cost of transportation. While the cost of a transit token in Curitiba in US dollars seems to be a bargain ($0.40 to travel across the city with free transfers) this is the equivalent of $8.00 per day when one takes into account the difference in earning power between cities. With this income, the transit system in Curitiba pays its own way, while the $0.75 fare in Phoenix covers only 30%.of operating costs. But, of course, the cost of a car in Phoenix ($6,000/year to have a car to go to work translates into $24.00/workday) is three times as expensive as taking the transit to work for a Curitibano.

Public expenditure on transportation in Curitiba (to build and maintain bus lanes, platforms, terminals, and a dense road network) is very low compared to Phoenix (which must pay transit capital costs and operating subsidies, and build and maintain an extensive roadway network).

To compare the effectiveness of these two systems it would be illuminating to find some realistic method of measuring transportation time saved or lost in the two cities.

To conclude, however, it is fair to say that people in both cities pay a lot for transportation. What they get is quite different as well.

3 CONTEMPORARY PLANNING IN THE TWO CITIES

Both Curitiba (with some assistance from the state of Paraná) and Phoenix (lead by the efforts of Maricopa County) are actively working to improve the quality of transportation, and to direct the development of the metropolitan area in anticipation of continued growth.

3.1.1 *Challenges in Phoenix*

Maricopa County is preparing for continued rapid growth, and at the same time hoping to correct many contemporary problems. It is currently considering major improvements to its public transportation system and methods of intensifying urban development in an effort to improve the quality of its physical and social environment. A Maricopa County Comprehensive Plan entitled "2020 Eye to the Future" has been developed through an intensive process involving citizens, planners and elected officials.

3.1.2 *A Plan for Metropolitan Phoenix*

The Comprehensive Plan describes a transportation system for Maricopa County that is balanced among modes, is integrated with land use, provides for safe and efficient movement of people and goods, is environmentally sensitive and supportive of economic development.

Maricopa County is served by an extensive system of roadways that carries more than 50 million vehicle miles of travel per day. This travel exceeds the system's capacity in many corridors every day; and travel growth will be far greater than the region's capability to provide additional capacity. Public transportation is seen as a critical component of a balanced transportation system as it provides a transportation choice for choice riders, mobility for the transit dependent, young and elderly riders, and relieves travel pressure in highly congested corridors. Phoenix believes that no region can be considered as world class without an effective public transportation system that is integrated with land use and, the Phoenix region lacks that basic urban necessity.

What role can Maricopa County play in transit in the Phoenix region?

The Comprehensive Plan and the Transportation System Plan adopted by the Board of Supervisors in 1997 provide guidance. Much of unincorporated Maricopa County is urban/suburban in nature and Maricopa County is the logical service provider in those areas. Legislation passed in the 1999 State Legislature would appear to eliminate the Regional Public Transportation Agency (RPTA) when the current transportation excise tax expires, and that begs for a greater County role in serving its constituents. County partners in the cities and towns are looking to Maricopa County to assume a transit role both within selected city corridors and in unincorporated areas at the urban fringe.

3.1.3 *Maricopa County Goals and Objectives*

The transportation element of the Comprehensive Plan contains goals and objectives to help guide transportation decisions. The goal of this element is to provide an efficient, cost effective, integrated, accessible, environmentally, sensitive, and safe countywide multi-modal system that addresses existing and future roadway networks, as well as promotes transit, bikeways, and pedestrian travel.

Within this goal, the following objectives apply:

* Reduce the proportion of trips made in single occupancy vehicles,
* Increase transit ridership,
* Employ applicable technology to improve the use of transportation facilities,
* Identify and accommodate transportation corridors,
* Optimize public investments, and
* Minimize travel times.

3.1.4 *Components of a Comprehensive Transit Program*

The following elements are components of the Phoenix and Maricopa County transit programs:

* Phoenix Rapid Transit System -- At the center of this metropolitan area, The Maricopa Associated Governments and the RPTA have adopted the recommendations of a Major Investment Study to design and build a light rail transit system. This 25-mile Central Phoenix/East Valley LRT Project between Phoenix and Mesa would connect the downtowns of Phoenix and Tempe in its initial phase. A future extension to the northwest would link Phoenix with the Chris-Town Mall and Metrocenter. Seven additional corridors are being studied for future fixed-guideway transit. It is estimated that this project will cost $40 million per mile.

* County Villages -- In an effort to guide rural expansion, and to improve public transportation, Maricopa County is planning for its future space needs and has identified a decentralized service delivery model where employees would serve customer needs at locations remote from the central city in County Villages. These villages would include not only government service offices, but also commercial and other uses in a citizen-oriented environment. Sites for seven villages are being studied. The concentration of public and private services at each village would lend itself well to transit service, both for those employed in the village as well as those using the services.

* Downtown Area Shuttle -- Phoenix Transit and the Downtown Phoenix Partnership have approached MCDOT to renew County sponsorship of the DASH that serves many County offices. MCDOT has expressed interest but only if the partners consider enhancements to the system such as incorporating Intelligent Transportation System features and enhanced bus stops. Maricopa County can demonstrate a commitment to transit and demonstrate its performance by sponsoring DASH and instituting improved customer service and service delivery.

* Express Transit Corridors -- Curitiba, Brazil; Adelaide, Australia; and Ottawa, Canada are all examples of successful express transit corridors that incorporate advanced vehicle technology, intelligent transportation systems, electronic fare payment, integrated land use and public/private partnerships to deliver service superior to the automobile. Maricopa County can demonstrate a commitment to finding creative and innovative solutions to transit through feasibility planning, corridor planning and implementation through legislation or other means as appropriate. The concept is to request the private sector to identity express transit corridors where they could enjoy development incentives and profits in exchange for providing public transportation service.

* Joint Development Feasibility Demonstration Study -- Miami, Florida and Portland, Oregon are two examples where government has negotiated development rights of government land with the private sector in exchange for rent, a percentage of profits and private sector provision of public infrastructure and improvements. In Miami, the private sector developed commercial uses of property adjacent to transit stations in exchange for rent and a percentage of profits. In Portland, the private sector enjoys profits from a 400 acre commercial site near the airport in exchange for interstate improvements and extending light rail transit through the site to the airport that is not currently served by the LRT system. Maricopa County hopes to demonstrate a commitment to finding creative and innovative solutions to transit through feasibility planning of joint development and drafting legislation to put the idea into practice. The concept is to package properties for private sector development in exchange for rents, royalties and public infrastructure and services.

* Rural Transit -- The Rural Transportation Study identifies several corridors where bus service for rural communities and residents can allow those constituents to have greater access to the goods and services in metropolitan Phoenix. MCDOT and Human Services have worked together to pursue funding for the plan through State and Federal sources and will continue to do so.

* Unincorporated Community Transit -- The Board of Supervisors adopted the Transportation System Plan in December 1997. This plan identifies several large unincorporated communities like Sun City, Sun City West, and Sun Lakes where the County could provide transit services to connect those communities with the regional transit system. Maricopa can demonstrate a commitment to transit to serve unserved and underserved suburban constituents living in established master-planned communities.

* Technological Improvements -- Also being proposed for the metropolitan transit system is the incorporation of Intelligent Transportation System technologies. Vehicles would be equipped with automatic vehicle locators that transmit signals to kiosks at bus stops to inform riders when the bus will arrive. Smart card technology would make fare collection more efficient and minimize boarding time and improve service. Innovative approaches to route design and vehicle technology would make the transit system more attractive and efficient.

This comprehensive approach to transit is designed to meet the basic public transportation needs of Maricopa County customers but to do so in a creative and innovative environment. Success in any one component would be a tremendous accomplishment but the overall program is best served by committing to the total package.

3.1.5 *Cost and Funding*

Public transportation is an expensive proposition but at the same time, traditional roads and streets are expensive as well. The 2,800 mile road system that MCDOT maintains is conservatively valued at more than $3 billion. Typical MCDOT roadway construction can be close to $1.5 million per mile with annual operation and maintenance costs of almost $20,000 per mile. Freeway construction can exceed $20 million per mile while freeway-to-freeway interchanges can exceed $100 million. The 25-mile light rail transit (LRT) corridor between central Phoenix and the East Valley is estimated at nearly $1 billion, with 50% of the funding anticipated to be federal sources. Conventional buses exceed $300,000 to purchase.

Funding traditionally has been a combination of federal transit funding, local general fund subsidy and fare collection with an overall fare box recovery of about 25% of service costs. This might be the anticipated funding scenario for the rural transit and unincorporated transit service. However, some transit properties throughout the world enjoy fare box recoveries that exceed 50% and in rare instances, like Curitiba, Brazil, the fare box recovery will pay the full bill. Maricopa County intends to pursue innovative and alternative approaches to reduce public subsidy.

Some approaches that have been successful elsewhere that Phoenix is studying include:

* Public/private partnerships,
* Joint development of government properties,
* Private sector corridor development incentives in exchange for public infrastructure and services,
* Incentives to encourage transit use (could be user incentives, residential or commercial developer incentives, or employer incentives),
* Disincentives to single occupant vehicle use, and
* Collaborations with other service providers.

3.2.1 *Contemporary Challenges in Curitiba*

Curitiba, as well, is feeling new pressure to satisfy the growing demands of the automobile. Following the experience in more developed countries, suburban residential expansion, "big-box" retailing and new shopping centers are creating traffic congestion that may imperil the efficiency of the city's public transportation system.

3.2.2 *Curitiba's Current Planned Interventions and Long Range Strategies*

At IPPUC (the city Planning Agency) and URBS (Urbanization of Curitiba, the bus authority), urban planners, architects and civil engineers are studying new ideas for improving the road system and mass transit. With the predicted continued increase in the population of Curitiba, it is necessary to find alternative solutions to the anticipated increase in automobile circulation in the city.

The city is currently concerned about the air pollution index, the increase in volume of mass transit users, and the lack of space for parking in the downtown. Included in current studies are electric vehicles, buses with diesel/alcohol fuel, a future rail transit line and underground parking.

* Rail-Transit Connection to the Industrial City -- A major new initiative has recently begun to develop a heavy-rail transit line linking the downtown with the peripheral Industrial City. This above-grade line, to be built in partnership with Japanese investors, would focus further concentrated development and include a linear park. Zoning has already been changed to make the land acquisition possible. The first phase of 18 kilometers is expected to cost $370 million.

* Metropolitanization of the Bus-Transit Network -- The long-anticipated process of reducing direct access by metropolitan buses into downtown Curitiba has begun. Bus service in outlying towns is being directed to the ends of the radial system in an effort to strengthen these outlying activity centers and to reduce overall traffic.

* Electric Vehicles -- The city is developing, in collaboration with the new automotive factories in Curitiba, an alternative power system for automobiles: one which doesn't pollute (Most electricity in Brazil is hydroelectric). The current number of privately owned cars in the city of Curitiba is 580,000, which makes the development of electric transportation viable.

* Electric Buses -- This power alternative can also be adapted for electric buses, serving the entire population, thus contributing to the preservation of the environment and the reduction in the number of cars in circulation.

* Parking in Downtown -- The "Ecological Parking" project aims to create parking places surrounding the central area where the citizen can leave a gas-run vehicle and take an electric vehicle. In exchange, the electric vehicle user will the have easy access to all parking lots in the center of the city.

* Underground Parking -- By means of a program which awards public services to private initiative, underground parking will be added to downtown. These parking structures will act as a support for the revitalization projects of the central region. The criteria for location will be a combination of technical feasibility, market, and the capacity of the environmental infrastructure.

4 ANALYSIS

4.1.1 *Do Curitiba's Breakthroughs Apply to Phoenix?*

Will the bus-transit concepts developed in Curitiba be successful in Phoenix? Several appear to be appropriate, and implementation should be straightforward. Others are more difficult. Some may neither be possible, nor appropriate.

4.1.2 *Easily duplicated Characteristics*

The characteristics of the Curitiba transit system that are most easily duplicated are incremental implementation and level boarding.

INCREMENTALISM -- Curitiba's system is the result of an evolution in service organization and technology applied over time. This evolution was an essential characteristic for a system created in a developing city with severe limits on available capital. It should apply to cities in the United States as well where local financial assistance is limited and federal assistance is elusive and time consuming. A strategy of incrementalism that establishes an extensive bus network can lead directly to the implementation of light rail transit. The hazard with starting with light rail is that so many transit dollars are used in a very limited corridor and development of the rest of the system may not be attended to.

BOARDING -- Rapid and convenient boarding is achieved in Curitiba through the use of the stylish boarding tubes on the Express and Direct lines (which have the highest volumes). In Phoenix, this important characteristic can be accomplished with low-floor buses, and by opening all doors to speed ingress and egress (made possible by a proof-of-purchase fare system.)

4.1.3 *More Difficult Challenges*

More difficult, but still reasonably possible for Phoenix will be creating a strong identity for the bus-transit system.

IDENTITY -- Although, worldwide, buses carry many more people that rail transit systems, they lack a positive image. It is said that people cannot rely on buses, and that cities are not shaped by buses. Curitiba has succeeded in giving buses a positive and powerful identity. The express bus spine is clearly defined by the exclusive bus lanes, the circular steel and glass loading platforms and the beautiful red bi-articulated buses. Even more visible are the twenty story towers of dense residential and commercial activity lining the busway. The Identity of the bus transit system in Phoenix can begin with catchy designs of bus and busway, but it won't be complete without the exclusive lanes, and, most importantly, reinforcing land uses.

4.1.4 *The Most Difficult Characteristics*

The characteristics of the Curitiba transit system that are most difficult to apply in Phoenix are frequency of service, exclusive lanes, and coverage.

FREQUENCY -- The short headways of Curitiba's bus system are a natural byproduct of the size of the vehicle and the number of people being served. Headways had become so short on the trunk lines that platooning was required. The bi-articulated bus was developed to avoid problems at intersections by reducing frequency. In the United States, the demand is an order of magnitude less, and the challenge will be to achieve sufficient frequency to attract ridership. This means it is very important to start with small vehicles, and only increase size with ridership. The cost of labor is often used as a reason to use large vehicles, however such a strategy dooms the system to infrequent service and spending too much on vehicles. In addition, the lower labor rates for drivers of small vehicles may make it possible to pay for the additional drivers required.

EXCLUSIVE LANES -- The exclusive lanes in Curitiba are essential to the system's reliability and to its identity. In the United States it is difficult to achieve any reasonable parity with the origin to destination time of the automobile. High speed service, also a product of exclusive lanes, is of even greater importance when one is trying to get people out of their automobile. When there is vehicular congestion, the bus can be seen providing faster service. Providing exclusive lanes when traffic is already congested is difficult politically, however, because car drivers predominate. The bus-transit lanes appear to be making traffic worse for the car, while providing for a service that is only infrequently visible (another reason to use small, more frequent buses). This is less of a problem where the exclusive lanes can be added to rather than subtracted from the roadway.

COVERAGE -- The transit oriented mindset that exists among the citizens of Curitiba would be impossible without the extensive coverage of the system. A feeder bus route is within one-half kilometer of every dwelling. Using the bus network, one can get from home to any destination, and thus the system works for captive and choice riders alike. It will be very hard to duplicate this coverage in Phoenix because of the extreme distances and low densities that spread origins and destinations across the landscape.

4.1.5 *Issues that are Different in Phoenix*

Not all issues have any equivalency between the two cities. It may be inappropriate to attempt to apply one to the other.

SCHEDULE -- With short headways, as in Curitiba, the reliability of the headway is important to the rider, especially the choice rider. In the case of Phoenix, with fewer riders on a line, the headways will necessarily be longer and schedule becomes more important. This is especially true for the linked trips of feeder and mainline service. One opportunity in Phoenix may be to provide a one-seat ride by allowing the feeder buses to continue onto the main line. The authors believe that, to be successful, service along the main line must have a frequency of 5 to 10 minutes with feeder frequencies of 10 to 20 minutes, tightly linked to the main line schedule.

CONCENTRATION OF LAND USE -- At the time Curitiba's bus-transit system was initiated, the city's commerce was centered in a dense downtown. Since that time, commerce and dense residential development has grown along the spines. It is stylish to live in high-rise units. Phoenix, on the other hand, has already grown with scattered commercial development and low-density housing. Low density seems to epitomize the American west. Successful public transportation requires some concentration of uses, and Phoenix hopes to concentrate new development at County Villages served by the proposed busways. It will be necessary to "prime the pump" with publicly sponsored development of these regional service centers before private capital will follow.

4.2 *Lessons that Curitiba might learn from Phoenix*

In spite of its obvious success, the pressures on the transportation network in Curitiba are great. These pressures will likely increase. Curitiba has been able to attract many international manufacturing firms to provide jobs and to help in its economic development. Among these firms are Volvo, Renault, Audi and Chrysler. Will the anticipated prosperity of Curitiba bring about greater auto usage that will quickly doom the bus-transit system through congestion or disuse?

Several of the realities of transportation planning in Phoenix can provide guidance to Curitiba.

ACCOMMODATION OF THE AUTOMOBILE -- The United States if filled with examples of cities that have attempted to become more attractive and strengthen their economy by building streets, highways and parking garages to satisfy the appetite of the car. The car is still hungry and demands more. Curitiba should already know that autos are not a prerequisite to a healthy downtown. Most center-cities in the United States have become less viable because of the car.

CONGESTION -- Some planners hope that in response to clogged roadways people will choose public transportation (although people do seem to have a remarkable tolerance for congestion). This argument may have validity where there is an extensive transit network. It may be more useful to look at Europe rather than to the United States to understand this tradeoff. In Curitiba, the hazard posed by congestion is that it will be a direct impediment to the bus system, a substantial portion of which shares the road with general traffic.

GLOBALIZATION -- Multinational companies are becoming a greater force in Curitiba. Big-box retailing and fast food seem to be a by-product of the car--or is it the other way around? Adapting these forces to a transit-dominant city will prove challenging.

METROPOLITAN EXPANSION -- People who settle at the edge of Phoenix generally do so at quite low density and have a higher than average income. In Curitiba, density at the periphery is greater and income lower. In either case, it is difficult to provide public transportation to serve this growth. A few US cities are learning that metropolitan growth boundaries, one method of achieving greater efficiency in providing public services, may also assist in keeping the city center viable.

RAIL VS. BUS -- Both cities are caught up in the debate regarding the appropriate use of rail technology. When will it become essential to utilize the high carrying capacity of rail? Is there enough money to do so? Is rail transit the essential building block that will efficiently prepare the city for decades of growth and prosperity? There is no agreement on the answers to these questions. The history of Phoenix illustrates that neither a rail nor a bus-transit system is immune to being overwhelmed by the car, especially in a country that subsidizes the auto and suburban expansion so heavily.

4.3 *Predicting Success in Developed and Developing Countries*

Ralph Gakenheimer notes that "Curitiba is a flagship case of the assertion that getting what you want is a matter of clearly knowing what you want."

Mid-sized cities in both the developed and developing worlds are searching for answers to their transportation and land use dilemmas. Many US cities with deteriorating downtowns and/or high levels of traffic congestion are currently thinking that rail transit is the first step towards solving their problems. They may or may not have already come to the conclusion that building more roads will not resolve either of these issues. Moderate-sized developing cities also have severe traffic congestion, and are often caught in the same conflict between private automobiles and public transportation.

The choices made by these cities are likely to be, and should be, different for each individual situation. Social expectations, the natural and built environment, politics and economic realities will all enter into the decision.

The "public will" to put public transport needs ahead of private demands is not the normal or fallback condition. The result of a lack of public action is greater reliance on the auto; This, however, does not mean that the problems of the city will be solved. In fact it ultimately means they will be more difficult to solve.

There are lessons that can be learned from both Curitiba and Phoenix in predicting the success of new interventions in both developed and developing countries. Consider:

* Interaction between transportation and land use,
* Housing and commercial location and density,
* Specific transit strategies,
* Incremental development--coverage and technology,
* Financial realism,
* Timing, and
* Political leadership.

To dwell on two of these, first focus on the financial realities. The cost of both the transportation system and development is a complex interaction of public and private expenditures. Transportation money is spent on capital investment (building roads, laying rails, buying autos) and on operation and maintenance (transit drivers, gas and repairs for the car.) Similar examples can be given for development. These expenditures have a very complex relationship. Governmental expenditures will affect private costs, and vice versa. There is an added complication in developing countries with no natural fuel resources or automobile industry. Nearly all the money spent on automobile transportation goes directly out of the country, while much of the money spent on public transit (in wages) benefits the local economy.

Next, consider the interaction between transportation and land use. Public controls over development will guide the nature of land use as well as the type of transportation that can effectively service that development. Zoning throughout the United States was developed with the expectation that trucks and autos would be capable of providing efficient service. We now know that most zoning establishes land uses that are too dense for the auto, and too sparse for transit. Changes to this well-entrenched system is difficult and may involve both the carrots of encouragement to new transportation systems and land use patterns as well as the stick of discouragement to counter-productive behavior.

5 CONCLUSION

In the eyes of someone from the United States, it is refreshing to see that in Curitiba such a well thought out plan for public transportation has borne fruit; however, there is concern that current planning is giving too much accommodation to the automobile. The worry is that accommodation will never overcome vehicular congestion, and will ultimately lead to the deterioration of public transit and its ultimate displacement as the dominant system.

In the eyes of a Brazilian, it is rewarding to see that in Phoenix so much attention is being paid to bus-transit and land use innovations in a developing country. It would appear, however, that the proposed transit planning in Phoenix is unlikely to have a significant impact unless land use controls and concentrations of intense development are linked with aggressive transportation interventions. Public transportation must either be significantly expanded and supported financially to match current auto subsidies, or the cost of both must be allowed to rise to meet expenses so that this expansion can happen more naturally.

Rail-transit is an important component of an integrated transportation network in large, dense metropolitan regions. In nearly all cities, however, more attention should be paid to the bus as the most important component of a cost-effective and broadly based public transport network. An efficient bus-transit system, and its concomitant land use and societal benefits, can only be achieved through aggressive public policy and action.

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Les politiques des transports nationaux et/ou métropolitains à l'épreuve des politiques municipales de revalorisation ou de requalification des centres historiques – Réflexions générales à partir d'expériences en Amérique Centrale

Silvia Rosales Montano
France

ABSTRACT : The main challenges of planification, management and urban transports are, in the Latin-Americancities, the set up of actions of revaluation and re-qualification of the historical on the non-historical centers. This actions are done often without a commun vision between the technical and decisional skills and this is an obstacle for this same actions.

RÉSUMÉ : Les actions de revalorisation et/ou requalification des centres « historiques » ou pas, des villes centraméricaines sont un des enjeux majeurs des nouvelles formes de planification et gestion des villes et des transports urbains. Mais celles-ci se réalisent dans un contexte de cloisonnement entre compétences techniques et décisionnelles et sans une vision commune et consensuelle de ville souhaitée, faisant souvent des politiques de transports un frein voire un obstacle à la requalification urbaine, plutôt qu'un élément « facilitateur » de cette qualité.

RESUMEN : Las acciones de revalorización de los centros – « históricos » o non - de las ciudades centroamericanas son uno des los grandes desafíos de las nuevas formas de planificación y gestión de las ciudades y de los transportes. Pero estas se realizan en un contexto de separación entre el urbanismo y el transporte, tanto técnico como político y social, en la medida en que no existe una visión común y consensual sobre la ciudad deseada. Así las políticas de transportes son lo mas seguido, un freno u obstáculo para la implementación de políticas de recualificación urbana y muy poco, un elemento "facilitador" de esta calidad.

INTRODUCTION

Dans une optique d'échanges sur les déplacements urbains et l'environnement, une réflexion autour de la planification urbaine des centres – historiques ou pas - se justifie par différentes raisons :

- Les centres (principaux ou secondaires) des villes sont les principaux attracteurs des déplacements quotidiens, concentrant de fait les multiples problèmes environnementaux (bruit, pollution atmosphérique et visuelle, congestion, etc.)
- Ils concentrent tous les problèmes mais aussi des atouts de base pour une planification transversale urbanisme/transports : patrimoine immobilier et activités économiques importantes, déséquilibres dans les usages des sols, occupation privative de l'espace public (ventes ambulantes), sur-desserte en transports collectifs …
- Ils sont aussi des espaces de référence – malgré leur dévalorisation face aux « centres d'affaires » et « centres commerciaux » – où s'expriment et se matérialisent les rapports entre le pouvoir local, les habitants et le passé, mais aussi les logiques économiques tant formelles qu'informelles (entreprises de transport, marchands dans les rues, etc.)
- Ce sont des lieux où subsistent des fonctions de cohésion sociale et qui peuvent servir de passerelle entre des espaces de plus en plus ségrégués socialement et spatialement.
- Les politiques de transports et de déplacements « partent » et « arrivent » des centres des villes : TCSP, hiérarchisation des voies, espaces publics, réorganisation des lignes, etc.
- Les politiques urbaines aussi « partent » et « arrivent » des centres dans une optique d'équilibre urbain, de valorisation des espaces,

de requalification, mais avec une logique transversale.

Cette communication approchera donc la question de la coordination entre planification du développement de la ville et des transports urbains à partir de cet enjeu central des politiques publiques qu'est la reconquête et revalorisation des centres historiques (ou de référence urbaine).

1 LES POLITIQUES URBAINES CONCERNANT LES CENTRES DES VILLES CENTRAMERICAINES

L'intérêt structuré porté sur les centres dits historiques des villes centraméricaines peut être considéré comme relativement récent (environ dix ans), même si les actions de valorisation et d'embellissement peuvent être plus anciennes.

Cet intérêt pour les centres historiques est plus ancien en Amérique Latine (ex. Quito, Mexico). Mais c'est en effet la structuration de cet intérêt et le dépassement d'une vision « architecturale » et « patrimoniale » qui marque les vrais changements. Ainsi, même les politiques de revitalisation et réhabilitation du centre historique de Mexico, qui pourtant sont de nature «supérieure » aux centres des villes centraméricaines, datent seulement d'environ cinq ans. Ces dix dernières années, on a pu constater que les villes – principales ou secondaires - commencent à se doter soit d'« Oficinas del centro historico » (*bureau du centre historique*), soit d'une planification spécifique, sectorialisée (plans de revitalisation, etc.) et transversale, en vue d'interventions plus concrètes, cohérentes, suivies, etc. à différentes échelles.

Cette politique a été dans certains cas très développée. C'est le cas des centres des villes à forte richesse historique et architecturale comme par exemple, Antigua Guatemala. Cette ville historique a bénéficié d'une aide nationale et internationale très importante que bien d'autres villes centraméricaines ayant des centres de « moindre » importance patrimoniale ne pourront pas obtenir. Les raisons ? La notion de « centre historique » tant au niveau local qu'internationale est chargée malgré tout de connotations « patrimoniales » dans le sens architectural... Ce sont donc des objectifs purement de gestion et d'équilibre urbain qui se poseront pour les centres dits non patrimoniaux.

Mais l'évolution – parfois peu perceptible – d'une approche archéologique et muséographique des centres des villes – comme le note J. Monnet[1] - a facilité le développement d'approches plus urbanistiques qui se sont souvent traduites par des politiques de « protection ». Ces approches se confrontent néanmoins à une réalité : la dissociation entre les politiques urbaines et les politiques des transports. Les centres des villes – historiques ou pas – illustrent au quotidien cette rupture et les tentatives de « couture » réalisées. Les planificateurs des transports tant au niveau national qu'au niveau des agglomérations partagent rarement la même vision sur les centres des villes. Ceci n'est pas étonnant car même les habitants de ces villes saisissent difficilement cet intérêt.

Nonobstant, des élus ont engagé – à force de convaincre les différents acteurs de la ville y compris les habitants – différentes politiques autour des centres des villes. Ces politiques sont, même si les objectifs diffèrent parfois entre sites, axées bien évidemment sur une protection du patrimoine architectural mais aussi sur la récupération, revitalisation voire rénovation urbaine, spatiale, économique et sociale.

Dans ces politiques, les transports – fonctionnement en effet et apparaissent souvent comme un des problèmes à résoudre ... et très marginalement – pour ne pas dire jamais – comme un élément pouvant structurer les centres ... sauf lorsqu'il s'agit de centres où les projets en site propres sont envisagés à « court » terme.

1.1 *Les politiques de « récupération » et de « régénération » urbaine des centres historiques – San Salvador (El Salvador) – Panama (Panama)*

Après dix ans de guerre civile et la signature de la paix en 1992, la planification et la gestion des villes salvadoriennes ont été confrontées à de sérieux handicaps.

Face à l'absence de contrôle des activités, des usages des sols, d'investissements et d'entretien, le centre de la ville a été très largement occupé par les activités marchandes informelles et les transports ont

[1] J. Monnet, Centres historiques et centres d'affaires: la centralité urbaine, in. La ville et l'Amérique Latine, Problèmes d'Amérique Latine, juillet-septembre 1994

plus que jamais investi les espaces urbains. Aujourd'hui le centre de San Salvador est le plus grand « pôle d'échanges » entre transports collectifs urbains et interurbains, internationaux, de marchandises, etc.

En 1996, le schéma directeur métropolitain de San Salvador (environ 1 million d'habitants, dont 50% réside dans la commune de San Salvador)) prévoyait de constituer une agglomération métropolitaine polycentrique, avec des unités autonomes.

Pour répondre à cet enjeu, ce plan prévoit la consolidation et/ou régénération des centralités urbaines existantes et le développement d'autres centres. Les centres de San Salvador et de Nueva San Salvador étaient intégrés dans une optique de régénération urbaine.

En 1998, un Plan de récupération du centre historique (12 000 habitants) de San Salvador a été réalisé par le Bureau de la planification de l'Aire métropolitaine de San Salvador (OPAMSS).

Les orientations stratégiques de ce plan, pour cette ville créée en 1525 et ayant subi au moins 18 grands séismes depuis sa création, sont les suivantes :

- Rationaliser le trafic, les transports collectifs, les parkings et les parcmètres
- Relocaliser le commerce informel et moderniser les marchés municipaux
- Augmenter la sécurité citoyenne
- Changer l'image des places, parkings, rues piétonnes et mobilier urbain
- Récupérer les immeubles de valeur historique et culturelle les plus en danger
- Préparer un règlement de zonage et de construction spécifique
- Moderniser les infrastructures des services collectifs (eau, transports, électricité, téléphone, égouts ...)
- Créer de nouvelles sources fiscales
- Réinventer la gestion urbaine

Ces orientations illustrent les problèmes auxquels sont confrontés la plupart des centres des villes centraméricaines, mais démultipliés lorsqu'il s'agit de la ville capitale : occupation des rues par plus de 4 000 vendeurs informels, quasi monofonctionnalité économique de l'usage des sols, sur-convergence des transports collectifs vers le centre, haut niveaux de pollution de tout type, etc.

Si d'importantes actions ont été réalisées dans le cadre de ces objectifs, les transports urbains ont été encore peu touchés. En effet, la Mairie, porteuse de ce plan, ne possède pas la compétence en matière de transports. Les dialogues possibles se situent surtout au niveau des compétences en matière d'espaces publics.

En parallèle, Nueva San Salvador (ou Santa Tecla) – deuxième ville de l'aire métropolitaine – a entamé en 1998 un diagnostic urbain lui permettant d'annoncer des objectifs de récupération et de protection de son centre, sans pour autant disposer de financements directs ou indirects, pouvant lui permettre de faire face aux objectifs. En effet, cette ville, malgré son importance urbaine est considérée comme étant en banqueroute. Le diagnostic et les ébauches d'orientations urbaines ont d'ailleurs été réalisés bénévolement par une ONG d'urbanistes franco-latinoaméricains.

Cette ville – planifiée et construite en 1854 pour permettre de délocaliser la capitale détruite par un séisme au cours de la même année - possède aujourd'hui plus de potentiel urbain que le centre ville de San Salvador. Effectivement, cette ville a moins subi les destructions de multiples séismes, et elle reste très mixte du point de vues des usages des sols, habitée par des classes moyennes, etc. Malgré ceci le centre de Santa Tecla subit constamment les nuisances d'un trafic national et international Est-Ouest (environ 50 000 véh./jour). Ce problème puis l'occupation de l'espace public de cet axe routier par les ventes formelles et informelles (environ 2 000 marchands) sont aujourd'hui les points d'achoppement de la récupération urbaine de ce centre.

Les premières orientations –issues des diagnostics – ébauchés pour « récupérer » ce centre sont :

- Concevoir et créer des structures partenariales, des lois et systèmes d'incitation à la récupération et maintien de la qualité urbaine

- Compléter, structurer et développer toutes les fonctions urbaines et économiques constitutives d'un centre de référence sociale
- Récupérer et valoriser le patrimoine social, urbain et culturel
- Ré-approprier et requalifier l'espace public
- Réorganiser le trafic pour renouer avec la ville « écologique » et de qualité d'un passé récent
- Préserver les équilibres sociaux

Aujourd'hui, à la fin d'un mandat politique qui dure seulement 3 ans, les élus se sont donnés comme priorité de résoudre le problème de la relocalisation des ventes formelles et informelles des rues, problème majeur dans le fonctionnement de la ville.

Dans un autre contexte, le centre historique de Panama – qui ne possède pas pour le moment de véritable plan ou projet urbain – accueille néanmoins même si c'est de manière très marginale, un processus de réhabilitation de son très important patrimoine architectural. Les lignes de transports collectifs ne circulent plus au sein de cette vieille ville, des familles aisées commencent à réhabiliter des anciennes demeures, le siège du pouvoir politique y est installé (mairie, bureaux présidentiels, etc.) mais les problèmes d'accessibilité et les niveaux de pauvreté existants sont très importants. Population majoritairement noire, pauvre, faiblement motorisée, etc. prédominent sur un site en mutation douce.

Ces deux contextes expliquent ce type de politique : des années d'absence du pouvoir et de la gestion dans une ville expliquent une politique de « récupération » et de régénération urbaine.

1.2 . *Les politiques de revitalisation des centres : Granada (Nicaragua)*

Actuellement en cours de réalisation, le Plan de revitalisation du centre historique de Granada (environ 6 000 habitants sur les 90 000 que possède la ville) se donne pour objectifs :

- L'élaboration d'un diagnostic
- La formulation d'une proposition d'aménagement urbain
- L'élaboration de lois et normes urbaines
- L'actualisation du catalogue des immeubles de valeur patrimoniale, architecturale, urbaine et culturelle.
- La définition d'une stratégie générale pour l'exécution des propositions.

Centre très restauré aujourd'hui, il possède des atouts majeurs (touristiques, économiques, etc) au niveau national. Ce qui explique qu'il ait été déclaré patrimoine historique et culturel du pays en 1995. En effet, ce centre possède un certain équilibre urbain : mixité des usages des sols, revalorisation des immeubles, trafic faible, usage important du vélo et de la marche (y compris au niveau de la ville et de son aire rurale), etc.

Si les objectifs urbains sont en cours d'élaboration et d'articulation avec le Plan, l'interface avec les transports revêt une importance majeure dans la mesure où les compétences dans ce secteur viennent d'être transférées de l'Etat aux municipalités. Dans le contexte local, des enjeux en matière de transports apparaissent : sauvegarde et consolidation des modes de déplacements doux face à une tendance à l'augmentation de la motorisation automobile dans le centre, et qui se manifeste – entre autres – par la déformation des trottoirs pour la construction « privée » de rampes d'accès aux maisons, par la segmentation des surfaces habitables pour la construction de garages, par la demande de parkings par les hôtels (cars de tourisme et véhicules particuliers) existants et en construction, etc.

Cette revitalisation recherchée se fait dans un contexte favorable mais avec une très lourd problème : la crise économique locale, la dépendance très forte de Managua, distante seulement de 50 km, pousse à de très fortes modifications dans les modes de vie locaux.

1.3 *Les politiques de "rénovation" des centres : San José (Costa Rica)*

La proposition de Plan directeur pour le développement urbain de San José inclut très spécifiquement un objectif : la « rénovation » du centre.

Face au processus de dépeuplement du centre de San José, et de ce fait à la prédominance des activités tertiaires dans les usages des sols, ce schéma directeur propose :

- De stimuler l'expansion sélective du centre traditionnel d'affaires

- De créer et fortifier des aires commerciales dans d'autres sites de la ville
- De développer les équipements d'importance métropolitaine
- De décongestionner le trafic piétonnier et véhiculaire (déviation du trafic de transit)
- D'améliorer les conditions environnementales et esthétiques de l'air.

Parmi les actions on peut citer l'aménagement et la relocalisation des ventes de rues par la création de petites places commerciales, l'établissement d'un système piétonnier ainsi que d'un nouveau système de transit, de terminus et de parkings.

Un très important investissement en qualité urbaine a été réalisé dans cette ville depuis cette date même si cette proposition de Plan maestro n'a jamais été adoptée officiellement. En effet, les problèmes liés aux activités marchandes de rues se sont très largement résolus ainsi que la conception de certaines rues piétonnières. Une politique très forte de réhabilitation du patrimoine architectural a été réalisée mais avec un processus de rénovation qui ne permet pas d'englober dans la notion de patrimoine, une richesse architectural issue des années 30, 50. Reste quand même le problème majeur sans solution forte pour le moment : la congestion véhiculaire permanente et l'accès sans contrôle dans le centre historique de la ville.

Quelles que soient les politiques urbaines concernant les centres historiques, celles-ci comportent d'importantes orientations et actions en matière de transports collectifs et de gestion du trafic. Elles avancent des projets et des actions concrets permettant de venir à bout – tout au moins dans un secteur de la ville – des nuisances les plus fortes (congestion, pollution, bruit, etc.), mais sans pour autant disposer des compétences et de la maîtrise nécessaires. C'est ce qui constitue leur faiblesse, comme on le verra plus bas.

La dissociation entre urbanisme et transports, qui même dans les pays occidentaux atteint parfois des niveaux insoupçonnés en Amérique Latine, est en effet un problème majeur. Mais il y en a un autre aussi important : l'absence de vision commune (politique, décisionnelle, sociale, technique) sur la ville et ses centres pour les années à venir

2 LES POLITIQUES DE TRANSPORTS URBAINS ET LES CENTRES HISTORIQUES : UNE COHERENCE A RECHERCHER

Une des difficultés majeures concernant les centres historiques est l'absence de prise en considération locale du fait que le système de transports se trouve à la base de la structuration micro-spatiale. La plupart des projets moteurs dans les villes continuent à être pour une très large part des projets routiers. Encore aujourd'hui les principales villes centraméricaines construisent des routes dénivelées, des passerelles, des voies à grande capacité … des politiques de fluidité où la composante sociale – du point de vue du premier acte que constitue la marche – disparaît. C'est dans ce contexte que ces politiques routières peuvent être questionnées au regard des politiques parallèles de revitalisation ou réhabilitation des secteurs des villes.

Quels sont les principaux problèmes posés par les politiques de transports ?

2.1 *Les politiques des transports urbains sont un instrument de pouvoir et de confrontation sur des territoires patrimoniaux*

Les politiques des transports urbains sont dans une très large majorité des villes centraméricaines conçues et mise en œuvre par le gouvernement central, les municipalités gardant pour elles des compétences plus restreintes comme par exemple la gestion de l'espace public.

Récemment, les municipalités nicaraguayennes se sont vues transférer les compétences en transports urbains, sans pour autant avoir bénéficié du transfert des capacités techniques et financières. De ce fait, elles engagent des réflexions sur les transports urbains afin de prendre en considération autant les problèmes de désenclavement des secteurs ruraux et semi-ruraux que l'accessibilité et la protection du centre historique.

Mais avec des compétences en matière de transports ou non, c'est dans ce secteur que se cristallisent le plus ardemment les rapports de pouvoir entre Etat et gouvernements locaux, surtout lorsque les élus et représentants appartiennent à différents partis politiques.

De ce fait, le processus de requalification urbaine est souvent bloqué lorsqu'il est question pour le pouvoir local de demander des marges de manœuvre sur le trafic automobile, la relocalisation des arrêts de bus, etc.

Au Salvador, Costa Rica et Panama, les compétences en matière de planification des transports sont encore centralisées et les politiques municipales de reconquête des centres – par les transports – se font de ce fait difficilement ou très partiellement. Cette centralisation des compétences et le besoin qu'ont les municipalités de maîtriser l'élément clé de la planification urbaine que sont les transports est aujourd'hui un point de négociation et de débat très important.

En effet, les transports cristallisent le plus fort affrontement politique lorsque les gouvernements centraux et locaux ne représentent la même tendance politique. Ainsi toutes les politiques de diminution de capacités de voirie dans les centres, de relocalisation des arrêts de bus et de mobilier urbain, de réorganisation de la circulation interne du centre par la réalisation de contournements, sont difficilement concertées voire sont bloquées, autant politiquement que techniquement.

2.2 *Des hauts techniciens très fortement marqués par une « culture » trafic et non de partage de l'espace public*

Les politiques des transports urbains sont marquées par des orientations très ingénierie du trafic, donc des politiques d'offre de capacité de circulation, de fluidité pour les véhicules particuliers.

Des autoroutes urbaines ou d'autres types de voies rapides (y compris de voies aériennes – « vías a desnivel ») sont construites ou en cours de construction, quand dans les pays européens elles sont parfois en cours de destruction et de réaménagement urbain.

Même les contournements des villes qui sont souvent une politique urbaine en soi pour permettre la requalification urbaine des centres, ne sont pas conçus dans cette logique. Ainsi les contournements qui devraient faciliter l'évacuation du trafic de transit des centres deviennent en soit des voies « supplémentaires » de l'armature de voirie.

L'absence de prise en compte des piétons et des vélos, de l'embellissement des villes comme atout économique et touristique, etc. dans les politiques nationales et métropolitaines – au-delà des centres dits historiques – démontre la prédominance de ce type de technicité et de projets. C'est une fuite en avant : aux « modes de vie motorisés » doit correspondre plus de capacités … même si la congestion, la saturation , la pollution diminue sectoriellement et à très court terme.

2.3 *Des techniciens locaux manquant de formation et de vision transversale pour ébaucher des projets urbains avec une réelle composante transports*

Le travail des techniciens locaux sur les centres historiques a été très longtemps concentré sur un périmètre d'action qui souvent les empêche de se rendre compte que les problèmes de ces centres sont en lien direct avec les alternatives créées dans d'autres secteurs de la ville voire de l'aire métropolitaine. Les limites peuvent se trouver là.

Ainsi s'il y a souvent correspondance entre la localisation des ventes informelles à proximité des axes de transports et des arrêts dans le centre et ailleurs, des solutions se trouvent non seulement dans un contrôle très fort du fonctionnement quotidien des transports collectifs mais aussi dans la recherche de développement ou de recréation des « centres » de quartiers … équilibrant de ce fait « la rentabilité » de la fréquentation du centre.

Face à des projets de contournements, la plupart des techniciens et élus sont souvent incapables de présenter – même en absence de compétences politiques – des projets suffisamment sérieux et fondés sur la réutilisation des voies dégagées dans le centre. Cette absence d'anticipation par des projets rend difficile un dialogue à posteriori sur la hiérarchisation de la voirie qui théoriquement aurait pu bénéficier directement aux centres.

Il ne s'agit même plus, dans ce cas, d'un simple problème de cohérence entre politiques ni de concertation mais du manque de vision globale du rôle moteur que pourrait jouer un centre ville requalifié en matière d'attractivité économique.

2.4 *Manque de concertation et d'innovation et déficit de « projets de ville »*

La plupart des grandes planification des transports sont conçues à partir de scénarios tendanciels. Or, face à la situation actuelle, on prévoit des réponses sans qu'aucun débat soit engagé sur les marges de manœuvre que rendraient possible l'évolution de certains comportements urbains.

Aujourd'hui, les nouvelles formes de dialogue en cours en Europe, avant et après les planifications des transports, conduisent à construire des scénarios différenciés rendant possible un débat politique et la clarification des enjeux et orientations possibles pour les villes de demain. Si dans ces débats les centres historiques n'ont pas un poids fort, ceci s'explique par une vision globale de traitement des centralités à part entière et à tous les niveaux : centre historique, centres des communes, centres de quartiers.

En Amérique Latine, cette entrée "centre historiques" est en train de provoquer un questionnement politique et technique des approches de la ville par une politique réseaux et fluidité. C'est une longue lutte qui commence par apprendre et faire comprendre que la qualité urbaine et l'identification à la ville passe surtout par une approche de partage équilibré des espaces publics ....

Ainsi, peut être que si la plupart des projets transports ne sont pas consultés ni ne font l'objet d'enquêtes publiques, ils peuvent être questionnés auparavant au regard de la « qualité urbaine » réelle qu'ils induisent, qualité urbaine qui va au-delà de la décongestion temporelle et relative des axes sur lesquels les projets urbains se greffent difficilement.

Si dans les années 80 des tentatives d'aménagement des espaces piétonniers se sont heurtées parfois au manque de qualité et de suivi de ce type d'investissements, comme d'intégration dans une politique urbaine et de déplacements d'ensemble, aujourd'hui les politiques sur les « centres historiques » sont en train de pousser – même si cela se fait très marginalement - les responsables des politiques de transports à porter un regard différent sur ces espaces qui concentrent les grands dysfonctionnements urbains.

L'intérêt de la BID pour les centres historiques pourrait aider à aller dans ce sens, mais ne pourra résoudre des problèmes des fonds : traiter les centres des villes et de vie de la même manière, car c'est dans cette globalité que se trouvent les solutions

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The Brazilian SENAT experience in qualifying human resources for the transportation sector

L'expérience de SENAT de Brésil dans qualifier les ressources humaines pour le secteur de transport

La experiencia del instituto SENAT del Brasil en la capacitación de recursos humanos para el sector transporte

J.J.G.de Aragão & M.T. Pantoja
University of Brasília, Brazil

ABSTRACT: In the present contribution the experience of the Brazilian SENAT Institute (National Training Service for the Transportation Sector) is discussed as well its role for improving the efficiency of the Brazilian transportation sector, which is responsible for 6,5% of the Gross National Product. This paper describes the history of the institution, its infrastructure, as well the course program, and gives a brief outlook of its users (both trainees and enterprises). Finally, a short assessment of its successes, failures and problems is given, as a major research is still under way.

RÉSUMÉ: Dans cet document on présent une discussion sur l'expérience et le rôle joués par l'Institut de SENAT de Brésil (le Service National de Entraînement pour le Secteur de Transport) vers l'amélioration de l'efficacité du secteur de transport au Brésil, un secteur qui est responsable par 6,5% du Produit National Brut. Ce article décrit l'histoire de l'institution, son infrastructure, les programmes des cours et présent aussi une perspective assez brève de ses utilisateurs (les stagiares et les entreprises). Magré le fait que la rechercher est toujour en cour, on préset quand même une courte évaluation de ses succès, ses échecs et ses problèmes majeurs.

RESUMEN: En este trabajo se discute la experiencia del instituto brasileño SENAT (Servicio Nacional de Entrenamiento para el Sector Transportes) y su papel para mejorar la eficiencia del sector transportes en Brasil, el cual es responsable por 6,5% del producto bruto interno de ese país. Se describe la historia de la institución, su infraestructura, así como el programa de cursos, y se dá una visión resumida de sus usuarios (tanto de los alumnos como de las empresas). Finalmente, se muestra una corta evaluación de sus éxitos, fracasos y problemas, dado que una investigación más profunda aún está siendo desarrollada.

1. INTRODUCTION

The transportation sector accounts for the moving of all kinds of products, goods and people, generating jobs and income. Thus, it is responsible for the flow of distribution of materials for the industry and agriculture, the provision of internal trade, the flowage of exports and the moving of people. The transportation industry in Brazil – considering just the production of such services, accounts for 6.5% of the GDP and provides employment to around 2.5 million people. About 300 thousand autonomous workers – truck and taxi drivers - are added to the latter (SEST/SENAT, 1993).

Transportation companies in Brazil have started a modernisation process aiming at meeting the new demands of the market and the changes occurred in the legislation in force. The investment in human resources has become an important measure for the survival of organisations under this new reality. A survey by Figueiredo (1999) on criteria of support to decision taking revealed that the development of human resources is considered a significant decision criterion for businessmen in the transportation industry. The survey demonstrates that 34.4% of the interviewees consider the human resources criterion as the first or second criterion of support to decision taking. Personnel enhancement aiming at major agility to meet market issues is understood as human resources management. The sample handed in the mentioned qualitative is quite representative, for the interviewees account for the operation of 12.07% of the urban transportation national fleet.

According to a survey presented on the profile of the industry's workers, carried out by SENSUS (CNT, 1997), there lacks manpower training, and following results can be founded:

- the vast majority of traffic accidents can be attributed to human flaw;
- high level of incidence of sexually transmissible diseases;

- high level of drugs/alcohol use;
- prevalence of traditional managerial practises not compatible with the modern business management reality;
- low educational level of manpower, limiting the incorporation of technology and contributing towards the reduction of productivity;
- low level of awareness and motivation in the sector with respect to the development and implementation of actions geared towards the increase of both quality and productivity;
- Primary stage of the sector as to the utilisation of suitable technological resources in order to ensure the quality of services such as: normalisation, technique, quality certification, measurements of productive processes and the standardisation of processes in the different stages of the production of services;

The survey reveals that workers involved in the operation and maintenance areas have an average of 5 years of education, while managerial levels and those of heads of department present an average of 8 years of education, not including repeating years at school. The verified educational level does not correspond to the need of human resources qualification in that sector, which fact demonstrates the need and urgency of additional efforts in the qualification and enhancing of a large part of this work force.

The starting point for the formulation of a professional qualification action is therefore the knowledge on the population's low educational level, resulting in serious repercussions on the performance of workers. Qualification inserts itself into such a context as one of the educational opportunities capable of bringing benefits to the company as it meets the needs of sustaining its growth, the maintaining of its competitiveness, and the promotion of the worker himself, for it presents itself as an alternative to broaden his knowledge and professional satisfaction, in addition to make possible a significant improvement in the performance of is professional activities.

Goldstein (1991) defined training as a systematic acquisition of attitudes, concepts, knowledge, and skills. This process is subsidised by data gotten from the analysis of task functions, the trainee's capabilities, and the principles of training technology.

Any training technology in an educational context, aimed at the adult worker, brings features that are fundamental to guide the preparing of programmes. The central feature is the conception of knowledge that is to subsidise the process. Considering that the worker to whom this is destined carries knowledge and habits derived from his professional experience, it is necessary to understand knowledge as a network of meanings variously articulated in a permanent movement of construction.

The explicit meaning expresses itself in the symbolisation and generalisation through a process between what is understood and its representation. It is possible to say that learning takes place as its meaning becomes explicit. The learning that attributes itself an explicit meaning shall stimulate the person to live additional experiences from which he shall be able to draw new meanings. Thus, knowledge and skills may generate the enhancing and the building up of convictions, the latter being understood as new forms of acting which express themselves in the professional area and in broader social relations.

In that regard, training actions are prepared and taught with the implicit intention of causing a positive impact on the performance of workers and consequently the companies', co-operating towards the delivering of a service that meets the market's demands.

2. ACTION STRATEGIES

In order to speed up the modernisation process of the transportation companies, especially those in the road sector, one of the most important and effective measures was the establishment of the National Service for Transportation Education – SENAT. This non-profit civil entity was created to execute specific programmes geared towards the learning by the road transportation worker and his dependants. SENAT's potential target-public is about 7,500,000 beneficiaries among workers, autonomous personnel and their dependants.

In order to execute its mission of qualification and enhancing the cultural level of transportation workers, the following system has been assembled:

1) Implantation of the Operational Establishment Network, through the setting up of integrated assistance centres for workers and their dependants with actions of social promotion and professional development. Such a network constitutes itself in two kinds of stations:

- Integrated Assistance and Professional Centres for the Transportation Worker - CAPIT, located at urban regions; and
- Assistance Care Stations for Workers on the Roads - PATE, located at major highways where the flow of workers at the sector is more intense, aiming at providing them with prompt assistance during their work journey.

So far, 33 CAPIT and 39 PATE, spread throughout the different regions in the country, are already under operation. The geographic deployment of these organisms is shown on Figure 1. The size of the investments was limited by SENAT's revenue, which is directly proportional to the number of companies and workers.

2) Implantation of the Transportation Network: this is a national satellite television network with private digital signal and reception points, which are installed in the of-

fices of the road transportation companies and of the federations and unions of the industry, as well as at SENAT's own operational establishments. Presently, 1,509 reception points of the Transportation Network are already set up. The geographic deployment of antennae is shown on Figure 2. The distribution policy of the antennae followed the same criterion of the deployment of operational establishments.

3) Implantation of the Information Network, an on line network linking SENAT's organisational structures (Operational Centres, Regional Councils, Executive Department) as well the National Confederation of Transportation). This system contains informations on administrative service procedures and their management, production data and on managerial reports.

3. ACTIONS FOR PROFESSIONAL DEVELOPMENT

SENAT performs educational and professional development activities through courses, training sessions and seminars, priority being given to the implantation of presential education and distance education programmes. Activities in those two areas are described as follows:

3.1 Presential Education Actions

This programme characterises itself through the development of courses, training sessions and seminars carried out with the physical presence of the instructor and the trainees, establishing a direct interaction in the teaching-learning process. They are taught at the operational establishments, directly in the premises of the companies and at alternative spaces. There are over 90 presential courses; a special mention deserve the following

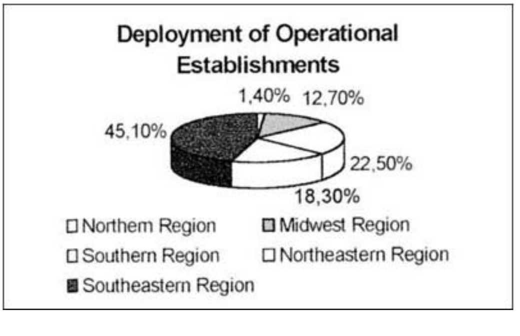

Figure 1. Regional Deployment of Operational Establishments of SENAT

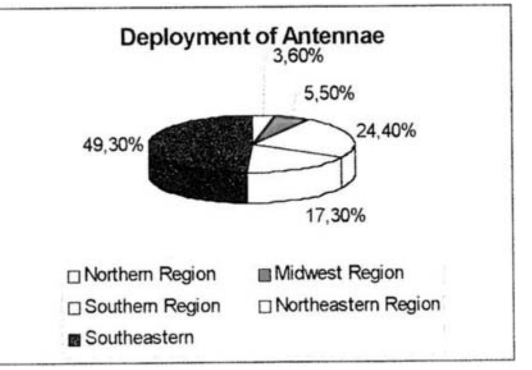

Figure 2. Regional Deployment of Antennae of the Transportation Network

programmes: Further Qualification of Taxi Drivers, Preparation Courses for New Taxi Drivers, the SITPASS Programme (which deals with eletronic bus patronage control), Despatching of Freight Goods and Handling with Hazardous Materials.

In the context of the presential education programme a special Programme for Qualification of Multipliers was created, which has the purpose to enable the companies to develop own professional qualification actions, helping their instructors to adopt the SEST/SENAT educational methodology. The Programme aims to persuade the industry's agents and businessmen of the importance of investing on their own human resources for the improvement of the company's productive performance, and it is supported by the companies and the industrial federations, which develop parallel actions to those of the SEST/SENAT operational establishments.

3.2 Distance Learning

The Distance Learning Project is geared towards a target-public made up of workers/autonomous personnel of the transportation industry and their family members. Its signals are emitted daily to the reception rooms installed in the companies, federations, and unions of the industry and in SENAT's the own establishments (CAPIT and PATE). This project is formed by 3 blocks of programmes:

- Distance Learning Programme /PEAD;
- Supplementary Education Programme (High School)/ PES;
- Social Programmes/PS.

The PEAD Distance Learning Programme has as objective to bring specific professional notions and technical and behavioural skills to the worker, in order to enhance his professional qualifications and to improve his professional performance. This Programme offers three types of courses:

- occupational training courses, which qualifies the trainee for a whole professional occupation;
- courses for further qualification in specific cross-functional themes, which aim to transmit to the trainee knowledge on topics which are relevant for his professional performance, but apply to different sectors of the company;
- courses for further qualification in specific innovative themes, which aim to transmit knowledge necessary for a new occupation or for dealing with a new issue/procedure.

The PEAD Distance Learning Programme has developed its own specific methodology, using television as a supporting tool, which has been recognised as a valuable instrument for the transmission of knowledge, as far it is supported by a whole network of instructors, who are already employees at the own transportation companies, as well by the work of the teams at the SENAT's units.

The training and further qualification courses are based on video programmes, and its contents result from research work executed by experts. These courses include also printed educational material and are monitored by facilitators especially trained for the SENAT programme. There are 70 courses with more than 600 video-classes, with programmes ranging from defensive driving, transportation and handling of HazMat, economic driving, traffic legislation to managerial programmes and foreign languages.

The Programmes for Supplementary Education aim to provide workers with access to basic education in order to fill in educational gaps. This is important for broadening the awareness of citizenship, for enhancing the learning capacity, as well for ensuring the worker's commitment to the company and his respective activities within. For this purpose, the utilised material are the video-classes and the respective educational material produced by the Telecurso 2000 Programme of the Roberto Marinho Foundation (high school supplementary education), which are broadcasted through the Transportation Network.

Finally, the Social Programming includes themes that are part of two main areas, health and leisure, the latter being constituted by issues related to sports, culture, and to a variety of interesting topics concerning the industry. Its priority goal is to inform and educate the target-public in order that it can acquire new knowledge and develop new skills and attitudes as well adopt new habits and incorporate new concepts of life quality.

In addition to such programmes, and because of its vast experience on training and human resources qualification specifically on the transportation sector, the SENAT started to integrate the National Network for Driver Qualification – RENFOR, acting as a Centre of Qualification of Drivers and offering theoretical-technical courses. Therefore, it is entitled to prepare all candidates for driver's license examination (first time or renewal) and to re-educate infractors. It also offers specific courses on dealing with and transporting hazardous material, passengers, students, and on emergency transportation.

4. RESULTS AND EVALUATION

In its two main programmes SENAT trained 1,701,695 employees from 1994 through June 1999, whereby 42.7% of these were trained through presential courses, as shown on Table 1 (SEST/SENAT, 1999).

Table 1 – SENAT's Training Performance (in Thousands)

Pro-gram-me	1994	1995	1996	1997	1998	1999 *	Total
Pre-sen-tial	3,8	52,7	77,0	290,1	247,1	56,3	727,01
Dis-tance	-	102,7	608,4	110,8	89,8	62,7	974,7
Total	3,8	155,5	685,3	401,0	336,9	119	1.701,7

* figures by June 1999

Due to its recent existence, the evaluation of the impact of the programmes with respect to the development of the work performance of the employees are still very incipient. Nevertheless, experimental impact measurements with respect to vehicle driving performance reveal positive results. In 1997, the São Paulo Operational Unit carried out two monitoring studies in different groups of vehicles, aiming at measuring the impact of the training actions on economic driving (IDAQ, 1997). The results are shown below.

Another item for evaluation should be the appraisal of the organisation process, especially of the equity of the spatial distribution of the services (which are to be delivered in the very places where the workers are), of the use of hi-tech for optimising human, physical, and material

Table 2 – Measurement of Impact of Training on the Vehicle Performance

Indicators	Before	After 1st measurement	After 2nd measurement
1st group			
Running time	30,27	28,30	28,43
Engine revolutions	39.155	37.964	36.924
Gear shifting	109	40	39
2nd group			
Running time	28.16	26.49	27.39
Gear shifting	138	49	48

resources; as well of the structure of large-sized programmes which allow gains of scale in the implementation, operation and effectiveness. Such technological options have actually revealed themselves to be quite appropriate, as they meet with the peculiarities of the transportation industry, turning feasible the necessary capillarity of the supply offered by the operational units and the Transportation Network.

As far as the programme's management is concerned, the data generated on the performed actions are consolidated on a daily basis thorough the national replication of data bases, thus allowing the perfect control of the management of actions at national level.

In regard to the programme for multipliers, the large turnover of workers and the large number of companies turn difficult for SENAT to carry out an effective monitoring of the presential programmes developed by instructors at the companies which are qualified by SENAT. In order to not affect the quality benchmarking of the courses taught at SENAT-certified companies, the programme has been restructured, dealing only with the educational qualification for monitors, but without certificating any more the concrete educational actions performed by the instructors of the companies.

There has been also a problem in the education at distance programme: the deployment of the Transportation Network points was not preceded by a mobilisation campaign for the effective use of the channel; in the first moment, there has been a large adhesion by companies, but later, the effective utilisation has been slowing down, as it can be seen by the reduction of the number of calls in the distance learning programmes of the year 1997.

5. FINAL CONSIDERATIONS

The aim of this contribution has been the description of the programmes of the Brazilian SENAT institution in the field of qualification and cultural upgrading of the employees of the transportation industry, identifying their successes and failures, as well pointing out the necessary measures to be taken in order to improve the programmes. Looking at the quantitative outcomes, the results appear to be satisfactory, as the reports reveal that more than 50% of the universe of the employees have been reached by the training actions.

As far as the qualitative aspect is concerned, because of the lack of systematic appraisal, the only results have been produced so far by monitored experiments and testimonies by participants and managers, which tend to give a positive picture. However, there is a clear need for more scientific studies to check the degree of impact of the training actions on the professional performance of the employees. The result of such surveys can be extremely useful as a feedback for an eventual refocusing of programmes.

For this purpose, some preliminary surveys have been carried out on the most demanded training programmes (SEST/SENAT, 1998), which revealed that 85% of the most used courses, both in the presential and distance education modalities, are related to specific areas, and that within this sub-universe, 90% have been training programmes for drivers. Such data lead to the conclusion that investment in full professional training in the industry is still in an embryonic phase.

In face of this, an interesting strategy would be the implantation of a special programme for managers, which would create some awareness for the need and on the usefulness of in house training programmes, thus making possible the extension of training actions both to the operational and decisional levels of the enterprises.

In such a context, it can be concluded that SENAT's main goals during these first 5 years have been fully met despite flaws and problems. At least, SENAT can be recognised to have made a considerable contribution in developing awareness for the importance of investing in human resources as an important mean for the improvement of the efficiency of the companies and consequently of the whole industry.

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Institutional framework for managing urban transport in India

Y.P.Singh
Indian Railways, New Delhi, India

ABSTRACT: The population trends in India indicate continued urbanisation and metropolitanisation in the decades to come. The existing urban transport infrastructure is stretched to limits. There is multiplicity of agencies dealing with urban transport making it no body's baby. The paper has suggested institutional framework at National, State and City levels. The author has proposed to setup Unified Metropolitan Transport Authorities with summary powers to plan, execute, coordinate, operate and maintain urban transport systems.

1.0 INTRODUCTION

1.1 Growth of Population and Urbanisation

India is one of the largest urban systems of the world. The growth of urban population in India has been very rapid during twentieth century, especially in the post independence era after 1947. While the total population of the country has grown by 3.5 times from 1901 to 1991, its urban population has grown approximately 9 times from 25 million to 217 million during the same period. The share of urban population in the total population has risen from 11% in 1901 to 26% in 1991 and is expected to further rise to 37% by 2021. The urban population is estimated to touch 306.9 million by 2001 and 540 million by 2020. A specific feature of India's urbanisation is the increasing metropolitanisation i.e. the growth in the number and size of cities with more than one million population. The concentration of population in million-plus cities is very striking. Their number has increased from one in 1901 to 5 in 1951 and 23 in 1991. This number is expected to be 51 by 2021.

The several factors responsible for rapid urban growth in India include vital impact of higher birth rate and low death rate, inability of agriculture sector to absorb and provide employment to large rural population, expansion of trade and industry and technological revolution among others. The trends indicate continued urbanization and metropolitanisation in the decades to come. The metropolitan concentration shows high levels of migration to large cities from rural areas as well as smaller towns and indicate increasing spatial imbalances in the development and concentration of employment opportunities in urban areas, particularly in bigger cities.

2.0 EXISTING URBAN TRANSPORT SCENARIO

Rapid growth of urbanisation is straining the civic services in the cities and urban transport sector is no exception. Augmentation of the urban transport system has not kept pace with the growth in demand. Due to improved socio-economic levels of urban middle class coupled with liberalisation of the Indian economy, there is a tremendous growth of personalised vehicles in Indian cities. This growth has mainly been abetted by lack of proper mass public transport system in the cities. Increased vehicular traffic on limited and nearly stagnant capacity roads has led to reduction in average journey speeds (as low as 5-10 km/h in central areas), thereby, increased travel times resulting in loss of productive man-hours. The cost of congestion and delays in a Mega city like Delhi may be enormous. Air pollution and accidents are increasing and there is general degradation in the quality of city life. Consequently, efficiency of cities and their economic potential are declining leading to flight of capital from cities like Bangalore. Urban centers are considered `generators of economic growth'. It is estimated that the contribution of urban population of India to the GDP in 55-60% It requires an efficient urban transport infrastructure to provide mobility to labour force and to maximise the contribution of urban areas to the national economy. However, the existing urban transport infrastructure in India is quite weak and is strained to limits by in creased vehicular traffic. Moreover, there is hardly any mass public transport system even in the million-plus cities of India except Mumbai and to some extent in Calcutta and Chennai where Indian Railways are running rail-based urban transport services.

3.0 PRESENT MANAGEMENT OF URBAN TRANSPORT

3.1 Multiplicity of Agencies

The main hurdle in resolving urban transport related problems is the multiplicity of agencies responsible for planning, development, operation and maintenance of urban transport infrastructure. Due to lack of a single agency to oversee and coordinate the planning, development and maintenance of urban transport, this subject has become an institutional orphan as none of the agencies takes it up with utmost sincerity. So far, rail-based urban transport systems have been planned, developed and are being operated and maintained by the Indian Railways (IR). The largest suburban rail transport system of Mumbai (Bombay) carries 6 million passengers daily over Western and Central Railway systems. The only underground metro railway system of India was also developed by the IR in Calcutta. The IR are running suburban trains in metropolitan towns of New Delhi and Chennai apart from Calcutta and Mumbai. However, whenever there is a demand to construct and develop further suburban routes in metropolitan cities, the IR develops cold feet because it is a loss-making preposition and moreover the IR gives much more attention to long distance passenger and freight traffic, which are its bread and butter. The subject of 'Urban transport' has been transferred to the Ministry of Urban Development vide Allocation of Business rules, 1986. The Ministry of Urban Development (MUD) has no expertise either in rail or road based urban transport. There are no professionals with this Ministry. The subject is looked after normally by officers of Indian Administrative service (IAS) who have no professional expertise in rail/road transportation.

The State Road Transport Corporations (SRTCs) operate inter-city bus services. Only in some of the cities, SRTCs are operating few city buses in the name of urban public transport like New Delhi. In some other cities, such buses are run by municipalities. There are various private bus operators running such public transport in cities along with skeletal urban transport run by the State Governments and municipalities. The traffic is controlled by Police with or without the help of signaling. The road network in cities is developed and maintained in some cases by the Central or the State Public Works Department or the municipal corporation in others. Land use planning is done by the local Metropolitan Development Authority. Licensing of motor vehicles is done by State Transport Authority while that of non motorised vehicles by the municipalities. Then, there are Cantonment Boards and in some metropolitan areas, there are more than one municipalities. In most of the cases, there is no coordination between these various agencies and they work in isolation, the result of which is always a badly managed, urban transport.

At the level of State Government, there is hardly any State having an independent secretariat for urban transport. This subject is tagged to different departments in different States. In some states, it is included in Deptt. of Transport while in the Deptt of Urban Development or Deptt of Planning and Development or even Deptt of Environment in others.

3.2 Urban Transport is a Secondary Responsibility

As mentioned above, there is a multiplicity of agencies concerning urban transport. At central level, Ministry of Railways (MOR) give lower priority to suburban transport, firstly, because the subject has been transferred to Ministry of urban development and secondly, it is a loss making proposition. Only under political compulsions, the MOR is forced to give due attention to operation and maintenance of its existing suburban services. In fact, the MOR is not at fault as it is starved of funds and experiencing financial crunch for wiping out huge backlogs of track renewals and shortage of wagons and coaches. It is only natural that the MOR gives higher priority to long distance passenger and freight traffic due to which it earns a surplus, again, to be reinvested in construction of main lines and renewals of assets.

The Ministry of Surface Transport (MOST) is responsible for National/State Highways passing through cities and it hardly coordinates with the municipal corporation for urban transport problems. The police is more concerned with law and order. The traffic police who manages important signaling on road junctions is a neglected part of the police. The Transport Department of a state is normally engaged in issue of driving and vehicle licenses rather than planning and development of urban Transport infrastructure.

Similarly, primary responsibilities of municipalities is to provide civic services like water supply, sanitation and electricity etc. They don't think of planning and development of urban transport infra structure, at all. Thus, there is nothing wrong in saying that urban transport is an institutional orphan and is nobody's baby.

3.3. Lack of Trained Professionals

Only the MOR and the MOST have trained professionals in the field of railways and roads respectively. The MUD entrusted with the subject of urban transport has no professionals either in rail or road based transport. The state of affairs is the same in the states and in various Municipal Corporations. Only isolated efforts have been made to engage trained urban transport planners or engineers in some cities. Even these planners have felt disgusted as they are not 'heard' by the bureaucracy and they have no promotional prospects.

4.0 INSTITUTIONAL MECHANISMS FOR MANAGEMENT OF URBAN TRANSPORT

4.1 National Level Institutions

At the National level, the MUD has been designated as the nodal Ministry for Urban Transport. The MUD has to discharge its responsibilities of policy formulation and planning, preparation of programs and projects, funding and monitoring etc. An Urban Transport Wing to be headed by a Joint Secretary level Officer having professional experience should be created. The level may be upgraded to Additional Secretary in future. The Wing should have an independent Director/Deputy Secretary alongwith two transport planners and one Transport economist to start with. All these officers should be professionals and the Director and the Joint Secretary should be Engineers/professionals in rail /road based transport taken on deputation from the MOR and MOST including National Highway Authority of India and Public Works Departments. At present, these posts have been filled up with IAS Officers who are not transport professionals by any count. Moreover, they are looking after many other responsibilities in addition to Urban Transport.

In long term, a National Urban Transport Commission/Board (NUTC/NUTB) as recommended by the National Commission on Urbanisation (1989) or a separate Development of Urban Transport may be created.

However, it is advisable that the MUD should not, in any way, enter into the field of execution of urban transport projects either directly or through its undertakings as has been done in case of Delhi Metro project, which is being carried out by Delhi Metro Rail Corpn. Ltd. a joint venture of MUD and Goverment of Delhi because it will lead to proliferation of agencies and multiply the problems of coordination. This is advised in view of the fact that the MUD will never have the bank of professional expertise as available with the MOR and MOST or their various agencies nor it is supposed to possess as it will only proliferate the Govt. staff already in large number. Once, a particular rail or road based urban transport project is finalised or sanctioned by the MUD, it should ask the MOR or MOST to execute the project and monitor that upto completion until UMTAs are in place which can get the projects executed through competitive tendering.

4.2 State Level Institutions:

The States having million-plus cities should set up Directorates of urban transport under their Departments of Urban Development or Transport or any other department handling Urban Transport. The Directorate of Urban Transport should be headed by an appropriate level (Chief Engineer or Deputy Chief Engineer) of Engineering / transportation professional and assisted by one or two transport planner(s) and one transport economist with supporting staff. These directorates may be strengthened further depending upon work load and increase in number of million plus cities. Whenever, there is a separate Secretary for Urban Transport in a State, he/she should be an engineering/transportation professional and may be taken on deputation from the MOR/MOST or State PWDs. There is no need for proliferation of the Directorate into various Divisions like planning, finance, management, legal, technical or information systems etc. to start with. This may be done as per need in long term. In India, there is a tendency for proliferation, which ultimately leads to overstaffing everywhere. Larger number of staff leads to reduced promotional prospects, increased unionism and procedural delays.

As at National level, State Urban Transport Board or separate Department of Urban transport may be set up depending upon the work load.

4.3 City Level Institutions

In all Metropolitan cities, Unified Metropolitan Transport Authorities (UMTAs) should be set up under an enabling UMTA act to be legislated by the State Governments or by the Central Government on the request of the State Government.

The Government of National Capital Territory of Delhi have drafted a Delhi UMTA bill which is under consideration. The UMTAs will plan and coordinate various modes of urban transport in the concerned cities, operate and maintain various urban transport systems, monitor the projects and evolve integrated fare structures including common ticketing for various modes of urban transport. The rail-based transport systems consisting of suburban rail, metro rail, intra-city transport may be delinked from the Railways and attached to the UMTA. Similarly, the operation and maintenance of bus transit within metropolitan limits may be brought under overall operation and coordination of the UMTAs.

The role of the Unified Metropolitan Transport Authorities should include:

(a) estimation of the traffic demand
(b) liaison with educational institutions, industrial and business establishments and Government offices regarding staggering of working hours etc.
(c) integrated planning of transport supply,
(d) coordination of time tables and allocation of the routes
(e) planning of inter-modal transfers
(f) determination of fare structure, and
(g) collection and sharing of revenues among various partners.

It should also monitor the execution of urban transportation system projects. The UMTAs should work under the Ministry of Transport/Urban Development of the state as the case may be. It has been suggested by some quarters that such Authority should have Chief Minister of the state as Chairperson along with various other ministers and bureaucrats as members, while one of the studies for Delhi Unified Metropolitan Transport Authority (DUMTA) under consideration in the MUD has proposed the Lieutenant Governor of Delhi as ex-officio Chairperson along with the Minister of Transport as Vice-Chairperson and a Member of Parliament, a Member of Legislative Assembly and a horde of other bureaucrats either as ex-officio or whole time members totaling to 18 members. It has further suggested an Advisory Council of 23 members, again, most of them all bureaucrats working in various departments, ministries, government institutions including some representatives of user groups and operator associations. The suggested framework will hardly work because none of either the political leaders or the bureaucrats would find time for serious discussion at the meetings. The UTMA should not have more than 10 members as more the number, difficult it would be to arrive at a fruitful decision. The UTMAs should have a permanent board of directors solely devoted to its cause. They should be selected from a wide field of professionals from private/government organisations. This has to borne in mind that urban transport planning is not to be done in isolation but it has to be a part of overall urban development. Full powers should be given to the UMTAs otherwise they will remain sick like any other State Transport Corporation. Till UMTAs are in place, Traffic and Transportation Cells (TTCs) should be created in the Municipal Corporations of the Metropolitan cities to carry out regular collection and analysis of traffic data so as to plan, design and develop urban transportation systems. These TTCs should be placed under the control of UMTAs after they are created.

5.0 CONCLUSIONS

The trends indicate increasing urbanisation and metropolitanisation of India. There is lack of proper institutional mechanism at the National, State and city levels. At the National level an Urban Transport Wing to be headed by Engineering/Transport professional of Joint Secretary level should be created. At the State level, Directorate of Urban Transport should be set up under the Department of Urban Development or Transport as the case may be, staffed with engineering and transport professionals. At the city level, Unified Metropolitan Transport Authorities (UMTAs) having summary powers should be set up. The execution of rail or road based urban transportation projects should however, be executed by the Ministry of Railways and Ministry of Surface Transport respectively on the request of the Ministry of Urban Development after finalisation of the project proposals until UMTA takes over the transport network in a particular metropolitan city.

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Evolutions of Prague and Ho Chi Minh Ville

Transports publics et transition vers le marché: evolutions comparées des trajectoires Tcheques et Vietnamiennes

M. Mathias Schmitt

Laboratoire d'Economie des Transports (LET-ENTPE), Lyon, France & CEntre Français de REcherche en Sciences Sociales (CEFRES), Prague, Czech Republic & Boursier Lavoisier, Ministère des Affaires Etrangères Français, France

ABSTRACT : The issue of urban services delegation is not a new one but is still an up to date topic, specifically for post-communist countries, where urban services used to be considered as « quasi rights ». The almost free of charge mass transit has become a consumer good and leads to changes of mobility and modal choice. Considering the consequences of this changes for urban environment, one can guess the importance of urban transport policy for « transitional cities ».

On the main question of urban transport systems convergence, we come to the notion of « limited convergence » of post-communist countries whom path to market economy is determined both by an « international leading pattern » and by the come back and affirmation of regional influences.

RESUME : La question de la délégation des services urbains n'est pas nouvelle, mais elle s'avère particulièrement intéressante dans les pays post-communistes, où la plupart des services collectifs étaient comparables à un droit dans l'ancien système. Le transport public presque gratuit est devenu un bien marchand et donne lieu à de nouveaux choix modaux. A travers les conséquences de ce choix pour l'environnement on mesure l'importance de la politique des transports urbain pour les « villes en transition ».

La question centrale qui apparait est de savoir si les nouveaux systèmes de transports publics de ces pays convergent vers un modèle d'organisation et un niveau d'offre moyen. Nous aboutissons finalement à la notion de "convergence limitée" des pays post-communistes qui adhèrent pour partie à « un modèle dominant » et réintègrent par ailleurs leurs aires d'influence géopolitiques.

INTRODUCTION : DEUX FORMES DE LIBERALISATION DES TRANSPORTS PUBLICS A PRAGUE ET HCMV

Les transformations qui touchent actuellement le secteur des transports publics de Hô Chi Minh Ville et Prague auront des conséquences considérables sur les conditions du développement de ces villes. L'explosion de la motorisation à HCMV pose avec urgence la question d'une amélioration du réseau de transports publics. A Prague cette même motorisation représente un défi quotidien pour des transports collectifs de surface dont les performances s'amenuisent à mesure que la congestion augmente. Dans les deux cas une politique publique locale de transport est affichée mais pas ou peu mise en œuvre, alors que tout le secteur se restructure. Les nouveaux modes de gestion efficaces intégreront ils la dimension du développement durable auquel participent les transports publics. Le coût de la transition sur le fonctionnement urbain est dores et déjà considérable pour la collectivité, que l'on se situe du point de vue du temps perdu, des accidents ou de la pollution atmosphérique.

Alors qu'une description de l'état des lieux nous conduit évidemment à constater l'éloignement des contextes de Prague et Hô Chi Minh Ville dans ce que nous convenons de dénommer transition post-communiste, une analyse plus fine de la nouvelle organisation de l'activité présente de nombreux points de rapprochement possibles.

1. *Deux transitions vers l'économie de marché dans deux civilisations différentes*

Les contextes très éloignés des deux régions rend caduque toute comparaison quantifiée.

A Hô Chi Minh Ville, ville d'Asie du Sud Est essentiellement caractérisée par son organisation mixte, par une morphologie horizontale hormis au centre ville, par une trame viaire largement constituée de ruelles dans les quartiers et par l'importance de la petite entreprise familiale et donc du transport individuel deux roues, le transport public a été fortement développé pendant la période coloniale. Dés la fin des années 50 son caractère exogène et son inadaptation au mode de vie commun, mais aussi l'instabilité politique qui régnait alors ont contribué au démantèlement progressif du réseau de transports collectifs, à commencer par son segment le plus lourd, le tramway.

Dans les deux décennies qui suivent, le niveau de service dépend essentiellement des importations de matériel étranger, à la faveur de la présence américaine notamment. Cette contrainte technologique est symptomatique d'une situation déterminée par la pauvreté des ressources du pays pendant cette période. La libération de Saigon renommée Hô Chi Minh Ville en avril 1975 provoque une rupture et désorganise largement les institutions locales. Malgré l'adoption des principes du socialisme (d'organisation centralisée, de production par une entreprise d'Etat et de contrôle de la mobilité via, par exemple, la prise en charge du transport des salariés par les entreprises), les difficultés économiques entraînent rapidement une nouvelle réduction de l'offre des transports collectifs.

Au Viêt-nam donc, sous développement, organisation urbaine et adoption à la fois courte et brutale du socialisme se conjuguent pour laisser s'amenuiser dans une spirale descendante offre et demande de transports collectifs. En 1986, le Doi Moi, littéralement « New Deal » vietnamien, entraîne en matière de transports urbains un phénomène de transition paradoxal, désigné par certains par le terme de « double transition », dans laquelle l'augmentation rapide de la richesse s'accompagne d'un discours autoritaire et du maintien de la bureaucratie hérité du communisme et de la tradition mandarinale.

A Prague au contraire, nous nous trouvons à une extrémité culturelle opposée, où se sont conjugués une tradition germanique favorable aux transports publics et une politique autoritaire de planification socialiste des transports urbains, avec une tradition d'organisation industrielle forte et un niveau de développement élevé (6ème puissance mondiale entre les deux guerres). Dans cette ville, au moment de la révolution de velours (1989) le partage modal est très largement en faveur des transports publics, comme dans tous les pays d'Europe Centrale et Orientale, ainsi que dans les pays de l'Europe balkanique. On peut néanmoins observer que dans l'ensemble des ces pays, comme dans les pays occidentaux, l'augmentation du revenu à des conséquences sur la motorisation ; aussi les pays les plus riches de l'ancien bloc socialiste présentent ils les taux de motorisation individuelle les plus élevés, en croissance dans les années 80.

Alors qu'une transition apparemment radicale - et en réalité très pragmatique - est promue par le premier Ministre de l'époque V. Klaus, sur les conseils d'économistes tels que D. Friedman (fils du fameux monétariste), et consiste à appliquer les préceptes libéraux de privatisation, décentralisation et désengagement maximum de l'Etat, au Viêt-nam le modèle chinois du socialisme de marché accouche d'une synthèse originale dans laquelle se conjuguent maintient de l'autorité du Parti, organisation bureaucratique et développement de l'initiative individuelle.

Enfin, alors qu'une certaine anomie semble frapper la société Tchèque qui par ailleurs figure au premier rang des « pays en transition » en matière de revenu par habitant, mais aussi de réinsertion internationale (première adhésion à l'OCDE, entrée à l'OTAN et pressenti en priorité pour entrer à l'UE) mais subit comme toute l'Europe Centrale une récession économique durable, le Viêt-nam du sud en particulier, se jette dans l'expérience du marché avec une aisance liée à la tradition de l'entrepreunariat familial. Dans ce pays, la tension apparaît plutôt dans l'effort de « rerégulation » que les autorités souhaitent exercer. C'est donc au pays de l'oncle Hô que le libéralisme le plus abouti s'affiche, davantage qu'en République Tchèque où les grands conglomérats industriels et les entreprises d'Etat ont du mal à se restructurer et où l'opinion publique réagit lorsqu'elle se sent menacée par des mesures d'austérité jugées trop libérale.

En tous cas dans les deux villes, l'explosion de la motorisation place les autorités devant l'urgence d'une gestion des transports urbains pour assurer les conditions d'un développement durable de leur ville.

2. Des transformations parallèles dans le secteur des transports collectifs

D'une part donc, la recherche de plus de libéralisme et un apprentissage comportemental laborieux, de l'autre la recherche de dispositifs de contrôle pour mettre en œuvre une véritable politique urbaine qui

devient urgente face au développement de la motorisation. Nous sommes bien en présence de deux pays dont l'expérience socialiste contrastée dans deux aires géographiques très différentes donne lieu à une transition dont les trajectoires sont apparemment divergentes.
Pourtant les transformations institutionnelles qui constituent une première étape de cristallisation de nouvelles références et valeurs et qui conditionneront par la suite les principales décisions publiques sont très proches dans les deux villes étudiées. Il y a identité dans le changement au niveau des cadres organisationnels issus du socialisme et des orientations prises.

Les cadres issus du socialisme

L'organisation classique socialiste est pyramidale et ne peut concevoir de contradiction en son sein : chaque partie est un rouage dans la mécanique d'ensemble dont la direction est assurée par le parti dans le système du centralisme démocratique.
Dans ce schéma le transport public urbain est géré par le Ministère des Transports, déconcentré en partie dans les villes. Notons qu'à Prague comme à HCMV il n'y a pas a proprement parler d'entité administrative urbaine. La ville est comprise dans l'équivalent du département et divisée en arrondissement mais ne présente pas de réalité intermédiaire. A Prague comme à HCMV, deux entreprises d'Etat assurait l'ensemble des services de transports collectifs urbains, articulés en périphérie avec les services de transports interurbains.

Les orientations prises

- les pouvoirs locaux se développent dans les deux pays, mais avec difficulté,
- la collectivité interpose une autorité du transport entre elle et les opérateurs,
- l'état se désengage complètement du transport urbain, alors qu'il s'occupait de tous les aspects de la vie sociale, dans une organisation pyramidale,
- les entreprises publiques donnant naissance à des sociétés privées et apparaissent à côté d'elles d'autres opérateurs,
- enfin, les media se saisissent du problème des transports urbains, informent, relaient l'opinion et/ou les autorités pour initier un débat qui fait intervenir la société civile : une des tâches principale de la nouvelle autorité est de gérer les plaintes des usagers, liées à la dégradation de la situation ou à des mesures impopulaires.
- les diverses formes d'assistances et de conseil jouent un rôle important dans la recomposition du secteur.

1 DE L'ORGANISATION MONOLITHYQUE A LA DILLUTION DE LA PUISSANCE PUBLIQUE

Un mouvement général de dilution du pouvoir caractérise les systèmes des pays en transition. Cette dilution présente des conséquences pour les transports collectifs.

1.1 privatisation et décentralisation

La décentralisation procède du phénomène de privatisation au sens large d'un transfert du pouvoir et de l'exercice des droits de propriété de l'Etat vers l'ensemble des autres personnes, morales ou privées, du pays. Les collectivités locales se retrouvent donc acteurs dans le nouveau jeu. Globalement la question des transports urbains, dont la zone d'action doit être l'agglomération, se heurte au difficultés de mise en place de l'intercommunalité, pour définir un périmètre de compétence institutionnel nécessitant la coopération de plusieurs communes ou parties de communes. Par ailleurs les capitales et grandes villes buttent sur le problème de l'intégration modale et tarifaire, face à une urbanisation et à des pratiques de mobilité quotidienne qui rendent complexe la définition d'un périmètre de transports pertinent.
Pour pallier ces nouveaux besoins en périphérie, un nouveau segment d'offre de transports publics se développe, pris en charge par de petits entrepreneurs, généralement dotés d'un outil de production vétuste (anciens autobus CSAD à Prague, vieux tricycles lambrettas à Hô Chi Ming Ville).
Alors que le système communiste entraîna une homogénéisation de l'espace (pas de marché foncier) et une logique de production basée sur l'offre, le capitalisme produit une hétérogénéisation et appuie sa production sur la connaissance de la demande et la maîtrise des coûts. Dans le premier cas la polarisation spatiale est limitée, dans le second elle se développe autour des centres urbains. L'hétérogénéité caractérise aussi les modes de vie et donc les besoins, qui sont au contraire préétablis dans le système communiste (certains auteurs parlent de dictature sur les besoins). Tous ces changements provoquent une transformation de l'offre de transports et de son organisation :
en périphérie règnent la concurrence et les petites entreprises récentes, pour l'exploitation de lignes à faible rentabilité, puisque les distances sont longues et les densités de population faibles.
au centre de la ville, les enjeux se concentrent et « les places sont chères ». Ceux qui bénéficient des acquis du socialisme les conservent : les entreprises d'Etat se restructurent, mais conservent et renforcent même une position de force, du fait de leur maîtrise technique et capitalistique du secteur.

1.2 multiplication des acteurs et questions de contractualisation

La privatisation donne lieu à une segmentation du marché. Sur chaque segment, on rencontre au moins un opérateur, et au fur et à mesure qu'on s'éloigne du service de type communiste (modes de transports lourds, centralisés et centraux), la concurrence est plus forte car les exigences de la collectivité plus faibles.

<u>les nouvelles autorités du transport</u>

Dans tous les cas, un besoin de coordination, de contractualisation et de contrôle se fait ressentir et donne naissance à une nouvelle institution chargée à la fois d'une tâche technique de planification et d'une fonction politique de négociation dans un système non plus unilatéral descendant, mais multilatéral, à la fois vertical et horizontal. Cette nouvelle institution ne dispose pas d'une réelle autonomie financière et reste largement organisée autour de la ville centre, qui la finance exclusivement ou quasi exclusivement. Qu'il s'agisse du Centre de Gestion des Transports Publics à HCMV (septembre 1996) ou de ROPID à Prague (décembre 1993), le problème majeur, même si les causes en sont différentes, concerne la différenciation des opérateurs et le périmètre des transports urbains qui nécessite une médiation complexe avec plusieurs types d'acteurs et la rédaction de contrats commerciaux inédits, liés à la délégation de service public. Aux actifs spécifiques de l'intégration verticale hiérarchique socialiste se substituent les coûts de transaction d'une organisation différenciée mixte dans laquelle se mêlent hiérarchie, contrat et marché comme modes de coordination.
A HCMV, le CGTP correspond à un service de la Direction des Transports et Travaux Publics, service du Comité Populaire de Province (niveau déconcentré de l'Etat), qui a été externalisé. Au contraire à Prague, ROPID s'est constitué à partir du Département de planification de Dopravni Podnik, ancienne entreprise publique privatisée en 1992. Cette origine institutionnelle différente s'explique par les répartitions respectives des pouvoirs dans chacune des structures d'organisation précédente.
Dans les deux cas les compétences correspondent à des activités de conseil pour la collectivité locale, qui attire des compétences réelles afin d'assumer ses nouvelles attributions, de coordination et de médiation entre plusieurs collectivités locales de plusieurs niveaux et des opérateurs diversifiés.

<u>de nouvelles entreprises</u>
Antérieurement, l'ensemble des services de transports étaient théoriquement assurés par une entreprise d'Etat, prenant en charge non seulement la production des véh.*km nécessaires au service, mais l'ensemble des activités attenantes, de la formation des cadres, aux vacances et à la protection sociale des employés, en passant par la maintenance, une petite production de pièces détachées, ou le fonctionnement d'un musée des transports publics à Prague. Ce phénomène classique de conglomérat socialiste est beaucoup plus marqué à Prague, et fonctionnait relativement bien, en terme de production. Par contre à HCMV, les excès du décalage entre tradition et modèle exogène ont rapidement conduit à un blocage complet du système de production organisé et laissé la place très rapidement au transport « informel », phénomène celui ci très classique à la fois dans les pays en développement caractérisé par la faiblesse de la collectivité et dans les pays socialistes avec un marché parallèle important.
En résumant dans une perspective neo-institutionnaliste, dans les deux villes, le schéma d'organisation de la production adopté produisait un très fort investissement en actifs spécifiques pour une économie importante de coûts de transaction (faible recours aux contrats et aux marchés). En effet, le système de production socialiste choisit de faire plutôt que d'acheter, d'intégrer verticalement et horizontalement, chaque segment de la production devant finalement s'intégrer dans une structure globale nationale, voir de l'ensemble du bloc socialiste. Cette intégration très poussée s'appuie sur le développement d'actifs spécifiques, dont le coûts varie en fonction des ressources et acquis hérités : en matière de transports publics, Prague bénéficiait d'une véritable tradition du transport public et dans l'ensemble du pays, on fête encore aujourd'hui l'anniversaire des réseaux de transports publics, centenaires dans plusieurs villes. Au contraire, HCMV, tout en rejetant l'expérience coloniale, a dû réemprunté les schéma de l'ancienne CFTI (Compagnie Française des Tramways d'Indochine) créée dans les années 20. Les dysfonctionnements qui apparaissent rapidement conduisent à une externalisation des activités d'entretiens et de maintenance en périphérie des garages officiels et le développement de services informels. Il est intéressant de noter qu'après une période de trois ou quatre ans (75 - 78) durant laquelle le régime ne tolère aucune entrave aux exigences du parti communiste vietnamien (désurbanisation vers les zones d'économie nouvelle, interdiction du petit commerce et de l'artisanat...), les adaptations sont nombreuses. Le Doi Moi ne vient en fait qu'entériner politiquement un courant de libéralisation économique et social amorcé dés la fin des années 70 qui préfigurait l'adoption du socialisme de marché.
Les nouvelles entreprises présentent une base spatiale. A Prague, l'entreprise des transports garde la gestion de l'ensemble des itinéraires d'autobus

exploités jusqu'à présent et des deux réseaux de tramway et de métro, dont la dérégulation s'avérerait très compliquée, compte tenu de leur intégration physique (dépôt, garages, etc...). L'entreprise est devenue société par actions en 1992, mais l'ensemble du capital est détenu par la municipalité.
Trois types d'opérateurs apparaissent autour de cette nouvelle société largement liée au pouvoir municipal :

- des entrepreneurs qui répondent à des appels d'offre organisés par ROPID pour l'exploitation de lignes en périphérie. Il s'agit en général d'anciens chauffeurs de CSAD.
- des entrepreneurs qui passent des contrats de sous-traitance avec Dopravni Podnik, dont la nouvelle logique de maîtrise des coûts conduit à certains choix d'externalisation.
- des sociétés privées correspondant à d'anciens départements de Dopravni Podnik, tel que les transports collectif fluvial ou les activités d'ingénierie, et dont l'essentiel du chiffre d'affaire dépend encore de contrats établis avec Dopravni Podnik.

On mesure ici le pouvoir que conserve l'ancienne entreprise de transports publics dans le secteur, en intégrant progressivement des logiques de maîtrise des coûts ou de rentabilité : certains itinéraires sont abandonné à une concurrence considérée comme insignifiante. Dopravni Podnik ne sait produire que des Véh*km chers, du fait de sa lourdeur mais aussi des exigences internes qu'elle s'est construite. Les décideurs de l'entreprise rechignent à produire au rabais. Or les services périphériques doivent répondre à des exigences de service allégés, privilégiant la réduction du coût kilométrique.
Dopravni Podnik développe donc une stratégie autour de son investissement en réputation. On aurait tort d'associer certaines réticences à un symptôme d'incapacité d'adaptation. Les cadres de l'entreprises savent par ailleurs très bien intégrer les outils de contrôle et de management occidentaux et ne craignent pas de recourir à la sous-traitance, y compris dans une logique de concurrence interne entre modes de transports. Par exemple la section des tramways choisira, pendant une période de travaux sur tel ou tel ligne, de contractualiser avec une entreprise privée plutôt que d'avoir recours en interne aux services de la section des autobus.
Enfin, la formation de « sociétés soeurs » est considérée comme une évolution positive pour la direction de Dopravni Podnik : c'est le capital faiblement productif qui a été externalisé, et les activités concernées se retrouvent largement dépendantes, aujourd'hui affublées de devoirs qu'elles ne connaissaient pas auparavant.

Globalement la recomposition du secteur se fait donc sous contrôle d'une entreprise qui dépend elle même largement du contrôle politique et dont la légitimité ainsi que les compétences techniques sont très supérieures à celle de la nouvelle institution coordinatrice, ROPID.

A HCMV, l'état déliquescent des transports collectifs a provoqué une atomisation beaucoup plus nette du secteur dont la forme a été présentée dans une communication lors de la précédente CODATU (singularité et adaptation des opérateurs de transports publics à HCMV, Viêt-nam). La nouvelle structuration du secteur est très fortement segmentée, allant des taxis urbains et d'une ligne de transports gérée en « joint venture » à l'autoproduction de services de lambrettas en passant par les services relativement organisés des coopératives. Dans ce schéma, le Centre de Gestion des Transports Publics ne souffre pas de la concurrence institutionnelle de l'entreprise restée publique qui se charge d'exploiter directement les trois itinéraires les plus rentables, de collaborer avec la joint venture pour l'exploitation de l'axe principal de l'agglomération et de tirer profit de sa compagnie de taxi. Cette entreprise publique porte bien plus une logique de rentabilité que ne la fait Dopravni Podnik à Prague, pourtant société par action. Elle demeure publique, et se comporte relativement plus en gestionnaire d'un service public que les autres entreprises (les chauffeurs sont en effet salariés et on observe rarement la passation de contrat annexe à la place du service comme s'est couramment le cas chez les chauffeurs entrepreneurs) ; mais la collectivité est excessivement démunie à HCMV et si le discours proclame la relance du transport public, aucun dispositif concret ne vient assurer la mise en pratique : a HCMV aucune subvention ne vient accompagner les obligations de service public, si bien que le changement des logiques de production se fait par le biais d'un apprentissage expéditif, rendu possible par un système politique qui reste autoritaire.

1.4 L'irruption de nouvelles logiques de production présente des conséquences pour le services

Pour les transports collectifs pragois, la nouvelle logique de production s'inscrit dans un temps d'apprentissage et un niveau de ressource du secteur conséquent qui permet d'amortir la tension réelle de diminution du niveau de service, sous l'effet notamment des recommandations internationales. L'amaigrissement de Dopravni Podnik se fait lentement et sa vocation sociale s'amenuise à un rythme qui doit composer avec un personnel bien organisé. Les obligations (y compris militaires !) de l'entreprise s'accompagnent de fait de droits importants, exercés à la fois dans une relation hiérarchique avec les nouveaux opérateurs ou fournisseurs, dans une relations contractuelle avec la

municipalité ou dans une relation de concurrence de marché avec la nouvelle institution ROPID.
A HCMV, le secteur peut être assimilé à une activité commerciale tant sont faibles les moyens qui lui sont consacrés par la collectivité. Il n'y a donc pas de tension à la baisse du service lié à un changement de logique de production. Par contre la segmentation très forte du marché qui s'oriente naturellement vers le développement d'une offre de haut niveau sur les « axes de la richesse » (entre Saigon et Cholon et entre Saigon et l'aéroport) et d'un service concurrentiel sans contrôle de la collectivité en périphérie, entre en conflit avec la notion de service public qui implique une certaine égalité d'accès à la mobilité. En l'absence d'héritage en matière de transports collectifs, HCMV connaît naturellement une libéralisation rapide du secteur face à laquelle les autorités réagissent en créant un Centre de Gestion censé injecter des obligations de service public chez les opérateurs. En refusant d'y adjoindre des avantages financiers substantiels, le système autoritaire vietnamien tente de passer par le contrat de délégation sans en acquitter le coût ; il se comporte comme dans un schéma hiérarchique intégré, alors qu'il y a bien délégation de fait d'un service qui avant d'être public, présente un caractère commercial fortement concurrentiel. De plus la majorité des fonctionnaires des administrations entrent eux mêmes dans des logiques de négociation qui font de l'ensemble du système vietnamien un vaste marché, sans frontière claire entre public et privé, entre intérêt privé et collectif, entre organisation et jeu de marché.
Cette cécité apparente des pouvoirs publics s'explique peut être par la synthèse du socialisme de marché. Il est clair que le socialisme vietnamien, dans la mouvance chinoise, n'a pas du tout structuré un secteur des transports publics sur les mêmes bases que celui de Prague. Pourtant des phénomènes parallèles peuvent être observés, phénomènes de transition, d'adaptation et d'apprentissage qui correspondent bien à une période de libéralisation, mais qui présentent deux enjeux radicalement différents :

- A Prague, la notion de service public est nouvelle puisqu'elle est associée à une notion corrective dans le système libéral, mais elle découle naturellement de l'organisation précédente, dans la mesure ou elle procède d'une logique mixte ou de compromis entre intervention de la collectivité et libre jeu du marché. On peut dire que le processus de transition est ici classique et que les enjeux collectifs du secteur aidant, le processus est maîtrisé dans sa globalité économique, politique et sociale. Au centre de ce processus se trouve Dopravni Podnik, dont le poids devrait diminuer progressivement, en même temps que la part des transports publics.
- A HCMV, la notion de service public, nécessaire dans un système de marché régulé qui tente de se mettre en place, est beaucoup plus radicalement nouvelle, puisqu'elle ne peut être héritée d'un système socialiste dont le travail de prise en charge des individus n'a pas dépassé le niveau de discours ou de quelques actions très ponctuelles. Le socialisme vietnamien a soumis les individus mais apporté très peu de droits et d'acquis qui correspondent aux dits services publics, ces domaines dans lesquels la collectivité se reconnaît des devoirs vis à vis des citoyens. Pauvreté, caractère pionnier de la province d'HCMV et maintien de la mainmise de l'Etat communiste rendraient très incertain la naissance d'un service public de transports si les actions étrangères n'injectaient pas régulièrement des exigences de régulation et n'initiait pas un débat sur le rôle de la collectivité. Intervenant dans le nouveau jeu, le consultant étranger vient tirer le Viêt-nam vers un minimum de normalisation. D'aussi loin que puisse venir le Viêt-nam, en cette fin de XXème siècle, l'adaptation passe par le développement d'un service public, même minimum, sur le renforcement naturel prévisible du secteur commercial.

3 LES TERMES D'UN NOUVEAU RAPPORT DE FORCE INSTITUTIONNEL, ENTRE MARCHE ET HIERARCHIE

Cette nouvelle structure institutionnelle laisse place à une confrontation d'intérêt entre l'économique et le politique.
Dans ce contexte de négociation plus ou moins inégale, Prague et HCMV convergent-elles vers un "modèle dominant" qui, en matière de services urbains conduirait à un niveau de dépenses publiques équivalent (part de revenu collectif par habitant affecté aux transports publics sur revenu disponible par habitant), et en matière de transports publics à un niveau d'offre donné comme optimal (densité kilométrique ou nombre de v*km produits par habitants) ainsi qu'à des productivités commerciales comparables (coût d'un passager transporté).

3.1 L'ancienne entreprise d'Etat détenteur des savoirs faire et de la gestion du capital

L'entreprise est au cœur du processus de recomposition et dispose de pouvoirs et de ressources importantes, pour faire face aux nouvelles formes de coordination qu'elle rencontre. C'est elle qui conditionne assez largement l'évolution prise par le secteur. A Prague, elle est le garant d'une activité qui présente à la fois des enjeux sociaux et politiques. A HCMV, l'entreprise, restée dans le giron de l'Etat n'est pas dépositaire du même pouvoir ni des mêmes enjeux. Elle est cependant le partenaire de l'intervention étrangère et son mode d'action privilégié est la négociation inégale, appuyée sur un système bureaucratique autoritaire qui soumet autant les activités externalisées vers le privé (les coopératives) que la joint venture, le point de rupture étant donné par le départ de l'investisseur ou la disparition du service.

3.2 La collectivité locale, ordonnateur et comptable face aux mouvements de l'opinion et au fonctionnement urbain

Car le baromètre que l'appareil politico-administratif place en face des dépenses de transports public est bien celui d'un mécontentement plus ou moins manifesté de l'opinion. Il est à l'affût du seuil d'acceptabilité social.
A Prague, la prise en compte des indications du baromètre sont réelles, mais les manifestations de l'opinion encore timides ; au Viêt-nam, le rôle de ce baromètre est tout à fait inopérant. Ce sont les petits entrepreneurs, accrochés à leur activité dans un contexte de sous emploi généralisé qui, poussés à bout, manifestent, parfois violemment. Dans cette perspective, le transport public à HCMV peut être considéré comme un secteur économique classique, sans dimension collective particulière, à la différence de Prague. L'enjeu grandissant que doit intégrer le Centre de Gestion des Transports Publics concerne le fonctionnement de la ville. Cet enjeu nouveau n'est pas pris en compte par l'entreprise publique des transports, qui n'a jamais eu de fonction de planification et de réflexion sur l'interface urbanisme et transports. Ici il n'y a pas concurrence institutionnelle comme à Prague, entre Dopravni Podnik et ROPID

3.3 Entre héritage socialiste, ressources économiques publiques, volonté d'intégration mondiale et réaffirmation des spécificités régionales.

C'est donc par le prisme complexe de l'histoire et de la genèse actuelle de l'articulation des différents acteurs que doit être traitée la question de la convergence en matière de services de transports collectifs urbains. Ces aspects très variables nous conduisent à proposer une tendance générale qui devraient donner lieu à des investigations quantifiées plus poussées.
La santé économique et plus généralement les ressources endogènes du pays (connaissance des pratiques étrangères, niveau technologique...) conditionnent la capacité d'adaptation et d'interprétation des modèles exogènes, dont la prise en compte conditionne assez largement la crédibilité internationale d'un pays. Tendance à l'uniformisation et singularité des contextes régionaux se rencontrent donc dans un jeu de reconnaissance réciproque ou au contraire de confrontation. Dans tous les cas, l'autarcie étant considérée comme impossible (l'Union Européenne a par exemple signalé à V. Klaus, face à ses attaques répétées contre le bureaucratisme européen, que c'était bien la République Tchèque qui souhaitait entrer à l'UE et pas le contraire) sauf peut être pour la Chine, et les exigences du modèle démocrate libéral relativement élevée, l'orientation prise par les pays en transition est forcément convergente. Comme le montre le cas vietnamien, cette convergence peut très bien, en fonction de la situation de départ, occasionner un renforcement du secteur des transports collectifs, phénomène a priori paradoxal dans une transition post-communiste et paradoxe levé par l'observation de la diversité des expériences du socialisme réel.

CONCLUSION : RISQUES ET PROMESSES DE LA TRANSFORMATION DU SECTEUR

Les deux trajectoires prises par les systèmes de transport public de l'après réforme (puisque le communisme reste doctrine d'Etat au Viêt-nam) sont intimement liés à l'expérience socialiste et même pré-socialiste des deux pays : elles influencent fortement les volontés et capacités d'adaptation aux nouvelles exigences d'un marché qui induit un changement de logique de production et des stratégies d'intégration nouvelles du secteur. Alors que le Viêt-nam était naturellement préparé à un schéma concurrentiel et contractuel et que son problème demeure un problème de régulation, accru par l'intensification du fonctionnement urbain, la République Tchèque reste attachée à un service collectif dont les déficiences économiques ne justifient pas le sacrifice, en regard de son efficacité sociale.
Finalement les tensions s'exercent dans une même direction et avec un problème commun : le maintien ou le renforcement du contrôle de la collectivité dans une nouvelle logique de négociation, de délégation et donc de formulation des exigences du service.

1 Les termes d'une « convergence limitée » : une grille d'analyse pour l'évolution du secteur des transports publics dans les pays en transition

Cela nous permet d'envisager les transformations du secteur des transports collectifs urbains à Prague et HCMV comme des modalités de rapprochement des transports publics d'une fourchette de niveaux moyens observés dans les pays capitalistes, en distinguant bien sûr les deux grandes catégories des pays développés solvables et ceux des pays en développement faiblement solvables, et en reconnaissant évidemment les différences importantes entre les sociétés d'Amérique du Nord, d'Europe Occidentale, ou encore d'Asie du Sud Est... Ainsi, malgré le faisceau de facteurs favorables aux transports collectifs à Prague, leur part diminue irrémédiablement, et malgré des facteurs négatifs tout aussi importants à HCMV, la part des transports collectifs devrait augmenter.

La proposition est recevable à deux titre :

- d'abord les tentatives de types socialistes ont pour ainsi dire disparues et les systèmes de types capitalistes, même s'ils ne sont pas uniformes représentent une réelle réduction du champ des possibles.
- ensuite, les observations faites à HCMV et Prague permettent de constater un phénomène d'homogénéisation des solutions apportées à des problèmes qui entrent dans des typologies, résultat sans doute d'une communication accrue entre les techniciens et politiques des grandes villes, qui diffusent des « best practices » adaptées à un large éventail de situations : les problèmes techniques quantifiés conduisent à des solutions techniques d'ingénierie et les questions de gestion trouvent une réponse de finances publiques.
- enfin, les conseils et exigences étrangères qui conditionnent la réinsertion (ou réintégration) internationale se caractérisent, avec des fondements issus de l'appui institutionnel ou de l'aide au développement, par une faible prise en compte de la réalité des pays et de leur héritage, pour des raisons d'efficacité même de l'aide. Le service de transports publics communiste est intimement lié au système déchu. La logique de rupture des premières années de transition, ainsi que l'abandon rapide de l'idée d'une troisième voie ont rendu très rares les efforts de compréhension par les experts et consultants étrangers. Aussi une « raison peu rationnelle » conduit-elle a priori les consultants a conseiller un maintien des transports publics « dans les limites du raisonnable ». On oublie ici que le niveau d'un service peut présenter plusieurs niveau viables, dans une situation économique donnée, en fonction des politiques mise en œuvre et des priorités retenues.

2 Les conditions de mise en œuvre d'une politique de transports urbains soutenable

L'intervention étrangère à Prague et à Hô Chi Minh Ville dans le secteur des transports collectifs: entre Plan Marschall et Chicago boys

On sait que l'idée d'un Plan Marschall a l'attention des pays de l'est est considérée comme farfelue par les spécialistes de l'aide internationale pour des raisons de capacités d'absorption limitées notamment par la faiblesse des cadres juridiques et réglementaires, évaluées à 5% du PIB par l'UE. L'intervention qui peut s'observer ne correspond pas non plus à celle qui a eu lieu au Chili sous forme d'un groupe d'experts économistes, les Chicago Boys, après le renversement de S. Allende. Entre aide financière massive et mise sous tutelle idéologique, le processus à l'œuvre avec les pays en transition, varie en fonction des enjeux qu'ils représentent et en premier lieu de l'aire géographique à laquelle ils appartiennent. La transformation peut donc se payer très cher si les ressources internes du pays (financières mais aussi culturelles) le contraignent à des chocs violents et dangereux pour le maintien, notamment, des services de transports collectifs.

La (re)constitution de la société civile

Le processus de démocratisation et la participation accrue des citoyens qu'il nécessite conduisent à une prise de parole qui constitue un véritable contre poids social face aux dérives possibles de gestion des services collectifs : Les plaintes d'usagers se multiplient auprès des entreprises de transports et des manifestations ont même éclatées face à des mesures telles que l'augmentation du prix de l'énergie en Rép. Tchèque. Le renforcement de la société civile est une variable essentielle dans le jeu qui préside à la restructuration des services collectifs.

Le renforcement et la revalorisation du politique

Enfin, la dilution du pouvoir politique et sa perte de crédibilité contribuent à accroître les risques de décalage dans les évolutions parallèles de l'organisation économique, politique et sociale. Les nouvelles instances locales souffrent en effet d'une légitimité et d'un savoir faire qui restent réduits. La rapidité d'apprentissage de l'action politique et la prise de conscience de son rôle pour la collectivité, loin d'être évident pour certains élus, conditionnent la formation du troisième contrepoids.

Le développement durable des villes post-communistes dépendra de leur capacité à gérer en parallèle les trois évolutions. Un décalage dans le temps trop favorable aux transformations économiques conduira à une réduction difficilement réversible des services collectifs compte tenu des types d'investissement et de la complexité des systèmes en cause. A Prague, comme à HCMV, si la tendance semble fixée, le rythme du changement n'est pas facilement identifiable. Il semble que ces deux villes présentent la similarité, jusqu'en 1997 en tous cas, d'un contexte relativement équilibré entre force politique et économique, et ce malgré le maintien officiel du communisme au Viêt-nam ou les velléités ultra libérales du gouvernement de V. Klaus. Le manque demeure au niveau de la participation : le citoyen reste largement et naturellement exclu d'un jeu qui le « dépassait » sous le communisme et qui peut l'écraser dans le système capitaliste. Son retour est subordonné au changement qui semble le plus long : celui des comportements quotidiens, au travail, dans la vie de la cité ou au marché. Son absence met en péril la gestion durable des villes telles que HCMV ou Prague, qui bénéficient pourtant de secteurs assez structurés bien que très différents, mais manquent d'un gouvernail social. La dérive se fait pour l'instant au gré des exigences extérieures, et les négociations exagérément portées sur la question des coûts du duo collectivité locale décentralisée/entreprise.

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Institutional framework for managing urban transport in Indian cities

O.P. Agarwal
Department of Transport, Government of Assam, Guwahati, India

ABSTRACT: The rapid growth of cities in developing countries has brought to the forefront the need to properly manage urban transport. A major drawback in India has been the multiplicity of agencies involved in urban transport planning and management. More often than not, these agencies work in isolation, with little or no coordination between them. A single agency would facilitate better integration of land use and urban transport planning, more optimal allocation of resources, better co-ordination of operations and more effective management.

This paper looks at various institutional models that have been adopted for managing urban transport systems, particularly in the United States. It examines the advantages and disadvantages of each of these models and recommends an institutional framework for managing urban transport in Indian cities.

INTRODUCTION

The rapid growth of cities in developing countries is nearly universal. While less than 22% of the developing world's population lived in urban areas in 1960, it averaged 34% in 1990 and is projected to exceed 50% by 2015. By then the number of city residents will reach 4 billion and there will be 225 urban agglomerations with a population of more than 2 million each. India is no exception with the number of million plus cities having increased from 5 in 1951 to 23 in 1991. The population in our million plus cities has gone up from 11.7 million to 70.3 million during this period.

Unfortunately, urbanization has been accompanied by congestion, pollution and uncontrolled urban sprawl. Expansion of economic activities has resulted in the road transport of more goods and services over greater distances. These developments have increased the demand for roads and vehicles, adding to congestion and air pollution. Adverse effects of these have been felt on the health of the people, their quality of life and the productivity of the economy. Good urban transport planning and an efficient urban transport system are critical needs for mitigating the problems of congestion and pollution in our cities.

ELEMENTS OF URBAN TRANSPORT PLANNING AND MANAGEMENT

Integrated planning for urban transport involves several activities. It is not merely the design of bus routes and construction of a road network, but includes activities like:

- Land use planning
- Developing a master plan for the city
- Designing and constructing a road network
- Developing criteria for new constructions
- Granting building permits
- Designing an integrated and efficient public transport system
- Operating and promoting the public transport system
- Fixing fares and schedules
- Formulating and enforcing traffic laws
- Laying down and enforcing environmental standards
- Laying down and enforcing safety standards
- Managing travel demand
- Maintaining the right of way for transportation services
- Formulating strategic plans for the future

EXISTING INSTITUTIONAL ARRANGEMENTS FOR MANAGING URBAN TRANSPORT IN INDIA

At present there are several agencies responsible for some aspect or the other of urban transport planning. More often than not, these agencies work in isolation with little or no coordination between them. There is no effective forum where their individual plans can be dovetailed into an overall framework. As an example, the city of Guwahati, which is the capital of the State of Assam, in India, has the following agencies responsible for some aspect or the other of urban transport:

Transport Department

The transport department is responsible for the transport planning, development and regulatory activities in the entire State of Assam. Its regulatory functions are discharged through a State Transport Authority (STA) and several Regional Transport Authorities (RTAs). The STA is responsible for matters covering more than one region, whereas the RTA deals with intra-regional transport matters. Regulatory functions include the registration of vehicles, licensing of drivers and enforcement of safety and environmental standards for vehicles. It also includes the grant of route permits, fixation of fares and laying down of the operational schedules. The STA/RTAs administer the Motor Vehicles Act, which empowers these agencies to discharge their functions. The transport department also controls the Assam State Transport Corporation (ASTC) which operates public bus services both within the city as well as in the rest of the State.

Police

The police is responsible for enforcing the traffic laws and bringing violators to book. They have a traffic police branch, which is specifically entrusted with this task. In fact, the traffic police even uses a different uniform from that worn by the rest of the police force. Upon their effectiveness depends the worth of the traffic laws. Laws that are not effectively enforced are meaningless. However, being burdened with other crime detection responsibilities as well as maintenance of law and order, the extent of importance given to enforcing traffic laws is limited. Quite often, this comes low in their order of priorities.

Public Works Department

The Public Works Department (PWD) is responsible for the construction and maintenance of the road network throughout the State. Major roads within the city are also built and maintained by them.

Their list of priorities is often not motivated by socio-economic considerations and genuine public needs, but by the influence exercised by powerful political leaders. If there is no powerful political leader from Guwahati, then its roads would suffer neglect. They may get an occasional facelift if a VVIP, like the President or Prime Minister of the country visits the city, but this facelift is usually a very superficial job, designed to last only for the duration of the VVIPs visit.

Municipal Administration Department

The Municipal Administration Department, through the Guwahati Municipal Corporation (GMC), provides basic civic services within the city. The GMC is also responsible for the construction and maintenance of smaller city roads. It provides road lighting and traffic signaling infrastructure. The GMC also licenses cycle rickshaws, which are very large in number and virtually choke several roads in the city. The GMC lays down building bye-laws and issues building permits. It is responsible for the water supply and sewerage infrastructure in the city and is often responsible for roads being dug up frequently due to its bad planning of repair work.

Guwahati Development Department

The Guwahati Development Department has been set up recently to build urban infrastructure on a commercial basis rather than through budgetary support. Towards this end, the Guwahati Metropolitan Development Authority (GMDA) has been incorporated and functions under the administrative control of the Guwahati Development Department. As of now, it has built only a few housing colonies and one truck parking complex.

Town and Country Planning Department

This department is responsible for developing master plans for a city and is the repository of technical expertise in town planning. However, it has little direct responsibility for enforcing its master plan and is dependent on other agencies for making sure that its master plan is adhered to.

Indian Railways

Urban railway systems, wherever they exist, are controlled and operated by the Indian Railways, an agency of the Central Government. It is not answerable to the State Government.

While Guwahati has no urban railway system, an inter-city railway network runs through the heart of the city. Surplus capacity on this network could be fruitfully utilized to run shuttle services for city commuters. Besides, the preferential right of way for railway trains often leads to severe choking on some segments of the city roads. Better co-ordination between the Railways and the State Government agencies could perhaps minimize such choking, without compromising on the need for providing preferential right of way to railway trains. However, there is little that the city administration can do about this as the Railways are under the control of the Central Government.

Deputy Commissioner of Kamrup

The Deputy Commissioner is the head of the district administration and, in particular, controls revenue administration. He is primarily responsible for removing encroachments within the city and keeping the right of way clear. He is also the chairman of the Regional Transport Authority, but given his multifarious tasks, he has little time to devote to RTA matters. As such, the Regional Transport Officer, who works under the control of the Transport Department, largely handles this work.

Finance Department

The Finance department controls the State finances and is responsible for budgeting and financial management. It releases funds for the construction and maintenance of different assets. It is also responsible for allocating the available financial resources between competing demands.

Planning and Development Department

This department draws up development plans for the entire State. In fact, its role is to integrate the sectoral plans submitted by the different departments and integrate them into a State level plan. They also allocate plan funds received from the Planning Commission of India, specifically for development projects. The State plan is usually a compilation of sectoral plans with only a limited effort to dovetail the sectoral plans into a meaningful whole.

Environment Department

The department of Environment lays down environmental standards and monitors air and water quality. It depends on the police and the RTA for enforcing the norms laid down by it. A Pollution Control Board, which functions under this department, renders technical advice to the department of Environment. This department also supports pollution control measures but with its limited finances, it has not been very effective.

Assam Human Rights Commission

The Assam Human Rights Commission is a quasi-judicial body set up to deal with cases of human rights violations. It has taken a proactive role in controlling pollution within the city of Guwahati and has been directing the enforcement of environmental standards among vehicles plying within the city.

Judiciary

Of late the judiciary has been playing a very active role in reducing pollution in the city. In some cities the judiciary has banned the use of commercial vehicles that are more than 15 years old and also directed that no vehicles should be registered unless they meet some stringent emission standards.

Besides, upon the speedy disposal of cases brought before it depends the effectiveness of the enforcement machinery. Unfortunately, the disposal of cases has been tardy with many having remained undecided for years together.

NEED FOR A CO-ORDINATING AGENCY

As is clear from the above, there is a lot of confusion due to the multiciplity of organizations. The positive effects of one department's work are often nullified by another not having the same focus. Establishing a co-ordination mechanism would facilitate the integrated planning and development of urban transport systems, a more optimal allocation of resources, better co-ordination of operations and more effective management. It would also facilitate better integration of land use and urban transport planning.

INSTITUTIONAL MODELS

Very useful lessons can be learnt from institutional models adopted in the US and a few other countries for managing public transport systems. Although these institutions are limited in their functions, being responsible only for managing public transit systems and not for the larger role of urban transport planning and management, they can easily be adapted for a more broad-based responsibility. Hence, before deciding on an institutional form for managing urban transport in India, it would be prudent to look at these models. The models can be classified into four broad categories, as described in the following sections:

Traditional Regional Public Transport Authority model

The traditional Regional Transport Authority (RTA) model integrates policy and operations responsibilities in a single agency. It has only a limited role beyond the provisioning of transit services and usually operates on fixed routes. Among examples are the Massachusetts Bay Transportation Authority (MBTA) and the Washington Metropolitan Area Transportation Authority (WMATA). The major advantage of such a structure is strong coordination and control with clear accountability. There is limited possibility for conflict among agencies and overheads are low (an advantage for smaller cities). However, such a structure has little or no incentive for providing efficient services. It is vulnerable to labor and political pressures and is usually resistant to change.

Enhanced Public Transportation Authority model

The Enhanced Public Transportation Authority model also integrates policy and operations responsibilities but offers an expanded range of services, including services such as van pooling and para-transit. It also plays a role in land use planning. Intervention in land use planning offers the advantage of being able to better match service with needs and enables securing a market share for public transport. However, it is more complex to manage and it is difficult to measure its performance. Like the traditional Regional Public Transport Authority, it is also vulnerable to political and labor pressures. Seattle is an example of the Enhanced Public Transportation Authority model.

Split policy/planning and operations model

In the split policy and operations model, a "Policy Board" is generally responsible for definition of the service area, capital planning, setting revenue goals and performance measures. One or several service providers are responsible for delivery of the service including marketing, route planning, maintenance, and workforce management. Examples of such split policy and operations models are seen in Minneapolis - St. Paul, and San Diego. The major advantage of this model is that it limits the extent of political influence on operations thus allowing it to function efficiently. It allows operations staff to focus on service provision. A disadvantage is the difficulty of defining a clear separation of roles as there may be some duplication. With several providers the difficulties of periodic contracting and regular monitoring also exist.

Privatization of operations model

A typical example of the privatization of operations model can be seen in U.K or in Sri Lanka, which have almost free market entry and represent complete deregulation of private providers. In such a model there may be no public operator at all with public involvement being called for only when social needs require a service not provided by the market. The advantage of such a model is that it minimizes costs. Its introduction has stimulated innovation. It offers the opportunity to penetrate new markets. It is also highly responsive to changing consumer demands. A key concern, however, is its social equity basis. It is likely that many urban areas have routes and services that are warranted but can not be operated at a profit. Further a completely unregulated market offers no assurance of service reliability and occasional discontinuities may result. If the number of operators are too many there could be problems of dangerous "passenger capture" practices.

LEVELS OF URBAN TRANSPORT MANAGEMENT

As evident from the above, the planning and development of urban transport requires two levels of responsibilities. At one level is the policy and planning function and at the second is the actual operation of services. Some models integrate both responsibilities in one agency whereas others separate the two responsibilities. Accordingly, the institutional arrangements could be organized in a single tier or multiple tiers. In a single tier structure, provisioning and operations responsibilities are with a single agency. In a multiple tier arrangement, the responsibility for planning and operations is split among different agencies.

RECOMMENDED FRAMEWORK FOR INDIA

On consideration of the relative merits of each model, it appears that the split policy/planning and operations model would be most suitable for the larger cities in India. It would enable the existing multiciplity of agencies to discharge their respective responsibilities without compromising on the proper co-ordination of their individual programs. It would combine the likely efficiencies that can be secured from private operation without sacrificing on the responsibility of the government to ensure an efficient, cheap, safe an environmentally friendly urban transport system. It would insulate operators from political pressures and enable them to functio in a more cost-effective manner (the bane of several State Transport Corporations has been the political pressures that they have not been able to withstand). Such a model would also enable better integration between modes as also between land use and urban transport planning.

Hence, the management of urban transport could be organized into two tiers. The upper tier would be responsible for strategic planning, policy making, inter-modal co-ordination, integration of land use and transport planning, setting environmental and safety standards as well as capital financing. For this tier, a new agency needs to be set up and it may be called the Metropolitan Transport Authority (MTA). Ideally, a separate MTA would be required for each major city. The MTA should essentially be a "Board" with a small secretariat attached to it. The Board of the MTA for the larger cities should have representatives of the different departments involved, namely the:

- Transport department
- Municipal Administration department
- Public Works department
- Department of Environment
- Finance department
- Planning & Development department
- Indian Railways
- Police department
- Metropolitan Development Authority

It should also include the Deputy Commissioner, some representatives of user groups and operator associations.

Ideally, the MTA must have legislative backing to ensure that its decisions can be enforced and it has the necessary teeth to make sure that it is taken seriously by the different implementing agencies. The legislative backing could come either through a separate enactment or even a set of amendments to the Motor Vehicles Act. Funds meant for urban transport should be routed through the MTA, to strengthen its hands for effective supervision of urban transport activities.

The second tier functions would cover all the implementation responsibilities of the different agencies. These could continue to be discharged by the existing multiplicity of agencies, though under the overall supervision of the Metropolitan Transport Authority.

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Regulatory reform of passengers public transport in Brazil: Public authorities or independent agencies?

Nouveaux modèles de réglementation des transports publics des passagers au Brésil? Autorités organisatrices ou agences de régulation?

Reforma de la reglamentación del transporte público en el Brasil: Las actuales oficinas de transporte o las nuevas oficinas independientes de reglamentación?

A. Brasileiro & O. Lima Neto
Federal University of Pernambuco, Recife, Brazil

J.J.G. Aragão
University of Brasília, Brazil

ABSTRACT: In this paper, we approach the roles played by independent regulatory agencies in the new regulatory scene being implemented for the provision of infrastructures, specially public transport. Moreover, the paper addresses main questions concerning to relationships between regulatory agencies and public authorities, private or public operators and service consumers. Specifically in Brazil, where the public service approach to public transport has been applied for almost a century, what should be the sphere of influence, goals and tasks of independent regulatory agencies? Is there a real necessity of these institutions where public transport has a long tradition of being regulated and managed by public authorities while operated by private enterprises? How could an independent agency replace public authorities in the task of guaranteeing service quantities and quality as desired by people?

RESUMEN: Este atículo trata del papel de las oficinas independientes de reglamentación en el nuevo contexto de la provisión de las infra-estructuras y de cambios en los reglamentos de la prestación de los servicios públicos, especialmente en el sector del transporte público. El artículo apunta las principales cuestiones relativas a la relación entre las oficinas de reglamentación y las oficinas de transporte público, los operadores públicos y privados y los usuarios. Especialmente en Brasil donde adotase la visión de servicio público en el transporte a casi uno sieglo, ponese las siguientes cuestiones:Cuales serán las metas, las tareas y la área de actuación de las oficinas independientes de reglamentación? Hay la real necesidad de este tipo de oficina en el sector de transporte público donde adoptase desde mucho una regamentación donde la gestión pública es ejercida por las oficinas de transporte y la operación por compañías privadas? Como las oficinas independientes de reglamentación podrán replazar las oficinas de transporte en la tarea de garantizar la cuantidad y la cualidad de los servicios deseados por la población?

RÉSUMÉ: Dans cet article nous analysons le role des agences de regulation independents dans le nouveau contexto de reformes réglementaires dans les transports publics de passagers. Dans le cas brésilien, quel rôle pourra jouer une agence nationale de regulation ? Sur le plan local, il y a vraiment la necessité de creátion des organismes nouveaux, car il y a depuis des années toute ume expérience de coordination locale des transports exercée par des autorités organizatrices ? Comment ces agences independentes pourront garantir un service de qualité aux usagers ?

1 INTRODUCCIÓN

Analisando las razones de la crisis del Estado en América Latina, y en Brasil en particular, Bresser Pereira (1996) desarrolla la hipótesis de que la crisis del Estado en los años 80 y 90 tendria tres componentes: i) fiscal (déficit público, cuentas públicas negativas o bajas, deuda interna y externa exesivas, falta de credito del Estado, falta de confianza en la moneda nacional y de credibilidad del govierno); ii) crisis del modo de intervención estatal en la economia; iii) crisis de la forma burocrática e ineficiente de administrar un Estado que se torno grande demas para poder ser generado. Para el autor, el objetivo de la reforma del Estado no seria llegar al Estado mínimo, y si reconstruir el Estado, desarrollando la capacidad de governar y exigiendo que los prestadores de servicios al Estado compitan entre si en vez de tener el monopólio sobre los servicios.

La reforma del Estado que fundamenta la estrategia del Plan Director de la Reforma del Aparato del Estado adoptado por la MARE, se basa en los siguientes ejes:

→ Definición de cuatro sectores dentro del Estado:

núcleo estrategico - donde son definidas las leyes y políticas públicas (Presidente de la República, Ministros de Estado y cúpula de los Ministérios, Tribunales Federales)
actividades exclusivas del Estado - las que garantizan que las leyes y las políticas públicas sean cumplidas e financiadas (policia, fuerzas armadas, agencia de recaudación de impuestos, agencias ejecutivas, etc,)
servicios no exclusivos o competitivos - aquellos que el Estado realiza y/o subsidia por que considera de alta relevancia (universidades, hospitais, centros de pesquisa, museus)
producción de bienes de servicios para el mercado – realizados por las empresas estatales en proceso de privatización en sectores estrategicos (energia, telecomunicaciones, transportes, saneamiento, etc.).

→ Creación de las Agencias — ejecutiva (para los servicios exclusivos) y reguladora (para los servicios privatizados o produzidos para el mercado) —; y de las organizaciones sociales (para los servicios no exclusivos);

→ Contrato de gestión firmado entre el Ministério de tutela y la agencia;

→ Programas de publicización (para las organizaciones sociales) y de privatização (para las infraestructuras concedidas através de licitaciones al sector privado);

La decisión política de poner en práctica el proceso de privatización de las infra-estruturas en Brasil, encuanto parte integrante de las reformas económicas del Govierno, tuvo início con la creación del Programa Nacional de Desestatización – PND (por la Ley n° 8.031 de 1990). En los primeros años, el PND concentro esfuerzos en la venta de estatales productivas, pertenecientes a sectores anteriormente estrategicos para el desarrollo del país, a ejemplo de la siderurgia y petroquímica. A partir de 1995, la privatización pasa a tener una mayor prioridad con la creación del Consejo Nacional de Desestatización – CND, cuando las concesiones de las infra-estruturas públicas pasam al sector privado. La agenda pasa a incluir los sectores de telecomunicaciones, electricidad y transportes.

2 TRANSPORTES: EL DEBATE EN TORNO DE LAS AGENCIAS REGULADORAS ?

La desestatización en el sector de transportes toma una forma mas sólida con la implantación, en 1993, del Programa de Concesiones de Cerreteras – (Despacho del Ministro n° 10/93 del Ministério de Transporte), bajo la responsabilidad del Departamento de Concesiones de Carreteras del DNER. En su primera etapa, el programa incluye la concesión al sector privado de los trechos carreteros que habian sido objeto de peaje por el propio DNER, a los cuales incluían el puente Rio-Niterói em 1994 (13,2 km) y los trechos de las carreteras Osório - Porto Alegre – Guaíba, 112,3 km (1997), Rio de Janeiro – Petrópolis – Juiz de Fora, 179,7 km (1995); Rio de Janeiro – Teresópolis – Alto Paraíba 44,4 km (1995) y Rio de Janeiro – São Paulo, 406,8 (1995). Paralelamente, programas de concesiones de carreteras fueron puestos en práctica en los estados de São Paulo, Paraná, Santa Catarina, Rio de Janeiro, Rio Grande do Sul y Minas Gerais.

En el sector ferroviário de cargas, la red nacional bajo la tutela de la RFFSA fue repartida en seis regionales y sometidas a subasta, teniendo en 1997 terminado este proceso de desestatización, con la concesión a la iniciativa privada de la red Nordeste. De aí en delante, en los transportes urbanos de pasajeros, ocurrio la privatización de operadoras públicas, tanto en el modal ferroviário (Flumitrens e Metrô, no Rio de Janeiro), cuanto en el de carreteras (CMTC/SP, EMT-Santo André e João Pessoa, CTC-Rio de Janeiro, TRANSURB-Salvador e CTU-Recife) y en el hidroviário (Conerj, no Rio de Janeiro). En sector hidroviário hubo el arrendamiento de la terminal de Containers del Puerto de Santos y la transferencia a la iniciativa privada de la explotación de la Terminal de Containers del Puerto de Sepetiba, de las Compañia Docas de Rio de Janeiro y Espírito Santo, del Terminal roll-on-roll-of de Rio de Janeiro y del Puerto de Angra dos Reis.

2.1 *Necesidad de una instancia nacional ?*

La pregunta que se coloca aquí es: teniendo en vista la historia de planeamiento y coordinación pública en el sector de transportes, existe la necesidad de una agencia para actuar en los moldes de las hoy existentes hasta el momento? Los organismos existentes, en los niveles federal, estatal y municipal no podrian cumplir las tareas de regular los servicios? Si existe la necesidad de un organo regulador, a que atribuciones y objetivos debera atender? Para responder a estas preguntas, se deven distinguir tres planos relativos a lo que seria una agencia:

- nacional - en este caso ella tiene una actuación agarrando el transporte de pasajeros y de cargas, sobre ruedas, rieles, acuaviário e aéreo
- estatal - agarrando los modos existentes en el território estatal
- municipal - especificamente ligada al transporte público de pasajeros

Por las atribuciones del Gobierno Federal en la Constitución, la respuesta es positiva. Esto por que, según el art. 21 compete a la Unión :

- elaborar e ejecutar planos nacionales y regionales de ordenación del território y de desarrollo económico y social;

- explotar, directamente, o mediante autorización, concesión o permisión diversos servicios, entre los cuales la navegación aérea, aeroespacial y la infraestrutura aeroportuária; los servicios de transporte ferroviário y acuaviário entre puertos brasileños y fronteras nacionales, o que transpongan los limites del Estado ou Território; los servicios de transporte por carreteras interestatal e internacional de pasajeros; los puertos marítimos, fluviales y lacustres;
- instituir directrizes para el desarrollo urbano, incluso habitación, saneamiento básico y transportes urbanos;
- establecer princípios y directrises para el Sistema Nacional de Vialidad

Según el artículo 22, queda claro que compete privativamente a la Unión legislar sobre las directrises de política nacional de transportes; el regimen de los puertos, navegación lacustre, fluvial, marítima, aérea y aereoespacial; el transito y transporte.
Cuanto a los Estados Federados, según el artículo 25, ellos podrán, mediante ley complementar, instituir regiones metropolitanas, aglomeraciones urbanas y microregiones, constituidas por agrupamientos de municipios limítrofes, para integrar la organización, el planeamiento y la ejecución de funciones públicas de interes común. En el caso de los municipios, según el artículo 30, es de su competencia organizar y prestar, directamente ou bajo regimen de concesión o permisión, los servicios públicos de interes local, incluyendo el de transporte colectivo, que tiene carácter esencial.

2.2 A que tipologia debe la instancia reguladora nacional responder ?

Con el intuito de contribución al debate, a que atribuciones y objetivos deberá la Agencia Nacional de Transportes responder ? No se trata aquí de detallar la reglamentación de la Agencia. Lo que se pretende es establecer una espécie de un cuadro de referencia para su estructuración, obtenido a partir de una análisis de la creación de diversas Agencias (a ejemplo de la ANATEL, en Brasil) y de la literatura internacional (Aragão, 1999, Eustache, 1996). O sea, ella deberá tener una estructura técnica, material y financiera que permita el atendimiento de un conjunto de elementos así definidos:

- incentivo al desarrollo económico, tecnológico e social;
- claras relaciones entre poder concedente (Gobierno Federal, Ministerios, Alcaldias) y agencia reguladora de un lado; y clara definición de los papeles de ambas frente al concesionario privado;
- desarrollo y adopción de procedimientos y mecanismos de defensa de los derechos de los usuários;
- introducción a la competencia en el sector através de la abertura de los mercados via procesos licitatórios cíclicos;
- garantia de los princípios de universalidad: accesibilidad generalizada, buena cobertura territorial, modicidad de las tarifas, cortesia para con los usuários;
- estructura y política tarifária;
- fomento a la pesquisa y capacitación de personal através de la alocación de recursos, oriundos de tasas sobre el consumo de combustible,
- fomento al desarrollo industrial y tecnológico;
- desarrollo de procedimientos eficazes y eficientes de arbitraje de conflictos;
- terminos en el contrato (critério para entrada en el mercado; cumplimiento de las especificaciones reglamentares; definición de las bases para el cálculo tarifário; organización de audiencias públicas) sí, pero que afirmar sobre ellos?
- elaboración de un relatório anual de actividades y recomendación de medidas políticas para el Ejecutivo, en la medida de las necesidades.

2.3 Redefinir los papeles de los organos nacionais

Brasil tiene una larga tradición (negativa, de por sí) de creación y de extinción de organos, lo que compromete la continuidad de las políticas de transportes. Así, el hecho de la Reforma del Estado crear la Agencia reguladora implica necesariamente en la extinción de organismos existentes ? La pregunta se pone, por ejemplo, para un organismo de asesoria técnica en los moldes de la actual Empresa Brasileña de Planeamiento de Transportes - GEIPOT.

Por su tradición en planeamiento, conocimiento de la realidad brasileña, en una visión intermodal, bien como por la capacitación de su cuerpo técnico el GEIPOT, o un organismo que lo substituya, deberia asumir funciones mas amplias de que las de asesoramiento. Estas funciones deberian abrigar la realización de estudios técnicos complementarios a los realizados por la Agencia y por el Ministerio de Transporte. Organismos de este tipo son encontrados en diversos paises como el caso del INRETS frances y el TRL ingles. Evidentemente, en el caso de la permanencia del GEIPOT, esta tendria que darse en moldes totalmente nuevos, pasando esta entidad a funcionar como Organización Social.. Claro está que esta situación merecerá un amplio y cuidadoso debate, antes de cualquier tomada de decisión mas definitiva.

3. Y EN EL NIVEL LOCAL, COMO QUEDA EL ORGANO GESTOR DELANTE DE LA AGÊNCIA ?

En la medida en que se defiende aquí la idea de una agencia con atribuciones de gestión del servicio público (planeamiento, coordinación, reglamentación) y no apenas fiscalizadora del cumplimiento del contrato, es necesario avaluarse com prudencia la situación de aquellas ciudad donde existen organos gestores ejerciendo con suceso las atribuciones de coordinación y regulación de los servicios de transportes articulados con instancias nacionales y regionales, a ejemplo de los Foruns de los Secretarios Municipales y estatales de transportes (Brasileiro et al, 1999).

En este contexto, un importante debate se instala en torno de la necesidad de la creación de agencias sectoriales o multisectoriales. Ambos modelos poseen ventajas y desventajas. Los aspectos positivos de la agencia sectorial - sobretodo en el caso del transporte público urbano de pasajeros - dicen respecto al hecho de que los diferenciales de experiencia em reglamentación y planeamiento de las infra-estructuras (saneamiento, energia, telecomunicaciones, gás, transporte) son muy grandes, cada uno de estos servicios contando con una experiencia propia. Según ese raciocínio, sería eventualmente prematuro colocarlos todos, en un mismo organismo, cuando las propias reglas de reglamentación de cada uno de ellos no está todavía bien definida. Los limites resultan de la mayor posibilidad de estos organismos sectoriales vinieran a ser capturados por los intereses específicos de cada uno de los actores envueltos.

Evidentemente, se puede levantar, por otro lado, el argumento que la agencia multisectorial atenderia mas adecuadamente a un enfoque inter-disciplinar e integrado de la ciudad y de sus servicios. Pero si defendemos la idéa de prioritariamente trabajar y perfeccionar los organismos existentes, la experiencia brasileña es rica en ensinamientos de posibilidades de prácticas inter-sectoriales mismo en el contexto de los organismos gestores sectoriales.

Citese la Región Metropolitana de Recife, donde el CONDERM - Consejo de Desarrollo de la Región Metropolitana de Recife - posue Camaras sectoriales de transporte, de saneamiento, de energia, etc. Reforzar estos instrumentos de cooperación inter-sectorial y los consórcios inter-municipales constituyen hoy una necesidad, sobretodo en el campo de la formación de recursos humanos, con vistas a poner en práctica la legislación en vigor, tanto en relación a los procesos licitatórios com vista a la introducción de la competición en los mercados urbanos / metropolitanos de transportes, cuanto en relación a la cobranza de las cláusulas contractuales.

Portanto, se debe quedar alerta para los riesgos de una ruptura institucional radical, donde se pueda perder una preciosa experiencia acumulada. Así siendo, la multisectorialidad de la gerencia reguladora tendria que ser construída paso a paso. Claro, hay que resaltar que estados y municípios existen, donde hasta hoy no se creo la devida experiencia en el transporte o en cualquier otro sector. Para estos, esa advertencia no vale tanto, y esas unidades bien podrian construir (del nada) agencias multisectoriales y edificar, a partir de aí, su experiencia reguladora, que desde la cuna seria multisectorial.

3.1 Reforma regulatória con introdución de competición: una necesidad local

Por otro lado, se debe adoptar una cierta flexibilidad - buscando siempre llevar en cuenta las experiencias históricas de cada ciudad - urge que se ponga en práctica por los organos gestores la necesaria reforma reguladora con vista a compatibilizar la situación de las concesiones y permisiones de servicios públicos de transporte, después de la promulgación de la nueva legislación sobre licitación, contratos administrativos y concesiones de servicios públicos (Leyes n° 8.666/93, 8.987/95 e 9.074/95; cf. Aragão, 1998).

La realización de licitaciones para los servicios públicos de transporte urbano de pasajeros es una exigencia de la Ley y deberá propiciar la necesaria **abertura** del mercado a la competición, pues la filosofia de los reglamentos actuales señaliza claramente en la dirección de mercados cerrados, que se omiten de riesgo y de competición frente a potenciales concurrentes y no contienen elementos que posibiliten los operadores a esfuerzos para la obtención de reducción de costos, de busca de cualidad o de ganancia de productividade(Orrico Filho, Brasileiro & Sá Fortes, 1998).

Para proceder a tan importante reforma reguladora, el Poder Concedente, através del Gobernador o Alcalde, debe dar a los organos gestores un conjunto de condiciones ligadas a aquellas ya discutidas en este trabajo (ver arriba), relativas a la independencia y transparencia de sus actividades frente al poder concedente y a los operadores. Esto significa el fortalecimiento de la capacitación del staff técnico, la contratación de profesionales através de concursos públicos, la existencia de recursos financieros propios que garantizen el ejercicio de sus atribuciones de servicio público.

Además, la elección de la dirección de los organos gestores — presidente, directoria técnica e administrativa — se debe basar en critérios técnicos y con total transparencia. Así, la elección se puede basar, por ejemplo, en listas de candidatos previamente inscritos. Sus currículos serian analizados por un organismo especializado, siendo de aí selecionada una lista triple a ser sometida al Gobernador o Alcalde. Esta metodologia ya viene siendo seguida, por ejemplo, por diversas fundaciones de amparo a la pesquisa en diversos estados del país. Se podria pensar también, en la realización de concursos públicos para la ocupación de determinados cargos técnicos de dirección en los organos gestores. La idea, aquí, es que una vez tomadas las decisiones políticas — claro, envolviendo directamente los políticos — através de camaras metropolitanas, de consejos de administración, etc., los organos gestores tengan la necesaria capacidad técnica y permanência para ponerlas en práctica.

4. EN CONCLUSIÓN, DE UNA REGULACIÓN DE ESPECIALISTAS PARA UNA REGULACIÓN DE ACTORES

De las experiencias internacionales y brasileñas acerca de la creación de agencias reguladoras, tres aspectos merecen ser resaltados.

Primero, el hecho de que la creación de uma agencia reguladora no se dá por acaso, viniendo acompañada de una reforma reguladora y de la introducción de competición en los mercados. Ella solo tiene sentido de existir si fuera para asegurar que las cláusulas contractuales con los operadores privados sean cumplidas, sobretodo resguardando la cualidad de los servicios y los derechos de los usuários. Así, antes de su creación es importante que el poder concedente ya haya elaborado el diseño regulador que asumirá la infraestrutura. De la misma forma, no es correcta la puesta en práctica de políticas de privatización, sin que el Estado, através de los poderes concedentes y de las agencias, este devidamente equipada, en materia de capacitación técnica, jurídica y financiera.

Segundo, es necesario que quede clara la relación entre el Poder Concedente y la Agencia Reguladora. Ellas no se confunden. Al Poder Concedente - Unión, Estados y Municípios - compete la definición de las directrizes de políticas, la decisión de realización de licitaciones y de la filosofia general de los contratos, además de las atribuciones de planeamiento de las redes de transportes, de capacitación de personal. A la Agencia cabe garantizar los terminos del contrato con los operadores privados, garantizando que los servicios sean prestados de forma eficaz y eficiente a la población.

En la verdad, la agencia representa una nueva forma de gerenciar infra-estructuras, diferente de aquellas a las que se habia acostumbrado con os organos gestores. Así siendo, esa diferencia debe estar bien clara, y la administración pública (y los contratos) tienen que adaptarse y equipar debidamente para la nueva filosofia de gestión. Aunque no se pueda negar de antemano la construcción de agencias reguladoras para el transporte, pués esas pertenecen al contexto de la Reforma del Estado anteriormente expuesta, su creación debe respetar las realidades locales surgiendo como resultado de un amplio y representativo debate de la sociedad.

Lo que no significa que no se deban perfeccinar los organismos existentes, tanto a nivel local cuanto nacional. Esto significa, a nivel local, reforzar su capacitació técnica, material y financiera, creando condiciones para el ejercicio de una coordinación metropolitana, realizando las licitaciones necesarias a la adequación de la estructura jurídica vigente. Se hace necesario, todavia, realizar concursos públicos para llenar sus cargos, perfeccionando la selección de sus dirigentes, de modo a que estos organismos sean lo mas independientes posibles de interferencias políticas y de mudanzas conjunturales.

En tercer lugar, se coloca la pregunta - talvez la mas importante - de la democracia. A este respecto, Bauby (1998) llama la atención para la importancia de pasarse de una regulación de experts (de especialistas) para una regulación de actores. O sea, la regulación resulta de un complejo equilíbrio entre mecanismos de mercado e intervención pública, expresandose en el interior de esta articulación, de maneira conflictual, los intereses de la sociedad.

Así, si es verdad que la regulación tiene una dimensión técnica, - y aquí se llamo la atención para la importancia de esta dimensión - ella no es propiedad de una tecnocracia poseedora de la verdad; al contrário, sus decisiones son políticas en esencia, en el sentido de que deben orientarse para las atribuciones de servicio público, para el buen atendimiento de los ciudadanos, usuários de esta infra-estructura técnica y social.

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Coordination and competitiveness levels of transit services in the metropolitan areas of Recife, Brazil, and San José, Costa Rica

Les différents niveaux de coordination et de concurrence au transport en commun des agglomérations urbaines de Recife, Brésil, et San José, Costa Rica

Los niveles de coordinación y competitividad en el transporte público colectivo de las áreas metropolitanas de Recife, Brasil y de San José, Costa Rica

J.J.G.de Aragão – *University of Brasília, Brazil*

C.Contreras-Montoya – *Transport Division of the Ministry of Public Works and Transport, Costa Rica & Federal University of Rio de Janeiro, Brazil*

O.Lima Neto – *Federal University of Pernambuco, Recife, Brazil*

ABSTRACT: This paper aims to discuss two issues that have inflicted some inefficiency in Latin American urban public transport regulation: firstly, the lack of co-ordination between the authorities competent for different governmental resorts that are relevant for transportation administration (i.e. administration of infrastructure, traffic and urban development); secondly, the lack of any competitive stress that could lead the incumbent firms the struggle for more productive efficiency. These two aspects are analysed in two case studies, namely those of Recife Metropolitan Area (in North-eastern of Brazil), and of San José (Capital City of Costa Rica).

RÉSUMÉ: Dans cet article on présente une discussion sur deux facteurs qui ont entrainés de problèmes d'inefficacité réglémentaire aux transports publics urbains de l'Amérique Latine: le manque de coordination entre les autorités responsables et le manque des éléments de concurrence entre les entreprises ce qui pourrait les mener vers une efficacité plus productive. Ces deux aspects sont analysés dans deux études de cas, à savoir ceux-là de l'Agglomération urbaine de Recife (dans du Nordest du Brésil), et de l'Agglomération urbaine de San José (capitale de Costa Rica).

RESUMEN: El objetivo de este trabajo es discutir dos características que han provocado problemas de ineficiencia en la reglamentación del transporte público urbano en América Latina: deficiencia en la coordinación entre autoridades gubernamentales y falta de incentivos a la competitividad entre empresas operadoras para promover la búsqueda de una mayor eficiencia productiva. Estos aspectos son analizados en los casos de las regiones metropolitanas de Recife (en el noreste del Brasil) y de San José (capital de Costa Rica).

1 INTRODUCTION

In Latin America, public transport services are usually regulated by the legal public concept of public service, inspired by French Administrative Law. Nevertheless, some countries have pursued a radical deregulation policy; in others, the governmental organisational capacity has not been able to enforce the regulatory order, and thus the sector has become actually deregulated, despite of the existing regulation.

Brazil and Costa Rica are known as countries that have been so far able to keep a regulated system, where public transport authorities have broad planning competencies (although in some Brazilian cities, these authorities are being increasingly challenged by illegal operators; on the other side, regulations and regulators are almost fully captured by the established, i.e. regular bus operators).

The present contribution aims to discuss two issues that have inflicted some inefficiency in Latin American urban public transport regulation: firstly, the lack of co-ordination between the authorities competent for different governmental resorts that are relevant for transportation administration (i.e. administration of infra-structure, traffic and urban development); secondly, the lack of any competitive stress that could lead the incumbent firms the struggle for more productive efficiency.

With respect to the first topic, the problems due to the lack of co-ordination are particularly severe in Metropolitan Areas, as they include also the general lack of co-ordination between the different municipalities. However, some cities have experienced some co-ordination efforts by building up Metropolitan Councils or Authorities (general or sector specific ones). In other cases, regional or central Governments take over directly the co-ordination task.

The other issue is the lack of competitiveness. Although some regulations foresee a formal and rigorous selection procedure of the operators to be contracted by the authorities, these rules are rarely applied and the operation remains in the hand of long established groups that are not challenged enough to produce more effectively and to transfer productivity gains to general society.

These two main thesis are analysed in two case studies, namely those of Recife Metropolitan Area (in North-eastern of Brazil), and of San José Metropolitan Area (the Region of the Capital City of Costa Rica).

2. THE CASE OF THE METROPOLITAN AREA OF RECIFE

2.1 *The Metropolitan Area of Recife: an Outline*

In 1991, in the year of the last census, the Metropolitan Area of Recife (MAR) counted a population of over 2,8 million souls, which was distributed among 12 municipalities over an area of 2,201 square kilometres. The Core City Recife itself had a population of 1,3 million inhabitants and an area of 209 square kilometres.

Recife has suffered during the last decades a phenomenon most common in other cities of Latin America: a shift of the population towards the periphery and a rapid motorization (COPPETEC 1996).

Between 1980 and 1991, all satellite towns of the MAR had a larger mean annual growth rate than the core city (whose per annum rate was 0,66%, compared to 1,81 of the whole MAR). In 1991, the population of the core city accounted for 45,2% of the population of the MAR, whereas in 1970 and 1980, it had been 57,8% and 50,4%, respectively. And as it is also common in other Latin-American cities, the periphery is the typical habitat of the lesser income groups, which have to content themselves with areas where the infrastructures are relatively poor.

2.2 *The Public Transport System in the MAR*

The regular transit system of the MAR is compounded by bus and rail systems, whereas the bus absorbed in 1996 92,7% of the total transit patronage, leaving for the rail system resting 7,3%. The mean daily amount of passengers in a workday was in the same year 1,7 million.

In this same year (to which all other data will refer here, if not announced otherwise), the bus fleet had 2.271 vehicles and supplied a total of 20.339 schedules in a workday along 359 lines; the average age of the vehicles was 3,66 years.

If we concentrate on the bus system, its service could be evaluated as fair to good, as the fleet is relatively new, and 99,65% of the planned trips had been fulfilled as planned.

Nevertheless, this system is being increasingly challenged by informal operators, which compete with their vans, offering a relatively direct, flexible and quicker service; as the busses do not have at their disposal exclusive lanes and busways as e.g. in Curitiba, they get stuck in the same congestion as individual transport (and the vans) but have to attend in addition a large number of stops. In several satellite municipalities of the MAR, the informal transport has supplanted the formal system (COPPETEC 1996).

2.3 *The Institutional Structure of the Transit Administration in the MAR*

In Brazil, administrative competencies regarding to public transport are clearly defined and subdivided. Whereas the Union is in charge of the intestate transport, the state itself rules over the intermunicipal services, leaving for the municipalities the (intra) municipal ones. Of course, this apparently straightforward structure poses problems in metropolitan areas, as different municipal administrations are involved in the supply of the services, which should be treated as a common and integrated system.

For this purpose and also for the co-ordination of the different other services of common interest (e.g., sewage, power, etc.), the military regime which ruled Brazil between 1964 and 1985 had determined that the nine larger cities of the country should build up so-called Metropolitan Regions (RM's), and Recife was included in this list. These RM's would be ruled by special councils (one deliberative, the other consultive), headed by the respective State Government, but with participation of the mayors.

With particular respect to public transport, the regime had tried to build up metropolitan transit authorities (*Empresas Metropolitanas de Transporte Urbano - EMTU*), whereby the municipalities, which were constitutionally in charge of the service, would pass their authority by means of a convention to the State Government. As at this time the State Governor nominated the mayors of the state capital cities, this would be done without any resistance; the problems lied with the satellite municipalities.

Actually, this uniform model, imposed by central order, has had weak success, and many metropolitan authorities that have been built up have been dismantled once the regime was over.

Recife's EMTU, however, has been able to survive, maintaining the metropolitan rule over the intermunicipal bus service within the MAR (whereas the services to and between the municipalities outside the MAR are in charge of the State Road Administration – DER), as well the municipal service of the City of Recife. The satellite cities have so far refused to join their municipal services to the EMTU scheme. Also the rail system (run by the federal enterprise CBTU) and the taxi, school bus and contracted transport services remained outside the scope of EMTU's duties. The City of Recife had until recently an own bus company (CTU), which was also supervised by EMTU; but it has been privatised in 1999. All the other municipalities administrate their own internal bus system; some of them have at least celebrated conventions for operational and technical co-operation with EMTU.

Thus, created by the State Law no. 8.043 of the year 1979, the EMTU/Recife has gained broad competencies regarding to the metropolitan bus transit, to its bus terminals and even to planning of the street and road infrastructure that would be in interest of the transit service.

Presently, EMTU/Recife is subordinated to the State Secretary for Infrastructure, but its functions are also supervised by the Metropolitan Council for Urban Transportation (CMTU), which is headed by the Secretary of Infrastructure and composed by the State Secretary for Planning, the Head of the EMTU, by the mayors of the MAR, by representatives of the CBTU, representatives of the State and of the Municipal Legislative of the City of Recife and of two other satellite municipalities, further by representatives of the syndicate of the bus operators, the union of the road transportation workers, of the State syndicate of the industry (FIEPE) and of the community.

The description of the institutional structure with respect to transportation in the MAR would be incomplete without mentioning the Development Foundation for the Metropolitan Region of Recife (FIDEM), which is in charge of the overall planning actions for the MAR, especially of those which are in the scope of "the common interests" of all the metropolitan municipalities . As transportation infrastructure has been defined to be within this scope, this Foundation has also a say in the metropolitan transportation policy, particularly in the policy for public transportation; on its turn, FIDEM is supervised by the Metropolitan Council (CONDERM), which is composed by all the mayors of the MAR and by several State Secretaries. CONDERM on its turn has an own Technical Chamber for Transportation.

All in all, we can therefore observe a very complex administrative structure regarding to the competencies in the public transportation sector within the MAR, although Recife have had the luck to preserve the metropolitan administration at least in the main part of the public transportation service.

Nevertheless, to build up clear administrative structures is one thing. Quite another story is the daily struggle of the authorities to gain technical and political capacity to run properly their business and to control effectively the services run by (now entirely) private operators. This is the topic of the next section.

2.4. *Public Transport Regulation: a Law Against Competition?*

The bus service under control of EMTU is ruled by the State Decree no. 14.846 of the year 1991 and several other detailed resolutions. In general, as in all other cities of Brazil, public line transport is regarded as a public service, which shall be executed directly by government or be delegated by means of a concession or permission, preceded by a tendering process (Article 30 of the Federal Constitution). So the respective authorities remain with the full planning functions and the competence to determine the fare prices.

But actually very few cities have executed tendering procedures; moreover, they have continuously renewed the permissions (which is now forbidden by the national legislation), without even imposing any conditions e.g. the attainment of productivity and/or quality indicators for this. The result is that the industry in the different cities sector has been progressively captured by incumbent firms, which have undergone a historical concentration process, but have little incentive to improve their productivity levels (Brasileiro *et al.* 1999). In 1995, a new legislation on public procurement was issued, imposing the execution of tendering procedures for every administrative and concession contract (Laws no. 8.987 and 9.074); notwithstanding, very few cities have executed them, as the operators have been so far successful in impeding this by different means (Aragão & Brasileiro 1999).

In the case of Recife, the metropolitan regulation has imposed productivity benchmarkings for the renewal of the permissions (and even for the length of the renewal). This is an important progress in relation to other cities, where even these conditions are absent; but still, it goes against the national regulation, as the contracts have so far not been awarded by proper tendering procedures. These are foreseen by the metropolitan regulation only for the case when a contract is not renewed or suspended by failure of the operator. Equally, the metropolitan regulation foresees permanent renewal of the permissions, if the operators comply with the minimal benchmarkings; but this runs also against the national legislation, as contracts with undetermined period are not admitted by this.

The metropolitan regulation has also introduced the concept of "service" or "influence areas", which are awarded to the different operators and create local exclusivity rights for the respective incumbent firm (Article 26). Only the centre of the City of Recife is excepted from exclusivity rights for any firm. The regulation admits also that the firms can interchange between themselves the line services, avoiding thus the execution of a tendering procedure, if any company desires to quit a particular line.

With respect to fare prices, these are determined by CMTU, on the base of a cost table (cost-plus system), which is detailed by a proper "Operations' Handbook". There is also a cross-subsidy system between the different lines and even between the different firms. The respective regulation determines that the reward of each firm shall be based upon the operational costs but also upon productivity indicators, which is an unique incentive system compared to other Brazilian cities.

3. THE CASE OF THE METROPOLITAN AREA OF SAN JOSÉ

3.1 The Metropolitan Area of San José: an outline

The Metropolitan Area of San José (MASJ) lies within the Province of San José, one of the seven provinces into which Costa Rica is subdivided. Presently, this area has a population of about 1.1 million and is compounded by 11 cantons (which are equivalent to municipalities) spread over an area of 365 square kilometres. The core municipality (San José Central Canton) itself has a population of more than 300,000 inhabitants and an area of 45 square kilometres.

The population of the MASJ makes out 30% of the total national population and is concentrated in an area smaller than 1% of the national territory; the resulting demographic density is therefore over 3000 inhabitants per square kilometre. On its turn, the core municipality shows a density of 9500 inhabitants per square kilometre and is the residence of 30% of the population of the MASJ.

The mean annual growth rate of the population has been of 2.3% during the seventies and eighties (INICEM, 1995), but in the recent years, there have been strong distortions because of the immigration from the neighbour countries. Thus the usual structure where people with lesser income live in the peripheries, which have poorer infrastructures, can also be found in the MASJ; but these classes have been concentrating themselves in those very areas where the authorities responsible for social housing have developed in the past major projects, as it is the case of the Alajuelita-Hatillo and Pavas communities; thereby, the immigration wave has turned the problems more acute.

3.2 The Public Transport System in the MASJ

Presently, the public transport system of the MASJ is made up of bus lines and, at a lesser degree, of minibus (between 26 and 44 seats) and "microbus" (between 9 and 25 seats) services; all of them are operated by private companies owning concessions or permissions. In the year of 1996, according information from the Direction for Technical Studies of the Ministry for Public Works and Transportation (MOPT), the total bus fleet counted 1038 vehicles, which offered a total of 226,339 of schedules per month and transported a monthly total of 16.65 millions of passengers along 130 lines. The fleet of minibuses and "microbuses" counted on their turn 187 vehicles, which transported per month a total of 1.89 million passengers in 49,443 schedules along 30 lines.

Presently, 75% of the motorised trips during the peak hours are executed by public transport, 25% by individual transport, and 5% by taxicab services. The total daily amount of trips sums up to 1.2 million. Accordingly to the national vehicle licensing data, the national bus fleet (including the minibuses and "microbuses") has shown a geometrical growth rate of 8.59% in the years between 1987 and 1996; this mean that this very fleet has doubled within nine years.

The informal services by "microbuses" and vans have been growing strongly during the last years, and this by the same reasons as those appointed in the case of Recife, but without supplanting the formal system in any community. This kind of service has rather been flourishing in such a type of communities like Pavas, which has been mentioned before. Another kind of service which has developed itself very quickly is the informal taxicab running along pre-defined lines and competing with some formal transit lines, but doing this with vehicles in very poor conditions.

3.3 The Institutional Structure of the Transit Administration in the MASJ

On the ground of historical, political and geographical reasons, the governmental actions concerning infrastructures and transportation services (including public transport) are defined by the Ministry for Public Works and Transportation (MOPT), which was created by the Law no. 4786 of the 5th July 1971.

Public transport itself is ruled by the following statutory framework:

- Law no. 3503, called Regulation for Rewarded Passenger Transport by Automotive Vehicles, promulgated on the 10th May 1965;
- Law no. 5406, called Regulation for Rewarded Passenger Transport by Taxicab Vehicles, promulgated on the 31st October 1973;
- Law no. 6324 (Transport System and Road Safety Administration Law), promulgated on the 24th May 1979;
- Traffic Law (no. 5930) of the 13th December 1976, but reformed by the Law no. 6249 of the 2nd May 1978, by the Law no. 6529 of the 18th May 1978 and by the Law no. 7331 of the 30th March 1993.

The Law no. 3503, which concerns the rewarded passenger transportation, establishes that this kind of service is a public service to be regulated, controlled and overseen by the MOPT. But it is also defines that the execution of this service may be delegated by the Ministry to private operators, strictly according to the rules established by this same Law. Moreover, it regulates the different aspects related to the rewarded passenger transportation by bus, minibus, "microbus" or by all other modality supplied on ways, streets and highways within the national territory or outside of it, provided that at least one terminal point lies within the national territory.

The Transport System and Road Safety Administration Law (no. 6324) has on its turn created the Road Safety Council and redefined the competencies of the Technical Commission for Transportation (CTT), which had been created by the formerly mentioned Law. Some of the most central competencies of this Commission are to award the permissions, to extend their validity periods, to suspend, to modify or even to revoke them; and also to determine and to adapt the fare prices.

The Provinces themselves have no competencies regarding to the public transport service, and the municipalities at most build up Transportation Commissions, which contact the officers of the Ministry, when traffic signs and some the itineraries of lines within the respective municipalities are concerned; in some cases, they reach over pledges by local associations with respect to the creation of new lines or to the modification of the existing ones.

The Municipality of San José, by contrast, has some co-ordination functions in co-operation with the MOPT and other institutions, all within the statutory rules. Recently, as direct election of the mayors has been introduced, the main municipalities have gained some space for action within the MOPT structure, as for example to have a stronger presence at Commissions like the CODEGAM, where different institutions are represented and define together with the MOPT the directives for the transportation policy in the so-called Great Metropolitan Area (GAM), which includes parts of other provinces which are neighbour to that of San José. Before that, some measures had already devolved some powers to the municipalities, as it is the case of the Law no. 3580 of the 13th November 1965, which empowered the municipalities to collect parking fees on the streets.

The CTT Commission is directly subordinated to the MOPT; but the Regulator Authority for Public Services (ARESEP), which was created by the Law no. 7593 of the 5th September 1996, has gained the competence to approve the fare policy proposed by the CTT.

3.4 *Regulation and competition in the public transport industry of the MASJ.*

As mentioned before, in Costa Rica public transportation is defined by Law as a public service, which is regulated, controlled and overseen by the MOPT, whereby the direct execution of the services may be within the competence of a public operator or be delegated to a private one. The planning functions and the competence to determine the fare policy remain with the authorities.

Beyond the mentioned Laws there is a lot of complementary decrees which confirm the legal framework. But it would be relevant to point out the absence of more specific regulations for these Laws; thus many procedural aspects remain unclear.

By the rule of Law, the delegation of the services is to be awarded by a formal tendering procedure (Chapter IV of the Law no. 3503; and Chapter XII of the Law no. 7593); hereby, the duration of the concession is seven years, but it can be renewed.

The Law admits also the permission without tendering procedure, which is regarded as precarious and should be theoretically used only in extreme case of necessity, while the proper tendering procedure is under preparation. But historically, this legal duty has been hardly observed as a result of direct political pressures by the private operators or of lack of political definition by the MOPT itself. This fact has led to a multiplication of the permissions and to the systematic renewal of the concessions, without establishing clear efficiency and quality targets (Contreras 1998).

Exceptionally, between 1991 and 1993, a great lot of lines in the MASJ that were operating on the grounds of permissions has been submitted to tendering procedures; but again, the mentioned targets have not been established.

The fare prices are determined line by line by the CTT, whose proposals are then submitted to the Regulator Authority ARESEP (Law no. 7593); the respective calculations are based upon a cost table which considers the service production costs and a fixed surplus rate (*cost-plus* approach).

By mistake, this method has been called "econometric model"; but actually, this model shows little concern for assuring that the services are executed in an efficient manner.

In 1997, ARESEP has contracted a private consulting company in order to develop a fare model, which takes in account quality criteria.

4. FINAL CONSIDERATIONS

All in all, we could resume the assessment of the regulatory regime in the bus industry of the MAR and MASJ by saying that it introduces a closed shop into the industry, bypassing and even going against the national legislation, as tendering procedures are not executed and permissions, or concessions, unduly renewed.

In the case of the MASJ, the fact that the majority of the concessions arrive at its end in the year 2000, is an important opportunity to obtain a more productive and efficient system through a competitive tendering process, with rules and time limit technically reasoned under concepts of competitiveness and quality.

Although ruled by the principle of public service, which does not exclude the search for efficiency and even for competition, the transit market in both areas is thus not competitive, and the effect of this is that productivity efforts are weak; eventual productivity gains by one or other more modern firm are anyway not transferred to society by means of lower fare prices.

In the long run, this kind of industry risks to suffer a deep political and economical demoralisation, and the growth of the informal sector is a clear sign that the society will not be forever indulgent with this captured industry.

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Public sector – private sector partnership – The immediate solution to problems of urban transport

Association entre le secteur public et le secteur privé – La solution immédiate aux problèmes de transport urbain

La sociedad del sector público – sector privado – La solución immediata al problema del transporte urbano

Pradeep Singh Kharola & Bipin Gopalakrishna
Bangalore Metropolitan Transport Corporation, India

ABSTRACT: In India, urban transport has been the monopoly of Government companies. Caught between providing low-fare transportation to the urban poor of Indian cities and being a model employer giving high wages with job security to employees, government companies are struggling to break even. A partnership is now being sought with the private sector to remedy the situation. Private enterprise with increased managerial efficiency and reduced costs combined with public sector values will provide an immediate solution to the problems of Urban Transport. Bangalore Metropolitan Transport Corporation (BMTC) began a scheme of hiring private buses that has been working extremely well. This paper analyses the working of the private operator scheme and presents a detailed economic and financial review, and concludes that this could well mark the beginning of a long and fruitful partnership between the public and private sectors in Urban Transport.

RESUME: En Inde le transport urbain a le monopole des sociétés contrôlées par l'Etat. Ces sociétés jouent le double rôle de fournir un tarif réduit à un public économiquement faible du secteur urbain des villes indiennes et de devenir un employeur modèle qui assure un salaire élevé avec la sécurité de l'emploi. Elles ont ainsi la difficulté de maintenir le point de rentabilité. Une tentative d'associer avec le secteur privé est en cours de se mettre en place afin de trouver une solution à cette situation. Une entreprise privée avec une efficacité de gestion accrue et des tarifs réduits conjugués aux valeurs du secteur public fournira une solution immédiate aux problèmes du Transport Urbain. *Bangalore Metropolitan Transport Corporation (BMTC)* a commencé un système de location des autobus privés qui marche très bien. Cet abrégé procède à une analyse du fonctionnement d'un projet d'opération privée et présente un bilan financier et économique détaillé et infère que cette tentative pourrait débuter à une association à long terme rentable entre le secteur public et le secteur privé en ce qui concerne le Transport Urbain.

RESUMEN: En la India, las companias de Gobierno han sido el monopolio del transporte Urbano. Sorprendida entre la Condicion de un transporte barato para los urbanos pobres de las ciudades de la India y ser un ejemplo de patron dando un alto salario con trabajo seguro para los empleados, las companias del Gobierno luchan para cubrir gastos. Para dar solucion al problema se ha asociado con el sector privado. Empresas privadas con una gran capacidad de administracion y reduciendo los costos daran una solucion inmediata al Trasporte Urbano. La Coperativa de Trasporte Metropolitana de Bangalore (BMTC) ha comenzado un projecto alquilando autobuses privados qua han estado operando muy bien. Esto analiza que el projecto de los autobuses privados presenta un resumes economico y financial, y que puede ser el comienzo de una larga y fructifera asociacion entre el transporte publico y privado en el sector del Transporte Urbano.

1 BACKGROUND

Public transport has been facing many challenges in different parts of the world, especially in the cities of developing countries. The public transport system of India is no exception. The bus-based transport systems here, have been criticized, on the one hand, for not creating adequate capacity and not providing quality services to the commuters and on the other, for costing too much to the taxpayer.

The public transport sector in India was totally regulated until the end of the 70s. Services were operated either by government companies or by private individuals who were given permits by a regulatory agency. From the early 80s, the entry of private capital into the transport sector was encouraged largely because government was unable to cater to the increasing demands of a burgeoning population. In the large metropolitan cities of India, however, government owned bus companies continued to enjoy a monopoly. Fares were deliberately kept low for the millions of low-income passengers. The low fare structure coupled with high government salaries that employees were paid led to a very uneconomic and inefficient public transport system. As a result, people began to fend for themselves. Private vehicle ownership increased exponentially over the years leading to traffic congestion and increased levels of pollution. This in turn adversely affected the already fragile finances of the bus companies as commercial speeds and utilization of buses reduced considerably.

Confronted with these problems, many Governments have taken decisions to change the general organisation of public transport. Most important of these restructuring decisions have focussed around "De-regulation and Privatisation".

In a government dominated system de-regulation means privatisation. Privatisation can be brought into the system in many forms. At one extreme are laissez faire operations where public authorities have little or no control and market forces determine the fares and services. This system exists in several medium sized Indian cities where smaller vehicles like minibuses, with carrying capacities of 15, and three wheel tempos with carrying capacities of three passengers, are used to supplement the grossly inadequate government owned public Transport. Commuters are generally at the mercy of these unscrupulous operators and pay whatever is demanded. Dependence on such a system leads to chaotic conditions with passenger needs, comfort and safety taking a beating.

Another widely accepted form that privatization can take is competitive bidding. Today, most cities of the developed world have taken recourse to it. In this system, the public authority purchases transport services from the competitive market, awarding contracts to the most economical, responsible and responsive bidder. Buses are therefore owned and operated by private operators. The public authority, however, retains full control over policy, routes, schedules, fares and service decisions. Competitive tendering results in reduction of operational costs as the induction of private entrepreneurship brings in competitiveness and efficiency. It has proved to be highly successful in many European and American cities. The introduction of a similar system in cities of India, however, poses certain problems. Competitive bidding requires cities to have reached a certain degree of stability so that the bidder can evaluate the immediate future scenario with reasonable certainty. In fast growing cities of developing countries, where growth is haphazard and unplanned, introduction of competitive bidding becomes difficult. Also, the system is successful only when the private buses are monitored closely to ensure that all the conditions imposed by the Authority are fulfilled. Monitoring and enforcement are very difficult in crowded cities of the developing world.

In New Delhi, the capital city of India, the Delhi Transport Corporation (DTC) attempted another version of the privatization in 1969-70. DTC, which had been expanding its fleet to meet the demand by a wet-lease of private buses, began to hire out the routes instead. It allowed private operators to ply the routes in return for a fixed daily 'operational charge'. The results were not satisfactory, as competition on the roads led to complaints of rash driving, overloading and rude behaviour. The scheme was wound up in 1976. Again in 1992, DTC introduced another model of privatisation. Under this scheme, private operators, who were given routes by draw of lots, brought in 3000 buses. These operators charged fares prescribed by the DTC. On the financial front the scheme was a success for private operators who made profits while DTC buses plying on the same routes made losses. Although the private operator made money, the quality of service was bad, accident rates were high and the passenger dissatisfied. As the enforcement system was totally inadequate, few private operators also started to manipulate records resulting in excess payments.

From the above analysis it is evident that privatisation alone cannot provide clear-cut solutions to the problems of urban transport. Undeniably, privatisation brings in its wake increased efficiency, reduced costs and higher profits. All this is meaningless to a passenger if affordable fares, travelling comfort and safety are not a part of the system. A system that combines public sector values with private sector efficiency is therefore the only way out.

Bangalore, called the Silicon Valley of India, is the fifth largest city in India, with a population of 5 million. With a high growth rate, it is becoming the fastest growing city of Asia with the population expected to cross the 10 million mark by the year 2010. Bangalore Metropolitan Transport Corporation (BMTC), owning a fleet of 2200 buses, provides public transport services to the people of Bangalore. The inadequacy of the fleet both quantitatively and qualitatively is manifested in the fact that there are 750,000 registered two-wheelers in the city. This clearly indicates that the public transport system has not lived upto expectations, and that the people have begun fending for themselves. BMTC has been unable to cope with the demand because of the unviability of its operations due to low fares and high cost of operations.

It is against this background that BMTC has embarked on a project of inducting private capital to augment fleet strength and cater to the increasing travel needs of the people of Bangalore. Although private operators had already entered the fray, their operations were illegal, substandard and uncontrolled. The elimination of these unscrupulous persons from the market was also to be achieved by this private capital project.

BMTC took the major step of inducting private capital and entrepreneurship in 1997. The first batch of 4 buses was run for BMTC in December-1997. From then on, to the end of 1998, 34 buses were provided for operations and another 64 by the end of June 1999. Today this number stands at 102 with applications for another 400 buses being processed.

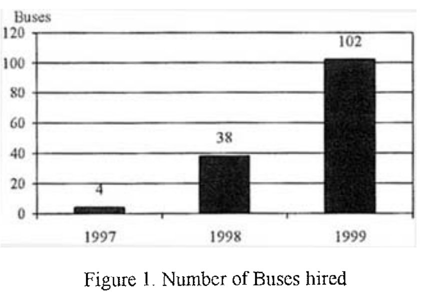


Figure 1. Number of Buses hired

From the Figure 1 it may be seen that the scheme began in a small way in December 1997. Soon it showed a smart rise resulting in 102 buses being hired in a little over one year. The upward trend will continue when the 400 pending applications are processed.

2 THE SCHEME OF HIRING OF PRIVATE BUSES

2.1 Salient features of the scheme of BMTC.

Private operators can offer their buses on hire to BMTC for a fixed period of five years. A

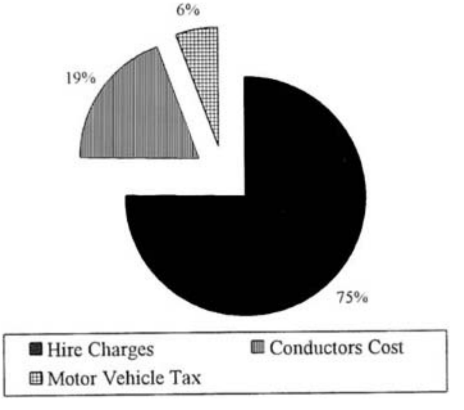


Figure 2. Components of Cost

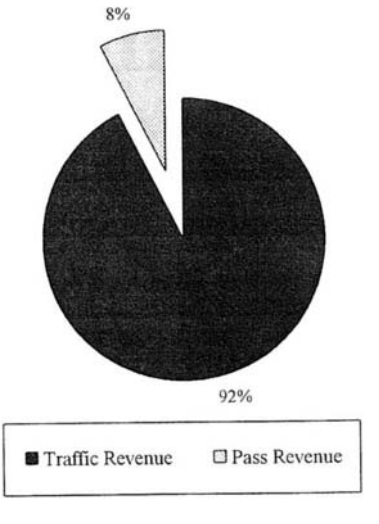


Figure 3. Components of Revenue

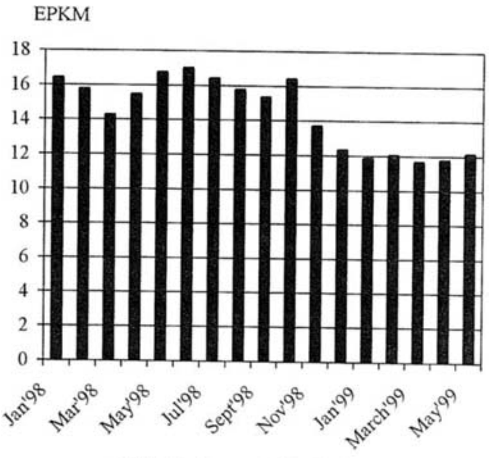


Figure 4. Earnings per kilometer of Private buses

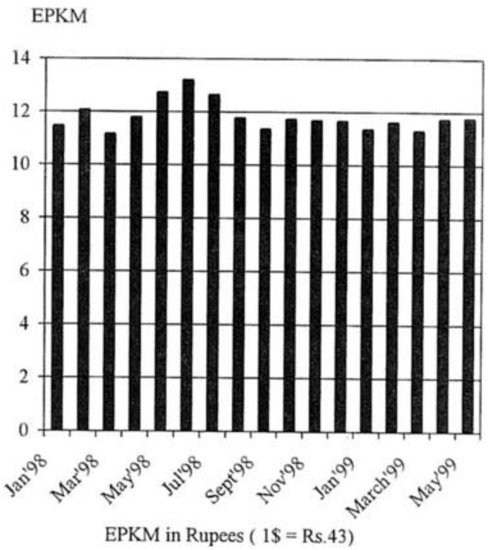


Figure 5. Earnings per kilometer of BMTC owned buses

commitment has been given for 5 years to enable them to get sufficient returns on investments. The buses have to be brand new ones fabricated under the supervision of BMTC.

The operator has to provide the bus and the driver. All costs of consumables and repairs have also to be met by him. BMTC provides the conductor and collects ticket revenue. The operator is paid to run his buses on the prescribed route without having to worry about ticket sales. This ensures that buses run properly as per a prescribed time schedule.

The minimum number of buses that an operator must run is ten. This has been done to ensure that only serious operators participate in the scheme and that they enjoy economies of scale.

The private operators are paid on the basis of kilometers (kms) operated. The rates payable per km have been arrived at after a detailed cost analysis. The note worthy feature of the scheme is that the rates have been linked to various indices. As the indices vary, the rates are adjusted automatically. This precludes the possibility of lobbying by the private operators for frequent rate increases.

BMTC ensures that a bus would be given a minimum of 250 kms per day. This gives tremendous security to the private operators.

3 ECONOMIC ANALYSIS OF THE SCHEME

To make an economic analysis of the scheme, a comparison has been made between the cost incurred and revenue earned. The CPKM (Cost Per kilometer per bus) includes the hire charges paid to the operators, cost of the conductor and Motor Vehicle Tax (Figure 2). Revenue comprises collection through sale of tickets and public passes (Figure 3).
Figure 4 and Figure 5 shows the monthwise EPKM (Earning Per Kilometer per bus) of private buses hired by BMTC and the buses owned by BMTC.

From the charts above, it may seem that the EPKM of private buses has declined over a period of time. This, however, is not true. To understand why EPKM appears to have declined, a study of vehicle utilisation (distance covered by a bus in a day) of these private buses is essential.

Figure 6 shows that vehicle utilisation has gone up from 205 to 300 kilometers. Initially the private buses were run on high density, high revenue city routes. When the operations stabilised, they were shifted to long distance, sub-urban routes. This explains the increase in vehicle utilisation and consequent decrease in EPKM. From the diagram it is evident that the EPKM has now got stabilised around Rs 12.00 (US$ 0.28 or 28 US cents).

A comparison of the (EPKM) Earnings per kilometer and CPKM (Cost per kilometer) of private buses is shown in Figure 7.

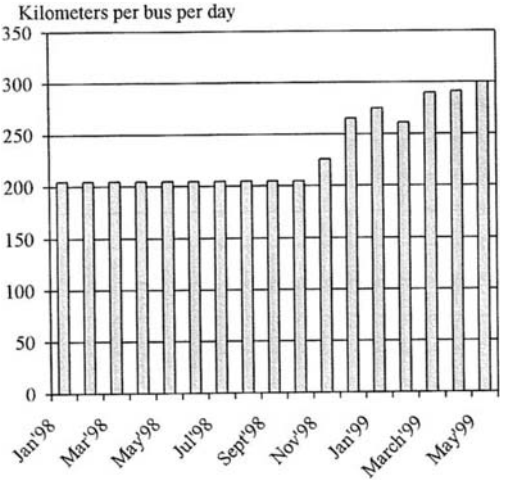


Figure 6. Month-wise Average Kilometers per bus per day

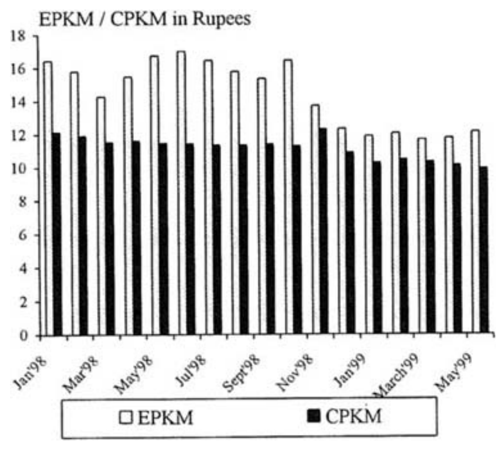


Figure 7. Earnings per kilometer and Costs per kilometer of private buses

Two conclusions can be drawn from the above diagram. First, the EPKM has been higher than the CPKM throughout. Secondly, both EPKM and CPKM have declined initially and then stabilised.

This behaviour of EPKM has been explained before. Similarly, the CPKM also has dropped as the kilometers assigned to each bus per day have increased. The rate being paid to the private operator has been made a function of kilometers covered per day as is evident from Figure 8. (Fixed Cost per day does not increase with the increase in kilometers performed per day).

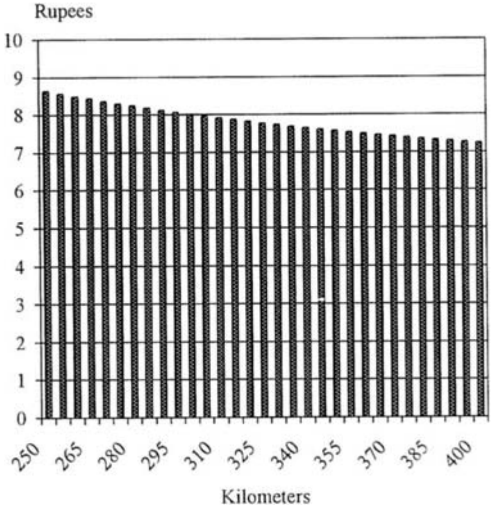


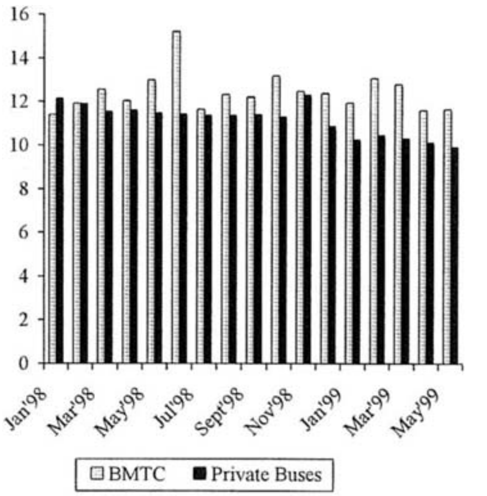
Figure 8. Rates payable for different Kms.per day

The rate per kilometer is linked to vehicle utilisation to ensure that the private operators do not always clamour for long routes. It is apparent from the above figures that BMTC is gaining financially from this scheme. Figure 7 clearly depicts the profit made by BMTC per kilometer. The gross profit from the day of inception until the end of May, 1999 works out to Rs.11.8 million.

4 COMPARISON WITH THE CPKM OF BMTC

Although the above analysis has established that the hiring of private buses has proved to be profitable for BMTC, its real benefits can be guaged only if cost of these operations are compared with the cost of the fleet of BMTC. This is so because if buses run on high density routes, the EPKM would be high and profits will be made. On such routes even a BMTC owned bus would register high gains.

Figure 9 shows that the hiring of private buses is extremely beneficial to Government Transport Companies (GTCs) financially. The CPKM of BMTC varies on a monthly basis because some payments to employees like bonus and wage arrears are made in some months while in the other months the employees get only their salaries. The CPKM is around Rs.13 while it is only Rs.10 when private buses are hired. There is an average clean saving of Rs.3 per km in costs when BMTC hires buses.



CPKM in Rupees (1$ = Rs. 43)

Figure 9. Comparison of Cost per Kilometer of BMTC with private buses

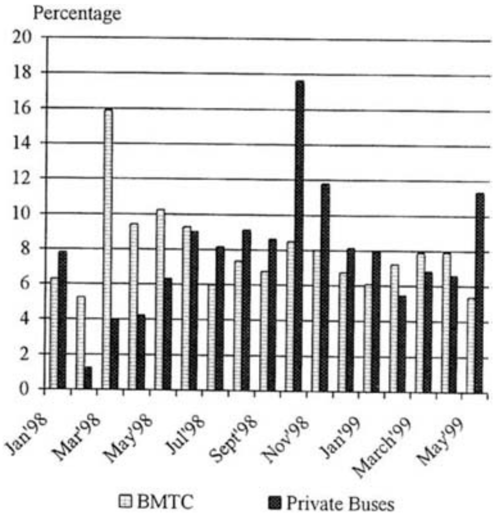


Figure 10. Comparison of Cancellations of Private buses with BMTC

5 ADVANTAGES

The hiring of buses has resulted in substantial cost savings. There are 102 hired buses plying under BMTC colours generating savings of Rs.3 for every km that they run, vis-à-vis BMTC owned buses.

There is no investment on garage and repair facilities. To run an additional 102 buses at least one garage would have had to be opened. The cost of each garage that can accommodate 100 buses is about Rs. 10 million. By opting for private buses there is a notional saving of Rs.10 million to the Corporation. There is also no investment on buses.

The Corporation is relieved of the burden of appointing operational staff like Drivers, mechanics and supervisors.

During emergencies like strikes by workmen, at least some skeleton services can be provided by these private buses.

6 DISADVANTAGES

Some of the disadvantages of the scheme are as follows.

- Operators can claim money for kilometers not run by manipulating records in connivance with employees.
- Unauthorised trips may at times be made in the name of the GTC.
- Higher cancellations of scheduled kilometers will take place due to poor maintenance as shown in Figure 10.
- Drivers of operators are less amenable to control.
- Operators prefer light long routes to high density routes.
- Operators are unable to provide spare vehicles in case of repairs/ breakdowns.

7 PERCEPTION OF THE OPERATORS

While the scheme for private operators has been an unqualified success from the point of view of BMTC, it is necessary to examine how the operators perceive it. Their views have been ascertained and are enumerated below.

- Entry as fleet owners is facilitated by the total absence of red tape. There is absolutely no need to apply for permits, routes etc.
- The scheme is risk free as the returns on their investment are assured.
- The scheme helps in the generation of assets that can be liquidated after a period of 5 years.

- The operators derive great satisfaction from the employment they in turn generate.

- Rates offered by BMTC are low making it difficult to make ends meet. Such a situation has arisen because of initial over-invoicing and additional finance being taken. This has created an increased outflow in terms of interest.

- In accident cases vehicles are detained needlessly for days by law enforcement agencies causing avoidable expenses.

8 CONCLUSION

The scheme of hiring private buses is definitely a viable option to fund starved Government Transport Companies (GTCs). By it, the fleet can be increased without any investment or risk, at the same time generating profits. The heavy burden of overheads that is the bane of Government Transport Companies can be greatly reduced now. In this age of liberalization, when private participation is being encouraged, this scheme could be an excellent way in which private individuals can contribute effectively towards improving the public transport sector. The transport companies on their part should actively assist the operators in stabilizing their operations. Help could be extended to the operators to set up garage and repair facilities. Later, they could be given a role in revenue collection and certain routes could be tendered. This could be done in a phased manner.

The response from private operators has been encouraging. Applications for more than 500 buses, with an Earnest Money Deposit of Rs. 10,000 per bus, have been received. While many of them are keen to enter the hitherto closed transport sector, finance for the project was not readily forthcoming initially for a variety of reasons. With BMTC assuring financiers that the money earned by the operators would be put into their loan accounts making debt-servicing tamper-proof, the situation has improved considerably.

The GTCs must also use modern technology to regulate and monitor the operations of private operators. As the number of operators and buses increase, it will critical to their finances to ensure that operators are correctly paid. Malpractices could be prevented by a Vehicle tracking and Monitoring System using the Global Positioning System (GPS). Finally, for the scheme to succeed there must be a harmonious relationship between the GTCs and the private operators. In the long run they should be allowed to own, operate and maintain routes with effective supervision. The GTCs in the larger interest of the travelling public should retain the key segment of revenue collection, at least for the time being. Once they get exposed to private operations and private operators gain experience, a gradual shift can be made to the competitive bidding system.

Until such time, the partnership between public sector values and private sector efficiency, as implemented by BMTC, will certainly provide immediate solutions to the problems of Urban Transport in developing countries like India.

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Measuring congestion externalities in Brazilian towns – An exploratory study

Le mésurement des externalités de congestion de traffic dans les villes Brésiliennes – Une étude exploratoire

Midiendo las manifestaciones del congestionamiento en las ciudades brasileñas – Un estudio casuístico

E.A.Vasconcellos & W.A.P.Aquino
Associação Nacional dos Transportes Públicos, ANTP, São Paulo, Brazil

I.M.O.Lima
Instituto de Pesquisa Econômica Aplicada, IPEA, Brasília, Brazil

Cities in developing countries are facing increasing congestion and have no simple tools to measure its impacts and define proper solutions. The study developed simple and reliable procedures to measure congestion levels and related externalities, such as excess travel time, fuel consumption and pollutant emissions, and the impact on the cost of bus operation (the dominant mode). Current conditions were measured in ten middle and large Brazilian cities. It was found that every year, in the case of severe congestion (road capacity at full use), the ten cities waste 500 million passenger-hours and 250 million gasoline liters, and throw in the atmosphere 123,000 extra tons of CO and 11,000 extra tons of HC. Buses are severely damaged by congestion, with large cities having to place in service from 12 to 30% extra buses, with direct consequences on fares. The procedures may easily be used by developing countries, at low costs.

Les pays en voie de dévéloppement soufrent des problèmes croissants par rapports aux encombrements du traffic, n'ayant pas les moyens pour les mésurer et pour établir des actions correctives. L'étude dans dix villes du Brésil a proposé des procédés simples et sûrs pour mésurer les variables suivantes: emploi du temps, la consommation des combustibles, l' émission des polluants et les effets sur les coûts des autobus. Dans les conditions sévères d'encombrement, pour les villes étudiées il est gaspillé par an, 500 millions des heures et 250 millions de litres de carburant. Il est produit 123 milles tonnes de plus d' oxyde de carbone. Dans les plus grandes villes, il y a un accroît de 12% a 30% d' autobus qui sont mis en circulation a cause de l'embouteillage, aussi en entrainnant des côuts supplémentaires aux usagers. Les méthodes presentées peuvent être facilement utilisées dans les pays en voie de devélöppement.

Los países en desarrollo sufren problemas crecientes de congestionamiento y no disponen de instrumentos adecuados para medir el problema y proponer soluciones. El estudio analizó diez ciudades brasileñas y creó procedimientos simples y confiables para medir las consecuencias de los congestionamientos, tales como el gasto excesivo de tiempo, el consumo de combustibles, la emisión de contaminantes y el impacto sobre el costo de los ómnibus. El estudio estimó que las ciudades pierden por año, en condiciones de congestionamiento severo (a plena utilización de la capacidad), 500 millones de horas y 250 millones de litros de combustible. Son lanzadas a la atmósfera 140 mil toneladas más de contaminantes. Las mayores ciudades necesitan poner en circulación de 12 a 30% de ómnibus adicionalmente, con impacto directo en el costo para los usuarios. Los procedimientos desarrollados en el estudio pueden ser fácilmente usados por los países en desarrollo.

1. OBJECTIVES

Several developing countries are facing increasing urban transport problems, specially those in Asia and Latin America. The measurement of such problems is an important tool to support the decision making process. In the case of congestion, the measurement of its characteristics may be very expensive, when sophisticated equipment such as electronic data collectors from computerized signal systems may be required. Most of the middle to large cities in the developing world do not have such tools and therefore are not able to measure congestion levels in a permanent way. This is also the case in Brazil, who is facing a continuous increase in its urban population and automobile fleet, leading to the worsening of traffic conditions in middle and large towns, affecting quality of life and efficiency in urban areas.

The main purpose of the study was to develop simple and reliable procedures to measure current levels of congestion and estimate the level of congestion-related externalities, such as excess travel time, fuel consumption and pollutant emissions, and the impact on the cost of public transportation by buses (the dominant mode). A consequent objective was to devise actions to improve traffic conditions. The study was contracted by the federal government's institute IPEA (Instituto de Pesquisa Econômica Aplicada)[1] and performed by the Brazilian National Transit Association ANTP (Associação Nacional dos Transportes Públicos).

To develop this study, it was necessary first to arrive to a useful definition of congestion for the average conditions of Brazilian towns, using the large literature on the issue and the experience of local engineers, and then develop specific relationships between speed, fuel consumption and pollutant emission. Considering the lack of such studies in the country, this specific study had to develop such relationships for the first time, implying the risks attached to any pioneering experience. The intent was to walk the first step in the analysis of transport related externalities in the country, opening the space for future developments of the methodology. Therefore, the study has more a practical intent than a scientific one (in the sense of searching for rigorous statistical analysis), in order to arrive for the first time to reliable estimates of average congestion conditions and its effects in the selected towns. Further developments of the methodology can and should be pursued, to get to more detailed results of such effects. It is important to say that the methodology that was developed by the study may help other developing countries to analyse their current conditions, once it is a low-cost methodology and easy to apply. In this respect, future uses of the methodology may help improve it, as long as new experiences are added.

2. BASIC SURVEYS

The study of transport related externalities comprise a large set of issues (Litman, 1996; Maddison et all, 1996). In the case of developing countries, the most important are congestion and traffic accidents. The purpose of the study was to measure the current level of congestion in cities and estimate its related externalities. Four main effects were analyzed: travel time, fuel consumption, pollutant emission and public transportation costs. A fifth issue – the roadway space needed to accommodate extra traffic – was also analyzed in a first methodological attempt.

Ten cities were selected, considered their size, average traffic conditions and the local support to perform the required field measurements. The sample range from Juiz de Fora (400,000 inhabitants) to São Paulo (10 million inhabitants).

For each city, a main roadway system was identified, based on the local engineers' experience. This system was divided into routes, where the field measurements were made. In some cases (larger cities) the survey was performed in a limited number of routes, yielding average figures that were later transferred to the remaining roadways, according to their similarity. The final roadway systems were expected to represent 95% of the main system in each city (irrespective of volume/capacity ratio) and also 95% of the congested links in each city. A total of 2.627 km of roadways were surveyed, ranging from a minimum of 55 km in Juiz de Fora to a maximum of 816 km in São Paulo.

In each city, the following measurements were made:

a) Physical and operational road conditions: road geometry and pavement, length, existence of median, width of tracks and sidewalks, location of signals and bus stops, slopes, predominant land use;
b) Traffic volumes: traffic volumes were measured in selected points along the routes, during eight hours – from 6AM to 9AM and from 3PM to 8PM. Measurements comprised automobiles, buses and trucks. In some cities, recent available 24hs counting were used to estimate the intended eight hours measurements.
c) Travel times and delays: automobile and bus travel times and delays were measured in all routes with test vehicles (for automobiles) and embarked personnel (for buses), with a minimum of three runs per direction, per hour.
d) Vehicle occupancy: automobile and bus average occupancies were measured through samples taken every hour on the same points where traffic volumes were measured. For cars, the number of occupants was measured by direct visual observation on slow-speed conditions. For buses, occupancy was estimated also by visual observation, by classifying passenger density according to a previously defined scale of 20 passengers increments (0-20, 20-40 etc).

3. METHODOLOGICAL DEFINITIONS

3.1 Ideal travel times

There is a large literature on the analysis of travel time on urban roads (ITE,1985; TTI, 1996). The study adopted the concept of extra travel time, by comparing "ideal" and "actual" values. The definition of the former considered three main characteristics: the geometric/operational features of the road, the signal density and three levels of volume-to-capacity ratio.

In the first case, four classes of roads were defined: freeways, class I arterial, class II arterial and collector. Freeways follow the HCM definition (ITE, 1985); a class I arterial is represented by a divided roadway with signals, good pavement and high standard geometric conditions, no parking and effective bus priority schemes (either curb bus lanes of bus corridors); a class II arterial is a divided roadway with lower geometric and operational standards (for instance, parking is allowed in certain blocks) with buses having no special priority schemes; a collector road is undivided, with or without parking and no bus priority scheme.

With signal density, the analysis of the set of routes in the ten cities showed that it ranges from 1 to 7 in almost all cases and then the curves relating volume/capacity ratio and travel time were developed considering this range.

With the volume/capacity ratio, three levels were defined: 0.70/0.85/1.0. The definition of three levels was made to cover a wide range of congestion possibilities. The 0.7 level represented "light congestion", the 0.85 level "moderate congestion" and the 1.0 level "severe congestion". To estimate the extra time, for each congestion level an "ideal" travel time (per kilometer) was defined and then compared to the actual travel times measured on the street. The definition of the "ideal" travel times was made for each sort of roadway, and for automobiles and buses. Departing from a free-flow speed for each class or road, its respective travel time per kilometer was defined and then a higher travel time per kilometer was estimated for each volume to capacity ratio. Such travel time rate was then increased according to the number of signals per kilometer, up to 7 signals per kilometer (observed from the sample) . The average delay per signal was estimated as 12 seconds (considering an average cycle time of 80 seconds and 60% of green time for the main street) for the first 4 signals, with this figure being slightly decreased for a higher number of signals per kilometer, implying that some sort of signal coordination exists. In the case of buses, it was considered that they would always have an extra one minute travel time per kilometer than that of the automobiles, implying an average number of three stops per kilometer (observed from the route sample). These procedures yield a set of six curves of "ideal " travel times per kilometer, per type of roadway, level of congestion and for autos and buses. Such curves represent average conditions for each sort of roadway according to field observations and to the experience of each engineer or technician involved in the study. It may be improved or changed according to new studies or surveys. Examples of ideal relative travel times (minutes per kilometer) for automobile and buses, in the case of severe congestion, are given on table 1.

Table 1: Maximum relative travel times for automobiles and buses, severe congestion

Signals/km	Maximum travel times (min/km)					
	Arterial I		Arterial II		Colector	
	Auto	Bus	Auto	Bus	Auto	Bus
1	2	3	2,3	3,3	2,9	3,9
2	2,2	3,2	2,5	3,5	3,1	4,1
3	2,4	3,4	2,7	3,7	3,3	4,3
4	2,6	3,6	2,9	3,9	3,5	4,5
5	2,7	3,7	3	4	3,6	4,6
6	2,8	3,8	3,1	4,1	3,7	4,7
7	2,9	3,9	3,2	4,2	3,8	4,8

3.2 Fuel consumption

Two curves relating speed and fuel consumption were developed, for automobile and buses, using data from Brazilian sources (equations 1 and 2)

Speed-fuel relationship, automobiles [1]

$C = 0{,}09543 + 1{,}26643/V - 0{,}00029V$, where
C = fuel consumption (liters/km)
V = automobile speed (km/h)

Speed-fuel relationship, buses (Balassiano, 1980) [2]

$C = 0{,}44428 + 0{,}00008V^2 - 0{,}00708V + 1{,}37911/V + 0{,}00107carr$, where
C = fuel consumption (liters/km)
V = bus speed (km/h)
Carr = bus loading (passengers)

3.3 Pollutant emission

Several curves relating speed and emission were developed, for automobile and buses. For automobiles, the following pollutants were considered: Carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (Nox); for buses, to these pollutants the emission of particulate matter (MP) was added. This was one of the most difficult tasks once there are no comprehensive curves already developed for Brazilian conditions. The curves were then developed using results form laboratory tests made by the São Paulo agency for environmental action (Swarc e Branco, 1983) and French studies made at the INRETS institute (Joumard, 1991).

3.4 Public transportation costs

The impact of congestion on buses was estimated in two ways. First, the extra number of buses that have to run in order to keep the planned headway; second, the impact of such extra buses on the cost of the system (and hence on the bus fare). The increase in the bus fleet was estimated for the peak hours, for

Table 2: Equations for pollutant emissions according to speed, automobiles and buses.

Pollutant	Emission (grams/km)	
	Automobiles	Buses
HC	$-0{,}28 + 62{,}48/V$	$14{,}14 - 3{,}67 \ln V$
CO	$-0{,}45 + 727/V + 1{,}34*0{,}001V^2$	$43{,}34 - 8{,}98 \ln V$
Nox	$1{,}03 + 7{,}477*0{,}001V^2$	$37{,}21 - 6{,}46 \ln V$
PM	-------	$1{,}74 - 0{,}32 \ln V$

each roadway section, considering the extra travel time caused by congestion, according to the formula:

$DF = DTp * L * Freq$,
Onde:
DF = bus fleet increase (vehicles);
DTp = excess travel time (hours);
L = section length (km);
Freq = bus frequency (vehicles/hour).

The impact on the systems' cost was estimated considering that the variation in speed impacts fuel consumption (20% of total costs) and that the increased fleet impacts the fixed costs (50% of total costs). Considering that the average monthly distance run by the bus is inversely proportional to the fleet size, it was considered that if congestion were eliminated bus operating costs will be reduced according to the formula:

CR = {0,2 * Diesel consumption change) + {0,5 * Fleet change), with all changes expressed in percentage.

3.5 Extra road space

The space required to accommodate the extra number of vehicles was estimated for each congestion level considering that an automobile uses $60m^2$ while circulating and 15 m^2 while parked.

3.6 The use of the space

The use of road space by automobiles and buses on peak hours was compared assuming that autos carry on average 1.5 person and buses 70 people.

3.7 Expansion of hourly data

Data from hourly surveys were transformed into daily data and then into yearly data using proper coefficients extracted from the city's traffic profiles. Yearly values were found to correspond to 250 daily values. Data were also expanded to include congestion effects on side streets that cross main streets, using proper coefficients.

4. RESULTS

The most relevant results are summarized below, for the case of severe congestion only (volume to capacity ratio equal to 1). Should the other two congestion levels be considered (moderate and light) resulting figures would be higher.

4.1 Average system speed

Figure 1 shows the average weighted system speed for automobiles and buses, in the evening peak periods. Auto average speeds range from 44 km/h Brasilia to 17 km/h in São Paulo. Most cities lye in the range between 25 km/h and 30 km/h. In the case of buses, speeds range from 27 km/h in Brasilia, to 12 km/h in São Paulo, with most cities in the range between 18 km/h and 22 km/h. This is a special concern, once well organized bus corridors could yield to speeds in the range from 20 to 25 km/h.

4.2 Impact on bus fleet and costs

Table 3 shows that congestion is causing the need to offer an extra quantity of buses that goes up to 30% in in the evening peak in the case of São Paulo and has also serious effects in the case of Rio de Janeiro (13.5%) and Belo Horizonte (11.7%), the three largest cities in the country. If we consider that the operating fleet has to be defined considering the most pressing demand – that happens in the evening peak – then such fleet increase has direct impacts on the bus systems operating costs. The last column of table 4 shows that such impact goes up to 16% in the case of São Paulo, 10% in Rio de Janeiro and 6% in Belo Horizonte. This represents a direct impact on bus fares, that have to be paid by the users or supported by some sort of subsidy.

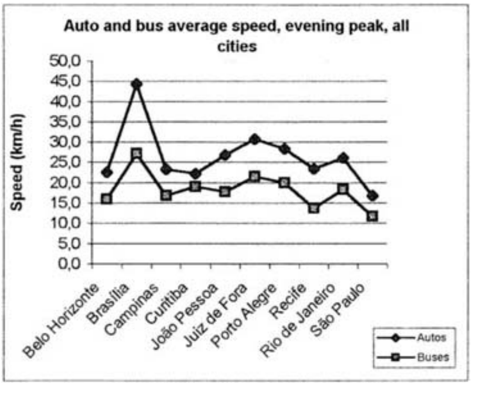

Figure 1: Average automobile and bus speed for each city, evening peak.

Table 3: Impact of severe congestion on bus fleet and operating costs on the three largest towns, evening peak.

City	Excess fleet		Impact on operating cost (%)
	Number	% of total fleet	
B. Horizonte	315	11.7	6.2
Rio de Janeiro	811	13.5	9.6
São Paulo	3,342	30.3	15.8

Table 4: Total and excess travel times under severe congestion, evening peak, buses and automobiles, Rio and São Paulo.

City		Travel time (pass-hours)			
		Total	Excess time with congestion		
			Light Concept	Moderate Concept	Severe Concept
Rio	Autos	65,604	16,288	13,135	10,113
	Buses	252,956	51,77	47,205	40,648
S. Paulo	Autos	212,056	124,415	116,842	107,323
	Buses	327,969	135,39	126,913	114,972

4.3 Excess travel time

Table 4 shows total and excess travel times for automobiles and buses in the evening peak hour for the three largest cities. Figure 2 shows the excess travel time in peak hours in relation to all travel time spent in the same period, for all cities.

Table 5 summarizes the annual excess time spent in severe congestion in the three largest cities. Brasilia, the nation's capital , shows a remarkably good condition. The most dramatic case is São Paulo, where automobile users spend 200 million extra hours and bus users spend 117 million extra hours due to severe congestion.

Table 5: annual excess travel time under severe congestion, selected cities, automobile and bus users.

City	Annual excess travel time in severe congestion (10^3 pass-hours)	
	Automobiles	Buses
Brasília	499	2,407
Campinas	3,507	2,452
Curitiba	2,819	2,366
João Pessoa	772	1,205
Porto Alegre	2,997	3,423
Rio de Janeiro	33,033	80,408
São Paulo	198,4	117,869

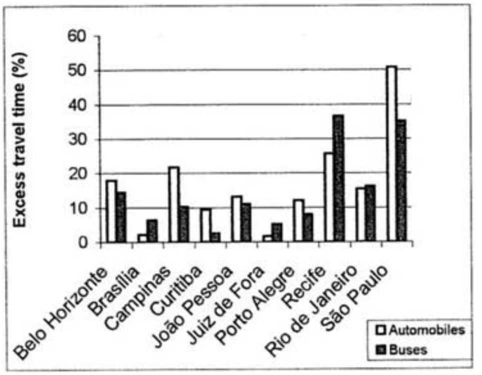

Figure 2: Excess travel time under severe congestion, evening peak hour.

Table 6: Annual excess pollutant emissions, severe congestion, selected cities, autos and buses.

City	Annual excess pollutant emissions (tons)					
	Automobiles		Buses			
	HC	CO	HC	CO	NOx	PM
Campinas	181.9	2,012	8	19.7	14.1	0.7
Curitiba	115.1	1,309	2.9	6.5	4.7	0.2
P. Alegre	116.1	1,309	6.9	16.9	12.2	0.6
Rio	1,605	17,884	86.4	209.8	150.9	7.5
S. Paulo	8,771	95,992	157.6	385.7	277.5	13.7

4.4 Excess fuel consumption

In the extreme case – São Paulo - , automobiles use 105.000 liters of extra gas in the evening peak. When the annual values are estimated – including crossing streets values - in São Paulo automobiles use 251 million liters of excess gasoline.

4.5 Excess pollutant emissions

In respect to average automobile pollutant emission per kilometer in the evening peak hour, data from CO emissions range from 15 grams in Brasília to 40 grams in São Paulo.

4.6 Congested roadways

The length of the roadway system under severe congestion in the evening peak is not high is most cities – around 30-40% - however reaching the 82% level in the case of São Paulo

4.7 The use of road space by mode

The percentage of road space used by automobiles and buses in the roadway system shows a clear dominance of the automobile, that occupies from 70% (Porto Alegre) to 92 % (Brasília) of the space.

When the relative road space used by automobiles and buses is computed considering average vehicle passenger occupancies (70 people per bus and 1.5 people per car), it can be seen, for instance, that a person using a car in Belo Horizonte occupies 25.6 times the space of a person using a bus.

4.8 Costs

To estimate travel time and pollution costs is still a controversial issue, with large differences among the available studies. Considering all these difficulties, the study adopted a conservative approach for travel time costs, that leads to the estimation of the minimum costs that congestion is causing. In the study, the average income of each city was considered, without taking the differences between auto and bus users. Taxes applied on salaries were included and factors referring to the possibility of alternative use of time and the productive use of time were included. With fuel costs, a shadow price of 0.718 of the pomp price was adopted. In the case of pollution, international average values were adopted to Brazilian income per capita. In the case of road space, local costs for construction, maintenance and operation (traffic) were used.

4.9 Annual total excess values

Table 7: Annual excess travel time and fuel consumption, severe congestion, all cities

Travel time (10^6 pass-hour)			Fuel consumption (10^6 liters)	
Auto	Bus	Total	Auto	Bus
250	256	506	252	7

Table 8: Annual excess pollutant emission, severe congestion, all cities

Pollutant emission (10^3 tons)					
Auto		Bus			
CO	HC	CO	HC	NOx	PM
122.7	11.1	0.725	0.297	0.521	0.26

Table 9: Excess road space, severe congestion.

Use	Excess road space (10^6 m^2)
Traffic	6.99
Parking	1.75

Table 10: Annual costs, severe congestion.

Item	Cost (10^6 U$/year)
Travel time	161
Fuel consumption	122
Air pollution	31
Road space	80
Total	395

5. CONCLUSION

The study developed a simple and reliable methodology to measure congestion levels and impacts, to be used at low cost in developing countries. Ten Brazilian cities were analyzed. The problem is already very serious in the three largest cities – São Paulo, Rio and Belo Horizonte and that middle sized cities are also suffering from the problem. Considering just the severe congestion (capacity at full use) the ten cities together waste 500 million passenger-hours and 250 million liters of fuel per year, and throw in the atmosphere 123,000 extra tons of CO and 11,000 extra tons of HC. The largest cities have to use from 12% to 30% extra buses to compensate for congestion effects, increasing costs and fares. Total annual cost, using conservative parameters, was estimated as U$ 400 million.

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Travel demand and traffic impact method of cost recovering for urban arterial roads in Windhoek

Demande en matière de transport et impact sur le trafic méthode de recouvrement des coûts pour les grandes routes de Windhoek

El metodo de la demandade viaje e impacto de tráfico para cubrir el coste de las vías urbanas en Windhoek

A.C.van der Merwe

Transportation, Policy Development and Co-ordination, City of Windhoek, Namibia

ABSTRACT: This paper deals with the introduction of a new method for the financing of urban arterial roads. Cost towards the construction of roads is recovered from the sale of erven. The new method determines the pro-rata contribution of erf owners based on TRAVEL DEMAND and TRAFFIC IMPACT principles. The initiation of the "Urban Arterial Account", the principles on which it will be managed and the transition from the existing to the new method will be dealt with. Other applications and advantages of this method will be discussed.

RÉSUMÉ: Cet article traite de la nouvelle méthode de financement des grandes routes urbaines. Les coûts de construction des routes sont récupérés par la vente des terrians. La nouvelle méthode, basée sur la demande en matière de transport et les principles de l'mpact sur le trafic, détermine la contribution de chacun des propertiétaires de terrains. L'initiation à l' "Urban Arterial Account", les principles selon lesquels il sera géré et la transition des méthodes existantes aux nouvelles méthodes seront abordés. Les autres applications et vantages de cette mé thode seront également discutés.

RESUMEN: Este trabajo trata de la introducción de un nuevo método para la financiación de Vías Urbanas. Los costes de la construcción son cubiertos por la vanta de solares, El nuevo método determina la contribución pro-rata de los propietarios de los solares basadosen los principios de la DEMANDA DE VIAJE e IMPACTO DE TRAFICO. Se tratarán el establecimiento de la "Cuenta Vial Urbana", los principios por los cuales será regida y la transción del método existente al nuevo método. Serán discutidos otras aplicaciones de este método.

1 INTRODUCTION

In the early 1970's the principle was accepted that each development should contribute towards the cost of the adjacent access roads. The method used to determine the pro-rata portion to be recovered was based on the adjacent access roads. This method worked fairly well but later proofed to have certain shortcomings. The major shortcoming was that there was no consistent relation between the capacity and length of the access road and the number of erven to be served. This method was administered by means of the Betterment Fund.

The Betterment Fund has served its purpose but with the development of the city, the demand for the upgrading of roads towards the CBD is increasing. The Betterment Fund Method does not make provision for a direct contribution to those access roads not adjacent to the development creating the traffic.

A new method was developed with the aim to resolve the shortcomings in the Betterment Fund with regard to the overall provision of access roads.

The method called the Travel Demand and Traffic Impact Method was developed whereby the pro-rata contribution towards access roads was based on the actual traffic generated by a development.

To manage the funding of this new method an Urban Arterial Account was also introduced.

The term access road was also replaced with the term Urban Arterial Road to avoid confusion with roads giving direct access to individual erven.

This paper deals with the development of trip generation models and the implementation and application of this method in the calculation of cost to be recovered from the sale of erven for the financing of urban arterial roads.

2 THE TRAVEL DEMAND AND TRAFFIC IMPACT METHOD: TRIP GENERATION MODELS.

2.1 *Trip feneration model for residential erven.*

Trip generation is directly related to the number of residents per household and the availability of vehicles. To convert and express the personal trips in vehicular trips the vehicle occupancy rates are taken into consideration.

The development of a mathematical model to simulate trip generation is dependent on the following data:

- Socioeconomic data of each household
  - Number of people in each household
  - Number of people additional to the household
  - Economic active people.
  - Scholars.
- Vehicle ownership
- Type of transport mode used.

The assumption is that trip generation is directly related to the sum of the household size and the number of vehicles in the household.

The following Trip Generation model has been developed: (morning peak trips)

$$TG_{(i)} = a\,H_{(i)} + b\,V_{(i)}$$

Where:

$TG_{(i)}$ = Trip generation for group i
a ,b = Calibration constants
$H_{(i)}$ = number of persons per household in-group i.
$V_{(i)}$ = number of vehicles per household in-group i.

2.2 *Traffic impact factor model for residential erven:*

The urban arterial requirement is indirectly related to trip generation. The following traffic flow principle is used: The traffic impact is an exponential function of the traffic volumes on a road. With an increase in traffic volumes the impact (capacity restraint) increases at a higher rate.

The objective is to determine the traffic impact from each development according to their economic group that will be used to calculate the contribution from the sale of erven for the financing of urban arterial roads.

The following model has been developed:

$$TI_{(i)} = V^{C}_{trips(i)}$$

Where:

$TI_{(i)}$ = Traffic Impact Factor for group *i*
$V_{trips(i)}$ = Vehicular trips for group *i*
C = Calibration constant.

2.3 *Data base.*

The data required are not readily available in the format required to analyze the different groups. Certain assumptions were made for the missing figures. The data used are given in Table 1

Table 1. Socioeconomic data

Group	Household Size	Persons/ household	Vehicles/ household	Vehicle Occupancy
Ultra low:	2.91	3.86	0.28	3.77
Low:	5.28	5.28	0.63	3.77
Medium:	3.84	4.03	1.43	2.81
High:	3.50	3.50	2.08	2.34

With the models developed and the data available the following results were obtained:

Table 2.Trip Generation per household: (residential erven)

Group	Person trips	Vehicular trips
Ultra low:	1.77	0.47
Low:	2.62	0.69
Medium:	2.76	0.98
High:	3.06	1.31

Table 3. Traffic Impact Factor:(residential erven)

Group	Traffic Impact Factor	Relative Ratio
Ultra low:	0.1029	1.00
Low:	0.3341	3.25
Medium:	0.9445	9.18
High:	2.2450	21.82

2.4 *Definition of income group categories*

The fact that trip generation is also a factor of the economic status of residents is acknowledged and taken into consideration. Four economic groups, related to the household income, have been identified for this purpose namely:

Ultra low
Low
Medium
High

Table 4 below gives an indication of the income per household in the different groups.

Table 4. Economic groups (Income categories)

Group	Income/month (household of 4)
Ultra low:	N$ 0 to N$ 1750
Low:	N$1751 to N$ 3000
Medium:	N$ 3001 to N$ 7000
High:	N$ 7001 plus

2.5 *Trip generation model for non-residential zonings.*

For each trip there is an origin and a destination. The larger portion of trips is home-to-work based. The origin is residential and the destination is at a non-residential zoning. The principle is that both erven should contribute towards the financing of urban arterial roads. The problem is that most business-zoned erven are already privately owned and the possibility to recover cost at this stage is limited.

The development of a mathematical model to simulate trip generation is related to the development potential of the erf. Therefore the following are regarded as significant variables:

- Parking requirement is an indication of trip generation potential.
- Bulk factor is an indication of the development potential.
- Size of the erf is directly related to the development potential of the erf.
- Zoning of erf.

For the purpose of this study the assumption was made that trip generation is directly related to the maximum number of parking required if the erf is developed to its full potential. This assumption was made due to the non-availability of trip generation data for non-residential erven.

The following Non Residential Trip Generation model is proposed:

$$TG(NR)_{(i)} = P_{(i)} \times B \times A$$

Where:

$TG(NR)_{(i)}$ = Non Residential Trip generation for zoning i

$P_{(i)}$ = Parking requirement for zoning i.

B = Bulk factor applicable on a specific erf.

A = Area of a specific erf.

Parking requirements as prescribed in the Town Planning Scheme will be used in this model. The requirements are given in table 5

Table 5. Parking requirements
(As prescribed in the Town Planning Scheme)

Use zone	Use	Parking requirement
General Residential.	Residential buildings	1 per dwelling unit
	Hotels	1 per 50 m²
Business.	Residential buildings	1 per dwelling unit
	Hotels	1 per 50 m²
	All other uses	1 per 33.3 m²
Restricted Business	All uses	1 per 50 m²
Garage	All uses	1 per 16,6 m²
Industrial	All uses	1 per 66,6 m²
Special, Institutional, Undetermined	All uses	As determined by Council
Office	All uses	1 per 25 m²

2.6 *Traffic impact factor for non-residential erven.*

The purpose is to determine the traffic impact factor for non-residential erven in relation to the relative values as determined for the different residential groups. This factor is applied to determine the contribution which non-residential erven must make towards the Urban Arterial Account for urban arterial roads.

The following equation is proposed:

$$TI(NR)_{(i)} = C \times TG(NR)_{(i)}$$

Where:

$TI(NR)_{(i)}$ = Traffic Impact Factor for non residential zoning i

$TG(NR)_{(i)}$ = Non Residential Trip generation for zoning i

$C_{(i)}$ = Valuation factor zoning i

The C value links the residential and non-residential traffic impact factors.

The initial values will be taken as:

C = 2.5 for all non-residential uses except for institutional and undetermined.

C = 0.5 for Institutional and undetermined.

This is based on the equivalent values used for residential and non-residential traffic impact factors as in the past.

These values will have to be verified when this method will be applied for the first time.

3. THE COMPLEXITY OF DETERMINING THE EFFECT OF DEVELOPMENT ON THE URBAN ARTERIAL ROAD NETWORK:

To understand the traffic impact generated from a development the following principles are highlighted:

3.1 *Traffic effect:*

When a new township is developed the burden on urban arterial roads are twofold:

- The urban arterial roads required giving access to this specific township.
- The incremental increase in traffic volumes on the existing road network.

3.2 *Financial effect:*

Any development requires pre-financing. When urban arterial roads are involved the financing can be for three different situations or a combination of situations:

- The urban arterial road needed for a specific development.
- A future development that will partly benefit from the urban arterial road provided for the first development. (provision of capacity)
- The cost of an urban arterial is included in the upset price but will only be constructed at a later stage. (expansion of capacity)

The above shows the shortcomings in the previous method where only the "access roads" bordering the township were taken into consideration. This method did not make provision for the recovering of cost for the upgrading and incremental expansion of the capacity of the total urban arterial road network.

The new method addresses this shortcoming and ensures a more consistent amount to be recovered.

4. APPLICATION OF THE TRAVEL DEMAND AND TRAFFIC IMPACT METHOD:

The following method is proposed to apply and manage the Travel Demand and Traffic Impact Method.

4.1 *Introduction of the "Standard value".*

The next step in the application of this method is to add a monetary value to the Traffic Impact Factor. This value, referred to as the *"standard value"*, will be based on the actual amount required for the provision of urban arterial roads. To avoid fluctuations in the standard value it will be done on a three year rolling average. The past nine-year's expenditure on urban arterial roads has been used to calculate the average expenditure per annum in real terms. The outcome of this analysis is indicated in table 6.

Table 6. Actual Expenditure on "Access Roads": 1991 to 1999

	Expenditure	Expenditure in real terms
Total for 9 Years:	N$40,725,975.93	N$79,611,494.89
Average per Year over 9 Years:	N$4,525,108.44	N$8,845,721.65

4.2 *Initial calculation of the Standard value:*

The amount of N$ 8 845 721.65 was used as target figure to be recovered. The assumption was that the rate of development would be the same. This will have to be verified, as more information becomes available.

The steps followed in the initial calculation:

- The past expenditure on urban arterial roads (access roads) was determined as stated in the previous paragraph.
- The number of erven in each economic group to be developed in the next three years was obtained from the Township Development Program. The number of erven is given in table 7.
- Urban arterial roads that need to be constructed to provide access to the developments (For the initial calculation the average past expenditure was used.)
- Urban arterial roads that need to be upgraded due to the incremental increase in traffic volumes. (There are a few large urban arterial road projects envisage for implementation in the next three years that was not included.)

With these data available the standard value was calculated. The basic principle was that the urban arterial road contribution from the developed erven should be equal to the expected expenditure on urban arterial roads.

The standard value amounted to N$ 668.19. The value of the urban arterial road contribution for erven in each economic group is shown in table 8.

An attempt was made to quantify the possible

Table 7 Township Development Program: number of erven to be developed in the next three years: 1999/2001

Group	Number of erven
Ultra low	10667
Low	1062
Medium	2666
High	0
Other	322
Total for 3 years:	10667

Table 8. Urban arterial road contribution per erf per economic group.

Economic group	Relative ratio based on the traffic impact factor. *	Number of erven	Urban Arterial Road contribution per erf
Ultra low:	1	10667	N$ 668.19
Low:	3.25	1062	N$ 2,171.63
Medium:	9.18	2666	N$ 6,134.01
High:	21.82	0	N$ 14,579.98

*See table 3

income from non-residential erven but due to the availability of detail information it was not possible. For the initial calculation a fixed value was estimated. The standard value is not very sensitive for variation of the non-residential component due to the relative small number of erven that can contribute.

An estimated N$ 750 000.00 for the three year period was used as a guideline value. The total income from contributions of all the erven amounts to N$ 8,845,721.65 per annum or N$ 26 537 164.95 over the three year period.

4.3 *Annual revision of the Standard value:*

The rate of development and expenditure on urban arterial roads will vary from year to year. To avoid large fluctuations in the standard value the calculation should be revised annually on a three year rolling average. Various assumptions were made due to a lack of available data. With the annual revision these assumptions can be revised on the hand of new information or replaced with the actual data. The balance of the Urban Arterial Account could also be an indicator whether the standard value is still valid.

5 ESTABLISHMENT OF AN "URBAN ARTERIAL ACCOUNT":

To manage this new method the establishment of an Urban Arterial Account is proposed. The principal on which the Account will operate is the same as the Betterment Fund. The major difference is how the urban arterial roads will be accounted for. For the Betterment Fund there was a budget item within each development for access roads. The Urban Arterial Account will centralize the entire budget items in one project from which all the urban arterial roads will be financed.

The purpose and responsibility of the Urban Arterial Account will be:

- Accept responsibility for the financing of all the arterial roads needed.
- Accept responsibility for all existing out standing obligations with regard to "access roads".
- With the acceptance of this responsibility the Betterment Fund surplus and obligations should be transferred to the Urban Arterial Account.
- The Account will then be entitled to a pro-rata contribution from the receipts of all future erf sales.

6 FUNDS FROM THE ROAD FUND ADMINISTRATION

The advantage of the Urban Arterial Account will be that any proceedings from the Government's newly established Road User Charging System will reflect directly in the expenditure, resulting in a lower standard value.

The Road Fund Administration was created to manage the Road User Charging System. The principle on which it is based is that the road users pay for the provision and maintenance of the road network through a fuel levy, licence fees and weight distance charges. (An indirect toll system) With the establishment of the Road Fund Administration the principle was accepted that Local Authorities would qualify for funds from the Fund for urban arterial roads on certain criteria. The advantage will be lower property tax and lower erf prices.

7 TRANSFER OF FUNDS TO THE URBAN ARTERIAL ACCOUNT.

To get the Urban Arterial Account operational the funds from the Betterment Fund should be transferred to the Urban Arterial Account. In the analysis of the Betterment Fund the following three different scenarios were identified:

- Developments completed: All erven sold but with outstanding obligations towards urban arterial roads. The funds available for these obligations will be transferred to the Urban Arterial Account.

- Developments still active: These are the developments where urban arterial roads have been provided and pre-financed. There are still erven available for sale. The pre-financing portion should be transferred to the Urban Arterial Account with the understanding that the pro-rata portion of the proceeds from erf sales will be for the Urban Arterial Account, based on the new method.
- New developments: Those are township developments currently undertaken and where the expenditure for urban arterial roads has been done. This pre-financing should also be transferred to the Urban Arterial Account. The understanding is that the new method of calculation will then be applicable when the erf prices are determined.

An indication of the amounts involve is given in table 9.

8 FURTHER APPLICATION OF THE TRAFFIC_IMPACT METHOD.

This method can also be applied on re-zonings and subdivisions. The current practice is that with re-zoning and subdivisions a levy is payable. The levy is a contribution towards the Endowment Fund and Betterment Contribution Fund. These funds were created to make provision for an additional financial contribution towards the main infrastructure. This was done on an ad-hoc basis by charging a certain percentage. The developers are however reluctant to pay the levy because it is not quantified on a scientific basis.

With the Travel Demand Method the effect on the Urban Arterial Road Network can be scientifically quantified and converted into real time monetary values. The Travel Demand and Traffic Impact Method will be made applicable on all new re-zonings and subdivisions to determine the levy. An additional income for the Urban Arterial Account can thus be generated.

Table 9. Funds to be transferred to the Urban Arterial Account

Applicable scenario	Balance on 30 June 98
Developments completed: Funds to be transferred to the Urban Arterial Account to meet outstanding obligations	N$ 192 162 727.99*
Developments still active: Pre-financed portion to be transferred.	N$ (89 624 029.19)*
New developments: Urban Arterial Roads Pre-financed	N$ (825 489.45)

*This is the balance in the Betterment Fund. The portion applicable to urban arterial roads must still be determined.

9 SUMMARY.

This method has integrated two principles and has made it possible for the Windhoek City Council to scientifically calculate the contribution for urban arterial roads from the sale of erven. The principles involved are economic and transportation related.
Economic: The user pay principle is enhanced. The user pays for the portion of urban arterial road required.
Transportation: The contribution is based on the Travel Demand of the user and the Traffic Impact it will have on the transportation system.
This system will ensure that the City of Windhoek can expand its transportation infrastructure on a sustainable and self-supporting basis.

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Private financing initiatives: Developing countries' experience

Les initiatives privées qui financent: l'expérience des pays en développement

Las iniciativas privadas que financian: La experiencia reveladora de países en desarrollo

M.S.A.Gaabucayan, K.Doi & T.Takada
Tokyo Institute of Technology, Japan

ABSTRACT: The expansion of middle income households and increase in the rate of urban migration has resulted in congestion in cities like Bangkok, Kuala Lumpur, and Metro Manila.

To address this situation, massive transportation infrastructure projects were undertaken in these cities. Traditionally, two sources of funds have been tapped for these projects: Official Development Assistance (ODA) and government revenues. However, it has been the amount of ODA has decreased in the last few years. Thus, the concept of private sector participation in financing of projects was explored. The private sector is involved in the planning and implementation of infrastructure planning through Private Financing Initiative (PFI).

This paper seeks to investigate the potential limitations of PFI and the possible extension of coverage of ODA based on the experiences of the rail transport projects in the three cities as well as endeavor to suggest implementation of both financing schemes in a complimentary manner.

RÉSUMÉ: L'expansion de ménages de revenu de milieu et l'augmentation dans le taux de migration urbaine a résulté dans la congestion dans les villes comme Bangkok, comme Kuala Lumpur, et comme Manila de Métro.

Pour adresser cette situation, ces projets de infrastructure de transport massifs ont été entrepris dans ces villes. L'Echangé-tionally, deux sources de fonds ont été tapées pour ces projets: l'Assistance de Développement Officielle (ODA) et les revenus de gouvernement. Cependant, il a été la quantité de ODA a diminué dans les tout dernières années. Ainsi, le concept de participation de secteur privée dans le financement de projets a été exploré. Le secteur privé est impliqué dans la planification et l'implémentation de planification de infrastructure par l'Initiative Privée qui finance (PFI).

Ce papier cherche à examiner les limitations potentielles de PFI et l'extension possible de reportage de ODA a basé sur les expériences des projets de transport de barre dans les trois villes de même que la tentative pour suggérer l'implémentation des deux arrangements qui financent dans une façon de complimentary.

RESUMEN: La expansión de casas medianas de ingresos y aumento en la tasa de la migración urbana ha tenido como resultado la congestión en ciudades como Bangkok, como Kuala Lumpur, y como Metro Manila.

Para dirigir esta situación, proyectos masivos de infraestructura de transporte se emprendieron en estas ciudades. De tionally comerciado, dos fondos provistos se han utilizado para estos proyectos: Ayuda (ODA) Oficial de Desarrollo y rentas de gobierno. Sin embargo, ha sido la cantidad de ODA ha disminuido en los últimos pocos años. Así, el concepto de la participación privada del sector a financiar de proyectos se exploró. El sector privado está involucrado en la planificación y la implementación de la planificación de la infraestructura por la Iniciativa (PFI) Privada que Financia.

Este papel procura para investigar las limitaciones potenciales de PFI y la extensión posible del alcance de ODA se basaron en las experiencias de los proyectos del transporte de baranda en las tres ciudades así como también tentativa para sugerir la implementación de ambos esquemas que financian en una manera de complimentary.

1. INTRODUCTION:

Notwithstanding the last three years, this decade has seen tremendous economic growth in the Asian region. Consequently, this has lead to a rise in the middle income households in major cities which in turn has translated into augmented household vehicle ownership and increased mobility. With the rate of urban migration and expanding urban population, the need for travel has rendered the roads of capital cities like Bangkok (Thailand) Kuala Lumpur (Malaysia) and Metro Manila (Philippines) heavily congested. Based on 1994 statistics, the number of vehicles per kilometer in these cities are 695, 620 and 592, respectively. Although the modal share of public transport differs in each city as seen in Table 1, it has truly become necessary for these cities to develop massive urban public transportation infrastructure planning to meet the increasing demand.

Traditionally, two sources of funds have been tapped for these projects: Official Development Assistance or ODA and government revenues. However, it has been noted that the amount of ODA assistance to these countries have decreased in the last few years. Moreover, Governments have found it increasingly difficult to cope with the burgeoning demand for transport infrastructure. Thus, the concept of private sector participation in financing of projects was explored. The private sector is involved in the planning and implementation of infrastructure plans through the concept of Private Finance Initiative or PFI.

It cannot be denied, however, that the implementation of mega projects, specially in the transport sector, has many pitfalls. As Allport[1] describes it, "few megaprojects are intrinsically profitable (i.e. the revenues are inadequate to fund capital, operating and asset replacement costs, and return a dividend to shareholders)." Despite this reality, this has been an increasing convergence for increased private sector participation in Asia. Table 2 shows the extent of private sector participation in selected Asian countries.

This paper seeks to evaluate the potential complimentarity of Private Financing Initiatives (PFI) and Overseas Development Assistance (ODA) in the implementation of Urban Transport Infrastructure in developing countries. It shall attempt to investigate this complimentarity in the light of the experiences of the BTSC Project (BKK), STAR LRT (KL) and EDSA-MRT (MM).

A cursory evaluation of the Privatization Policy in these countries yields the following similarities:

(1) It seeks to relieve the government of financial and administrative burden for major projects;

(2) It seeks to improve efficiency in the delivery of basic public services where government capacities are over-extended;

(3) It seeks to encourage private sector participation to introduce market-based efficiency in the management and operation of projects for the attainment of economic targets.

Private Sector Participation was conceived to ease the financial burden on the government without sacrificing the delivery of necessary services to the public.

Table 1. Modal Share in KL and MM

Mode	BKK	KL	MM
Private Cars	23%	47.5%	30%
Bus	41%	24.4%	17.4%
Motorcycles	14%	26%	0.7%
Rail	2%*	0.5%	2.2%
Others	20%	1.6%	52.5%**

(* for BKK, combined ferry and rail share)
(* *for MM, jeepneys constitute 39.1% of Others)

Table 2. Policy Convergence Towards Increasing Private Sector Involvement

Country	Comment
Malaysia	Strong, consistent commitment. Pragmatic implementation
Indonesia	Strong commitment. Little implementation
Thailand	Strong, consistent commitment. Implementation sometimes chaotic
Philippines	Strong commitment. Implementation sometimes chaotic.

Source: Roger Allport, Making Projects Happen in Asia (1998).

2. PROJECT IMPLEMENTATION

This section shall investigate the project implementation strategies of BTSC Project or the Green Line (BKK), STAR LRT (KL) and EDSA MRT (MM). BTSC was implemented under the Build-Operate-Transfer Scheme (BOT) with a concession period of 30 years. STAR LRT (KL) was implemented under the Build-Operate-Own Scheme (BOO) with a concession period of 60 years, subject to review after 30 years, whereas, EDSA MRT is being implemented under the Build-Lease- Transfer Scheme (BLT) with a concession period of 25 years.

(1) BTSC (Green Line)

The MRT Lines of Bangkok are a product of two studies, namely: the Mass Rapid Transit Systems Master Plan Report and the Conceptual Master Plan Project (CMIP). The BTSC Project or Green Line was awarded to Bangkok Transit System Corporation (BTSC) in April 1992. The 23.3-kilometer railway was projected to stretch from Sukhumvit Line to Silom Line in Central Bangkok. The initial estimated cost for the entire project was 32 Billion Baht (US$1.27B). However, a lengthy negotiation process for the depot site acquisition in Mo Chit has delayed the construction considerably. With this delay and the decline in Baht, the cost has been estimated to have increased to 58 Billion Baht (US$1.5B). Responsibilities for the implementation of the project were as follows:

BTSC (Concessionaire):

- Design, construct, equip, test, and commission the railway
- Finance the project
- Operate and maintain the railway
- Demand, collect, and retain fares from users of the railway
- Carry out the activities pertinent to the provision of the railway services and facilities within the site, subject to the prior written approval of the Government

Government incentives included: support loans, minimum operating income, concession to operating facility, and commercial freedom, foreign exchange guarantee, and interest rate guarantee. In addition, the concessionaire was granted "promotional privileges by the Board of Investments (BOI) include an 8 year-corporate income tax holiday and full exemption from duties on imported machinery and materials". Allocation of risks may be gleaned from Table 3.

Table 3. BTSC Project Risk Chart

	CNTR	*CONC.*	*GOV'T.*
POLITICAL RISKS			
Land Acquisition			x
Import License			x
Taxation		x	
ECONOMIC RISKS			
Foreign Exchange			x
Interest Rates			x
Inflation			
Construction	x		
Operations		x	
Cashflow Sensitivity		x	
Cost of Power Supply		x	
Fare Revenue		x	
Future Fares		x	x
TECHNICAL RISKS			
Construction	x	x	
Operations		x	
COMPLETION RISKS			
Price and time	x		
Delay in Start-Up	x	x	
Squatter Relocation	x	x	x
Contractor Default		x	
OPERATIONAL RISKS			
Adequate Skilled Staff		x	
Safety		x	
Power Supply		x	
Competition		x	

(2) STAR LRT

Based on two transport studies undertaken in Malaysia, the Kuala Lumpur Master Plan Transport Study (1979-1981) and Klang Valley Transportation Study (1986), it was identified that the introduction of a light railway transit system would be appropriate in four corridors, namely;

- North to Batu/Kepong
- Southwest to Petaling Jaya
- Southeast to Ampang/Cheras
- Northeast to Wangsa Maju

Thorough evaluation showed that the most viable corridor, from the financial and technical aspects, would be the Southeast corridor from Ampang to Jalan Sultan Ismail via Plaza Rakyat.

In April 1991, STAR submitted a proposal to the Government to implement a light rail system along the preferred route and negotiations started in July of 1991. The estimated project cost was $921 Million. The Build-Operate-Own arrangement for STAR included the following obligations of the key players:

STAR (CONCESSIONAIRE)

- Design, construct, equip, test, and commission the railway
- Finance the project
- Operate and maintain the railway
- Demand, collect, and retain fares from users of the railway;
- Carry out the activities pertinent to the provision of railway services and facilities within the site, subject to the prior written approval of the Government.

Table 4 shows the chart drawn to identify allocation of risks among the key players of the project, namely the Contractor (CNTR), the Concession Company (CONC), and the Government (Gov`t).

Although the Government provided STAR with no written assurance for political risks, it provided fund to offset costs incurred for delays due to land acquisition. Likewise, imposed no import duties for any equipment or supplies that may be required by the project but are not manufactured in Malaysia. In terms of economic risks, the Government provided foreign currency hedging at commercial rates during the construction period.

The Government refused to guarantee a "minimum ridership" so STAR had to rely on its own consultants. On the matter of future fare increases, a compromise was struck between the

Table 4. STAR LRT Risk Chart

	CNTR	CONC.	GOV'T.
POLITICAL RISKS			
Land Acquisition		x	x
Import License		x	x
Taxation		x	
ECONOMIC RISKS			
Foreign Exchange			x
Interest Rates		x	
Inflation			
Construction	x		
Operations		x	
Cashflow Sensitivity		x	
Cost of Power Supply		x	
Fare Revenue		x	
Future Fares		x	x
TECHNICAL RISKS			
Construction	x	x	
Operations	x		
COMPLETION RISKS			
Price and time	x		
Delay in Start-Up	x	x	
Squatter Relocation	x	x	x
Contractor Default		x	
OPERATIONAL RISKS			
Adequate Skilled Staff		x	
Feeder Bus		x	x
Safety		x	
Power Supply		x	
Competition		x	

Source: Ghani, Z.A.,Malaysia`s First Privatised Railway System – The STAR LRT

Government and the Concessionaire. The Government retains the statutory right to approve or disapprove proposed fare. However, if the government refused to approve based on a pre-determined inflation related formula then it would have to compensate. On the other hand, if fare increases would result in exorbitant profit for the Concessionaire, then the Government must impose control.

(3) LRT 3

There are five identified corridors for Urban Railway Development. These are:

LRT 1 Rizal –Taft Avnues

LRT 2 Magsaysay Blvd. – Aurora Blvd. – Cubao-Katipunan route

LRT 3 Epifanio De Los Santos Ave.

LRT 4Espana – Quezon Ave. – Commonwealth Ave.

LRT 6 Buendia – Zapote Route

The Capacity Expansion for LRT 1 as well as the construction for LRT 2 is funded by OECF. LRT 3 is funded through the Build-Lease-Transfer Scheme. LRT 4 and LRT 6, though to be funded through Build-Transfer –Build Operate-Own Scheme (BT-BOO), are still under negotiations.

In contrast to the thorough planning effected prior to and during the construction of STAR LRT, it is contended that the government of the Philippines gave up a lot of its control to the demands of the winning Concessionaire. in the guise of fast-track implementation (Santiago, 1993)[2]. Responsibilities

Table 5. EDSA MRT Risk Chart

	CNTR	CONC.	GOV'T.
POLITICAL RISKS			
Land Acquisition			x
Import License			x
Taxation		x	
ECONOMIC RISKS			
Foreign Exchange			
Interest Rates			x
Inflation			
Construction	x		
Operations		x	
Cashflow Sensitivity	x		
Cost of Power Supply	x		
Fare Revenue			x
Future Fares			x
TECHNICAL RISKS			
Construction	x		
Operations		x	
COMPLETION RISKS			
Price and time	x		
Delay in Start-Up	x	x	
Squatter Relocation			x
Contractor Default		x	
OPERATIONAL RISKS			
Adequate Skilled Staff		x	
Safety		x	x
Power Supply		x	
Competition		x	

of LRT 3 were allocated as follows (Table 5):

EDSA MRT Corporation (CONCESSIONAIRE)

- Design, construct, equip, test, and commission LRT3
- Deliver system to Department of Transportation and Communications (DOTC) by way of lease/purchase for over a period of 25 years during which DOTC will operate MRT system
- Provide technical management assistance and specific maintenance and repair service

DOTC (Government Entity)

- Technical Supervision of the Project

Highlights of the LRT3 Contract are as follows:

- Revenue guaranteed via a lease payment and commercial rights extend to depot.
- Common Carrier`s Insurance at Government`s expense
- Tax holiday for six years in the amount of $38.9 Million

Under the operation stage, except for the technical and operation and maintenance, all other risks will be borne by the Government. These include: ridership demand and market, fare setting, interest rate volatility, inflation, foreign exchange fluctuation and convertibility/transferability. In contrast to the STAR LRT contract, the Concessionaire of MRT is protected from complications arising from change of Government and legislation.

Due to the fact that the initial design was drawn by the private entity, LRT3 was conceived to be at-grade at most part. Thus, Government had to submit proposed changes as negotiation proceeded, otherwise the perceived benefit of having a rail transport in decongesting the roadways would be negated. The total project cost of the project has reached US$655 Million, up from the original cost of $160 M.

3. PROJECT STATUS

It was projected that operations of the Green Line would start in time for the Asian Games in December 1999 . However, this was not realized. Instead, start of operations has been moved to March 1999.

STAR LRT has started operations since December 1996 yet it has been evaluated to suffer from low ridership from projected figure. Possible factors contributing to this situation could be existing bus competition and lack of physical coordination.

LRT 3 is scheduled to be completed by year 2000. It is projected to have a capacity of 600,000 passengers per day with a total of 73 vehicles. However, based on the available studies on LRT 3 (Table 6), this may seem to be a very optimistic estimate.

Based on the EDSA LRT F/S, the best scenario for LRT 3 is if there should be a 70% reduction of the buses plying the Epifanio De Los Santos Avenue. The next challenge would then be how to encourage the commuters to shift from buses to rail.

Table 6 Available Studies on LRT 3

1. Metrorail Network Options Feasibility Study (1985), Electrowatt Eng`g.
   - Assuming distance-related fare, same as bus
     Pax/day in 1990 430,941
     Pax/day in 2000 768,294
   - Assuming flat fare of P3.50 (US$0.08) in 1985 prices
     Pax/day in 1990 214,161
     Pax/day in 2000 384,245
2. MManila Urban Transport Dev`t. Plan (1991), Dept. of Transportation and Comm.
   - Assuming flat fare of P4.50 (US$0.11) in 1990 prices
     Pax/day in 1996 267,260
     Pax/day in 2006 577,000
3. EDSA LRT Line F/S (1991), internal study of ALMEC Corp.
   - Assuming distance-related fare with 70% bus curtailment
     Pax/day in 1998 527,140
     Pax/day in 2010 583,705
   - Assuming distance-related fare with full bus competition
     Pax/day in 1998 296,146
   - Assuming flat fare at P4.50 (US$0.11) in 1991 prices, full bus competition
     Pax/day in 1998 279,383

Source: Heresies of the BOT Kind, Rene Santiago, 1993

4. KEY AREAS OF COMMONALITY

Despite the differences in the financing schemes used, it is noticed that the following key incentives were given by the governments to attract private sector participation in urban rail projects:

- Import tariff exemption
- Tax holiday for a certain period of time
- Foreign Exchange Guarantee (although for STAR LRT this was implemented by funding in Ringgit on project finance basis)
- Interest Rate Guarantee

Land acquisition for the right of way and other pertinent facilities for the operation of the railways were performed by the different governments, although with differing levels of success and efficiency.

5. FUTURE DIRECTIONS

Despite the careful planning prior to the construction of the STAR LRT, it would appear that it still suffers from low ridership. On the other hand, LRT 3 and the Green Line which is projected to carry about 600,000 passengers per day and 2000 passengers per day (in combination with the two other Metros) may suffer the same fate. In this perspective, the operational sustainability of these rail transport systems may be uncertain. Thus, two possible directions will be set forth in this paper: One, hat thorough planning for the urban rail transport must include a detailed study of the various strategies to encourage maximum ridership. The other is to tap the `newly` instituted Environmental ODA to fund the infrastructure for urban rail transport. The cost for building the infrastructure for urban rail transport is estimated to be about 30 to 40% of the total project cost. If this cost will be taken out of the total project cost, then the pressure to reach a particular level of ridership during the first few years of operation may not be so great on the Concessionaire. This will also be in line with the Japan`s June 1992 ODA charter which states "Environmental conservation and development should be pursued in tandem". Increasing the use of rail transportation will certainly go a long way in controlling vehicular emissions due to excessive use of the automobile. Moreover, by using the ODA only for infrastructure, the amount required for a grant may be not be as much as when the entire project will be funded solely by ODA. Operation of the transport system should be by the winning concessionaire. However, further investigation of ridership figures and costing of each project must be conducted to verify this hypothesis.

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From cordon toll to congestion pricing in Oslo – What are the benefits?

J.Odeck
Norwegian Public Roads Administration, Oslo, Norway

B.Grue, T.Hamre & J.Rekdal
Institute of Transport Economics, Oslo, Norway

ABSTRACT: This paper examines the benefits of moving from cordon tolls to congestion pricing in Oslo. It is hypothesized that any move to make motorists pay the full social cost of their trips according to marginal cost pricing principles, will generate considerable social benefits as compared to *status quo*. The results indicate that there is a sound basis for a system with time differentiated tolls with the peak traffic being charged higher than others.

1 INTRODUCTION

For more than 40 years it has been known that the motorists driving in congested road systems do not pay the full social costs(Walters, A.A 1968). From a social point of view the price of a car trip should equal the (social) marginal cost of the trip. In congested networks the difference between the price that the motorists actual pays in terms of operating costs of the vehicles, and the marginal social cost, can be considerably high, even in the presence of a toll cordon system as implemented in Oslo.

The Oslo toll system was implemented in 1990 to generate funds for road investments in the region of (about 50% of the projects have been completed). The Oslo toll system includes 19 toll stations located on all the inbound roads to and through the central areas of Oslo. The average fee for a round trip is NOK 9 (US$ 1.3). In 1997 the system served a total of over 85 million cars, and the operating revenue was NOK 737 million. The accumulated revenue is more than NOK 4000 million at the end of 1998 (US$ 666 million). The tolling license is terminated in the year 2007.

The marginal *congestion cost* for an average commuting round trip undertaken in the peak hours in the area is estimated to NOK 42 (US$ 7). Thus there is a considerable gap between private and social costs of rush hour trips in the area.

In the recent years the Institute of Transport Economics has conducted several studies related to different aspects of marginal cost pricing of car traffic in the Oslo region, both for local and central authorities. The most recent study focused on how to design a charging system for motorists assuming that the present cordon is kept. A second study focused on the impact on demand and supply for public transport services in the area.

2 THE MODEL SYSTEM

To analyze the effects of alternative pricing strategies for car traffic in the Oslo region, we developed an aggregate and zonal based transport model system. The basic idea with this model is the inclusion of a departure time choice in the rush hours. Otherwise the model is based on a gravity approach for trip generation, attraction and distribution (Willumsen & Ortuzar, 1990), and logit models for the mode and departure time choice (Ben Akiva & Lerman, 1985). The model system includes four sub models each representing different typical traffic periods in the Oslo region. In all models we only model for one way trips (not round trips that are the most common for this types of models). No connections between the sub models are assumed. This is a weakness of which its magnitude will become clearer as we proceed.

2.1 Matrix estimation

Data from a comprehensive travel survey conducted in 1992 for the Oslo region, and traffic counts for all inbound and outbound traffic passing the city boundary (1997) were used in the matrix estimation. These data were combined using entropy maximizing techniques to obtain four Origin-Destination (O-D) matrices for typical traffic periods as follows:

a) **Morning rush hours** (three hours from 6 a.m. to 9 am), consisting mainly of commuter traffic.
b) **Mid day traffic** (one hour representing an aver-

age of the period from 9 a.m. to 3 p.m.). This group is a mix of all traffic categories, but is dominated by business travel.

c) **Afternoon rush hours** (3 hours from 3 p.m. to 6 p.m.). This is a mix of traffic dominated by business, commuting and shopping travel.

d) **Low traffic periods** (one hour representing the average traffic situation in evenings, weekends and holidays), consisting of mostly private travel for leisure and visits.

The four matrices represent all the travel activities in the area for the modeled periods (by car, public transport, cycle and walk).

2.2 Logit models for mode split (and departure choice)

Based on the generalized costs of travel by different modes, a logit model was calibrated splitting the matrices into travel by car, public transport and cycle/walk. There is however a proportion of car and public transport riders who can be assumed to be inelastic to changes in level of transport service. This traffic was entered in inelastic demand matrices. The two models representing the rush traffic periods split the traffic into departure hours (one matrix for each mode and for each of the three hours of the rush periods). The mode specific generalized costs for an OD-pair is formulated as:

$$GC_{ct} = \beta_{ct} + \beta_i\, t_t + \beta_c\,(oc_t + pc_t + tc_t) \qquad (1)$$

$$GC_{pt} = \beta_{pt} + \beta_i\,(t_t + \alpha_a\, at_t + \alpha_w\, wt_t + \alpha_i\, \#i_t) + \beta_c\, fc_t \qquad (2)$$

$$GC_{wct} = \beta_{wct} + \beta_d\, d \qquad (3)$$

where t = in vehicle travel time; *oc* = operation cost; *pc* = parking cost; *tc* = toll cost; *at* = auxiliary transit time; *wt* = total waiting time; *#i* = number of interchanges; *fc* = public transport fare; and *d* = distance between origin and destination. The subscript *t* denotes the time period for departure and is only used in the two rush hours models. The subscript *c, p,* and *wc,* denotes car, public transport and walk/cycle respectively. The beta and alpha parameters are calibrated. The calibrated parameters imply an implicitly defined (generic) *value of travel time* in the model system of NOK 36 (US$ 6) pr hour. The logit model expresses the market share for the modeled modes of travel (combinations of mode and travel departure time in rush hours models) at each OD-pair as shown in the following expression (market share of mode *i* at departure time *t*):

$$P_{it} = \exp(GC_{it})/\Sigma_{mt} \exp(GC_{mt}) \qquad (4)$$

This model system is based on the idea of equilibrium between demand and supply. This works through the interaction between the car demand and the supply, in terms of capacity on the networks and in turn generalized cost for car driving. In the rush hours models, the demand and generalized cost for car in a certain departure hour is first calculated. The equilibrium here influences the driving conditions in the other departure hours. Thus sub equilibrium for the demand for car transport in each of the three departure hours is calculated several times until a grand equilibrium occurs, usually after 6-7 iterations.

2.3 The networks

The networks and models are implemented in the EMME/2 software package for transport modeling. Our networks includes 438 zones representing origins and destinations, connected by 15000 links with different characteristics, and a varying amount of public transport lines (train, subway, tram and bus) dependent of the level of service in the period. Different volume delay functions represents the driving conditions on the road network and expresses the travel time on each link as a function of free flow speeds, number of lanes, capacity, and the traffic volumes on the links.

2.4 Fuel consumption model

The environmental impacts of congestion pricing in this study are limited to the consumption and combustion of fuel on different parts of the road networks. A very simple model is used to illustrate how less congestion could give rise to considerably environmental improvements in terms of reduced fuel consumption in the most populated and environmental sensitive areas of Oslo. The model can be expressed in the following way:

$$D_i = \varepsilon\, x_i\, (1.25\, (v_i/60 + 60/v_i) - 1.5) \qquad (5)$$

where D_i = fuel consumption at link i; ε = minimum fuel consumption in liter pr kilometer for an average vehicle (0.08 l/km); x_i = traffic volumes on link i, and; v_i = speed on link i. The parameters 1.25 and 1.5 is turbulence factors that adjust consumption of fuel for the presence of acceleration and retardation, stop and start, that is characteristic for trips in urban areas. The parameter 60 is the speed in km/h for which fuel consumption is at minimum. The parameters represents driving conditions in urban areas and the composition of the car park in Norway.

3 ALTERNATIVE DESIGNS OF A FUTURE CONGESTION PRICING SCHEME

The present system (denoted PS in the following tables) is simulated with an average toll cost of NOK 9 pr inbound trip. We assume that this toll cost is divided equally on the inbound and outbound trip. The public transport in this simulation is assumed to offer the same level of service as today. The following four alternatives is simulated and compared with the present system.

Alternative 1 (A1): The toll is differentiated over the three hours in the morning and afternoon rush (NOK 20, 40 and 30 respectively). The toll in the mid day periods (incl. Saturdays) is assumed to have the same level as today (NOK 9). Between 6 p.m. and 6 a.m. on working days and in low traffic periods in weekends the passing is free.

Alternative 2 (A2): The toll is differentiated over the three hours in the morning and afternoon rush but with lower fees (NOK 15, 35 and 25 respectively). Otherwise the fees is the same as A1.

Alternative 3 (A3): The toll is increased to the same amount in each of the three hours in the morning and afternoon rush (NOK 25). Otherwise the fees is the same as A1.

Alternative 4 (A4): Same as A3 but with free passing on Saturdays as well.

There is a practical problem connected to the model simulations of the different schemes. The toll stations are located at inbound roads only, and there are no plans to charge tolls on outbound roads. Our simulations are best fitted on situations where the traffic is charged on outbound trips as well. This is due to the very strong assumption that the motorists divide the toll cost equally on inbound and outbound trips. Thus in our simulations for the rush periods we get a distribution over time of car traffic on outbound trips that is not likely to occur in practice. On the other hand one could argue that the choice of departure time for inbound commuting trips in the morning more or less sets the departure time for the home trip. The differentiated toll tax in the afternoon peak for outbound trips could capture the aspect of timing of departure time in this period.

Another practical problem that rises when a system based on differentiated tolls is to be introduced is the timing of the changes in tolls. Alternative 1 for instance implies a sudden increasing of taxes from NOK 20 to NOK 40. The question is what the behavioral effects of a doubling of taxes would be. To circumvent this problem, the exact timing of the change of prices could be drawn randomly each day from a short time interval around a certain point of time when the change should take place.

In the simulations of all alternatives the level of public transport service is adjusted to satisfy the increased demand due to more expensive car travel.

The alternatives analyzed in this project are all based on the present cordon. In previous projects more sophisticated tolling systems are analyzed. All these systems are however far more difficult and costly to implement in practice. Perfect marginal cost pricing means that motorists instead of the average cost of driving is faced with the marginal congestion cost which varies with the volume capacity ratio in time and space. In such a system the level of the toll of at trip is not determined until after the trip is finished, or at least until all the choices (of mode and route) are already made. In practice this type of pricing is very difficult to implement.

Our previous analyses of marginal cost pricing on links, such systems are very easy to implement in a model, as a considerable proportion of the benefits seemed to be connected to the route choice. We have also analyzed systems based on zonal tolling. The area was divided into several zones and the motorists were charged when passing each boundary. Such a system was however considerably more expensive to operate than the present system and the benefits did not exceed the benefits of a differentiated toll on the present system to any extent.

4 REVENUES FROM THE NEW PRICING REGIME

One could argue that the introduction of a toll financing system for road investments should be based on the idea of user payment. It is of course the peak traffic that acquires more capacity on the road network. The situation in Oslo is that the traffic in peak hours only contributes with one third of the revenues collected. Motorists driving in periods more or less characterized by free flow of traffic and low utilization of road capacity subsidize in great degree investments in more capacity on the road network in Oslo.

One of the aims with a change of regime to a system based on congestion pricing is to obtain a more appropriate distribution of taxation of the motorists. The present level of revenues collected should not bee exceeded. Table 1 shows the performance of the defined alternatives when it comes to revenues collected in different time periods. As can be seen, the revenues in the rush hours increases in all alternatives. These systems are only operated between 6 a.m. and 6 p.m. in weekdays and between 9.a.m. and 3 p.m. on Saturdays. There is no longer revenues collected in low traffic periods. In A4 the collection on Saturdays also is eliminated. This alternative is also the one with total revenue closest to the present level. The slight reduction of revenue in mid day hours is due to improved public transport. This effect is explained in the next section.

5 PUBLIC TRANSPORT

In Oslo, the traffic situation in the morning peak hours sets the dimension in terms of need for capacity in public transport. A procedure is thus developed that increases the frequencies on the transit lines with increased traffic in the peak hours. This procedure differentiates between transit lines that is a part of the base service (lines that is operated non-stop) and transit lines that is just operated in peak periods. If the frequency of a line that is a part of the base service is increased to satisfy the increased demand in the peak hours this yield also in low traffic periods. This is a great advantage in terms of cost effectiveness in the production of the public transport service. It is not so much more expensive to operate new public transport vehicles all day than it is to operate them only during a few peak hours (Larsen, 199). Other effects in addition to satisfy the new demand due to increased tolls is that the improved level of service also attracts new demand for public transport and that it represents benefits for the initial public transport users.

5.1 Changes in demand for public transport

The logit models for the four periods are used to calculate the changes in demand for public transport. The changes are influenced by several "mechanisms" with different implications for the modeled periods. In the rush hours models the main effect is caused by increased cost of car use. This reduces the car traffic and makes the situation better for the remaining car traffic (the model iterates between demand and supply until the generalized travel costs clears the market, i.e. a equilibrium between demand and supply in departure hours and on modes is obtained). Increased market share on public transport requires higher capacity in public transport. This demand is met by higher frequencies on transit lines that get congested when the toll is increased. If the lines are part of the base service the higher frequency also is offered to public transport users between the rush hours. The demand for public transport between rush hours increase as a result of this even though the toll is assumed fixed at the present level. In low traffic periods the toll is completely removed but public transport is improved. The overall effect of this is a slightly reduced market share for public transport

Table 2 shows that the public transport is estimated to increase by 4.5% to 6.5% on an annual basis compared wit the present situation. The income this generates for the public transport companies is shown in table 3.

Table 1. Annual changes in revenues from tolling in different periods. Compared to the present system (million NOK/year).

	Morning rush hours	Mid day traffic	Afternoon rush hours	Low traffic periods	Sum
A1	271	-2	197	-257	209
A2	222	-2	155	-257	117
A3	213	-2	166	-257	120
A4	213	-47	166	-257	76

Table 2. Annual number of public transport users (million) and changes in different periods. Compared to the present system.

	Morning rush hours	Mid day traffic	Afternoon rush hours	Low traffic periods	Sum
PS	33	17	33	47	130
A1	13.2%	3.4%	13.7%	-2.1%	6.5%
A2	10.4%	3.3%	10.7%	-2.2%	5.0%
A3	9.7%	3.0%	10.5%	-2.5%	4.6%
A4	9.7%	2.0%	10.5%	-2.5%	4.5%

Table 3. Annual changes in income from public transport in different periods. Compared to the present system (Million NOK/year).

	Morning rush hours	Mid day traffic	Afternoon rush hours	Low traffic periods	Sum
A1	70	10	73	-13	139
A2	55	9	57	-14	107
A3	52	9	57	-16	101
A4	52	6	57	-16	98

5.2 Income and operation costs

The table shows that income from public transport is estimated to increase the most in rush hours. Income drops significantly in low traffic hours when the toll is eliminated.

The income in public transport is relatively easy to estimate once we have estimated the effects on demand. This is far form the case with the operation costs. The following formula is suggested for calculation of time and distance dependent cost

$$C_t = \Sigma_L (v^L \tau^L + d^L v^L \delta^L 60/h^L) \qquad (6)$$

where C_t = total operating costs in an hour t; v^L = number of vehicles needed to operate the transit line L; τ^L = cost pr hour for line L; d^L = total distance of line L; δ^L = cost pr km for line L; h^L = time of a roundtrip with line L. The first component of (6) expresses the time dependent cost of operating a transit line, and the second component expresses the distance dependent cost.

The first component of (6) is dominated by the wage for the operator of the vehicle, and the second component contains costs of fuel, oil, etc. The cost of positioning of the vehicle is not included. The unit costs vary by type of vehicle. The summation over all transit lines gives the total operating costs in hour t.

The fixed cost of public transport is assumed constant except of capital costs that are calculated on the basis of the need for investments in extra vehicles. In the different analyzed alternatives there is a need

Table 4. Annual changes in operation costs of public transport for different periods. Compared to the present system (Million NOK/year).

	Morning rush hours	Mid day traffic	Afternoon rush hours	Low traffic periods	Sum
A1	32	33	32	67	164
A2	29	31	29	63	151
A3	26	27	26	56	135
A4	26	28	26	56	136

for between 122 and 142 new vehicles or train/tram/subway sets. The capital costs however are difficult to trace back to a certain operating period and are therefore omitted in table 4 below.

The table shows that the increased cost of operating the public transport exceeds the increased income. In the rush hours the increased costs are lower than increased income. This is however just a part of the picture. In all transport, but especially in public transport, the users carry a big share of the total production costs. The next section focuses on the overall benefits from the different tolling schemes and their implications.

6 A SOCIAL BENEFIT MEASURE

Larsen (1998) suggests the following expression as a measure of social benefits from different transport policies:

"Consumers surplus"
\+ Revenues form "congestion pricing"
\+ Income from public transport
– Operating cost for public transport (7)

All the components of this expression are already accounted for in the previous sections except for the term "consumers surplus". In cost-benefit analyzes of transport projects consumers surplus very often is the most important component on the benefits side. To estimate the user benefits "the rule of the half" is often applied. A change in consumer's surplus in this method is estimated as changes in generalized cost times the average demand before and after the introduction of the project as shown in (8).

$$CS = ½ (GC_1 - GC_0)(X_1 + X_0) \qquad (8)$$

where GC_0 = generalized costs before implementation; GC_1 = generalized costs after implementation; X_0 = demand before implementation; X_1 =demand after implementation. In our analyses however there are changes in generalized costs both for motorists and for public transport users. In the rush hours models the changes also vary with departure time. Thus we have applied an alternative method of estimating the consumer's surplus, based on the well-known property of the logit model. Changes the logsum of the logit model is as de la Barra (1989) amongst others point out conceptually equivalent to the traditional consumer's surplus indicator shown in (8). The logsum can be expressed as

$$LS = \ln(\Sigma_{it} \exp(GC_{it}))/\beta_c \qquad (9)$$

where GC_{it} = is the generalized costs expression in the model for mode i at departure time t shown in (1), (2) and (3); β_c = the model parameter for monetary costs.

Table 5 summarizes the calculation of consumer's surplus made for the alternatives analyzed in this project. As we can see the commuters in the rush hours is worse off in all the alternatives. This is of course due to the increased tolls, which negative effect is larger than the positive effect of a better public transport system. The traffic in mid day periods is better off due to better public transport and slightly improved accessibility on the road network. The toll in this period is left at the present level. The traffic in low traffic periods is much better off manly because of free passing of the toll cordon.

The negative effects in rush hours are of course the reason why this type of policy for a long time has not been acceptable amongst politicians, authorities and the general public. The effects of the alternatives to this type of policy (increased road investments, more car traffic, wider commuting areas, etc) seems however to get more attention as the years go by and car traffic increases.

The overall effect of the analyzed alternatives, calculated by (7) is shown in table 6. The values shown for the present situation (PS) for toll revenues and income and costs of public transport coincides remarkably with the actual figures in the Oslo region. In the table we have also included the capital cost and the estimated changes in this due to investments in new vehicles to meet the new demand.

The figures in table 6 suggest that all the analyzed alternatives are profitable from a social point of view. Ideally one should choose the most profitable amongst them. It seems however that A4 is the most likely to be implemented. This alternative avoids the problems of timing of the changes of the toll, and implies less increased revenues, both factors important to local authorities and politicians.

Table 5. Annual changes in consumer's surplus for the alternative systems. Compared to the present system (Million NOK/year).

	Morning rush hours	Mid day traffic	Afternoon rush hours	Low traffic periods	Sum
A1	-178	24	-184	351	13
A2	-134	23	-136	349	102
A3	-134	22	-143	345	90
A4	-134	68	-143	345	135

Table 6. Annual social benefits for present system and changes in benefits for the alternative systems (Million NOK/year).

	A1	A2	A3	A4
"consumers surplus"	13	102	90	135
toll revenues	209	117	120	76
income PT	139	107	101	98
operating cost PT	-164	-151	-135	-136
capital cost PT	-24	-20	-18	-18
Sum	174	155	158	155

Table 7. Annual amount of fuel consumption (million liters) in different parts of the area in different periods and changes connected to the alternative systems (Million liters pr year).

	Total	In rush hours	Inside cordon	Inside cordon in rush hours
PS	637	215	236	82
A1	-4.7%	-14.0%	-5.8%	-18.0%
A2	-3.7%	-11.3%	-4.6%	-14.5%
A3	-3.6%	-10.9%	-4.4%	-13.9%
A4	-3.5%	-10.9%	-4.2%	-13.9%

7 ENVIRONMENTAL PERFORMANCE

In table 6 there is no explicit valuation of the environmental performance of the alternatives. In Norway the tax on fuel and vehicles is amongst the highest in Europe, perhaps even in the world. Over 65 % of the price of fuel are special taxes. It is therefore often argued that the taxes exceed the average negative external effects from car traffic in Norway. The Oslo region is however the densest populated area in Norway, with a large proportion of the population exposed to the local pollution from the traffic. Even though the environmental cost of car traffic is internalized by taxes, which is a subject for discussion, the environmental performance is of great importance and interest for the public.

Table 7 shows the results from the fuel consumption model described in section 2.4. Again, the figures for the present situation coincide satisfactorily with fuel sales figures in the region. As we can see the consumption on the road network inside the present cordon, which is the most sensitive area, is reduced by 14 % to 18 % in rush hours. The reduction of fuel consumption for the whole area is calculated to between 10 % and 14 % in the rush hours, whilst the annual reduction for the whole area is ca 4 %.

8 CONCLUSIONS

The Oslo Cordon toll system, in its original form was designed to collect funds for road investment purposes. Increasing environmental problems caused by road traffic within the inner city raises the question as to whether motorists should be made to pay the full social cost of their trips. Both the local and central authorities are looking for ways to deal with the Oslo problem. Specifically, the question that is being raised is whether a move towards optimal congestion pricing would generate any benefits worth consideration.

In this paper, we have demonstrated that such a move will generate significant social benefits worth consideration. Specifically, we have shown that a move from cordon tolling towards congestion pricing will:

(i) Raise the revenue substantially as compared to the current situation. This is because in a congestion pricing regime, the peak traffic is taxed more in line with marginal cost pricing as compared to the current situation where peak traffic contributes with only one third of the total revenue collected.

(ii) Optimal congestion pricing increases the costs of car use and hence reduces the traffic volume. This in turn leads to increased demand for public transport as well as reduction of travel time for the remaining traffic. Increased demand for public transport imply increased income for public transport. Arguably, congestion pricing leads to improvement of the environment as it reduces car traffic.

(iii) Even though the cost to public transport will increase, the sum of consumer surplus and income to public transport will be very large to offset it. Thus the total social benefit for moving from cordon toll to congestion pricing will be greatly positive.

Our study has thus identified a number of points that are of direct relevance for marketing of congestion pricing in Oslo. The bottom line is that a move from current cordon toll to congestion pricing will improve both the environmental quality and the quality of transport services in the region.

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Spatial economic externalities and coordinated land use-transportation planning

Economies externes spaciales et planification coordonnée de l'utilisation du sol et des transports

Economías externas espaciales y planificación coordinada de uso de suelos y transporte

Antonio Páez & Takashi Uchida
Graduate School of Engineering, Tohoku University, Sendai, Japan

Kazuaki Miyamoto
Center for Northeast Asian Studies, Tohoku University, Sendai, Japan

ABSTRACT: Planners often use land price models as tools to support coordinated land use-transportation planning, and as instruments to measure the benefits of land use and transportation improvements, particularly when considering a value capture approach to alternative taxation possibilities. In this paper, we present a land price model characterized by the use of spatial data in a spatial context, by the use of a spatial association parameter and a formal definition of neighborhood that we interpret as elements of an economic externality. Our model analyzes the effects of some usual land use and accessibility variables, and the magnitude of external economies affecting prices using a spatially switching autoregressive model. Using as a case study the city of Sendai in northeastern Japan (pop. about 1 million), we find considerable presence of spatial external economies, and heterogeneous effects of the price determinants between the CBD and the rest of the city.

RÉSUMÉ: Les urbanistes utilisent souvent les modèles de prix du sol comme outils pour entretenir une planification coordonnée utilisation du sol-transport, et comme instruments pour mesurer les bénéfices de l'utilisation du sol et l'amélioration du transport, particulièrement en considérant une approche de la valeur capturée aux possibilités de taxation alternative. Dans cet article nous présentons un modèle de prix du sol caracterisé par l'utilisation des données spatiales dans un context spatial, por l'utilisation d'un paramètre d'association spatiale at une définition formelle du voisinage que nous interprétons comme des éléments d'une externalité économique. En utilisant comme cas d'étude la ville de Sendai dans le nord-est du Japon (pop. environ 1 million). nous trovons une présence considérable des économies externes de l'espace et des effets hétérogènes des determinants de prix entre le centre et le reste de la ville.

RESUMEN: En planificación urbana se suelen usar modelos del precio de los suelos como un apoyo a la elaboración de planes coordinados de uso de suelos y transporte, para medir el impacto del uso de suelos y el transporte, y para estudiar alternativas tributarias. En este artículo presentamos un modelo caracterizado por el uso de información espacial en un contexto espacial, y por el uso de un parámetro de asociación espacial y una definición formal de vecindario que interpretamos aquí como elementos de una economía externa. El modelo analiza los efectos de algunas variables comunes de uso de suelos y accesibilidad al transporte y también la magnitud de las economías externas que afectan a los precios. Estudiando la ciudad de Sendai en el nordeste de Japón (pob. cercana al millón), revelamos la existencia de considerables economías externas, además de efectos heterogéneos de las variables entre el centro y el resto de la ciudad.

Urban planners and policy makers interested in coordinated land use and transportation studies often support their work with empirical evidence provided by land price models. These models are frequently obtained under the hedonic approach framework, which quantifies the implicit price of non-marketed good characteristics such as accessibility or environmental attributes. Examples of the use of land price models in transportation planning include measuring the benefits of railway infrastructure improvements on land prices (Pior et al. 1998), and the study of alternative taxation possibilities to finance roadways based on the concept of value capture (Cervero & Susantono 1999).

Implicit prices for different characteristics are econometrically estimated by means of regression analysis, paying attention to structural and environmental attributes, and in particular to externalities for which, by definition, no markets exist. However, for some reason most studies have focused on the effect of negative externalities, such as emissions from stationary sources and traffic congestion, while positive effects resulting from proximity to other activities have been, with a few exceptions (see for instance Dubin 1992), largely ignored. The treatment of spatial effects in econometric models was motivated, in the first place, by methodological concerns derived from the use of spatially associated data for model estimation and the well-known estimation pitfalls that result from such practice. Spatial error autocorrelation and structural model instability over space, for instance, are two current topics in empirical research (Goodman 1996). However, the interpretation of spatial effects as a form of external economy has been, in our opinion, understated, in spite of the conceptual richness of the approach.

The purpose of our study is to analyze the effects that a number of variables depicting land uses and accessibility to transportation facilities have on land price determination. We pay particular attention to the existence of spatial externalities, that is, situations where an economic agent is affected by decisions made by others (Cornes, R. & Sandler, T. 1996). We part from the hedonic approach linked to a model of economic externalities, and then proceed to estimate an econometric model that includes a spatial association parameter and a formal definition of neighborhood.

The case study is Sendai City, a typical middle sized city in northeastern Japan, for which we find evidence of a strongly monocentric spatial structure. We show that the effect of accessibility to transportation is heterogeneous between the CBD and the periphery, where two emerging subcenters locate, and that land use distribution also exerts different effects in the two regions. Moreover, we show that spatial externalities are smaller in the CBD, reflecting decreasing returns in an area nearly saturated and where the effect of proximity to other activities loses some of its relative importance.

1 FORMULATION OF THE MODEL

1.1 *The hedonic approach*

The hedonic approach is a method in planning used to measure the implicit price of different attributes of a real state site. Price function p is given in terms of a vector $\mathbf{Z}$ of neighborhood and structural characteristics, such as accessibility to transportation infrastructure, air quality and size of the lot:

$$p = p(\mathbf{Z}) \tag{1}$$

Rosen (1974) has shown that a conventional utility maximization problem underlies the price function, and that it represents the envelope of demander's marginal bids. In other words, the individual agents maximize utility function $U(c, \mathbf{Z})$ subject to budget constraint:

$$m = c + p(\mathbf{Z}) \tag{2}$$

with m as the budget given in terms of units of composite good c. When consuming optimum quantities, utility is maximized and the minimum price they face is $p(\mathbf{Z})$, given by the hedonic price function.

1.2 *Economic externalities model*

Although land price determination is influenced by a number of external conditions, some of these, such as land use at neighboring locations and others, are specifically spatial. It is our assumption here that said conditions are implicitly represented by land prices, which in turn constitute an indicator of neighborhood quality in general. That is, we suppose that demanders, in addition to being interested in $\mathbf{X}$ local characteristics such as accessibility to transportation and land uses, also care about proximity to other locations and the perceived level of consumption and quality there as measured by the prices.

More formally stated, the prices p_j ($j \neq i$) enter the model through the utility function at i as a spatial external effect, that we distinguish from other characteristics as follow:

$$U_i = U_i(c, \mathbf{X}_i; p_1, \ldots, p_{i-1}, p_{i+1}, \ldots, p_n) \tag{3}$$

The above utility function corresponds to a model of general externalities (Cornes, R. & Sandler, T. 1996), except that the consumption level of this particular characteristic at location i does not directly enter the utility function (it does indirectly as a result of regional dynamics). The above function is maximized subject to the usual budget constraint, and results, following the logic behind the hedonic approach, in price function at location i as:

$$p_i = p_i(p_1, \ldots, p_{i-1}, p_{i+1}, \ldots, p_n, \mathbf{X}_i) \tag{4}$$

or in aggregated form as:

$$p_i = p_i(P_{Ei}, \mathbf{X}_i) \tag{5}$$

with scalar P_{Ei} being the aggregated, location specific form of the spatial externality. We conceptualize the aggregation of this term as being additive to give a neighborhood average, and weighted according to some function of distance, so that the perceived influence of closer locations is greater than that of far away locations. This is discussed in the following sections, in relation with the econometric representation and the estimation of the price function.

1.3 *Econometric model*

The price function given by equation 5 can be represented using a spatially autoregressive model.

Models of this kind were originally proposed as a solution to the estimation problems that arise when using autocorrelated spatial data (Cliff & Ord 1981), but more recently have been used in the analysis of public good problems (Murdoch et al. 1993; 1997). The following regression specification is used to represent the price funtion (in matrix form; see Anselin 1988):

$$\mathbf{P} = \rho\mathbf{P}_E + \mathbf{X}\beta + \varepsilon = \rho\mathbf{W}\mathbf{P} + \mathbf{X}\beta + \varepsilon \qquad (6)$$

with vector $\mathbf{P}_E = \mathbf{W}\mathbf{P}$ as the aggregation of economic externality in equation 5. The structure of the variance is given by:

$$E[\varepsilon\,\varepsilon'] = \Omega \qquad (7)$$

In the above equations **P** and $\mathbf{P}_E$ are vectors $(n \times 1)$ of land price observations and spatial externality terms. **X** is a matrix $(n \times k)$ of k variables (characteristics) that include the usual constant term for the mean, while vector β $(k \times 1)$ are k parameters associated with the charactersitics. Element ρ is a spatial association parameter that defines the magnitude of the external effect (in this case the marginal price) in the neighborhood of a location, defined by the matrix of spatial interactions **W** $(n \times n)$ used to formally give a spatial structure to the region (see section 3.1). Vector ε is a set of stochastic disturbances, and heterogeneity can be introduced in the variance structure for residuals Ω.

2 CASE STUDY

2.1 *Description of the city*

Sendai City is the capital of Miyagi Prefecture in northeastern Japan, one of the country's 10 largest cities with a population of 1 million, and a pole of regional growth with a strong commercial and industrial standing and a number of major universities.

Predominantly monocentric in its structural shape, Sendai is served by radial rail transportation, with urban railway lines in the south-north and east-west axes, and a subway line that runs in the south-north axis. In addition to the central business district near Sendai Station, there are two rapid growth subcenters in the surroundings of Izumi Station to the north, and Nagamachi Station to the south (Fig. 1a).

2.2 *Data and variable definitions*

We used two sources of data. Land price data was obtained from the 1996 Land Price Map published by Sendai City's Information Office (scale 1:50,000). Land use and demographic data was taken from the 1995 Basic Planning Survey for Sendai Metropolitan Area. This information was handled with a GIS, and other variables were produced using GIS operations such as distance calculations and map overlays to obtain dummy variables.

Variable selection reflects the primary interest of the study, and includes, in addition to land prices, accessibility to transportation (distance to station), and other land use and demographic variables to measure the intensity of land use activities. In order to investigate the influence of the two subcenters in the empirical section, we decide to introduce variables depicting distance to each station. The variables and units are as follow:

1 Land price (P; 10,000 ¥/m^2)
2 Distance to CBD (DIST; in this case distance to Sendai Station in m)
3 Distance to Izumi Station (DIST_IZ; m)
4 Distance to Nagamachi Station (DIST_NM; m)
5 Distance to nearest subway or train station, calculated using a GIS (DISTN; m)
6 Land use dummy (LUDUMMY; 1 if commercial use, 0 else)
7 Percentage of commercial land use area by zone (CommPct)
8 Percentage of residential land use area by zone (HousePct)
9 Population densities by zone (PopDen; hab/km^2).

2.3 *Exploratory analysis of the data*

Before proceeding to model estimation, the land price data was examined using spatial statistical tests, to find that it presents a high degree of spatial autocorrelation, as measured by Moran's *I* statistic (Cliff, A.D. & Ord, J.K. 1981). More interesting, however, was the application of Getis and Ord G_i local statistic of spatial autocorrelation (Getis, A. & Ord, J.K. 1992) to identify hot spots of spatial association. In this context, the G_i statistic is interpreted as giving the locations where the value of a cluster of land price observations is significantly high or low, thus appearing as an ideal tool to identify urban centers and sub-centers.

Details of the exploratory analysis can be found in Paez (1998), but the relevant result is that observations can be classified in two groups according to their location. The first group (60 observations) corresponds to the area of the CBD, where a cluster of high valued observations is found, while the second (419 observations) comprises the rest of the data set (Fig. 1b). This confirms that the spatial structure of land prices in Sendai is monocentric, and also that the prominence of the two aforementioned emerging subcenters is not yet significant from a regional perspective.

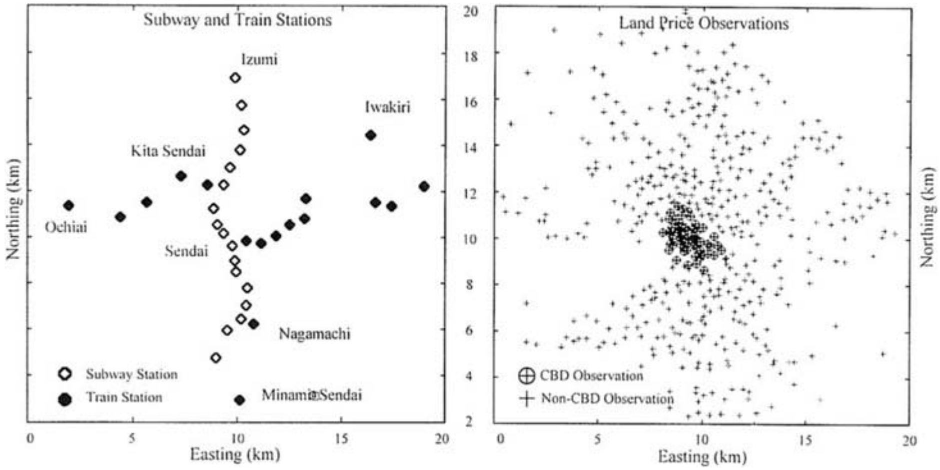

Figure 1. Sendai City: a) railway and subway network; b) land price observations and classifications: CBD and non-CBD

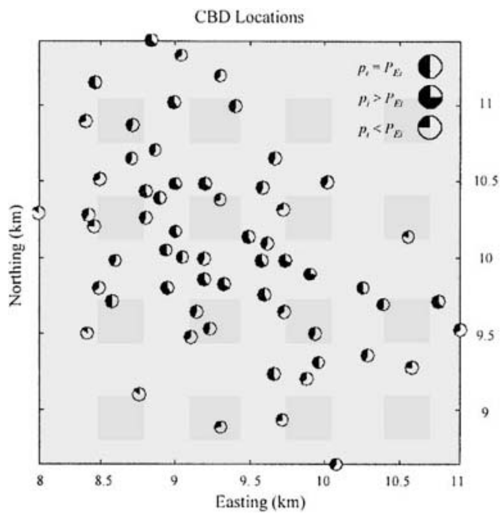

Figure 2. Relative size of neighborhood average price compared with price at location p_i (CBD; W with ϕ=650)

3 ESTIMATION OF THE MODELS

3.1 *Definition of neighborhood and aggregation of effects*

Estimation of a spatially autoregressive model involves the selection of spatial interactions matrix **W** in equation 6 to formally define the concept of neighborhood and aggregate the effect. This is a square matrix of size n (the number of observations in the sample), where the rows and columns relate each to a single observation, and the values in row i and column j represent the relative influence that jth observation has on ith observation.

The values in the matrix are positive for interacting location pairs, and 0 in the diagonal (by definition a location does not interact with itself) and everywhere else. Since all the values in **W** are positive, the sign of parameter ρ (eq. 6) is expected to reflect the overall effect, something that might appear as a limitation of sorts. Alternative studies might resort to other options to allow localized analysis (see for instance Paez et al. 1999). Under the approach taken here, the neighborhood of an observation is given by the distribution of interaction values along its corresponding row.

It is customary to 'row standardize' matrix **W** for ease of interpretation (when multiplied by vector **P** it gives the average value in the neighborhood of each location), and to allow comparison among different matrix definitions. To row standardize a matrix, the individual entries are divided by the sum of their respective rows, so that each row adds up to one and the sum of all elements in **W** is n:

$$w_{ij}^{st} = w_{ij} / \sum_j w_{ij} \tag{8}$$

$$\sum_j w_{ij}^{st} = 1 \tag{9}$$

In the case of studies where the interactions are physical flows, a univocal definition of matrix **W** can be obtained (see Murdoch et al. 1997). However, when more subtle, non-physical economic effects are in operation, an objective pattern of interactions is more difficult to obtain, and its definition largely becomes an empirical matter. It is generally agreed though, that the perceived strength of interactions decreases with distance, and that the set of interacting observations will define the neighborhood of a location. We select a negative exponential distance decay scheme to define **W**:

$$w_{ij} = \exp(-d_{ij}^2 / \phi^2) \tag{10}$$

Here d_{ij} is the distance between locations i and j, and ϕ is a parameter that controls the steepness of the distance decay curve. To select a matrix we estimate the models using different values of ϕ, trying to minimize the value of Akaike's Information Criterion (AIC), after Murdoch et al. (1993) and Takatsuka (1998). For technical details regarding the matrix of interactions, see Cliff & Ord (1981).

Figure 2 shows for the CBD the relative size of the spatial external term P_{Ei}, by comparison with the price at the location. In many cases, the average price in the 'neighborhood' amounts to about the price at the location, but this influence in the model is further reduced when multiplied by estimation parameter ρ (eq. 6).

3.2 *Spatially autoregressive model*

Following, we estimate the econometric model that represents the hedonic price function. The form of the model is the spatially autoregressive specification given by equation 6, under the assumption of homogeneity, that is $\Omega = \sigma^2\mathbf{I}$ in equation 7.

Two models were estimated, one using the complete data set comprising 479 observations (model 1), and other using the subset of 60 observations corresponding to CBD locations (model 2; see Fig. 1). Estimation of these models follows the procedure outlined in Anselin (1988), which as part of inference includes a Lagrange Multipliers (LM) test against residual spatial error autocorrelation. Parameter ϕ reported is the value used to calculate the elements of matrix $\mathbf{W}$ (eq. 10) that minimized the AIC (i.e. maximized the likelihood).

We can observe from the estimation results appearing in Table 1, that a number of parameters in model 1 are not significant, but the signs of the significant parameters are satisfactory, including that for the spatial association parameter ρ that represents positive spatial external effects. The model, however, fails the test against spatial error autocorrelation (LM statistic), and therefore is not considered to be valid.

Comparing models 1 and 2, notorious differences can be observed between parameter values and even signs for corresponding variables. This discrepancy between models suggests that there might be an element of model structural instability due to the existence of strong spatial heterogeneity, which leads to the idea of conducting a switching regression using two spatial regimes to overcome the problem of residual spatial autocorrelation. It is interesting to notice that the term ρ for spatial externalities is not significant when using the CBD data alone, reflecting decreasing returns in an area reaching saturation.

Table 1. Estimation of Spatially Autoregressive Models (SAM)

	Model 1: SAM All Data		Model 2: SAM CBD Only	
Variable	ML Estimate	t-value	ML Estimate	t-value
CONST	203.9873	1.65	-27561.8457	-1.95 *
DIST	-0.0723	-3.94 **	-1.6697	-3.18 **
DIST_IZ	0.0190	1.84	2.8222	2.04 *
DIST_NM	0.0336	2.11 *	3.2559	2.36 *
DISTN	-0.0010	-0.06	-1.0389	-1.45
LUDUMMY	274.7198	5.70 **	588.5361	1.01
CommPct	4.3639	2.44 *	-2.1475	-0.26
HousePct	-1.0070	-1.00	-12.7970	-1.23
PopDen	-1.7708	-5.34 **	-4.7906	-3.15 **
ρ	0.6380	21.72 **	0.1117	1.02
LOG LIKELIHOOD	-3314.472		-458.807	
ϕ	380		130	
σ^2	101631.55		510336.593	
n	479		60	
<< Test for Spatial Autocorrelation in Error Terms >>				
LM Statistic	9.659 ** (χ^2 with 1 DF)		0.08 (χ^2 with 1 DF)	

Significance: ** 1% * 5%

Table 2. Estimation of Spatially Switching Autoregressive Model

	Model 3: Spatially Switching Spatially Autoregressive Model			
	CBD		Non-CBD	
Variable	ML Estimate	t-value	ML Estimate	t-value
CONST	-28418.5423	-2.05 *	107.8228	5.54 **
DIST	-1.5890	-3.29 **	0.0056	1.86
DIST_IZ	2.9012	2.15 *	-0.0052	-3.29 **
DIST_NM	3.2826	2.46 *	-0.0065	-2.67 **
DISTN	-1.2558	-1.78	-0.0024	-1.08
LUDUMMY	600.1559	1.02	148.1973	19.36 **
CommPct	-2.9788	-0.36	1.0348	3.07 **
HousePct	-10.3336	-0.99	-0.4068	-2.42 **
PopDen	-5.0201	-3.36 **	0.3249	5.14 **
	ML Estimate		t-value	
ρ	0.2586		11.08 **	
LOG LIKELIHOOD	-2524.98			
ϕ	650			
σ_C^2	512109.90			
σ_N^2	2219.70			
n_C	60			
n_N	419			
<< Test for Spatial Autocorrelation in Error Terms >>				
LM Statistic	0.086		Distributed as χ^2 with 1 DF	
<< Test for Coefficient Structural Instability >>				
Chow Test	105.561 **		Distributed as χ^2 with 9 DF	

Significance: ** 1% * 5%

3.3 *Spatially switching spatially autoregressive model.*

Results obtained for models 1 and 2 suggest that there is an element of heterogeneity in the data, which might be at the root of spatial error autocorrelation in model 1. A solution to this problem is to estimate a switching regression, a method applied in situations where the data can be classified in a small number of heterogeneous regimes, as is the present case if we use the locational classification resulting from the analysis of land price data.

Estimation of a switching regression under a spatial framework can be done as follows, defining C (for CBD) and N (for non-CBD) as the different spatial regimes:

$$\begin{bmatrix} \mathbf{P}_C \\ \mathbf{P}_N \end{bmatrix} = \rho\mathbf{W}\begin{bmatrix} \mathbf{P}_C \\ \mathbf{P}_N \end{bmatrix} + \begin{bmatrix} \mathbf{X}_C & \mathbf{0} \\ \mathbf{0} & \mathbf{X}_N \end{bmatrix}\begin{bmatrix} f\mathring{A} \\ f\mathring{A} \end{bmatrix} + \begin{bmatrix} f\tilde{A} \\ f\tilde{A} \end{bmatrix} \tag{11}$$

Here the vector and matrix of observations have been rearranged and partitioned according to the locational classification, either as CBD or non-CBD observations. Matrix **W** is similarly rearranged, to match the observations in $\mathbf{P}_C$ and $\mathbf{P}_N$. In such a way, an independent set of parameters (β_C and β_N) can be obtained for each spatial regime, thus simultaneously addressing the issue of model structural instability.

The above specification introduces heterogeneity in the structure of the variance, and is applicable to our model of externalities since it is identical in form to equation 6. Estimation of this model closely resembles that of a spatially autoregressive model, and the technical details of estimation and inference can be found in Paez (1998). Results for this model appear in Table 2.

As before, we find significant presence of positive spatial external effects (ρ= 0.259). This means that proximity to other activities is seen as an asset and, according to our expectation, receives a positive valuation in the function of implicit prices of about 26% of the average price in the 'neighborhood' of the location as defined by matrix **W**.

An interesting result of estimating a switching regression is that we find heterogeneous effects between the CBD and the rest of the city. In the central district, proximity to Sendai Station results in higher prices, whereas proximity to the two subcenters has the opposite effect. This is reversed in the rest of the city, where we find that distance to Sendai Station is not a significant determinant of price, but proximity to the subcenters commands higher values. This appears to imply the existence of an attraction-repulsion effect between rival business centers.

We also find that the parameter for distance to nearest station is not significant as a determinant of prices in any region, which seems to confirm the dominance of the three main business centers. Under other circumstances and defintions of matrix **W**, we have found that inclusion of this variable, in addition to not being significant, introduces noise in the form of spatial error autocorrelation (Paez et al. 1999)

In terms of land uses, we show that commercial uses in the periphery receive a premium not found in the CBD. Since commercial uses dominate this region of the city, it is natural that there is no premium for new commercial development here. The effect of different land uses, on the other hand, is not relevant in the CBD and gives contrasting results in the rest of the city: more intense use of land for commercial purposes increases the price, while denser residential coverage decreases it. Finally, population density has opposite effects in the two regions, being beneficial in the suburbs, but not so in the CBD.

A Chow test, modified to take into account the spatial effects, rejects the hypothesis that parameters are statistically equivalent in both regions, thus confirming the model's structural instability, and the validity of the previous analysis. The model is also valid in the sense that no residual spatial autocorrelation was detected, as shown by the LM test.

4 CONCLUSION

External economies are a commonplace occurence in urban settings, and land price models used to study the influence that transportation and land have in the price determination often consider them when quantifying implicit prices of structural and environmental attributes.

In this study we turned to the usual hedonic approach, but linked it to a model of external economies that justified the use of a spatially autoregressive model of land prices. The autoregressive structure was interpreted as a form of external economy in which proximity to other activities results in positive spatial spillovers. Although neighborhood effects are recognized as important determinants of land prices, few studies approach the issue making use of formal definitions of neighborhood and spatial proximity. Our approach to the problem tackles technical issues, such as residual spatial autocorrelation and structural instability, and also offers a meaningful economic interpretation to the spillovers.

Two model forms were tried, but the one ultimately accepted was a spatially switching autoregression. This form includes the spatial elements needed to represent the economic externality, and in addition separates the data into two different spatial regimes, so that we could discriminate between parameters for locations in the CBD and the rest of the city. We found that external economies in space exist, and that the relationship between prices and characteristics are assymetric in a number of cases, which helps to clarify the role of different variables in the two regions, and also perhaps the effects of zoning. In conclusion, our work examplifies a spatial modeling tool that considers externalities, which we believe can substantially contribute to support the practice of land use and transportation planning.

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Economic regulation, costs reimbursement and operational control in local bus industries of Belo Horizonte and Petropolis, Brazil

La réglementation économique, le remboursement des coûts et le contrôle opérationel des transports en commun des villes de Belo Horizonte et Petropolis au Brésil

La reglamentación económica, la remuneración del capital y el control de la operación en los sistemas de autobuses de Belo Horizonte y Petrópolis, Brasil

C.Contreras-Montoya – *Transport Division of the Ministry of Public Works and Transport, Costa Rica & Federal University of Rio de Janeiro, Brazil*

R.Orrico Filho – *Federal University of Rio de Janeiro, Brazil*

A.Brasileiro – *Federal University of Pernambuco, Brazil*

ABSTRACT: The concept of flat tariff and the mechanism of the Tariff Compensation Chamber for public bus transport are measures that have been used with success in some Brazilian cities, under a regulation defined to plan and establish adequate levels of service in accordance with the concept of public service, respecting the financial balance of the operators when defining the methods of operational costs and capital reimbursement. The legal marks and respective economic regulations are analised and compared for two Brazilian cities—Belo Horizonte and Petrópolis—which have different areas, population, morphology, type of bus net and institutional organisation, evaluating the type of reimbursement which characterises each system, establishing a comparative analysis seeking to identify the efficiency, complexity and representativeness levels of each case analised.

RÉSUMÉ: L'adoption du tarif unique ainsi que le mécanisme d'équilibre multi-entrepreneur appellé Chambre de Compensation Tarifaire aux services de transport en commun ont été deux importants instruments utilisés avec du succès dans certain nombre de villes et d'agglomérations urbaines brésiliènnes où les services sont délégués à des entreprises privées. Les deux instruments sont placés dans un cadre réglementaire qui vise à la fois planifier et établir de niveaux de services acceptables par de couches sociales moins aisées et à la fois mantenir l'équilibre économique et financier des exploitants privés. Cet étude est une comparaison des cadres légal et réglémentaire de Belo Horizonte et Petropolis, deux différentes villes brésiliènnes en ce qui concerne le space urbain, population, morphologie, taux de couverture du réseau et organisation institutionelle du transport en commun. On évalue ses modèles de payment aux entreprise et on comparare ses differents niveaux d'efficacité, complexité et.représentation.

RESUMEN: Para el transporte por autobús de varias ciudades del Brasil la tarifa unificada y el mecanismo de Cámara de Compensación Tarifaria han sido medidas adoptadas con éxito, bajo reglamentación para establecer niveles de servicio adecuados y con el concepto de servicio público con tarifa social, respetando el equilibrio financiero de los operadores al definir la remuneración del capital. Se analizan y comparan los marcos legales y la reglamentación económica en los casos de Belo Horizonte y Petrópolis, ciudades con diferente área, población, morfología, cobertura de red y organización institucional, evaluando los tipos de remuneración para identificar los niveles de eficiencia, complejidad y representatividad de cada caso.

1. INTRODUCTION

Although Latin American countries present important socioeconomic differences, their history of public bus transport services has some significant elements in common. After their creation, which began in a more or less spontaneous manner, these services were strongly influenced by the State, not only in their planning, but especially in their operation. They also have in common a growing, and finally dominant, presence of the private initiative, either in an atomized form with relatively independent individual operators—a predominant situation in a great number of cities (like in La Paz, Quito and Lima)—or with small businesses (like in San José, for example), and even with the consolidation of large production units, with complex structures (like in Rio de Janeiro, São Paulo and Buenos Aires), with a total disappearance of the State in the operative function, and even perhaps in that of planning.

Such different dominant forms of entrepreneurship also mean different types of relationships between the Public Organisations responsible for transport and the private operators, who act as delegates of the public function, which can go from the formality that involves such relationships and their legal mark, up to the definition of different types of contracts, with the effective practice of this regulation.

Contrasting with the majority of the existing systems in other Latin-American countries, in Brazil, bus transport in the cities of large and medium transport capacity is characterised by being operated by formal, private companies with great entrepreneurial dynamism.

The Brazilian companies are large because, in one way or another, the Brazilian State has always (at least since the 50s) protected them through a regulation which, among other things, aimed exactly at creating strong companies. In the cities of other Latin American countries, on the contrary, this type of protection did not occur: they suffered constant tariff lags; only low investments were tolerated, allowing for the use of old gasoline vehicles; in some cases, they were obliged to keep to a small-size business etc.

The especial importance of this work lies in the analysis and understanding of the insertion of these production units within the context of the State's presence, in order to guarantee a service that is socially acceptable, keeping control over the economic regulation of the collective transport industry, i.e., by keeping the capacity to define the trinomial quantity-quality-price, in order to prevent private companies who receive concessions from operating through the use of monopolistic power, intrinsic to this type of service.

This work shows a conceptual description of the mechanisms of the tariff compensation and costs reimbursement used in Brazil. Its empirical complementation covers the cities of Petrópolis, in the State of Rio de Janeiro, and Belo Horizonte, in the State of Minas Gerais — which show different characteristics of population, area, topography, administrative importance and reimbursement model — aiming at as ample a spectrum as possible.

2. FORMS OF CAPITAL REMUNERATION

In Brazil, concessions and permissions for transport services are economically regulated through the method of *cost plus*, i.e., the services are delegated under conditions of exclusivity, but rights are taken away from the operator to prevent him from operating as a monopolist (defining the conditions of quantity and quality of the services, as well as the tariffs to be charged). As a counterpart, the public power undertakes to establish prices to guarantee cost compensation, with the addition of an extra sum relative to the presence of the company in this service, which is normally indexed at the value of the capital invested.

Two forms are basically used to compensate the companies for the transport services they render, the *tariff model* and the *public revenue model*, both of which present variables in connection with the competitiveness and profitability represented by mechanisms such as the Tariff Compensation Chamber (CCT) and the so-called Factor B (Orrico Filho, 1996).

2.1 *The tariff model*

In this model, the basic operational conditions are established by the Public Power and the operator's revenue derives from the number of passengers transported by his vehicles and the tariff he charges, which in principle, give him the capacity to operate and earn profit. The operational risks in this model rest with the operating company, the Public Power undertaking to determine the operational conditions, committing itself to calculate a tariff which will permit it to make a just compensation.

2.2 *The public revenue model*

As a solution to various problems that caused an accentuated increase in the tariffs charged from the inhabitants of the city's outskirts, usually belonging to very low-income populations, in the beginning of the 80s many Brazilian cities adopted a model in which the companies would no longer be compensated for the revenue earned by their vehicles, but would be paid for a previously established production unit (as distance per kilometer, for example), specified in a contract for services to be rendered signed between the companies and the Public Power.

This model especially permits the public entity to contract a company to operate lines with a very low revenue because other revenues deriving from lines with surplus will enable such services to be paid.

The main difference between the two models described consists in the manner in which the entrepreneur is remunerated. In the *tariff model*, the entrepreneur takes on the risk for the operation, with the responsibility of getting the greatest possible number of passengers, so that the income he collects may permit him to cover the operational costs as well as earn profit, the Public Power undertaking to establish the operational conditions, the fleet's characteristics and itineraries, with the commitment to define a just and opportune tariff for the operator. In the *public revenue model*, though, the operator will be remunerated for a pre-established number of production units, not taking into account the number of passengers he may be able to transport, discharging the cost per passenger from the value of the tariff, the Public Power becoming the owner of the revenue, with the responsibility for compensating him according to the contract for the rendering of services.

In both cases, the Public Power has the obligation to supervise and control in detail the real operational costs of the companies, in order to adequately determine the cost for the production of the service, thus preventing the calculation of high tariffs, which would damage the users, or otherwise, would establish a cost for the production unit below the real operational cost, which would cause loss to the operators.

2.3 *Intermediary cases: Factor B and CCT*

In order to prevent that once in possession of a public revenue model an operational company is no longer interested in effectively transporting passengers, some cities have adopted a variable: the Factor B. This model consists in linking the compensation received by the companies in part to the services supplied by them, and in part to the number of passengers transported by their vehicles.

In this case of mixed remuneration, an interesting situation occurs in that the greater the parcel related to the production unit, the more the model tends towards the Public Revenue type, whereas, the greater the part to be remunerated via the Factor B (transported passengers), the closer it gets to the Tariff Model.

The Tariff Compensation Chamber (CCT) is a mechanism that permits a system with entrepreneurial plurality—several operating companies independent among themselves—to operate as a single company, correcting financial imbalances when transferring the overage revenues from the surplus companies to cover the differences of the deficient companies, so that the financial equation of all the operators in kept positive. Figure 1 represents graphically the relationship between the mentioned models.

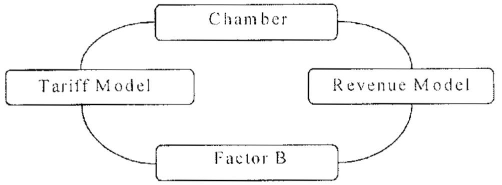

Figure 1. Representation of the relationship between the remuneration models

The mechanism of the Tariff Compensation Chamber enables the use of crossed subsidy between the companies that belong to the system, permitting that those routes or lines with less attractive characteristics for the operators (very long routes, reduced demand, congested corridors, etc.), and which make the service very expensive, become more interesting or attractive for the entrepreneurs, since they will be able to operate with lower tariffs than the cost per passenger, being later compensated according to the operational cost that will be recognised, and not for the revenue earned from tariffs. In like manner, the very profitable lines will continue to be attractive for the entrepreneurs, but they will be required to return the parcel of overage that exceeds a just compensation, transferring it to the companies in deficit in order to keep the balance of the system.

Another significant advantage is that, under these conditions, the Public Power or Managing Organisation has the possibility to demand a more homogeneous level of services between all the lines or regions of the system, in order to avoid differences in quality or a lower supply of buses in use in commercially low-profit lines.

It can be considered from this definition that there is a relation between the mechanism of the Tariff Compensation Chamber and the Public Revenue Model, since in both systems the commercial risk of the operation ceases to be the full responsibility of the operator, becoming the responsibility of the Public Power.

In both methods, the operation can be carried out as if the system had only one sole company (or even a flat tariff for all the lines), or various tariffs, according to the type or schedule of the service (i.e., jitneys, direct service, with air-conditioning, night-bus, end-of-week bus, which can have differentiated tariffs). The two models demand effective control of the operation by the Public Power, because in both cases the compensation due to the companies is linked mainly to the supply of service rather than to the transported demand or the tariff charged.

3 THE SYSTEMS STUDIED

This section describes the transport systems and the managing organisations of the Tariff Compensation Chambers in the cities of Petrópolis and Belo Horizonte. These systems have important differences, both physically (in their topography, regional size, operational area, etc.) and operationally (number of users, service supply, size and average age of the fleet, level of service, etc.), as well as in connection with the methodology used for calculating the operational cost (indices used, period for remunerating the companies, etc.) and the method adopted for compensation.

3.1 *The transport system of Petrópolis*

The municipality of Petrópolis, in the State of Rio de Janeiro, is located at 810 meters above sea level and 60 kilometres north of the city of Rio de Janeiro. It has an area of 853 square kilometres with a population of approximately 270,000 inhabitants.

Table 1. Principal data of the transport of Petrópolis

Issue	Quantity
Number of companies	6
Number of Lines	160
Fleet in Operation	280
Average age of the Fleet (July 1998)	3.78
Trips per month	233,000
Kilometres per month	2,049,060
Passengers per month	5,615,000

Source: Companhia Petropolitana de Transportes (CPT) [Petropolitan Transport Company – CPT], December 1998

The Petropolitan Transport Company (CPT), which dates from 1990, is a limited liability corporation of mixed capital, with the legal status of private law corporate entity, linked administratively to the Urban Development Coordination for the Municipality of Petrópolis. This company is responsible for managing and organising all the public transport system, making any modifications that are deemed necessary. Its initial project began with the creation of the Tariff Compensation Chamber, with the purpose to integrate all the public bus transport system and establish a flat tariff for the system.

One of the first measures adopted by CPT was to promote the tendering of each of the lines whose delegation terms were expiring, in order to establish new rules for the interested parties, excluding from the process the companies who, although participating in the operation, presented a poor performance and bad conditions in the quality of the service (Alvarado, Contreras & Orrico, 1996). In October 1992, a flat tariff was established for all the city's bus lines.

The Tariff Compensation Chamber was created about two years later. The system had an obsolete and insufficient fleet, nine different tariff levels, a relatively low number of trip offers, and overcrowded buses, which represented serious discomfort and high risk for the users. The Chamber's main objectives were:

- to establish an up-to-date Flat Tariff, which would benefit the users of the more distant regions, normally low-income individuals,
- to equate and maintain the operators' economic-financial balance,
- to improve the conditions of equity when compensating the companies,
- to operate passenger transfer terminals in order to rationalise the service supply.

CPT's compensation systems could be characterised as a typical Compensation Chamber Model. Synthetically, the mechanism consists of the following: annually, CPT establishes a cost per passenger transported for each operating company, afterwards calculating a tariff that will become the System's Flat Tariff, using the same cost indices to estimate the companies' costs and to calculate the system's tariff. Following this, it verifies the difference between the cost per passenger of each company and the system's flat tariff, determining which companies have to transfer resources and which will be entitled to receive them, specifying the monthly amounts to be transferred, the responsibility being left to the companies for effecting the transfers. The compensation between companies is done on a weekly basis.

In the Compensation Chamber model adopted in Petrópolis, it should be noted that if in a given period there is an increment in demand in a company member of the system, this company will have to receive or transfer, according to his case, only the amount previously specified by the managing organisation, keeping the overage gains that result from the increment in demand. Likewise, if in a given moment the demand is less that the number per month estimated by the Managing Organisation, the company will also receive or transfer the pre-established amount, bearing the burden of the loss.

This method's principal restriction lies in that the companies with high operational costs due to the particular characteristics of their routes will be in disadvantage, facing costs that will be estimated possibly below their real value. In order to keep these companies from suffering loss, the consumption and performance indicators of the system's lines in general should be less effective than the reality of said companies, so as to enable those who are operating under more difficult conditions to receive a more just compensation for their work. On the contrary, the companies that operate under better conditions will naturally have higher gains as a result of having, in reality, substantially lower operational costs than the ones that will finally be considered in the cost estimate.

3.2 *The transport system of Belo Horizonte*

The municipality of Belo Horizonte is the capital of the State of Minas Gerais, and center of a Metropolitan Region formed by twenty municipalities. It has an undulated topography and counts with a population of approximately 3,450,000 inhabitants (1996 Census). The main transport characteristics are summarised in Table 2.

Table 2. Principal data of the transport of Belo Horizonte

Issue	Quantity
Number of companies	46
Number of Lines	295
Fleet in Operation	2975
Average age of the Fleet (July 1998)	3.75
Trips per month	850,000
Kilometres per month	17,928,700
Passengers per month	42,938,065

Source: Empresa de Transporte e Trânsito de Belo Horizonte S.A. (Transport and Traffic Company of Belo Horizonte, Limited Liability Corporation) Internal Report, CCT., Jan. 99

Until 1993, the transport system was managed by only one public company and operated under only one Compensation Chamber, which was established in 1982 for all the Metropolitan Region. Currently, the compensation is carried out in two new Chambers. The first of these covers the municipalities of the Metropolitan Region, except the municipality of Belo Horizonte, and is managed by a state organisation, the Road and Highways Department of Minas Gerais-DER/MG. The second, which is managed by the Transport and Traffic Company of Belo Horizonte, Limited Liability Corporation-BHTrans, is in charge of transport only within the municipality of Belo Horizonte. Created in 1992, BHTrans is a Limited Liability Corporation of municipal public capital, which, besides being responsible for the collective transport in Belo Horizonte, in 1993 also took over the management of traffic in this municipality.

The economic-financial integration of the metropolitan system as a whole has been guaranteed by the local services in Belo Horizonte through BHTrans, who transfers the resources from its system—which has shorter lines and a higher income population—to the metropolitan system, which is predominantly formed by a very low-income population living in the city's outskirts and working in Belo Horizonte. This integration is possible because both companies use similar calculation methodologies, which permit a comparison between the performance costs and the indicators of both systems.

The transfers of resources were always made by the Municipal System, who operated with surpluses, to the Metropolitan System, who was always in the red. This subsidy was maintained until February, 1998, when the Municipal System got into deficit, and without resources, it was impossible to maintain the relationship.

In the beginning of 1998, there were 54 companies in operation, the smaller of which had a fleet of 15 units, and the larger, 176 vehicles. After a tendering process carried out in July, 1998, a total of 46 companies were operating in January 1999, the smaller of which with 24 vehicles, and the larger with 154. If, on the one hand, this shows a diversity in the size of the companies forming the system, on the other hand, it also points to a process of entrepreneurial concentration.

The specific objectives of CCT/BH, are :

- creation of a Social Tariff to enable the practice of subsidies in the price for low-income populations;
- optimisation in the System's operation by fixing the prices of the fares, increasing the competition between lines with similar operational characteristics.;
- similar profitability for the Companies,

All the operating companies are legally sub-concessionaires and form part of CCT/BH, who is the only concessionaire of the System's lines. Through a public tender, which was closed in February 1998, the best offers were chosen, followed by the signing of *Operation Contracts* with the winner companies for a period of ten (10) years.

Two innovations were incorporated in the tender's process: a) when an offer was made for a lot of vehicles without pre-determining the lines in which they would operate, in this case, the Public Power sought lower unit prices for making the vehicles available to BHTrans, and b) by simultaneously requiring that the companies pay a minimum amount equivalent to US$13,550 for each bus of the lots won by them, the Public Power was seeking to value capture a parcel of the amount established as a minimum cost. The money thus collected would be destined for the creation of an Transport Fund, which would later be invested exclusively in the transport development area.

To calculate the system's balancing tariff a mechanism is used which guarantees an average cost during a reasonably long period. The demand is projected based on the tendency of the last 12 (twelve) months, and, should such be the case, the accumulated amounts in deficit that at the moment CCT/BH may have are included in order to eliminate this deficit starting with the new tariff cost. With these presuppositions, the new tariff should cover the System's Operational Cost, the accumulated deficit and, in theory, permit CCT/BH to accumulate resources in reserve to stabilise the tariff, avoiding frequent increases (more details in Alvarado, Contreras & Orrico, 1996).

The compensation model for the Belo Horizonte Compensation Chamber is the Public Revenue Model, which means that the companies are compensated for a production unit, in this case, per kilometre offered.

The companies' compensation is done by calculating the *total cost per line*, relating the Variable Costs to the kilometres allowed per service and to the variant that relates the Fixed Costs to the fleet allowed. To correct the disadvantages presented by this method, constant control and supervision are established to keep the costs of the companies within acceptable parameters in order to avoid any excesses or to avoid benefiting the inefficiency of any one company.

4 CONCLUSIONS

Conceptually, the difference between a public or private management of a Compensation Chamber is very important. In the first case, the Public Power has an individual commitment with each company to maintain the economic-financial balance of said company, being responsible for guaranteeing a compensation for the services they render that will honour this commitment. In the second case, the Public Power's commitment in relation to this balance is no longer with each company singly (basis of the concession and permission system), but with the system as a whole.

The adoption of tariff compensation mechanisms has brought as a consequence a new type of competition between the companies. Due to the existence of a method for the division of a globally collected revenue, each company will try to increase its participation in the whole, either by using strategies to increase its fraction in an equation of distribution pressing for an increase in supply, or by raising its cost parameters within these same equations. Their behaviour will depend strongly on the specific model used to calculate these costs.

The compensation concept contained in the managing instrument denominated Tariff Compensation Chamber has shown an applicability which is independent from the systems' dimension, not only in connection with the net's coverage, but also with regard to the size and number of the companies, as well as the extension of the region in which they operate . The cases described for the cities of Petrópolis and Belo Horizonte clearly demonstrate the possibilities that exist under so very different situations, without mentioning the many other examples that exist in Brazil that could serve to reinforce this concept, but which have not been directly discussed in the present work.

In relation to the compensation methods described in this work, the method used in Petrópolis can be considered the more simple one because it pre-establishes the amounts to be transferred by the companies at the same time the tariffs are established, considering as constant in the period the difference between the tariff and the cost per passenger of each company. The Managing Organisation will only have to worry about keeping control over the operation as such, verifying if the service established is being really supplied, and monitoring the number of the transported demand in order to keep an up-to-date data base, which will later serve to calculate the new tariff, among other objectives.

The good result that this method has shown, in spite of its simplicity, is due to the fact that the system's size is relatively small, as is the number of operating companies, and their actual costs should not present an extremely large dispersion. In a larger system, with many companies operating, like in the other case analysed, it would be necessary to consider the operational costs individually (possibly with very great differences between companies) and keep a stricter control over the supply, so as to guarantee a good level of service to the user.

In the method utilised by BHTrans, an important observation is the frequency in which the operational cost used for compensating the companies is updated. This is done every ten days, a factor of great importance when the entrepreneur decides to invest in the system. For the user, the principal advantage noted is that the level of the service has improved, although this has in return brought a higher tariff.

Another important characteristic of the Public Revenue method utilised by BHTrans is that it requires a constant supervision of the operation by the managing company because the entrepreneurs are no longer required to reach, through a specific indicator, a certain level of transported passengers, and have the assurance of knowing that they will be compensated for the service they supply.

When we analyse the price of the tariff, and consider the fact that there is a stabilisation reserve or fund, it becomes clear that the tariffs charged have been actually somewhat higher than the balance cost, should this be considered as the average cost per passenger transported, which is the practice more usually used in Brazil.

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Dysfonctionnements du système des transports urbains d'Abidjan

Malfunctions in Abidjan's urban transport system

Deficiencias del sistema de transporte urbano de Abidjan

M. Abeille & F. Duprez
Centre d'Etudes sur les Réseaux, les Transports, l'Urbanisme et les Constructions Publiques (CERTU), Lyon, France

RÉSUMÉ: A la demande du Ministère des Transports de Côte d'Ivoire, le Certu réalise une étude sur les dysfonctionnements du système des transports urbains d'Abidjan. L'un des principaux objectifs de ce travail est d'évaluer, à l'échelle de l'agglomération abidjanaise, le coût social des accidents de la circulation, de la congestion, des freins à la mobilité ainsi que du bruit et de la pollution atmosphérique imputables aux transports. Cette communication présente les méthodes de monétarisation utilisées et met en évidence les difficultés ainsi que les limites de cet exercice. En particulier, le cas de la pollution atmosphérique montre que le transfert de concepts et de techniques étrangères à un pays en développement soulève des problèmes pratiques (collecte d'informations, calage des modèles) et théoriques (monétarisation des dommages, détermination de stratégies réalistes de dépollution).

ABSTRACT: At the request of the Côte d'Ivoire Ministry of Transport, the CERTU is conducting a survey on malfunctions in Abidjan's urban transport system. One of the main aims of the work is to assess, for the whole of the Abidjan area, the cost to society of road accidents, congestion, limitations on mobility as well as from the noise and atmospheric pollution that can be ascribed to transport. The report gives the costing methods used in the survey and shows the difficulties and limits of the exercise. In particular, through the case of atmospheric pollution, it shows that the transfer of concepts and techniques foreign to a developing country raises problems both practical (collecting information, adjusting models) and theoretical (costing damage, deciding realistic policies for reducing pollution).

RESUMEN: A instancias del Ministerio de Transportes de Costa de Marfil, el CERTU está llevando a cabo un estudio de las deficiencias del sistema de transporte urbano de Abidjan. Uno de los principales objetivos de dicho trabajo consiste en valorar, en lo que respecta al área metropolitana de Abidjan, el coste social de los accidentes de circulación, la congestión del tráfico, los obstáculos a la movilidad, así como del ruido y la contaminación atmosférica imputables a los medios de transporte. Esta comunicación expone los métodos de valoración empleados en el estudio, y en ella se indican asimismo las dificultades y limitaciones de la investigación que nos ocupa. En concreto, a través del caso de la contaminación atmosférica, queda patente que la transferencia de conocimientos y técnicas extranjeras a países en vías de desarrollo plantea tanto problemas prácticos (recopilación de datos, modelos que se calan) como teóricos (estimación de daños, definición de estrategias realistas para reducir la contaminación).

INTRODUCTION

Dans le cadre du Programme d'Ajustement Sectoriel des Transports (PAST), le Ministère des Transports de Côte d'Ivoire a commandé au Certu une étude sur les coûts des dysfonctionnements du système des transports urbains d'Abidjan.

Les deux principaux objectifs de ce travail sont d'établir un compte déplacements de l'agglomération et d'évaluer les coûts externes des transports urbains à Abidjan. Cinq effets externes sont appréhendés: la pollution atmosphérique, le bruit, les accidents de la circulation, la congestion et les freins à la mobilité. Au moment où cette communication est rédigée, l'étude est en cours de réalisation. C'est pourquoi nous présenterons essentiellement la méthode de travail retenue par le Certu. Nous aborderons successivement les trois principales phases de l'étude:

- la réalisation du compte déplacements, dont l'objectif est de déterminer comment les différents acteurs de la Ville financent le système des transports;

- l'analyse des dysfonctionnements des transports urbains et leur monétarisation;
- l'étude approfondie de la pollution atmosphérique imputable à la circulation routière.

1 LE COMPTE DEPLACEMENTS D'ABIDJAN: UNE EVALUATION DES DEPENSES DIRECTES DE TRANSPORTS URBAINS

Dans cette première partie, nous définissons le cadre du compte déplacements d'Abidjan, puis nous mettons en évidence les liens entre cet exercice comptable et l'évaluation monétaire des dysfonctionnements, abordée dans les deux parties suivantes.

1.1 *Le compte déplacements d'Abidjan*

Le compte déplacements d'Abidjan rassemble, dans un cadre synthétique, toutes les dépenses relatives aux déplacements des personnes, classées par mode de transport et par type d'acteur, à l'échelle de la Ville d'Abidjan. L'objectif est de savoir: qui dépense ? combien ? dans quels modes de transport ?

Cette synthèse macro-économique, qui repose sur une estimation préalable des déplacements et de leur répartition modale, intègre:
- les dépenses de transports individuels ou collectifs des ménages, des entreprises et des collectivités publiques;
- les dépenses d'infrastructure de transport et de police de la circulation des collectivités publiques;
- les recettes fiscales assises sur les activités de transport.

Les différents modes de déplacements identifiés à Abidjan sont:
- le réseau bus, mini-bus et bateau-bus de la SOTRA;
- les taxis-compteur, autorisés à charger sur l'ensemble des dix communes d'Abidjan;
- les Woro-woro. Il s'agit de taxis collectifs, autorisés à circuler au sein de chacune des dix communes d'Abidjan;
- les Gbakas. Il s'agit de mini-cars, autorisés à circuler sur une ligne interurbaine, mais pratiquant souvent la desserte des quartiers périphériques;
- les voitures particulières, dont le parc a fortement progressé depuis la libéralisation des importations, en 1996;
- les deux roues, très peu nombreux à Abidjan;
- la marche.

Les différents acteurs du système des transports urbains sont:
- les usagers des différents modes de transport;
- la SOTRA, entreprise exploitant le réseau de transports collectifs urbains;
- les propriétaires et chauffeurs des taxis-compteur, Woro-woro et Gbaka;
- les entreprises ou établissements scolaires assurant le transport des salariés ou des élèves;
- l'Etat ivoirien, qui finance la voirie et, en partie, la SOTRA;
- la Ville d'Abidjan;
- les dix communes d'Abidjan;
- les établissements financiers et les organismes internationaux.

Finalement, le compte déplacements peut se présenter sous forme d'une matrice synthétique des dépenses de transport (tab. 1). L'intersection d'une ligne i avec une colonne j donne la dépense du secteur j dans le mode de transport i. La colonne particulière « transferts fiscaux » indique les sommes transférées du secteur privé vers le secteur public (TVA, taxes sur les produits pétroliers, ...)

Tableau 1. Présentation synthétique du compte déplacements d'Abidjan

Mode de transport	Secteur privé	Transferts fiscaux	Secteur public	Total
Transports collectifs				
Transports individuels				
Voirie, police				
Tous modes				

1.2 *Liens entre le compte déplacements et la compréhension des dysfonctionnements du système des transports*

L'étude des dysfonctionnements d'un système des transports nécessite de bien connaître les acteurs de ce système et leur rôle économique. On peut ainsi déterminer les causes des dysfonctionnements et mesurer l'écart entre l'équilibre économique actuel et un équilibre économique de référence, dans lequel les acteurs paieraient le vrai coût de leurs activités.

Le compte déplacements, associé aux coûts de dysfonctionnement, facilite cette analyse, car il permet de calculer quelle est la part payée par les usagers des différents modes de transport dans:
- le coût direct de leurs déplacements;
- le coût social de leurs déplacements.

On peut alors repérer:
- quels sont les modes de transport les plus coûteux pour l'usager, en s'appuyant sur les coûts privés par déplacement;
- quels sont les modes de transport les plus coûteux pour la collectivité, en s'appuyant sur les coûts sociaux par déplacement;
- quels sont les modes de transport qui couvrent le mieux leurs coûts, en s'appuyant sur le rapport entre le coût privé et le coût social de chaque mode.

2 LE BRUIT, L'INSECURITE ROUTIERE, LA CONGESTION ET LES FREINS A LA MOBILITE A ABIDJAN

L'étude que nous réalisons pour le Ministère des Transports aborde cinq grands dysfonctionnements: le bruit routier, les accidents de la circulation, la congestion, les freins à la mobilité et la pollution atmosphérique. Cette seconde partie traite des quatre premiers thèmes; la troisième partie aborde le cinquième thème, qui pose des problèmes méthodologiques spécifiques.

L'évaluation de chaque dysfonctionnement passe par une quantification physique puis monétaire. Outre le caractère conventionnel des évaluations de coûts externes, notre travail se heurte à deux difficultés majeures:

- la disponibilité et la fiabilité des informations. Par exemple, les accidents de la circulation ne donnent pas toujours lieu à l'établissement d'un procès-verbal, ce qui conduit à interpréter prudemment les statistiques de sécurité routière. Lorsque les informations ne sont pas disponibles, nous nous appuyons sur une modélisation ou sur une évaluation par enquête légère: l'important est alors de bien préciser les hypothèses et la sensibilité du modèle ou la méthode d'enquête retenue. Lorsque les informations sont peu fiables, nous recoupons les différentes sources existantes;
- la transférabilité des méthodes utilisées en France. Par exemple, les modèles français d'émissions sonores s'appliquent à un parc de véhicules et à des types de revêtement routier qui sont très différents de ceux rencontrés en Côte d'Ivoire. Afin d'assurer la transférabilité d'une méthode étrangère, nous précisons les hypothèses sur lesquelles repose la méthode et nous adaptons les principaux paramètres à la situation locale.

2.1 *Le bruit*

Notre approche consiste à repérer les principaux « points noirs » bruit. Il s'agit d'axes caractérisés par une forte circulation et une forte densité de population à proximité de l'infrastructure.

Pour repérer ces points noirs, nous nous appuyons sur:

- les données de trafic existantes et des comptages spécifiques;
- le recensement de la population de 1998, réalisés par l'Institut National de Statistique (INS) ;
- des mesures au sonomètre.

Nous caractérisons alors chaque point noir par une intensité sonore et par un nombre de logements exposés au bruit. Puis, nous calculons un coût d'évitement selon deux approches:

- un coût d'isolation phonique des logements exposés au bruit (doubles vitrages);
- un coût de protection phonique des logements exposés au bruit (mur anti-bruit).

Ce coût du bruit ne prend pas en compte la gêne ressentie par les populations dont les activités se déroulent dans la rue (les commerçants, par exemple).

2.2 *Les accidents de la circulation*

Nous avons recueilli, auprès de l'Office de Sécurité Routière (OSER) et de la Préfecture de Police:

- le nombre de blessés légers, de blessés graves et de morts dans les accidents de la circulation;
- la répartition des blessés et des morts par mode impliqué.

Le Tableau 2 donne la répartition des victimes des 4117 accidents survenus à Abidjan en 1997.

Tableau 2: statistiques d'accidentologie à Abidjan en 1997, (source: OSER)

	Piétons	Deux roues	Voitures	Total
Tués	137	9	30	176
Blessés graves	862	90	677	1629
Blessés légers	2119	152	1 845	4116

En nous appuyant sur ces statistiques, nous pouvons estimer la valeur monétaire des accidents de la circulation par la méthode du Capital humain compensé (Le Net 1994). Cette approche, utilisée par l'Administration française, doit être adaptée au contexte ivoirien. Il convient donc de calculer, à partir de données locales:

- les coûts directs des accidents sur le plan matériel (dégradation des véhicules) et médical (coûts d'hospitalisation et de soin des accidentés);
- les coûts indirects des accidents. Ces derniers correspondent aux pertes de production réelles des blessés qui cessent momentanément (voire définitivement, en cas de handicap lourd) leur activité et aux pertes de production futures des morts qui auraient pu continuer de travailler si l'accident n'était pas survenu.

L'évaluation des coûts directs repose sur des entretiens avec des responsables d'assurances et d'hôpitaux. L'estimation des coûts indirects s'appuie sur des enquêtes de consommation et sur les statistiques relatives à l'emploi (niveaux de salaires) et à la démographie (espérance de vie).

La sensibilité des résultats aux hypothèses économiques est testée en retenant au moins deux niveaux de salaires et deux taux d'actualisation.

2.3 *La congestion*

La congestion se manifeste, pour les usagers ou les exploitants des différents modes de transport, par un allongement des temps de parcours et par des surcoûts d'exploitation ou d'utilisation des véhicules.

L'évaluation de la congestion repose sur la mesure de l'écart entre la situation réelle et une situation de référence clairement définie. Nous précisons ci-dessous la méthodologie retenue pour chaque mode de transport:

- pour les transports individuels et les transports informels, on effectue des mesures de temps de parcours en heures creuses et en heures de pointe. La situation de référence correspond à l'heure creuse et la congestion est approchée par le supplément de temps de parcours à l'heure de pointe;
- pour le réseau SOTRA, on recueille la longueur des lignes, le taux de charge des bus et la vitesse commerciale sur chaque ligne en heure de pointe et en heure creuse. Ces données permettent de calculer le temps perdu par les usagers en heure de pointe, par rapport à un temps de parcours en heure creuse.

Les pertes de temps sont valorisées à l'aide d'au moins deux types de valeurs du temps:

- des valeurs révélées dans le cadre d'études locales. Par exemple, une analyse contingente réalisée pour le 3ème Pont d'Abidjan montre que la valeur du temps des automobilistes se situe entre 1 200 et 3 100 FCFA, selon la commune de résidence (la valeur du temps des usagers des transports collectifs est nettement inférieure);
- des valeurs estimées sur la base des revenus.

2.4 *Les freins à la mobilité*

L'importance de la circulation aux heures de pointe se traduit par un allongement des temps de parcours, caractéristique de la congestion. En outre, certains quartiers périphériques d'Abidjan sont mal desservis par le réseau de la SOTRA. La clientèle de la SOTRA subit alors des temps d'attente importants ou se tourne vers les transports informels. Ces dysfonctionnements aboutissent à une incertitude sur les temps de parcours et, plus généralement, à une mauvaise accessibilité aux différentes activités de la ville. Il s'agit là de véritables freins à la mobilité, qui dépassent les pertes de temps liées à la congestion et qui se diffusent à travers le système économique de différentes façons:

- les usagers peuvent prendre en compte l'incertitude sur les temps de parcours et sur les passages des véhicules de transport en commun. Ils prévoient alors une « marge de sécurité » afin d'arriver à temps sur le lieu de leur activité. Le temps consacré à chaque déplacement (temps à bord d'un véhicule, temps d'attente et marge de sécurité) s'allonge, ce qui restreint les programmes d'activités possibles. Il s'agit là d'une internalisation des freins à la mobilité par les usagers des transports;
- les employeurs ou chefs d'établissement peuvent prendre en compte l'incertitude sur l'heure d'arrivée des employés ou des élèves, en réorganisant la production ou les plannings de cours. Il s'agit là d'une internalisation des freins à la mobilité par le système productif;
- enfin, les usagers peuvent renoncer à certains déplacements et les entreprises peuvent réduire leur zone de chalandises ainsi que leur zone d'emploi. On assiste alors à un recentrage des activités sur les quartiers, néfaste pour le système productif dans son ensemble. Il s'agit là d'un effet externe à long terme du système des transports sur l'activité économique.

La quantification des différents effets des freins à la mobilité sur les acteurs de la ville est complexe. Nous nous contentons donc de mettre en évidence les adaptations du système productif aux défaillances du système des transports. L'analyse repose sur des interviews de chefs d'entreprise et de chefs d'établissement scolaires, qui permettent d'évaluer les retards des employés et des élèves ainsi que les adaptations des emplois du temps.

3 LA POLLUTION ATMOSPHERIQUE LOCALE A ABIDJAN

A Abidjan, les transports urbains génèrent de nombreux composés nocifs pour la santé: monoxyde de carbone, hydrocarbures, oxydes d'azote, ozone, particules, dioxyde de soufre, plomb et cadmium. Ces composés peuvent être la cause de maladies graves, voire même entraîner la mort. Les principaux symptômes reconnus sont les troubles respiratoires ou cardio-vasculaires, les effets cancérogènes et, dans le cas du plomb, la néphropathie saturnine (Certu 1997, Ba et al. 1999).

Cependant, l'évaluation du coût sanitaire et du coût d'évitement pose de nombreux problèmes méthodologiques. Ces difficultés sont encore plus sensibles dans les pays en développement, où les mesures de la qualité de l'air et le suivi sanitaire des populations peuvent s'avérer insuffisants.

Nous mettons en évidence ces problèmes méthodologiques (3.1.) avant d'exposer la démarche retenue dans le cas d'Abidjan (3.2.).

3.1 *Monétariser les effets de la pollution atmosphérique: méthodes, limites, et tranférabilité aux pays en développement*

La monétarisation des effets de la pollution atmosphérique due aux transports peut reposer sur deux approches:

- une évaluation du coût des dommages générés par cette pollution. Ces dommages concernent aussi bien la santé des hommes, que les végétaux ou les bâtiments;
- une évaluation du coût d'évitement. Il s'agit d'évaluer le coût de réduction de la pollution. Ce dernier varie évidemment selon l'objectif

d'émission à atteindre et selon la technique de réduction employée.

Ces deux approches aboutissent à des valeurs différentes et n'ont pas la même utilité (Quinet 1994):

- le coût des dommages permet d'évaluer l'impact de la pollution et de sensibiliser les décideurs ainsi que la population à l'importance des problèmes générés par la pollution;
- le coût d'évitement indique le coût des mesures à mettre en œuvre pour lutter contre la pollution.

Selon la théorie économique, c'est la comparaison du coût des dommages et du coût d'évitement qui doit guider le décideur. Cependant, nous allons voir que le manque d'informations et les problèmes méthodologiques peuvent faire obstacle à l'évaluation de ces deux coûts.

3.1.1 *Evaluer le coût des dommages*

Notre étude traite plus particulièrement des effets de la pollution atmosphérique sur la santé des hommes. Nous devons appréhender:

- d'une part, les effets à court terme, caractérisés par une augmentation de la mortalité et de la morbidité lors des pics de pollution;
- d'autre part, les effets à long terme, caractérisés par une plus grande morbidité et une plus grande mortalité des sujets exposés de manière continue à une pollution de fond.

Pour déterminer les effets de la pollution atmosphérique à court terme, il convient de disposer d'un réseau de mesure continu de la qualité de l'air et de relations dose-effets de court terme. L'étude ERPURS, réalisée en région parisienne, a permis de dégager de telles relations dose-effets (Médina 1994). Cependant, rien n'assure que ces résultats sont transposables à Abidjan. En outre, la ville d'Abidjan ne dispose d'aucun réseau de mesure de la qualité de l'air. La mise en place d'un tel réseau serait la première condition à une meilleure connaissance des dommages causés par la pollution atmosphérique.

Pour déterminer les effets de la pollution atmosphérique à long terme, il convient, en l'absence de réseau de mesure, de reconstituer un niveau de pollution moyen. On procède donc en trois étapes:

- lors d'une première étape, on calcule les émissions de polluants. Ce calcul repose sur l'estimation du parc de véhicule et des émissions unitaires. Ces données essentielles ne sont pas toujours connues avec précision;
- lors d'une seconde étape, on évalue le niveau de pollution, à partir d'informations géographiques et météorologiques, d'une cartographie de l'occupation du territoire et d'un modèle de dispersion;
- lors d'une troisième étape, on évalue les dommages de la pollution atmosphérique à long terme, à partir de relations dose-effets de long terme. Ces dernières, à la différence des relations dose-effets de court terme, sont mal connues. Leur démonstration repose sur des études de cohortes soumises à différents niveaux moyens de pollution, sous contrôle d'autres facteurs de morbidité et de mortalité (tabagisme, alimentation, etc.). Dans une évaluation récente du coût sanitaire de la pollution générée par le trafic automobile en Europe (World Health Organization 1999), l'Organisation Mondiale de la Santé s'appuie sur deux études de cohorte américaines. Cependant, les conclusions de ces recherches américaines doivent encore être confirmées par d'autres études. En outre, il ne nous semble pas possible de transférer directement ces résultats américains au cas de la Côte d'Ivoire, car les conditions sanitaires des deux pays sont très différentes.

3.1.2 *Evaluer des coûts d'évitement*

L'évaluation des coûts d'évitement pose moins de problèmes méthodologiques que l'évaluation du coût des dommages. On se contente d'évaluer les coûts de solutions technologiques et/ou réglementaires à mettre en œuvre pour réduire les émissions de polluants. Deux écueils sont cependant à éviter:

- il convient de fixer des objectifs réalistes par rapport à l'état initial du parc de véhicules. On ne peut pas transférer directement des normes ou des technologies françaises sans les adapter au contexte ivoirien;
- le coût d'évitement varie évidemment selon l'objectif d'émission retenu. Par conséquent, on doit proposer plusieurs scénarios de réduction de la pollution atmosphérique et donc, plusieurs coûts d'évitement. Cette approche présente l'avantage d'offrir aux décideurs différentes solutions qui pourront être mises en œuvre progressivement.

3.2 *Méthodologie retenue pour le cas d'Abidjan*

Nous avons pu mettre en évidence les limites des méthodes couramment utilisées pour monétariser les effets de la pollution atmosphérique et les manques d'informations à Abidjan. Nous proposons maintenant une approche opérationnelle des problèmes de pollution atmosphérique à Abidjan. Cette approche consiste à:

- donner des éléments permettant d'apprécier les dommages générés par la pollution atmosphérique due aux transports, sans aller jusqu'à la monétarisation;
- proposer des coûts d'évitement correspondant à différentes stratégies de réduction de la pollution émise par les véhicules.

3.2.1 *Apprécier les dommages générés par la pollution atmosphérique due aux transports*

Afin d'apprécier les dommages générés par la pollution atmosphérique due aux transports, nous nous

appuyons sur:
- une reconstitution du niveau de pollution imputable à la circulation routière;
- des résultats de la littérature sur l'impact sanitaire de la pollution atmosphérique;
- des recueils d'informations auprès des autorités sanitaires abidjanaises.

La ville d'Abidjan ne possédant pas de réseau de mesure de la pollution atmosphérique, nous avons choisi de modéliser les émissions de polluants.

Cette approche nécessite de connaître la composition du parc et les trafics par type de véhicule. Les parcs de véhicules sont évalués par la SICTA (véhicules particuliers), la SOTRA (bus), la Ville d'Abidjan (taxis-compteur et Woro-woro) et le Ministère des Transports (Gbakas). L'estimation des trafics repose sur l'enquête ménages déplacements de 1988. La matrice origines-destinations issue de cette enquête est actualisée en comparant les résultats de comptages récents et de comptages contemporains de l'enquête ménages.

Nous pouvons alors modéliser les émissions de polluants en adaptant la méthode COPERT, mise au point par l'Agence Européenne de l'Environnement, aux caractéristiques des véhicules circulant à Abidjan.

Enfin, nous cherchons à mettre en évidence les effets de ces polluants en collectant, auprès des hôpitaux et des cliniques, des données relatives aux maladies respiratoires. Cependant, en l'absence de mesures de la qualité de l'air, nous ne pouvons pas imputer clairement une part de ces maladies respiratoires à la pollution atmosphérique.

Notre travail apporte donc un éclairage sur les dommages générés par la pollution atmosphérique due aux transports, sans aller jusqu'à la monétarisation de ces effets.

3.2.2 *Estimer des coûts de réduction de la pollution atmosphérique due aux transports*

Notre souhaitons proposer des estimations de coûts d'évitement de la pollution atmosphérique qui correspondent à des politiques réalistes. C'est pourquoi nous choisissons d'évaluer les dépenses qu'il conviendrait d'engager pour:
- rajeunir le parc de véhicules en circulation (avec plusieurs variantes possibles);
- limiter l'usage de carburants plombés.

Il s'agit d'éclairer les décideurs sur le prix de différentes politiques de minimisation de la pollution atmosphérique qui soient compatibles avec les contraintes financières et les objectifs de développement de la Côte d'Ivoire.

CONCLUSION

L'étude des dysfonctionnements du système des transports urbains d'Abidjan soulève deux types de problèmes:
- les incertitudes méthodologiques liées à la monétarisation des effets externes. La valeur d'une externalité dépend d'abord de l'approche monétaire retenue (coût d'évitement ou coût des dommages). Si l'on retient le coût des dommages, on doit préciser le champ de l'évaluation (santé des hommes, rendements agricoles, atteintes aux bâtiments, etc.). Si l'on retient le coût d'évitement, on doit définir clairementles objectifs à atteindre en terme d'émission;
- les limites de l'information disponible. A Abidjan, par exemple, l'évaluation de la pollution atmosphérique se heurte à l'absence de mesure de la qualité de l'air.

C'est pourquoi nous nous efforçons:
- d'expliciter les choix méthodologiques et de tester la sensibilité des résultats aux hypothèses de calcul;
- de palier les manques de données par la modélisation. Le transfert de nos modèles vers la Côte d'Ivoire s'accompagne alors d'adaptations au contexte local.

Enfin, notre travail doit être pérennisé à travers la mise en place d'un cadre de suivi des analysés. Nous proposerons donc, pour chaque dysfonctionnement, une liste limitée d'indicateurs robustes et faciles à collecter. La future Agence de gestions des transports urbains (Agetu) sera chargée de maintenir cet d'observatoire du système des transports d'Abidjan.

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Programa de rearticulación de los servicios de transporte público

F.J. Díaz Casillas
Dirección General de Transporte, Secretaría de Transportes y Vialidad, México D.F., Mexico

RESUMEN: El proceso de modernización de la Ciudad de México plantea el reto de reordenar en forma integral al Sector Transporte, con la finalidad de garantizar al usuario un servicio de elevada calidad. En este sentido el Gobierno del Distrito Federal ha puesto en marcha el Programa de Rarticulación de los Servicios de Transporte Público con una visión integradora de las vialidades y su respectivo equipamiento urbano, de renovación del parque vehicular con tecnología moderna y ecológica y de alternativa empresarial para las agrupaciones de transportistas a efecto de mejorar las estructuras organizativa, técnica y operativa que cubran satisfactoriamente la demanda del servicio.

La modernización y el reordenamiento integral del sector de transportes en la Ciudad de México comprende la puesta en marcha del Programa de Rearticulación de los Servicios de Transporte Público, como una línea estratégica fundamental del Gobierno del Distrito Federal, cuyo propósito es: Rearticular los Servicios de Transporte Público a través del establecimiento de la Red Básica de Transporte de Superficie y su Equipamiento Urbano (Red Básica) para asegurar a los habitantes de la Ciudad una operación continua del servicio de transporte de pasajeros, sustentada en una mejor estructura organizativa, técnica y operativa de las agrupaciones de transportistas que permitan renovar el parque vehicular a efecto de avanzar en la atención de la demanda, así como, elevar y garantizar la calidad del servicio.

Las líneas de acción que constituyen la plataforma de la Rearticulación son:

➢ La definición de 33 corredores viales estratégicos como base del establecimiento de la Red Básica, considerando la reestructuración de la organización y distribución de espacios de los Centros de Transferencia Modal;

➢ La aplicación del Programa de Sustitución de Microbuses por Autobuses a fin de renovar el parque vehicular y mejorar la atención a la demanda del servicio de transporte público de pasajeros;

➢ La conformación de Sociedades Mercantiles de Transportistas como la mejor alternativa en el proceso de la modernización del Transporte, buscando eliminar los elementos que conforman la figura hombre-camión;

➢ La licitación de rutas como instrumento coadyuvante en el proceso de rearticulación al convocar a los Transportistas que cuentan con la capacidad técnica, administrativa, económica y financiera para concursar y ser sujetos de adjudicación de alguna concesión para la explotación de determinada ruta;

Red Básica de Transporte de Superficie y su Equipamiento Urbano

La Reestructuración de la Red de Transporte de Superficie y Equipamiento Urbano se realizará con la implantación de los 33 corredores estratégicos que siendo vías de comunicación dirigidas a zonas de importancia en la Ciudad de México y conectores de enlace con modos de transporte masivo (metro y tren ligero), permitirán configurar la Red Básica requerida para satisfacer la demanda en condiciones adecuadas de calidad del servicio. Esta situación contempla vías de carácter complementario. Actualmente, en dichos corredores operan un total de 6100 unidades entre autobuses articulados, autobuses, trolebuses y microbuses con los que se atienden alrededor de 4.3 millones de los 9.3 millones de viajes persona día que se generan en la Ciudad, esta demanda representa el 46.2% del total que se atiende con unidades del Consejo de Incautación de Autotransportes Urbanos de Pasajeros Ruta-100, Servicio de Transportes

Eléctricos y Servicios Concesionados. (Gráfica No. 1).

La finalidad en estos corredores consiste en establecer un reordenamiento inicial que asegure a los habitantes de la Ciudad una operación continua y eficiente del servicio público de transporte de pasajeros, sustentado en una estructura administrativa, técnica y operativa con una calidad de servicio adecuada para la atención de la demanda.

Las ventajas de la comunicación y conexión, la oferta y los volúmenes diarios de demanda del servicio, la rotación de usuarios y la sustitución temporal del metro y/o tren ligero en casos de contingencia, fueron los criterios fundamentales utilizados en la definición de los 33 corredores estratégicos. Adicionalmente, se consideraron los Centros de Transferencia Modal, por ser espacios en los que regularmente se encuentran establecidos los puntos de orígen-destino del recorrido de los diferentes modos de transporte.

El establecimiento de la Red Básica incluye el equipamiento urbano en los corredores mediante la señalización e instalación de Parabuses con capacidad de colocar publicidad y dar información a la ciudadanía. Asimismo, considerando la importancia de la participación de los usuarios del transporte público y de los concesionarios en este proceso, se realizará paralelamente una campaña de difusión dirigida a los primeros y reuniones con los transportistas. Además, se capacitará y adiestrará a los cuerpos de verificación del servicio público de pasajeros concesionado y se tendrá el apoyo en lo referente al auxilio vial, a través del grupo denominado Radar.

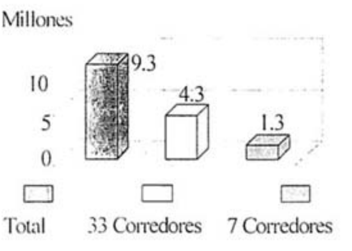
Bajo este esquema de modernización la incorporación de los 33 corredores estratégicos está proyectada en dos etapas, la primera, comprende la definición del marco normativo, técnico y de operación en un programa piloto de siete corredores que durará diez meses y, la segunda, corresponde a la realización de los estudios técnicos e incorporación de los demás corredores, en un periodo de 24 meses más.

Los siete corredores piloto cubren una longitud de red de alrededor de 389.5 Kms., requiriendo para su explotación un total de 1315 autobuses del tipo urbano y considerando los autobuses que actualmente operan es necesario sustituir 1122 microbuses por 708 autobuses. Asimismo, se plantea atender alrededor de 1.3 millones de usuarios que representan el 14% de los viajes que se generan diariamente en la Ciudad. (Gráfica No. 1).

Sustitución de Microbuses por Autobuses

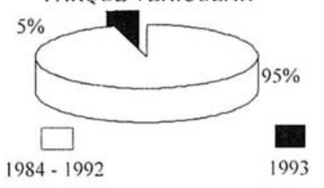
La idea central de la modernización del transporte y, a su vez, garantía de elevación en la calidad del servicio, se encuentra en la implantación de la sustitución de microbuses por autobuses, proceso que permitirá cambiar las condiciones de deterioro de la mayoría de las 22,933 unidades de microbús que dan servicio en el Distrito Federal y que han cumplido su ciclo de vida útil reglamentaria de 6 años. (Gráfica No. 2).

Estructura de Viajes Persona Día (VPD)



Gráfica 1

COMPOSICION PORCENTUAL DEL PARQUE VEHICULAR



Gráfica 2

La sustitución de unidades implica: elevar la eficiencia de los métodos de operación y administración; adoptar formas más avanzadas de participación en el mercado utilizando tecnologías de control de información en la programación y operación del servicio al menor costo y, lograr mejores niveles de rentabilidad. En este sentido, la factibilidad del programa está garantizada por la capacidad tecnológica y productiva de la industria automotriz mexicana, el nivel alcanzado respecto de los estándares requeridos en materia ecológica (EPA 98) y de combustibles alternos y; los recursos financieros disponibles.

En consecuencia, la implantación del Programa de Sustitución de Microbuses por Autobuses se llevará a cabo en los 33 corredores estratégicos seleccionados para configurar la Red Básica y en ramales complementarios, por medio de la realización de los estudios técnicos respectivos que servirán de soporte en la determinación de la tasa de sustitución de unidades de acuerdo a la demanda real del servicio en cada una de las rutas, a fin de evitar la sobreoferta del mismo.

Actualmente, se trabaja en la aplicación de los criterios que deben observarse en el mejoramiento de la eficiencia, rentabilidad, seguridad y calidad del servicio, dejando en claro que por las características de la demanda y la excesiva oferta del transporte público de pasajeros, así como por los problemas de saturación vial y los elevados índices de contaminación, la modernización del parque vehícular se realizará con unidades tipo autobús nuevas, por lo que no considera la sustitución de microbus por microbus, ni la repotenciación de motores.

Las Sociedades Mercantiles de Transportistas

Debido a la proliferación de la mentalidad que encierra la figura hombre-camión al seno de las organizaciones de transportistas, la modernización del sector se ha visto obstaculizada, especialmente, por la generación de un clima de desconfianza hacia el sector por parte de las fuentes de financiamiento y por el temor a incurrir en la sobreoferta de unidades, diluyendo las expectativas de mejorar la calidad del servicio. En este contexto, la conversión de sociedades civiles de transportistas en sociedades mercantiles constituye la mejor alternativa para dotarse de la figura jurídica, así como de la capacidad administrativa y financiera que permitirá realizar el proceso de sustituir microbuses por autobuses.

Asimismo, esta figura legal de carácter asociativo, regulada por la Ley General de Sociedades Mercantiles, ofrece dotar de un perfil empresarial al sector, pues proporciona a los prestadores del servicio los instrumentos jurídicos y administrativos que se requieren para integrar empresas cuya estructura orgánica permite lograr niveles más elevados de eficiencia y competitividad, en un ambiente de seguridad jurídica respecto al patrimonio de los socios o accionistas. Además, brinda la opción a los transportistas de organizase con base a las siguientes figuras asociativas: Sociedad Anónima, Sociedad de Responsabilidad Limitada, Sociedad Cooperativa y Empresa Integradora.

De igual manera, este esquema empresarial abre la oportunidad de que los socios o accionistas generen las condiciones propicias que consoliden su participación en el desarrollo del sector con mayores posibilidades de incrementar los ingresos, dado que como empresa se tendría la capacidad, entre otras cosas, de:

- ✓ Reducir costos de operación mediante la disposición de fondos para la adquisición en común de equipo, refacciones, accesorios, etc.;

- ✓ Optimizar los recursos mediante la estructuración de esquemas dinámicos y efectivos de mantenimiento de las unidades, alcanzando los niveles adecuados de operación y productividad que demanda el segmento de mercado a cubrir dentro del sector;

  adquisición de autobuses con tecnología de vanguardia y elevado valor en el mercado secundario, que permita ofrecer un servicio de calidad, recuperar la inversión y renovar continuamente el parque vehicular.

Por su parte en el plano financiero, las sociedades mercantiles abren la posibilidad de acceder a sistemas de crédito más convenientes y propicios para fortalecer la inversión en proyectos que contribuyan a eficientar las áreas de administración, operación, infraestructura y equipo de la empresa, con miras a consolidar figuras empresariales del sector con finanzas sanas y niveles importantes de rentabilidad.

En este renglón, el Gobierno de la Ciudad de México proporcionará asesoría a los transportistas sobre Sociedades Mercantiles con el objeto de despejar dudas y temores sobre la materia, en la idea de generar un clima de credibilidad que permita al sector obtener créditos bancarios o arrendamientos que ayuden a disipar los prejuicios del historial de cartera vencida y el miedo de volver a incurrir en situaciones de sobreoferta.

Con base en lo antes expuesto, el impulso de esta nueva cultura empresarial de inversionistas del transporte de la Ciudad de México conducirá a rebasar con disciplina la concepción de la figura hombre camión que existe entre los transportistas y, con ello, garantizar el mejoramiento de la calidad del servicio en favor del usuario.

Licitaciones de los Servicios de Transporte Público de Pasajeros

La licitación de rutas es un instrumento coadyuvante, en el proceso de rearticulación de los Servicios de Transporte Público de Pasajeros, al conjuntar una serie de elementos técnicos, administrativos, económicos y financieros que ofrecen a los transportistas organizados la posibilidad de participar en una competencia equitativa por la obtención del Título-Concesión que les permitirá la explotación de una ruta determinada y la modernización del servicio de transporte obteniendo una rentabilidad adecuada y, a su vez, beneficiando a los usuarios con un mejor servicio.

Para ello, la Secretaría de Transportes y Vialidad publicó el 1° de julio del presente año la Convocatoria dirigida a las agrupaciones de transportistas para invitarlos a participar en los concursos públicos nacionales, a fin de obtener en concesión la prestación del servicio público de transporte de pasajeros en autobuses con itinerario fijo de 17 Rutas que actualmente opera el Consejo de Incautación de Autotransportes Urbanos de Pasajeros Ruta-100, previa realización de estudios Declaración de Necesidad.

Los aspectos básicos que deben cubrir las sociedades mercantiles de transportistas son: Acreditar su capacidad técnica, administrativa, económica y financiera que les permitirá cumplir con las responsabilidades específicas de cada una de las rutas y con la presentación de la propuesta económica que deberá contemplar los montos de la inversión en sus diferentes rubros y las fuentes de financiamiento, mismos que deberán guardar consistencia con los señalados en la propuesta técnica.

La adjudicación de la concesión de 10 años prorrogables será otorgada a la sociedad mercantil que habiendo aprobado la evaluación técnica, haya formulado la mejor oferta económica de acuerdo a las bases del concurso y presente el menor costo de operación o tarifa de equilibrio en función de la demanda y la oferta correspondiente.

La finalidad de conjuntar y operar simultáneamente estas líneas de acción es lograr la mejora continua en la calidad del servicio de transporte público de pasajeros conforme los niveles de demanda, lo cual traerá beneficios de diversa índole tales como:

- ✓ La articulación de servicios en vialidades importantes y la sustitución de unidades que darán una mayor fluidez en el tránsito de vehículos.
- ✓ El equilibrio entre la oferta y la demanda de transporte público de pasajeros en los corredores estratégicos al resolverse la sobreoferta de parque vehicular que presta el servicio.
- ✓ Una menor emisión de contaminantes por la utilización de autobuses con tecnología avanzada, que favorecerá al medio ambiente de la Ciudad.
- ✓ La mayor eficiencia en el servicio como producto de la conversión de sociedades civiles de transportistas en sociedades mercantiles.
- ✓ Una mejor vinculación entre el Gobierno del Distrito Federal, las empresas automotrices, las arrendadoras e instituciones financieras con los transportistas a fin de brindar un servicio de alta calidad a los usuarios y,
- ✓ La generación de las condiciones propicias para el desarrollo de una Cultura Empresarial de Inversionistas del Transporte de la Ciudad de México.

Conclusión

La configuración de la red básica, la sustitución de microbuses por autobuses, la conformación de sociedades mercantiles de transportistas y la licitación de rutas, se constituyen como las acciones centrales que simultáneamente permitirán, en un ambiente de financiamiento propicio, la Rearticulación de los Servicios del Transporte Público en la Ciudad de México, dando paso a la conformación de un sector de transporte público moderno y de elevada calidad en la prestación del servicio.

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Política tarifaria y sustentabilidad en la Ciudad de México
Tariff policy and sustainability of Mexico City
Politique tarif et durabilité de la Ville du Mexique

Leticia Bonifaz Alfonzo
Directora General de Regulación al Transporte, SETRAVI-GDF, Mexico

RESUMEN: En la Ciudad de México el transporte público de pasajeros atiende diariamente alrededor de 15 millones de viajes, pasajero-viaje por día (P-V/D). El rápido aumento de población y el desarrollo insuficiente del transporte público colectivo ha provocado un aumento considerable en los vehículos de poca capacidad con alto consumo de energía. Esta situación ha contribuido al incremento en el congestionamiento del tráfico y el detrimento de la calidad del aire. Las consecuencias para la salud pública derivadas de la degradación ambiental han sido también ampliamente detalladas y analizadas por muchas agencias internacionales desde hace 20 años. Es necesario que esta Ciudad establezca un replanteamiento en su política tarifaria del transporte para que se centre en la inclusión de los costos y beneficios (económicos, sociales y ambientales) debiendo estructurarse de tal manera que sea flexible y dinámica a lo largo del tiempo y permita alcanzar la eficiencia y sustentabilidad.

ABSTRACT: It is considered that the public transportation of passengers assists daily around 15 million trips, passenger-trip per day (P-T/D). However, the fast population increase and the insufficient development of the collective public transportation has caused an increment in the vehicles of little capacity with high energy consumption. This situation has contributed to the increment in the traffic congestion and to worsen the quality of the air. The consequences for the public health derived from the environmental degradation have also been for 20 years copiously detailed and analyzed by many international agencies. It is necessary that this City establishes a redesign in its tariff politics of the transportation so that it is centered in the inclusion of the costs and benefits (economic, social and environmental), in all the ways of transportation and it should be structured in such a way to be flexible and dynamic through time and that allows the efficiency, the equity and the sustainability.

RÉSUMÉ: On le considère que le transport public des passagers aide quotidiennement autour 15 millions de voyages, passager-voyage par jour (P-T/D). Cependant, l'augmentation rapide de population et le développement insuffisant du transport public collectif a causé un incrément dans les véhicules de peu de capacité avec la consommation d'énergie élevée. Cette situation a contribué à l'incrément dans l'encombrement du trafic et pour empirer la qualité d'air. Les conséquences pour la santé publique ont dérivé de la dégradation environnementale ont également eu lieu pendant 20 années copieusement détaillées et analysées par beaucoup d'agences internationales. Il est nécessaire que cette ville établisse une nouvelle conception dans sa politique de tarif du transport de sorte qu'elle soit centrée dans l'inclusion des coûts et des avantages (économique, social et environnemental), dans tout voie transport et devoir structurer dans tel un voie pour flexible et dynamique traversant temps et cela permettre efficacité, équité et sustainability.

1 INTRODUCCIÓN.

El servicio público transporte de pasajeros es la actividad a través de la cual el Distrito Federal satisface las necesidades de transportación, por sí, o a través de concesionarios, y se ofrece al público en general en diversos modos de transporte, de forma continua, uniforme, regular, permanente e ininterrupida. Conforme a la Ley de Transporte del Distrito Federal, dicho servicio se clasifica en individual, colectivo y masivo; cada una de estas modalidades tiene características operativas es-establecer la estructura tarifaria aplicable a cada uno de ellos.

Actualmente se presta mediante los organismos descentralizados de transporte, el Sistema de Transporte Colectivo METRO, el Servicio de Transportes Eléctricos (encargado de administrar el servicio de trolebuses, autobuses articulados y tren ligero) y el Consejo de Incautación de AUPR-100.

Por otro lado está el transporte concesionado que opera en diversas modalidades y servicios, tales como autobuses, microbuses, combis y taxis libres o de sitio.
El Transporte de Pasajeros es una actividad vital para la Ciudad, en virtud de la magnitud de la demanda que satisface, la cual representa al 81.7% del total de tramos de viaje que en promedio diario que se generan en la Zona Metropolitana de la Ciudad de México[1]. Lo anterior nos permite ubicar la verdadera dimensión de la problemática del Transporte en la Ciudad de México.
Desde esta perpectiva el transporte de pasajeros se plantea como un factor de transformación, además de ser una actividad económica y social trascendente para el desempeño de las actividades que se realizan en el Distrito Federal. Existen dos aspectos importantes para su buen desempeño, garantizar con una eficiencia adecuada la movilidad de la población a un precio justo y que el servicio mantenga una rentabilidad adecuada para el prestador del servicio, de tal manera que se fomente el desarrollo adecuado de este sector.
Conforme a los artículos 63° y 65° del Reglamento para el Servicio de Transporte de Pasajeros en el Distrito Federal, la revisión de las tarifas que se aplican al servicio público de transporte de pasajeros se realiza con base en las solicitudes que presenten los prestadores del servicio, las cuales deben estar soportadas por información técnica sobre sus costos e ingresos, así como de la eficiencia con que operan, empleando los formatos y/o estudios técnicos que para el efecto publique la Secretaría de Transportes y Vialidad.
En este orden de ideas, la determinación o incremento de tarifas por sus implicaciones económicas, constituye un problema complejo, en el cual confluyen múltiples variables de índole operativa, económica y financiera, cuyo comportamiento influye en el logro de los siguientes objetivos:

- La satisfacción de las necesidades sociales de transporte con calidad.
  al cobro de tarifas accesibles, que no constituyan una restricción a su movilidad y a su economía.
- Garantizar una retribución justa a los prestadores del servicio por la inversión realizada y establecer los elementos para su sano desarrollo económico.
- Promover el desarrollo del sector logrando una operación eficiente.
- Contribuir a la protección ambiental de la Zona Metropolitana de la Ciudad de México, promoviendo el máximo aprovechamiento del parque vehicular, manteniendo una operación óptima y el uso de vehículos con tecnologías que generen bajas emisiones contaminantes para la prestación de dicho servicio.

Resulta imposible soslayar el aspecto político que rodea a las decisiones en materia de tarifas del servicio público de transporte de pasajeros, lo cual acentúa la necesidad de que éstas se tomen sobre bases sólidas en cuanto al manejo de la información que permita determinar el comportamiento de las variables asociadas al problema.

2 MARCO JURÍDICO.

El marco jurídico en materia de tarifas del servicio público de transporte de pasajeros, lo componen la Ley de Transporte del Distrito Federal y el Reglamento para el Servicio de Transporte de Pasajeros en el Distrito Federal.

2.1 Ley de Transporte del Distrito Federal.

En resumen, la Ley de Transporte considera un capítulo en donde se desarrollan los términos generales para la fijación o modificación de las tarifas del servicio público de transporte de pasajeros en el Distrito Federal en sus diversas modalidades. Los puntos básicos que se establecen son:
Las tarifas para el transporte de pasajeros en todas sus modalidades se proponen por la Secretaría de Transportes y Vialidad al Jefe de Gobierno quien es el responsable de fijarlas. Son conocidas por los usuarios a través de la Gaceta Oficial y dos periódicos de mayor circulación, cuando menos con cinco días de anticipación a su entrada en vigor.
Para el análisis que habrá de servir de sustento para fijar o modificar las tarifas la Secretaría debe considerar en cada modo de transporte, el tipo de servicio, el salario mínimo general vigente, el precio unitario del energético de que se trate y el Índice Nacional de Precios al Consumidor. Además de la prestación del servicio.

2.2 Reglamento para el Servicio de Transporte de Pasajeros en el Distrito Federal:

En este Reglamento se consideran los criterios para fijarlas y modificarlas pudiendo establecerse cuatro tipos de tarifas:
Diferencial. Se refiere al precio que se paga por la prestación del servicio en función de la distancia recorrida, o bien por las características, clase o tipo de servicio.
Promocional. Se aplica una reducción en el precio establecido del servicio, con el propósito de fomentar y atraer una mayor demanda, además de apoyar la economía del usuario.
Especial. Es el precio que cubre por la prestación del servicio, derivado de un acuerdo de carácter social, en beneficio a diversos sectores de la población.

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[1] Esta Zona incluye 28 Municipios conurbados y el Distrito Federal.

Única o Plana. Es el precio fijo que se paga por la prestación del servicio, sin importar la distancia y el tiempo.

La Secretaría para presentar su propuesta de fijación, revisión y modificación de las tarifas, debe elaborar un estudio técnico previo, mismo que incluirá la información relativa al desempeño y costos operación del servicio en la clase de transporte de que se trate.

De igual forma los estudios deberán reflejar las prácticas de operación de acuerdo a las características que cada modalidad de servicio debe ofrecer.

Para la adecuada evaluación en la revisión tarifaria los estudios técnicos deben contener por lo menos los aspectos siguientes:

- La definición del costo de la inversión requerida para proporcionar los servicios.
- Las mejoras de productividad y reducción de costos que sean alcanzables mediante el mejoramiento técnico de la operación y de la administración de la empresa, y
- Los costos que se deriven de la operación y el mantenimiento de la capacidad instalada.

3. MÉTODO.

En el Reglamento se establece el procedimiento para el cálculo de ajuste para modificar la tarifa, y con fundamento en los estudios realizados, la Se- ajuste, de acuerdo a la siguiente fórmula:

$$IT = [E\ (\Delta PE) + SM\ (\Delta SM) + DA\ (\Delta DA) + (MTTO+ID)\ (INPC2/INPC1)\ (1-X)$$

Donde:

IT:	Incremento tarifario
E:	Tipo de Energético utilizado
ΔPE:	Incremento del energético, dentro del periodo de análisis
SM:	Salario mínimo
ΔSM:	Incremento en el Salario Mínimo, dentro del periodo de análisis
DA:	Derechos administrativos
ΔDA:	Incremento en los derechos administrativos
MTTO :	Costo del mantenimiento en un periodo anual
ID:	Insumos diversos anuales
INPC1 :	Índice Nacional de Precios al Consumidor correspondientes al el mes en que se autorizó la tarifa vigente
INPC2 :	Índice Nacional de Precios al Consumidor correspondientes al mes en el que se autorizará el incremento

La innovación de este método para el cálculo y determinación tarifaria consiste en una redefinición de los formatos. Para el transporte que ofrecen los Organismos Descentralizados y de las Empresas de transporte concesionado, se definieron tres formatos: estructura de costos a nivel de empresa, datos de operación y mantenimiento a nivel de ruta y estructura de costos y operación para una muestra representativa de vehículos a nivel individual.

Para los concesionarios microbús, taxi libre y taxi de sitio, se estableció un formato de estructura de costos de operación.

De tal manera que para determinar el incremento tarifario de acuerdo a las nuevas estructuras de costos se diseñó un modelo que permitiera el ajuste tarifario de acuerdo a lo siguiente:

$$CB = E + SM + DA + MTTO + ID \qquad (1)$$

Donde:

CB:	Costo base
E:	Energético (Costo del energético en un periodo anual)
SM:	Salario mínimo (Costo de sueldos y salarios de un periodo anual)
DA:	Derechos administrativos (Costo de los derechos administrativos en un periodo anual)
MTTO :	Mantenimiento (Costo del mantenimiento
ID:	Insumos diversos (Costo de los insumos diversos en un periodo anual)

$$CA = \{E(\Delta E) + SM(\Delta SM) + DA\ (\Delta DA) + (MTTO + ID)(INPC2/\ INPC1)\} \qquad (2)$$

Donde:

CA:	Costo actualizado
E:	Energético
ΔE:	Incremento del energético (En el periodo de análisis)
SM:	Salario mínimo
ΔSM:	Incremento de los sueldos y salarios (En el periodo de análisis)
DA:	Derechos administrativos
ΔDA:	Incremento de los derechos administrativos (en el periodo de análisis)
MTTO :	Mantenimiento
ID:	Insumos diversos
INPC1 :	Índice Nacional de Precios al Consumidor (En el mes en que se autorizo la tarifa vigente)
INPC2 :	Índice Nacional de Precios al Consumidor (Proyección del INPC en el mes en el que se autoriza el incremento)

Determinación del Incremento aplicable a la tarifa

$$\Delta T = \{[(CA/CB)-1](1-X)\} + 1 \qquad (3)$$

Donde:

DT:	Incremento Tarifario
CB:	Costo Base
CA:	Costo Actualizado
(1 – X):	Factor de Ajuste por Productividad

En relación con la fórmula para la determinación del incremento tarifario esta se basa en: Las estructuras de costos que son diferentes para cada modalidad, y el incremento real de los precios en la medida que esto sea posible, y tomando en cuenta el desempeño de estos desde el punto de vista de su operación física.

4. EVOLUCIÓN DE LA TARIFAS.

A partir de marzo de 1995 se han registrado tres incrementos para los servicios que prestan los concesionarios y permisionarios, así como de los organismos descentralizados de transporte.

La magnitud de los incrementos se encuentran entre el 72% y 289%. Estos incrementos no han 1994 a la fecha, lo que implica una falta de recuperación en su nivel tarifario.

5. DIAGNOSTICO DE LOS PRESTADORES DEL SERVICIO.

Los ingresos y costos reportados por los organismos de transporte del Gobierno del Distrito Federal: Sistema de Transporte Colectivo, Metro, Servicios de Transportes Eléctricos y el Consejo de Incautación, implican elevados subsidios al transporte que afectan las finanzas del Gobierno, amén de los recortes al presupuesto. Asimismo, las necesidades de inversión de dichos organismos conllevan la necesidad de ajustar las tarifas a los costos reales en lo posible. En lo concerniente a los concesionarios y permisionarios del servicio, se distinguen diferentes situaciones. En el caso de los prestadores del servicio colectivo de ruta fija, los márgenes de utilidad que se deducen a partir de sus datos de costos e ingresos son aceptables; en cambio para los prestadores del servicio en su modalidad individual, los márgenes de utilidad estimados en función de su información de costos e ingresos que generan son bajos.

La observación más generalizada se refiere a la baja captación de usuarios que reportan los diferentes prestadores del servicio, situación que afecta por partida doble sus márgenes de utilidad, ya que por un lado evita que se diluyan los costos y por el otro significa menores ingresos. En general, la decisión para establecer el incremento a las tarifas debe considerar que se promueva la eficiencia y productividad de los prestadores de servicio, a efecto de que los intereses de los usuarios no se vean afectados. Cabe señalar que la clase de menores recursos es la más afectada por este tipo de decisiones.

6. LA TARIFA COMO INDICADOR DE SUSTENTABILIDAD

El interés creciente en el desarrollo sustentable ha sucitado la inquietud de crear indicadores susceptibles de medición. Este proceso se ha visto obstaculizado por la falta de indicadores adecuados y la información para medirlos y analizarlos. La transición hacia la sustentabilidad depende en gran medida de la aplicación afortunada de programas de conservación y desarrollo a nivel local. Debido al elevado costo de esperar a obtener más informadisponible en un marco que ayude a individualizar las dimensiones insostenibles de la economía en sus diferentes rubros. Actualmente, se utilizan diversos indicadores y criterios de sustentabilidad con ligeras variaciones de tal manera que las pocisiones económica y ecológica se centran en:

- La utilización de los recursos renovables a tasas menores o iguales que las tasas naturales o controladas de recuperación.
- La producción de desechos a tasas inferiores o iguales que la capacidad de asimilación del medio ambiente para absorberlos.
- Oprtimizar la eficiencia con que se utilizan los recursos no renovables, por medio del avance tecnológico, según lo determine la proporción en que se puedan sustituir los recursos no renovables por los renovables.

La discusión sobre ambiente y economía se ha enfocado erróneamente como una cuestión de intercambios: Esta perspectiva se apoya en una visión estrecha del desarrollo económico, que suele medirse en términos del PIB (producto interno bruto) u otros indicadores macroeconómicos en forma convencional. En el caso de la Ciudad de México la creciente deforestación, la erosión de los suelos, la congestión urbana y la contaminación tienen importantes repercusiones negativas en la calidad de vida. Hay importantes testimonios tanto de que la calidad de vida como el ritmo de desarrollo económico hubiesen sido mejores de haberse dado atención a las limitaciones que imponía el ambiente desde el principio. Si bien en la Cd. de México el panorama general de la eficiencia en la utilización de los recursos y el control de emisiones contaminantes ha mejorado en cierta medida, sus repercuciones en términos globales son aún mínimas, de tal manera que la perspectiva a futuro para lograr un transporte urbano sustentable se encuentra en función de políticas de inversión complementarias y regulación que permitan desarrollar un modelo que determine tarifas:

- Económicamente eficientes
- Ecológicamente sustentables
- Socialmente justas

La política tarifaria debe reflejar un sistema de incentivos y desincentivos económicos y regulatorios a partir de su costo beneficio ambiental reorientando la definición e incremento tarifario para que sirva como un indicador de sustentabilidad de la Ciudad.

En ese sentido, la definición de políticas sustentables para el tranporte público de pasajeros busca:

- Mantener las tarifas que aplican los organismos estatales en un nivel igual o menor a las de los concesionarios del servicio colectivo de ruta fija, a efecto de evitar que la demanda se siga desplazando hacia los modos de transporte de menor capacidad que operan estos últimos y promover el aprovechamiento de la capacidad de los servicios estatales.
- Adoptar una política diferenciada en cuanto a las tarifas de las distintas modalidades de servicio. a efecto de que se aprovechen las economías de escala que son capaces de generar los modos de transporte de mediana y alta capacidad.
- Asociar acciones tendientes a hacer más eficiente la operación tanto del transporte estatal como del privado a la autorización de nuevas tarifas, a efecto de evitar que la baja productividad recaiga sobre los usuarios del servicio, y de este modo promover que la economia de los prestadores del servicio no dependa exclusivamente de la tarifa.
- Adecuar la capacidad de servicio a la demanda. a efecto de reducir el impacto que genera la baja captación de usuarios en los costos e ingresos del servicio.
- Promover la introducción de medios electrónicos de peaje para eliminar la limitación que impone a la determinación de tarifas las denominaciones de la moneda, y de esta manera poder reflejar con precisión los incrementos que se determinen, así como facilitar que la estructura tarifaria refleje la distancia del viaje en los modos de transporte en que actualmente no se considera, como es el caso del Metro.
- Reforzar la regulación para hacer más eficiente la prestación de estos servicios y desregular aquellas actividades que desalientan el automovil particular como son los autobuses escolares y de personal.
- Buscar la reordenación de rutas y estimular los modos de transporte masivo o aquellos vehículos cuyas tecnología reduce considerablemente las emisiones contaminantes.

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Modalities of a public-private partnership in financing Delhi MRTS

Modalités d'une association privée-publique pour la finance de Métro urbain de Delhi

Sushil Verma
Rail India Technical and Economic Services Limited, New Delhi, India

ABSTRACT: Public agencies' inadequacy in provision of infrastructure support for urban development hardly needs any reiteration, nor does the fact that infrastructure provision, particularly in the context of a city with per-capita income as that of Delhi, would remain (and *should* remain) largely a public service. This dichotomy essentially then points to a partnership option where the public bodies look for a partner in the non-government sector for supplementing its resources. For making the partnership happen there are two basic questions that need to be answered.1) *Why* the partnership or *what would bring the private sector and the public sector together*? The answer to which is that this goal convergence could be the integration of transport with land development.2) *How* the partnership?-For construction of MRTS facilities and property development, a joint development approach through a "Special Project Vehicle" (SPV) is proposed. The partners in the joint venture would be under a legal contract. *It is important not to start with a final plan and then start looking for funds*. The development of the plan should rather be based upon the existing and future funding possibilities, which may consist both of monetary outlays and contributions in kind or the non-monetary outlays in the form of public law, sweat equity etc.

RÉSUMÉ: Aménagement de l'infrastructure pour les villes est pour la plupart la résponsibilité des gouvernements, en particulier dans le context des pays en développement. Mais on connait bien que les agences publiques n'ont pas de moyens necessaires de remplir cette résponsibilité à cause de leur situation financière. Alors, elles cherchent d'autres méthodes de finance et en la sitiation actuelle de libéralisation, association avec les enterpises privées devient une option plus attrayante. Pour réasliser la partenariat, il y a deux questions à considérer : pourquoi la partenariat ou comment est-ce-que le secteur privée et le secteur public travaillent ensemble ? Intégration de développement de transport et de développement urbain serait la réponse à cette question. La deuxième question – comment fonctionne cette parteneriat ? Pour la construction du métro et le développement de propriété, il est récommadé que le développement de tous les deux côtés au moyens d'une « organisation spéciale ». Les partenaires dans ce project seront reglés par un contract. Il importe que l'on ne commence pas par un plan définitif et après cherche la finance. Par conte, le développement de ce plan sera plûtot basé sur la finance actuel et les possibilités de fonds à l'avenir qui peut consister en les moyens financiers et les moyens matériels ou les moyens non financiers come le droit public, actions etc.

1 INTRODUCTION

In the fall of 1989, Delhi Administration commissioned a study to explore the feasibility of a rail based mass transit system for Delhi. The terms of reference for the consultants, Rail India Technical and Economic Services Ltd. (RITES) were to examine the technical and financial viability of the proposal.

1.1 *Background of the Study*

Since the nineteen sixties, the city of Delhi has witnessed an unprecedented urban growth. The population of the city grew from 2.36 million in 1961, to 5.73 million in 1981 and studies revealed that the trend was only to go on[1]. This phenomenal growth has been partly due to the natural growth of the population. But like most urban centers, a large part of this can be attributed to migration of the people who come to Delhi from smaller cities and the rural hinterland, in search of better economic opportunities and get settled in the city. For the metropolis, this means an increased pressure on its already stressed infrastructure, including the transportation network. The situation is not made any easier by the large floating population, which comes to Delhi from the neighboring towns and cities to work everyday.

Recognizing this problem being faced by the metropolitan Delhi, and the need to take immediate action to ameliorate the situation, the National Capital Region Planning Board (NCRPB) was constituted under the NCR planning board act, 1985, nearly 25 years after the concept was first introduced. The NCR extends over a geographical area of about 30,000-sq. km. covering the national capital territory of Delhi and spreading over 3 adjoining states. A number of studies were commissioned by the board, with the objective of identifying strategies for reducing the rate of migration to the metropolis in order to affect a balanced urban growth in the region in pursuance of the objectives it was set up to meet.

One of the proposals made in these studies was to develop an efficient transport network within the NCR and link it to a mass transit system in the city of Delhi. Improved mobility within the region was expected to shift the preference, of those living in the smaller cities and towns around Delhi, in favor of daily commuting over migrating there. It was against this background that the present proposal for a Mass Rapid Transport System (MRTS) for Delhi was conceived in the year 1989. Responsibility for implementing the Delhi MRTS was given to the Delhi Administration.

1.2 *Feasibility Study for Delhi MRTS*

Consequently, Delhi Administration decided to study the feasibility of the proposal and appointed RITES as consultant for this job. A working group was constituted to monitor the progress made by the consultants, as also to solicit the approval of the concerned public agencies. The group comprised representatives of the Delhi Administration, the Delhi Development Authority (DDA), Municipal Corporation of Delhi (MCD), Delhi Traffic Police, Fire Service, Indian Railways and the School of Planning and Architecture (SPA) among others. The Secretary, Ministry of Urban Development (MOUD) headed the working group.

RITES has been working on the feasibility study since, and has prepared a technical proposal[fig 1], which envisages, in a phased manner, a combination of underground, at-grade and elevated rail alignments. In the most congested parts of the city, where, there is no land available, the underground or elevated option has been chosen, whereas in the relatively lesser built up areas, the at-grade option has been exercised essentially in response to the cost constraints of the other options.

Figure 1
Modified First phase, Delhi MRT

To integrate this network with other modes of transport, at each MRTS station, adequate facilities for *park and ride* are provided. Station area plans have developed to encourage the use of public transport to further reinforce the concept behind the proposal.

The consultants estimate that the project would cost US $ 2 billion, at 1992 prices. Proposed financing plan suggests about 6 % of this to be raised through property development.

This paper is aimed at highlighting some issues related to property development for financing transport infrastructure, and draws attention towards certain 'must dos' for making a partnership possible among the various public agencies and the private sector in meeting this objective and at highlighting some of the issues that would need to be addressed while structuring this partnership.

2 QUESTION *WHY* WOULD THERE BE PARTNERSHIPS?

Answer: Integration of land and infrastructure Development.

DMRC is proposing to develop station and depot sites for commercial exploitation. The proposed developments above the MRTS facilities are expected to raise funds to meet approximately 6% of the total estimated cost of the project.

While the station locations would be commercially attractive sites, the potential of the adjoining areas should not be overlooked. In fact it is possible that in certain locations, It is the property not immediately next to the stations, but a little far, say half a Km, becomes commercially more attractive due to the improved accessibility of these sites.

2.1 *Integrated land and infrastructure development*

Introduction of a high speed, high capacity transport system, would automatically, result in increased demand for commercial and certain kind of residential properties along the route, particularly in the areas in the immediate vicinity of the stations, thereby boosting the land values in these areas and triggering off building activity in the area. Real estate development will boom benefiting builders and developers in both formal and informal secto**r.** It would be therefore relevant to look for ways and means of internalizing these benefits into the project and planning to exploit the increased property demand on a larger area rather than seeing property development over the station areas and MRTS facilities only as sources of revenue generation. Since the benefits of improved accessibility would not be limited to a small area but would be spread over a larger area, looking at MRTS project as an integrated land and infrastructure development would be the right perspective.

This would mean that the land development agency i.e. the DDA has to have a more direct role in the project than is being seen at present. Since land development is not the main activity of DMRC, nor is it its mandate, a partnership between DDA and DMRC is the first coming together of stakeholders, we are looking for. DDA and DMRC have to come together so that the benefits of the project are reaped by the government agencies, instead of letting the "free riders" cash on the opportunity. The government should take a proactive stand and become a partner in the scheme by planning in advance, exactly what the private sector would otherwise do after the project.

While the benefit to DMRC would be that it would gain from the experience of land development and the statutory powers of its partner, the benefits to DDA would be both short term as well as long term.

To begin with, DDA could capitalize on this increased demand through levying fees on the conversion of land use (from non-commercial to commercial) or through allowing higher FARs, as may be desirable in a particular case. As a policy DDA could think less about rigid building regulations, such as FARs, coverages, height restrictions etc, and more in terms of what it benefits it can leverage out of the developers, by discreetly relaxing some of these rules, as was done in the Brisbane, Southbank development project, Australia. Here the real estate developer was allowed to build extra floors if he provided facilities for parking and a public plaza in return. This practice is commonly used in that country to build public facilities. In a situation where DDA is not able to control the semi-legal or completely ill legal activities of the builders and developers, this strategy might come in useful. Depending on how much deviation, a developer wants, from the norms, the public agencies could negotiate facilities that they are interested in having as a return gift!

In the event of DDA or other public agencies themselves being the owner of the properties, redevelopment could be a big opportunity, which it could cash in on. Higher densities and greater commercial land use along this high capacity transport corridor is fully logical as this would optimize the cost benefits of the project, and review of land use and relaxing of building regulations is, therefore, justified. Though, the corridor is planned to serve congested parts of the city, further densification (within discretely decided limits, naturally) around the stations, stands to reason.

2.2 *Internalizing the Positive Externalities*

Enhanced land values and increased demand for commercial space around the stations, thus are the positive externalities of the project that could be internalized to finance the system. The under/ unutilized properties/ lands belonging to the public agencies have high commercial potential, which could be tapped. The returns from these projects could then be (at least partly) diverted into building the MRTS facilities, since that is, in a way, the *raison d'être* for these developments.

In the long term, DDA's perspective plan and MRTS extensions can be planned in co-ordination. The extensions of the network that would be taken up in the future could well be planned with DDA's land value concern in mind. In fact, these extensions could be very effectively used as tool for guiding the land markets in the new areas that the DDA plans to develop.

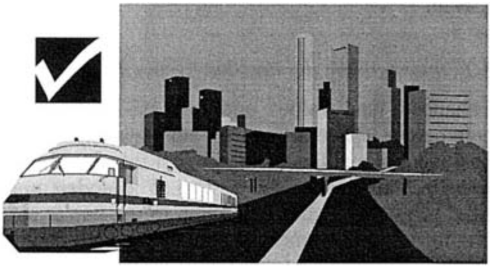
2.2.1 *Case study of Singapore*

The case of extension of Singapore CBD is a good example of this possibility, where, due to shortage of land in the CBD, a land reclamation project was proposed, but was found, upon making feasibility studies, to be prohibitively expensive. However, it was realized that, if the existing mass transit system was to be extended to this new proposed area, the land prices would be such that the sale proceeds would be able to pay not just for reclamation but also the extension of the transport network.

2.2.2 *The case of Mass Rapid Transit Project, Hong Kong*

The project was financed through development of commercial property along the rail alignment. The land which belonged to the government was leased to the Metro corporation, at market price, (for an indefinite period of time), who then developed it in collaboration with private real estate developers. The Metro Corporation is a limited company, with the government of Hong Kong as the sole shareholder. Property development along the route was used to finance the system. Government land and other law making powers were applied as public equity while striking deals with the private sector.

So, If the MRTS project is then redefined as the integrated property/ transport development project, and redevelopment of under-utilized properties is made an integral part of the project, it could change entirely, the view of the key actors and bring together their resources, which when pooled could "make" the project.



3 QUESTION *HOW* WOULD THE PARTNERSHIP OPERATE?

3.1 Answer: Special Project Vehicle, Joint Development of Ideas

Goal convergence of the different actors involved can thus be realised by redefining the scope of work of the project to include land and property development along the MRTS. In other words, property development along the proposed alignment should be integrated with the development of the mass transport network in a way that the profits from the sale proceeds of these properties could be used to finance the system. (Depending on the primacy of the land, the two could happen together, at the same time, possibly in a single structure subject to site conditions and architectural and structural concerns or, in separate phases, with the property development following the transport facilities)

3.1 *Structure of the Partnership*

The next question, then, is how, in what manner, could this partnership be structured? Or, what institutional form this coming together of the stakeholders, could take? The answer lies in addressing issues concerning resource, return and risk sharing among the partners, or the role related issues, as well as those concerning the manner and extent the actors like their own involvement and that of the other actors or in other words issues related to their mandates. Important it is for the government to determine how much of their investment and profits is it willing to share with the private sector.

The investments required in this task are a technical design of the MRTS and land, which the public agencies have, and the financial resources to build the facilities for MRTS which can be the private sector input. The public agencies also could contribute in "sweat" equity (which could mean statutory powers or the time spent by the public servants). A resource contribution in kind is as important as an up front investment per se. Although it is only the latter that is usually considered to be determining financial feasibility, contributions, which enable project implementation, are no less important. It is logical then, that the Government should apply its statutory powers and other intangibles (which in the case of the DDA, happen to be the building bye-laws) as its share in the partnership with the private sector. This in principle could be the partnership arrangement between the public and private sector.

3.2 *"Special Project Vehicle" (SPV)*

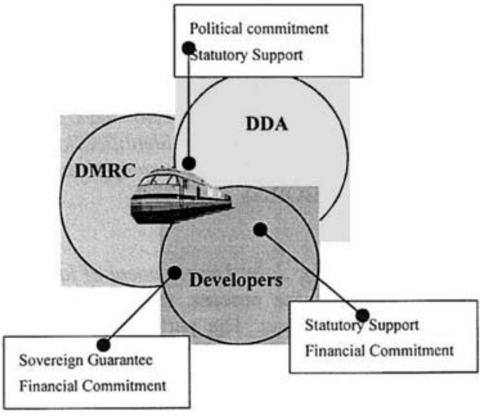
From the point of view of potential investors, the main risks involved relate to project completion, markets and supply of inputs. The objective should be to allocate risks to those partners who are in the best position to control the particular risk factor. *Sharing, not only, of the resources and returns, but also risks is essential for the satisfactory functioning of a PPP.* (Sinha). Other issues such as the legal status of the partnership, balance of power among the partners and conflict diffusing mechanisms could be satisfactorily addressed, if the Public Private Partnership took the form of a Joint Venture.

Building of stations and other MRTS facilities along with the redevelopment of properties is proposed to be taken up jointly by the public and private agencies though a statutorily created "special project vehicle" (SPV). The SPV would comprise all stakeholders who believe in the project. All partners pool in their resources, monitory as well as non-monitory. They work out, jointly, a project proposal (capital investment, debt servicing, cost estimates, cost recovery strategy fully or partly through property development). Additional funds required may be raised through loans, and after the project takes off and the public confidence in it is established, capital markets could be approached.

The SPV would need to inventorise it's "assets" such as the redevelopable properties and financial commitment of the parties. Next it would have to list out it's "liabilities" i.e. space needed to accommodate the functions presently housed in the properties as well as the functions for which unutilized land is held by, say the Railway; and the costs that might be incurred to re-house people and activities that need to be moved for considerations of optimal land use, as a starting point in the property development strategy.

The property development details will have to be such that the returns from them are sufficiently higher than the costs (capital cost + debt servicing + O&M Corpus) to allow a reasonable return to the participating agencies, and to the shareholders when there is a public issue. Depending on the primacy of the location of the property development sites along the metro alignment, this may be viable as it is. Alternatively, or in addition, the SPV could negotiate certain project advantages. For instance, in Delhi there is no policy for redevelopment of unutilized or under- utilized land. Real estate developers are working in semi-legal manner. The SPV could capitalize on this by providing opportunity for legal activity by builders, If it can ensure strict control on illegal activity elsewhere for the duration of the project, it can effectively increase the competition and, thereby the price on development rights.

A joint sector venture will address the most important issue that either side is much concerned with, that relating to the risks regarding supply of inputs (in this case the commitment of the resources), markets and completion. Advantage of a contract of intent would be for both sides. The public sector would, by this process secure the financial commitment of the private sector, which would be crucial for completion of the project particularly in case the real estate markets fluctuate. Secondly, since the actual construction would take place a few years from the time of the initial agreement, covering the market risk is also extremely important for the public sector, particularly since it has not much experience of markets behavior. A joint sector venture could be used for allocation of this risk to the private sector who knows very well how to control this risk factor.
For the private sector on the other hand, this would mean covering the political risks and ensuring that the government would continue to support the project, and that the changes in the political environment would not make the PPP fall apart. This security will help the private sector, plan and mobilize it's resources, in a better way,



3.3 *Partners in the SPV*

Essentially, those who would "own" the project are

- Delhi Metro Rail Corporation
- Delhi Development Authority
- Private Sector Builders and Developers

Given below is a possible layout of what would be the share of various stakeholders in terms of risks, returns and resources

Role / Partners	Resource	Returns	Risks
• Delhi Metro Rail Corporation	• Land • Matching grants • Enabling legislation	• MRTS facilities • O&M corpus • Fulfilment of NCR objectives	• Financial • Market
• Delhi Development Authority	• Land • Reforms in Development Norms • Opportunities to builders, end users	• Saleable properties • Enhanced land values • Fees/levies for land use changes/ added FARs • Opportunity for integrated land development	• Financial • Market
• Private Sector Developers	• Finances • Market understanding • Management	• Saleable properties • advertisement rights • Increased opportunities • Goodwill of public agencies	• Statutory support • Political commitment

3.4 *Plan Development Process*

PPPs are an important tool for handling the different dynamics of those urban development projects which feature the goal convergence and interdependence of the public and private agencies and *experience has shown that common goal is recognized as such if public and private sector seek contact in the first phase of the project identification, before either side has formulated it's own approach.* (Paul H.L. KLOPPENBORG)

3.4.1 *Platform for Joint Development of Ideas*

The first step in the process, therefore is the joint development of ideas. The parties involved in the MRTS, differ not only in the resources and instruments but also in objectives, the government focusing on the transportation problem, the DDA concerned with land use and land markets, the developers looking at their specific business interests. Identifying the interested and affected parties and establishing a platform for these parties to come together is essential. This has been achieved, already to a large extent, through the formation of the MRTS steering committee and the working group, both of which comprise the different public agencies that would be interested and/ or affected. The private sector builders and developers did not find a place in these groups primarily, because at the beginning of the exercise, as said earlier, the project was perceived as entirely a public responsibility. The main function of this platform is for all parties to know each other's intentions, know 'why' they are interested, 'what' is their perception of the project and 'what' would they be willing to put in it. This kind of a thorough stake holder analysis is often skipped and shortcuts to knowing 'how' the objectives are to be achieved. It is important, therefore, now to start a dialogue with this group and establish a base for its' participation in the next stage of the joint decision making that is the contract of intent.

3.4.2 *Contract of Intent, Investment Commitment*

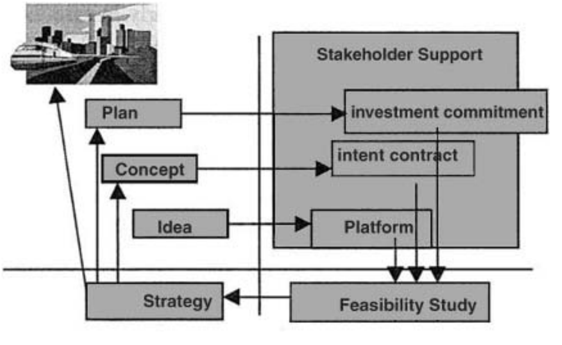
The steering committee and the working groups have met and discussed the ideas and plans developed by the consultants and, based on the feasibility study made, a strategy, which visualizes the concept of property development as a way to finance the building the system, has been agreed by the group. As said earlier, the public agencies' liquidity position does not permit them to come up with the investment on their own and therefore the involvement of the private developers is necessary. This, however needs to be agreed upon with them in advance of going ahead with the plans. and so the contract of intent (which is an agreement between the developers and the government on the general modus operandi rather than a specific project contract). Depending upon the intentions indicated by the developers and regarding this as a direction, the SPV could go ahead and draw up detailed plans and work out capital investment details.

3.4.3 *Directional Feasibility*

What is proposed here is a significant departure from the conventional approach adopted by public agencies. It is important not to start with a final plan and then start looking for funds. The development of the plan should rather be based upon the existing and future funding possibilities, which may consist both of monetary outlays and contributions in kind or the non-monetary outlays in the form of public law, sweat equity etc. A feasibility assessment should therefore be reviewed with regard to the stake holders analysis of objectives, benefits and resources and should include a survey of the funding possibilities. This directional feasibility would help identify a plan which has a better chance of succeeding since it is has the support of the key actors. In the case of *Brabantse Poort, Nijmegen*, this contract of intent was signed and was found to be a good instrument for ensuring the financial commitment of the investors, whereas in the case of *Kop Van Zuid*, Rotterdam only an informal agreement was made with the investors and it is reported that the investments are not coming forth as anticipated. The local and national governments have put in a lot of money, in infrastructure, as their part of the investment, it is feared that if the private parties do not put in their share of the investment, the money spent by the governments would be a sheer waste

3.4.4 *Figure 4. The Planning Process*

As the figure suggests, skakeholders' support in decision making should be considered crucial by the project implementing agencies (in this case the, the government) to avoid unpleasant surprises at the time of project implementation, since this is an important link in the process.



4 INSTITUTIONAL IMPLICATIONS

The Plan Development Process discussed in the previous chapter suggests a new approach to planning itself. Working in a Public-Private-Partnership or PPP means a new kind relationship between the private and public agencies (also among various public agencies themselves), which is quite at variance with their more traditional manner of dealing with each other. The new concept, as the name partnership, itself suggests, is built upon interdependence and mutual benefits. And, like any other business partnership, these PPPs, also demand, from the partners, a number of adjustments in the manner in which they operate, so that a meaningful association can be established. For the DMRC, DDA and the private sector, this would mean a major change in skills and knowledge needed, but before that, and more important than that, a change in attitude or the mind set.

4.1 *Need for Co-operation*

All the actors in urban development need to realize that they are not competing with each other. Instead, together they are in competition with other cities in the region, specially in the new, liberalized economy, and the city level agencies being evermore responsible for managing their own affairs independent of central support. If the local agencies do not recognize this they may be left behind by other cities in the region. A good example of this phenomenon is the city of Madras loosing out it's regional prominence to Bangalore, which is increasingly been seen as a major investment center by both domestic and foreign investors because of the environment that enables private enterprise. This could be of particular significance to DDA, although for more than one reason, there is little threat to Delhi's position in the region, many enterprises are likely to start looking for better opportunities outside, in the neighboring states (the trend is already started, with Delhi builders expanding their activities in the state of Haryana in the south of Delhi), if the city authorities do not present a more forward looking image. In coming forward with creative solutions to involve the private sector investors such as relaxing regulations for leveraging project advantages, the DDA, in fact, would be able to secure benefits that might not be there at all, in some cases, without the partnership.

4.2 *Reviewing rules and regulations*

Policy of inviting private sector in urban development has to be complemented with enabling environment. Without such a support, the private sector could hardly be expected to participate in projects that are in any case perceived as unprofitable. Easing of approval procedures and single window clearances should therefore be adopted by the DDA.

4.3 *Strategic Plan beyond 2001*

The DDA's currant master plan for Delhi expires in the year 2001. For DDA it would be worthwhile to keep in mind the benefits of integrating it's future land development with expansion plans of the MRTS. DDA may find it useful to make the new plans less prescriptive in nature (and therefore less rigid) and more performance oriented, which would lend themselves to being modified/ adjusted as and when needed, in response to ever-changing demands of the city. The flexibility of the new Master Plan will allow the planners to exercise strategic options that would meet the challenges of the changed reality and make planning more meaningful.

4.4 *Enlisting Support of Key Actors*

Given the global changes in the planning environment, any planning approach that does not involves the key actors and stakeholders in the process, does not inspire many hopes. On the other hand a participatory planning approach maximizes the potential of the key actors, even when unable to enlist their full co-operation, it would still be able to indicate to the planning team the possible hurdles in the execution process. *Support and involvement of the key actors is particularly important in this context since the DMRC has to depend heavily on DDA and Private developers to realize its concept and it is not in complete control of what is happening.* For the DMRC, coming to terms with this fact would be a precondition to forging any PPP arrangement.

4.5 *Information Systems*

Public information campaigns are necessary to make known to the public and potential investors, the plans of the government agencies. A very business like approach, here, is needed of the DMRC. In the case of the *Kop Van Zuid*, for instance, a separate information center has been set up, where comprehensive information is available to all prospective investors, in a variety of mediums such as audio-visual shows, three dimensional models, CD ROM, maps, drawings, brochures. The project has been given an identity of it's own by uniformalizing the color schemes (which is practically like a flag of the project) for all the publicity material. For the DMRC, more effective information campaign would mean better access to private sector finance and the increased confidence of this sector. More information means higher transparency, which in turn would mean higher investor confidence and so the DMRC should be willing to share and disseminate more information.

4.6 *Working with Communities*

A large number of people and properties are going to be affected while constructing the MRTS facilities, for various purposes. In order to get the co-operation of these communities, effective skills in community mobilization would be necessary for the Metro Corporation and DDA. A relocation policy would need to be formulated for which lessons may be drawn from similar project, being carried out in Bombay.

4.7 *Restructuring Organizations*

The union government needs to keep in mind, while considering the project and it's implementation that organizations, laws, rules and regulations are necessary to be modified for the Delhi Government to respond effectively to it's unorthodox role in the MRTS project, that of management instead of direct service provision, in order to avoid misuse and for it to able to monitor the results afterwards, ultimate responsability for which remains with it. Creation of the Metro Corporation has been a step in this direction, advantages of which would be many and varied. Within the Metro Corporation, structuring in the form of Inter-disciplinary project teams or task forces comprising individuals from various fields of specialization, working together on smaller and manageable sections of the project, having clear responsability and accountability might prove to be useful.

4.8 *Training requirements of the Government staff*

Apart from organizational changes, working in partnerships with other organizations and communities would demand the staff of the DDA and DMRC to display certain different kinds of skills, such that they have not needed in the past. Essentially the DMRC staff would now be required to 'manage' rather than 'do' thing, which means they must gear themselves with

- Ability to work in inter-disciplinary teams,
- Understanding of financial matters to ensure proper cash flows, debt servicing.
- Adequate capacity for efficient use of mobilized resources and
- Skills to negotiate satisfactory arrangements with the private sector
- Contract and construction management skills
- Communication skills,

4.9 *Image Builing*

The market image of the public agencies involved, is that of financially and managerially weak organizations. For the government to attract private sector investments, it's image has to be improved. Reforms in the managment practices and accountability through greater transparency in the public sector are necessary.

4.10 *Implications for the Private Sector*

The same applies to the private sector builders and developers. Their vision of their own role in urban development needs to be seen differently. Private sector, like the public sector also suffers from bad image, that of being unconcerned with social and environment issues. Conscious efforts in this direction, particularly by the big names in the formal sector would be required. Like the government, these builders and real estate developers also need to think up of innovative ideas that they could use to attract the public agencies' sweat equity, the importance of which should not be a undermined. Effective urban infrastructure is a prerequisite to economic growth, which must be a private sector concern as much as that of the public sector, and co-operation between the two, therefore, is hardly a matter of choice for either side[2].

6 Mobility and accessibility – Social aspects
Mobilité et accessibilité – Aspects sociaux
Movilidad y accesibilidad – Aspectos sociales

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A mathematical framework for measuring perception of accessibility by various interest groups using fuzzy measure

Un macro matemático para medir la percepción de la accesibilidad por medio de varios grupos interesados al utilizar la medida borrosa

P.K.Sarkar & S.K.Saha
School of Planning and Architecture, New Delhi, India

B.Nath & S.K.Deb
Indian Institute of Technology, Delhi, India

ABSTRACT: In this paper a mathematical framework using sample data has been developed towards determination of perception of accessibility by various income groups of peoples. A brief description of the concepts of fuzzy set theory has been made .The weights of various attributes of travel related to perception of accessibility were analyzed with respect to different modes used by the commuters. A fuzzy set concept was finally applied for the development of accessibility norms for different income groups.

RESUMEN:En esta ponencia se ha desarrollado un macro matemático al utilizar los datos muestra para eterminar la percepción de la accesibilidad por varios grupos de ingresos de lapoblación. Se ha hecho una breve descripción de los conceptos de la teoría del juego borroso. Fue analizada la importancia de varios atributos de viajar relacionados con la percepión de la accesibilidad con respecto a diferentes modos que utilizan los viajeros. Por último, fue aplicado un concepto del juego borroso para el desarrolo de las normas de la accesibilidad por los diferentes grupos de ingresos.

1 INTRODUCTION

The largest cities of India are increasingly confronted with the problem of poor accessibility. Often it assumes the dimension of a serious and complex issue to be addressed for improving the quality of life of existing residence and for locating new residential neighborhood. As long as this issue remains unaddressed, citizens suffer in terms of one or more of the following conditions; relative isolation from the rest of the city, spending disproportionately high amount of energy, time and money in order to participate in the diverse urban activities. Citizen's inability to participate in a large number of activities often results in trade off according to prioritization of accessibility as perceived by them. It is vitally important that such perception is known to the concerned planners so that the mismatch between the objectives of official proposals and citizen's priorities may be eliminated and plans may be implemented without obstruction.

Delhi, capital city of India, having experienced phenomenal growth and physical expansion during second half of the 20th century, appears to be no exception. Different types of residential areas such as plotted houses, government employees, squatters, corporate housing apartments, and resettlement colonies have been developed in different parts of the city. Beginning from mid 1980's, subcities have been planned and developed farther and farther away from the central areas of Delhi. As a result, the commuting times to work access to shopping and recreational areas and trip length for educational purposes continue to increase. The degree of uncertainty to perform a journey in a time bound way has also increased.

As a part of an on-going research work, perceptions of accessibility by various income groups have been studied. In this paper, an attempt has been made to develop a mathematical framework for measuring the perception of accessibility by predominant modes by various interest groups of people using fuzzy measures

2. IMPORTANCE OF ATTITUDES-PERCEPTIONS AND PREFERENCES

Every individual is constantly exposed to the changing environment when he visits one place to another within the city. As the environment changes, an individual perceives it in his/her own ways, reacts according to his/her appreciation. The attitude and image of every individual towards the environmental and physical aspects is believed to be related to his own preference. Thus, there is no single objective world, rather there is plurality of world -as many as there are attitudes and intentions of man. The understanding of the perceived world is therefore very important in context of prediction of human behavior. Most of the behavioral studies originate from the psychological theories. Gestalt and Stimulus-Response theory is widely referred Sarin (1986). In Gestalt psychology, man's perception of his surrounding is viewed as an organizing action of the nervous system. A subject's description of how things appear is regarded as his perception. Cognition refers to all modes of knowing and thinking and includes attitudes, beliefs that are subsequently gained through means of other direct experience, whereas perception is restricted to the process of direct experience.

This is the reason why direct experience is counted for dealing with such perceived world. In this world, the action/reaction of a human being is directed from traditionally built mental set-up which has grown up within him/or her over a long period of personal life in various places. For example, actual travel time (such as 28 minutes, 30minutes, 32minutes) hardly matters in his decision making process. The numerical values of 28,30,32 do not create significant impact in his biological brain set up. What he counts is what he feels. And what he recalls is what he counts. The same numerical travel time values for another human brain will create a different mapping as shown in Fig.1. So dealing with such numerical values will not be easy to develop any rationale using classical mathematics. The response of human brain depends on a number of socio-economic and psychological factors. It is, therefore, felt that this kind of data is to be analyzed by considering linguistic variables.

3.CONCEPTS OF FUZZY SETS

As its name implies, the theory of fuzzy sets is, basically a theory of graded concepts - a theory in which every thing is a matter of degree or, to put it figuratively, every thing has elasticity. During the last 20 years, the fuzzy sets are increasingly being used in a variety of ways in many applications. This includes the area of artificial intelligence, computer science, control science, decision theory, expert system, management science, operation research, pattern recognition, and robotics. Most of our traditional tools for formal modeling, reasoning, and computing are crisp, deterministic and precise rather than more or less type. But real situations are not often crisp and deterministic and these can not be described precisely. According to Zadeh (1965), as the complexity of a system increases, our ability to make precise and yet significant statements about its behavior diminishes until a threshold is reached beyond which precision and significance (relevance) become almost of mutually exclusive characteristics. Fuzzy set theory deals with imprecision relating to vagueness.

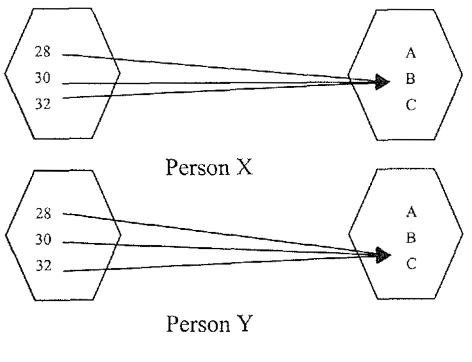

Fig. 1 Perception of travel time by two persons X and Y

Fuzzy set theory provides a strict mathematical framework in which vague conceptual phenomena can be precisely and rigorously studied. It can also be considered as modelling language well suited for studies in which Fuzzy relations, criteria, and phenomena exist. Fuzzy sets are usually intended to model people's cognitive states. They can be determined from either simple or sophisticated elicitation procedures. For example, change in weather conditions can be demonstrated by using fuzzy measures. A Fuzzy set representing the concept of cloudy weather may assign a degree of membership value of nearly zero as compared to sunny weather to nearly one. Depending on degree of cloudiness, the membership value may change from nearly zero to 0.2, 0.4, values indicating lesser degree of cloudiness. These grades signify the degree to which each percentage of cloud cover approximates subjective concept of sunny and the set itself models the semantic flexibility inherent in such common linguistic term.

Research and applications has been abundant with more than 4000 publications Zimmerman (1991) widely scattered over many areas in many journals.

4.MATHEMATICAL FRAMEWORK FOR FUZZY MEASURE

In this approach, qualitative grading are converted to quantifiable form. The values of membership functions are generally found to be convex, linear, concave or any other function deemed suitable. For developing a mathematical framework using the Fuzzy set in contest of measuring perception of accessibility, a considerable amount of data has been collected from various user groups to ascertain the level of satisfaction for their different purpose of journey. This includes the perception of their travel in terms of travel time, travel cost, travel distance, travel comfort, travel accessibility etc for which they feel to have been satisfied beyond which journeys are considered to be unaccepted. The ranges of their travel in terms of travel time, travel cost and travel distance by different modes of transport are viewed as perceptions of users looking for an opportunity to participate in different types of activities. These are generally defined as accessibility for different user groups. As the perception varies from user to user, it is therefore, extremely difficult to quantify through classical mathematics. So in view of this, fuzzy measures have been applied to develop the accessibility norms, by predominant mode for different user groups.

With a view to studying the perception of accessibility for different user groups, various factors are considered to have significant effect on the perception of accessibility.

For analysis of data using fuzzy set theory, it is necessary to construct fuzzy matrix using pessimistic, optimistic or any other approach Deb (1985). In the first step the symbol used in the analysis are explained below:

$J_1, J_2, \ldots J_4$ denotes the various alternatives considered

$I_1, I_2, \& I_3$ are the factors/attributes of the alternatives under consideration

$K^1, K^2, \ldots K^k$ is the rating matrix, superscripts 1,2,…k represent the respective matrices for different interest groups1,2,….k respectively.

r_{ij} the value of factor /attribute I_i of the alternative J_j

$\{J_j, \mu^k_{I_i}(J_j)\}$ The fuzzy set. The set of ordered pair.

$\mu^k_{I_i}(J_j)$ The membership function for the k-th interest group and i-th factors maps the alternative J_j. It has values in interval (0,1).

The next step is the formation of Dominance or Decision matrix. A flow chart for fuzzy set theory application is shown in Fig. 2

The steps involved in developing dominance matrix are as follows:

1. Specifying the alternatives (modes) among which the choice will be made.
2. Identifying the main attributes /factors of the alternatives.
3. Categorizing the different interest groups, who are involved in the system (commuters, planner's etc). In this study, only one interest groups i.e. commuter of various income groups has been considered.
4. Preparing questionnaire in the tabular (or matrix) form. The alternatives and factors represent the column and row of matrix.
5. Preparing Nomogram (Membership function) by categorizing commuters in different income group
6. The non-quantitative responses of the user groups are converted into quantitative forms by using Nomogram.
7. Constructing different rating matrices for different income groups of commuter.
8. Calculation of a dominance or decision matrix for each of the chosen income group.

This dominance matrix will finally help to develop accessibility norms for different modes of transport and for different user groups.

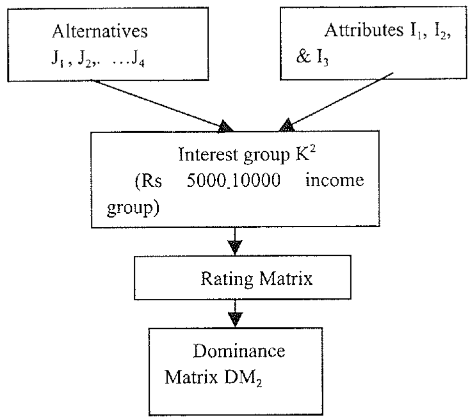

Fig 2 Fuzzy Set Theory Application

5. DATA INPUT

A questionnaire was designed to collect information relating to socio-economic and travel characteristics of different income groups with special emphasis of degree of satisfaction (DOS) of travel by different modes of transport. Primary data of about 500 random sample size from the different income groups was collected by personal interview method in the CBD in Delhi urban area. Data were coded and fed in the computer for further analysis.

6. APPLICATION OF FUZZY SET THEORY

6.1 RATING MATRIX

A non-quantitative scale was used to score the response relating to DOS of journeys with respect to travel time, travel cost and travel distance. The non-quantitative scale may be graded in four parts as satisfied, acceptable, tolerable and unsatisfied which can be assigned the quantitative value (score) of 0.8,0.6,0.4,0.2 respectively out of the maximum of 1.0. Using this scale, the data of DOS on travel particularly with respect to home based work trips (say commuter trips) was converted to a quantitative scale. The weighted average as well as the highest value of response were taken as representation of specific user groups These matrices are called rating matrix. They are also known as position matrix or net benefit evaluation matrix for that particular user group.

A cell of rating matrix represents the value of a factor for that alternative. Each cell in the matrix represents an element of fuzzy set while each column indicates a fuzzy set. Thus the entries in the column represent that each alternative satisfies the given factor.

6.2 *DEVELOPMENT OF MEMBERSHIP FUNCTION (NOMOGRAM)*

. The rating matrix was directly prepared from users response. This rating matrix was further considered with respect to different income groups. Further attempt was made to develop the relationship between the membership values i.e. degree of satisfaction values on 0 to 1 scale and attributes (travel time, travel cost & travel distance). The following steps are involved for development of nomogram for travel time

1. Find the range of travel time for which most of the commuters of selected income groups are satisfied. This was obtained by categorizing the data for different modes, income group, range of travel time, and degree of satisfaction rating value with respect to travel time. The data collected from the commuter's opinion survey relate primarily to the commuting journeys performed by four major modes, namely Bus (Delhi Transport Corporation), Chartered Bus, Two-Wheeler (motorized), and Car. The mid value of the range of travel time of maximum count was used for further analysis.
2. Find the mean value of travel time by weighted average (statistical method) from the above-categorized data.
3. Draw the best fit curves and find the model equations, which gives highest R^2 value from the values obtained by step1 and 2 taking DOS on X-axis and travel time on Y-axis.
4. Draw the best-fit curve by taking the average of the values obtained from the above two-model equation by extending the scale of DOS to 0 -1. Also find the final model equation which gives highest R^2 value. This is the Nomogram for travel time for selected mode of transport and selected income category of commuters of Delhi City.

Similarly Nomograms were also developed for travel cost and travel distance for selected mode and selected income group. The Figures 3, 4 &5 represent the Nomograms for Membership function of all commuter groups with respect to travel time; travel cost and travel distance.

6.3 *DOMINANCE MATRIX*

Dominance matrix is a square matrix with a dimension of maximum number of alternatives to be considered. For example the alternatives considered here are various modes of transport. It would be worthwhile to demonstrate an example how a dominance matrix is developed. Let us first take a rating matrix for income group Rs 10000-15000 per month and whose travel time inside vehicle is 30-35 minutes

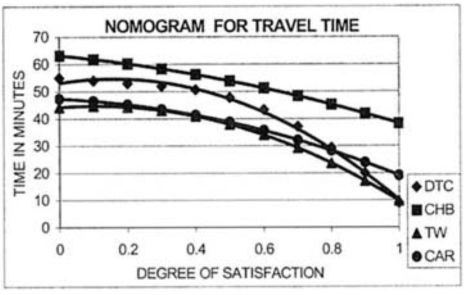

Fig.3 Nomogram showing Degree of Satisfaction as related to travel time per trip in minutes

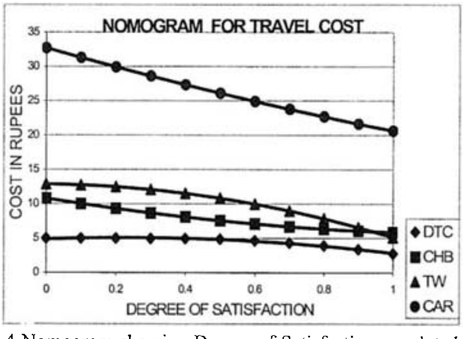

Fig.4 Nomogram showing Degree of Satisfaction as related to travel cost per trip in rupees

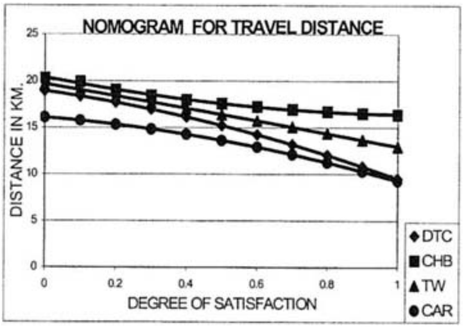

Fig 5. Nomogram showing degree of satisfaction as related to travel distance per trip in kilometers

Alternatives ▶ Attributes ▼	DTC	CHB	TW	Car
Travel time	0.72	1.0	0.58	0.61
Travel cost	0.9	0.6	0.4	0.4
Travel Dist.	0.6	1.0	1.0	0.4

As this is being developed in a disaggregate level, there is no need to develop pessimistic or optimistic aggregate matrix. After having developed this rating matrix, attempt has further been made to develop dominance matrix as explained below:

Each element in a row is compared with each other i.e. r_{i1}, r_{i2}, r_{i3}, r_{i4} (where i=1,2and 3) are compared and is established as being >, or =, or < than the other. The dominance matrix is found as a square matrix making both row and column as alternatives. Row elements of first column is compared with that of second column i.e. if r_{i1} >, or =, or < r_{i2} (where i=1,2 and 3) then 1.0, or 0.5, or 0.0 would be considered and sum of these forms the element d_{12}.

e.g., $r_{11} < r_{12}$ then value score is 0.0, $r_{21} > r_{22}$ then value score is 1.0, $r_{31} < r_{32}$ then value score is 0.0.

Now adding up 0.0+1.0+0.0= 1.0, Hence the value of element d_{12} is 1.0 .The other elements of dominance matrix are computed following the same procedure. Now adding column, the dominance of one alternative over other is found, e.g. .for bus (DTC) the dominance ratio is (d_{11} +d_{12} +d_{13}+ d_{14}= 0.0+1.0+2.0+3.0 =6.0). Similarly the dominance for the chartered bus, two-wheeler and car are calculated as 7.5,3.0 and 1.5 respectively. Thus the dominance ratio obtained is chartered bus: bus (DTC): two-wheeler: car:: 7.5:6:2.5:1.5. The dominance matrix is given below:

$$
\begin{array}{l}
\\ \text{DTC} \\ \text{CHB} \\ \text{TW} \\ \text{Car} \\ \\
\end{array}
\begin{array}{cccc}
\text{DTC} & \text{CHB} & \text{TW} & \text{CAR} \\
\left[\begin{array}{c} - \\ 2.0 \\ 1.0 \\ 0.0 \end{array}\right. & \begin{array}{c} 1.0 \\ - \\ 0.5 \\ 0.0 \end{array} & \begin{array}{c} 2.0 \\ 2.5 \\ - \\ 1.5 \end{array} & \left.\begin{array}{c} 3.0 \\ 3.0 \\ 1.5 \\ - \end{array}\right] \\
3.0 & 1.5 & 6.0 & 7.5
\end{array}
\begin{array}{l}
\\ 6.0 \\ 7.5 \\ 3.0 \\ 1.5 \\ \\
\end{array}
$$

7. DEVELOPMENTS OF ACCESSIBILITY NORMS

As discussed in the preceding sections the procedure for analysis of data was based on concept of fuzzy set theory. This has formed the basis for development of accessibility norms for different interest groups. An example is also shown in the earlier sections how a prominent mode is to be established for a selected interest group for a specified journey of time. After having obtained the results through the dominance matrix, an attempt has been made to work out accessibility norms with respect to travel time and travel distance for different selected interest groups. Table.1 present the accessibility by predominant modes of transport for selected income groups. The number of modes considered in the analysis includes DTC, CHB, TW and CAR, while the income groups considered are in the range of up to Rs 5000, Rs 5000to10000, Rs 10000to15000, Rs 15000to20000 and above Rs 20000 per month. The perception of travel time by different modes of transport for various income groups have been examined and evaluated by using the dominance matrix. Finally a set of accessibility values by predominant mode with respect to acceptable travel time and travel distance by various income groups have emerged as can be seen in Tables. 1 & 2. These are the reflection of their attitude to travel being performed by different modes of transport indicating their perception of accessibility. For example, Table.1 depicts the users of income group Rs 5000 to 10000 per month prefer DTC buses up to a travel time of 20 minutes beyond which they would like to travel by a CHB, as there is little difference in fare from switching DTC buses to CHB. The income group (Rs 5000-10000) feels that DTC buses are more predominantly accessible up to a travel time of 20 minutes beyond which CHB becomes accessible. Similarly the other figures also demonstrate the similar explanation. It would be noteworthy to mention that income range beyond Rs 20000 per month prefers car to be the most accessible and predominant mode up to a travel time of 40 minutes and beyond which this income group feels comfortable to travel by CHB.

Similarly the accessibility by modes for different ranges of distance has also been worked out and presented in the Table. 2. It can be noteworthy to mention that car is the predominant accessible mode up to a distance of 15 kilometers beyond which CHB becomes predominant for a income group of more than Rs 20000 per month.

Accessibility by predominant modes is shown in Tables. 1 & 2.

Table.1. Accessibility by predominant mode with respect to travel times

Income Group	Mode	Travel time per trips (in Minutes)
Up to Rs 5000	DTC	Up to 60
Rs 5000-10000	DTC CHB	Up to 20 20 to 60
Rs 10000-15000	TW CAR CHB	Up to 10 15 to 25 25 to 60
Rs 15000-20000	CAR CHB	Up to 30 30 to 60
Rs above 20000	CAR CHB	Up to 45 45 to 60

Table.2. Accessibility by predominant mode with respect to distances

Income Group	Mode	Travel distance per trips (in Kilometers)
Up to Rs 5000	DTC	Up to 25
Rs 5000-10000	DTC CHB	Up to 10 10 to 25
Rs 10000-15000	TW CAR CHB	Up to 5 5 to 15 15 to 25
Rs 15000-20000	CAR CHB	Up to 15 15 to 25
Rs above 20000	CAR CHB	Up to 15 15 to 25

8.CONCLUSION

This research study was primarily concerned with the application of fuzzy set theory in developing accessibility norms by predominant mode in context of work trips in Delhi urban area. As the response to same type of travel varies to a great extent from individual to individual and seems to include a great deal of imprecision, the application of fuzzy measures is considered to be appropriate in appreciating this kind of response of travel by different income groups of commuters. A detailed procedure for application of this theory has been demonstrated step by step including the development of rating matrix and dominance matrix. An attempt has also been made to develop nomograms exhibiting the relationship between membership values and other attributes of travel such as travel time, travel cost and travel distance. The nomograms developed have been tested and validated. Finally, accessibility norms by predominant mode for different income groups of commuters have been developed and can be used for planning of residential areas in Delhi.

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Social exclusion and public transport: Aspects of accessibility and mobility in bus systems environment

Exclusion sociale: aspects de l'accessibilité et de la mobilité dans les systêmes d'autobus

Exclusión social y transporte público: Aspectos sobre la accesibilidad y movilidad en sistemas de autobús

M.Caiaffa – *Centre for Transport Studies, University College London, UK*

P.Câmara – *Leicester City Council, UK*

T. Boeck – *Department of Social and Community Studies, De Montfort University, Leicester, UK*

ABSTRACT: The paper addresses the relationship between social exclusion and transport emphasizing the role of bus service as being a central part of public transport systems and a key element in promoting "inclusion". It defines social exclusion, identifies specific deprived groups and areas and it suggests a process of selection, collection and aggregation of the most important variables to be considered on measures to mitigate and minimize social exclusion problems. A list of initiatives developed in the United Kingdom, which promote full accessibility and improve mobility, will be used to explore good and fair alternatives to tackle social exclusion in transport.

RÉSUMÉ:.Cet article analise la relation entre l'exclusion sociale et le transport et insiste sur le rôle du servise d'autobus comme une partie centrale d'un systême de transport public et aussi un élêment-clé dans la promotion de l'inclusion. Il prêcise l'exclusion, identifie groupes et locaux spécifiques et suggêre une méthode de selection, rassemblement et aggregation des plus importantes variables à être considerées dans les mesures pour atténuer et minimiser les problêmes d'exclusion sociale. Une liste d'initiatives developée à Royaume-Uni qui promeuvent total accês et ameliorent la mobilité sera utilisée pour examiner bonnes et justes alternatives pour aborder l'exclusion.

RESUMEN: El trabajo analiza la relación entre la exclusión social y el transporte haciendo énfasis en el rol del servicio de autobús como parte central del sistema público de transporte y un elemento clave en la promoción de la "inclusión". Define exclusión social, identifica grupos carenciados específicos y areas y sugiere un proceso de selección, colección y agregacion de las variables más importantes a ser consideradas al tomar medidas para mitigar y minimizar los problemas de exclusión social. Una lista de iniciativas desarroladas en lo Reino Unido que promueven completa accessibilidade y mobilidad serán usadas para explorar alternativas justas para combater la exclusión social en el transporte.

1 INTRODUCTION

The paper addresses the relationship between social exclusion and transport emphasizing the role of bus service as being a central part of public transport systems and a key element in promoting "social inclusion".

The first part introduces the concept of Social Exclusion in attempt of helping practitioners to analyze the issues faced by communities in the wider perspective of social processes and direct their work in that perspective. It also analyses the transport as a dimension of exclusion.

The second part emphasizes the role of public transport in both developed and developing countries focusing mainly on bus systems.

The third part lists some good examples, adopted in the United Kingdom, reporting how to design fully accessible bus systems. It shows which variables to look for and how these can help to diagnose potential critic areas and social groups and ultimately how to begin to create some alternatives interfaces to improve them.

2 THE CONCEPT OF SOCIAL EXCLUSION

The concept of 'social exclusion' could help practitioners and policy makers to analyse the issues faced by deprived communities in the wider perspective of social processes and direct their work within that perspective.

According to Da Costa (1995) and Turunen, (1999), there are two major intellectual traditions concerning the methods of analysis and definition of the 'social exclusion phenomena':

1. The analysis that focuses on the resources and the redistribution of resources (the Anglo-Saxon, mainly British tradition),
2. The one that stresses on social links, more concerned with relational aspects of exclusion (the Continental, mainly French tradition)

Research within this field suggests that residents from deprived areas would define the issues of exclusion as both deriving from lack of relationships and lack of redistribution. Fridberg (1995), Heikkila (1995) and Washington & Paylor (1997) underline that the concept is a dynamic one in the sense that it is referring both to the processes of social exclusion and to the consequent situations. It also states the multidimensional nature of the mechanisms whereby individuals and groups are excluded from taking part in social exchanges and/or excluded from the fair distribution of resources. It also points to the nature of the processes of exclusion, which have cumulative effects on individuals, groups of the population, regions or urban areas and on society as a whole.

Within the discourse of social exclusion it is important to highlight the underlying social, political and economic processes, which lead to it. This seems to be dismissed by some policy makers, putting social exclusion equal with poverty, crime and 'threat' to society. Another aspect is that exclusion relates to groups of people - ethnic minorities, women, elderly people, disabled people - who, on a definition of poverty based only on income, would otherwise not be considered to be outside the main currents of society. Washington and Paylor reinforce that excluded people are denied full participation in society. Social exclusion does not refer just to the emergence of a 'new poverty'. It also refers to economic and social processes "which are creating a society which is radically divided between the relatively affluent who are employed in well paid occupations and those who are poorly paid or on state assistance, with the gap between the two growing wider".

Of great importance is the distinction between social inclusion and economic regeneration. Much of the thrust of the latter is focused on maximising inward investment and on training people so that they can compete on the labour market. Such strategies can be effective. Often however, they fail to engage with the issues of disadvantage, oppression and exclusion. Not to be overlooked is the spatial dimension of exclusion. Large numbers of poor people are clustered together in disadvantaged areas, and this makes the character of such areas very visible.

However there is another side which the discourse of 'exclusion' should not be allowed to obscure. Residents of 'deprived areas' (Boeck 1998) highlight the manifest evidence of strengths, capacities and success revealed and achieved in the most unpromising circumstances. Fundamental for this dynamic is that local residents seem to have a whole set of patterns of interchange and communication, which are more organic than structural. As a community worker stated: "They have within them elements of human interchange and inter-relationships which had to counterbalance individual consumerism and privatism. Out of need they had to keep alive elements of neighbourhood, community and collaboration". This means that deprived estates should not be seen as areas where only negative aspects such as crime, dysfunctional families, educational under-achievement, apathy, indifference and violence are concentrated.

2.1 Transport as a dimension of exclusion

According to Boardman and Fielding (1996), travel can affect quality of life, irrespective of levels of income or car use. Travel, not only provides the means for movement, but also creates opportunities and expectations about culture. Therefore transport is not only about environmental issues but also social ones. Behind travel lie cultural ideas, values and individual assessment of needs. In this sense one could look at the lack of transport in terms of 'travel poverty', stressing on the aspect of marginalisation within social exclusion.

Quite often public transport in cities operates on narrow corridors in and out of their centres with few cross-city services. The experience of local residents was that sometimes they are unable to attend events or facilities, which are available to other sectors of the population. The effect is, that people get isolated and feel that the area in which they live becomes the universe where they have to move. A core issue that it has been highlighted is that inadequate transport makes it impossible to residents to engage in certain kinds of social interaction (Boeck 1998). This makes life harder because people have to rely totally on what is available within the boundaries of movement relating directly to the services or lack of services available on the estate or bordering estates.

3 THE ROLE OF PUBLIC TRANSPORT - BUS SYSTEMS

Transport plays an important role - both as a potential cause and as a potential solution in order to 'repair' the perceived damage, which afflicts so many communities. Transport promotes economic development. It also allows access to jobs and other facilities or activities as well as acting as the means by which social and economic cohesion can be stimulated (Câmara and Banister, (1993)).

Different modes of transport have been crucial for economic development in different periods. In the early 20th century trams and suburban railway made it possible for cities that were already congested and crowded to increase in population size and to spread beyond their traditional boundaries. In Rio de Janeiro, Brazil, both modes played a key role in the city development as the building of the underground network in London just to name few examples.

Although car ownership levels are still growing in both developed and developing countries, a great majority of the world population, especially in developing countries, has still no access to private cars and depends entirely upon public transport. As underlined by Câmara, public transport still remains the principal mean by which motorized travel takes place in most cities. People live at varying distances from transport, and other facilities, they have different requirements and above all different abilities to pay. By definition the distribution of public transport is inequitable - both geographically and socially - but one important role for city planners is to ensure that the disadvantages faced by the social excluded groups are not increased but minimized.

The 1998 UK White Paper in Transport stresses that one in three households in the country still do not have access to a car (DETR, 1998). Those who do not have access to private cars are becoming more and more isolated from job opportunities and facilities, especially in rural and deprived areas.

Therefore public transport has a vital and key role to play in providing people access to facilities and services and in fulfilling their travel requirements. The bus (in Latin: Omnibus, that means for all) is one of the main modes of collective transport and can cater not only for shorter trips or as a "feeder" to higher capacity systems, but also for longer journeys.

The role buses play in both developed and developing countries is a very distinctive one. While in developing countries they may cater for up to 50% of all motorized trips or more, in developed countries they may have a much smaller share of all modes, see Table 1. The bus however, in both developed and developing countries may well be the only form of transport in rural areas.

The main question that may be asked is to which extent bus systems are capable of meeting the quantitative and qualitative requirements placed upon them and in including all segments of society. In other words, to which extent the bus system is including or excluding people access to its services and therefore depriving them from access to facilities, employment opportunities, education, health and leisure?

Table 1 –Percentage of Bus Share in some select cities worldwide

CITY MODAL	BUS SHARE* (%)
Bogota	80
San Jose, Costa Rica	75
Tunis	61
London	23
New York	14
Paris	8

Source: Hussmann, UITP (1995), modified by the authors. * Figures do not include trips on foot or by bicycle

Those quantitative demands or requirements will mainly be related to be balance (ratio) between demand and supply and can be measured in terms of frequencies of services, routes/itineraries, headway, night/weekend frequencies etc. The qualitative requirements will cover several attributes of the services, including mainly the vehicle, the stops and their environment.

4 DESIGN THE BUS SYSTEMS TO PROMOTE FULL ACCESSIBILITY AND IMPROVE MOBILITY

4.1 What to look for: selection of variables

As previously explained the core of the problem cannot be looked at exclusively in economical terms. At this point one should identify not only group(s) and area(s) excluded but also to determine the reasons why they are excluded. These problems are extremely difficult to be studied and the traditional methods to analyse demand will not work here. Each individual counts and as the concepts of individual means, the needs are different but not less important. Explore the detail of the necessity will contribute to enlarge the spectrum and therefore include more people on the mainstream transport. How do they actually are injected to the mainstream system is the second step to analyse. At this stage the economic analysis can be helpful.

4.2 How to look for: collection of variables

The aim is to provide a suitable bus service based on users' needs. Making it easier for people to use buses with adequate design of bus stop and associated information should be the aim of any transport plan. Potential problematic areas can be identified by looking at the basic five types of variables: population density, income, transport availability, network infrastructure and the most popular desirable destination points,. Once these are identified a closer contact within such areas and/or groups should be established. All social organisations on the area should be identified and contacted, they will deliver an overall view of current problems, as they will also act as partners to contact local individuals. All the needs from users should be considered. It is extremely important that pre-judgements of researcher teams should be avoided. This is the time to consider users' organisations needs. A cost constraint will be introduced at this time - not before a detailed diagnostic of the area in study.

At least three alternative routes should be worked out with a cost analysis associated to each of them. The decision for the service route should satisfy users' requirements. The partnership (including the community) set at the beginning to identify their problems, will now play its role on the decision process. Therefore the current concept of "Quality Partnership", see DETR (1999), should be revised once it does not consider the most important part on this relation - the users, as an active part of the scheme. A constant monitoring of the service taking into account users' point of view to improve the quality will lead to a crescent increase in demand.

4.3. Improve the quality of interfaces

This kind of bus service provision was developed inside an environment that guarantees full accessibility and improves mobility for all kind of users. In this context, the users considered in this paper-included people with mobility impairment (either permanent or temporary), wheelchair users, those with any kind of walking aid, elderly people, people with shopping and/or pushchair, sensory impairment- visual impairment, audio impairment; cognitive impairment - people with learning difficulties, people with mental illness and personal impairment, people with personal fear, lack of confidence and those facing safety problems.

This paper considers a six stage journey chain: (i) the enquiry, a pre-information step decision; (ii) the walk - the effort (physical and mental) to walk from home to a bus stop; (iii) the wait at the bus stop and the information needs associated at this point, (iv) the ride; (v) interchanges, when applicable (vi) and finally the walk at the final destination.

It is very important that the interfaces of the service are designed to assist users' expectations. Each individual element requires being both user-friendly and accessible for all kind of users (including disabled people). Four basic interface systems should be studied: vehicle, bus stop, accesses (footpath network), information systems and interchange points.

The vehicle should be a low floor type. The internal design should guarantee adequate space for more than one wheelchair. One other aspect, which is becoming evident, is that the wheelchair users do not know how to manoeuvre inside the bus. The partnership could help a lot to train and improve the use of the bus by people in wheelchairs. Audible and visual information are two other items that must be included as part of information systems (in-trip information). Inductive loop should be installed and the visual information must obey the three precepts of information: visibility (see), legibility (read) and, clarity (understand). The contents of in-vehicle information should provide: actual bus stops' name, the next bus stop name, most popular destination points associated to each bus stop, including interchange points. The driver is a fundamental part of this interface, and, at this stage, it is redundant to reinforce the importance of disabilities awareness training. Most of them are very keen to help users if they were not pressured by service schedules. If operators consider the amount of responsibility they have while driving they could also understand that drivers are capable enough to judge when it is necessary to stop to help people with difficulties and adjust their time.

A full description of the vehicle design and bus service oriented and constructed within the community participation (in urban and rural environment) is described on Hackney Plus Bus Project, (Lynas and Tyler (1998)) and Cumbria Plus Bus Project (Brown and Tyler, (1999)), respectively.

Improved low floor vehicle type will do no good if passengers cannot get on and off the bus. A detail study of the bus stop environment needs to be applied to design the area safely, comfortably and without interfering with pedestrian and traffic flows. In order to follow the recommendations of the European Community, in relation to the horizontal and vertical gap between the kerb and the floor of the bus, the kerb must be raised. Raised the kerb will affect the crossfall of the platform and the drainage system. A detail study and a compromised solution to please users and follow engineering restrictions will be necessary. Bus shelter is another important component of stops and interchange environment, as it is the area where disabled and elderly people comfortably and safely wait for the bus. Its layout is extremely important. Special attention on its location and shape should be paid in order to accommodate wheelchair users and to give visual impairment people direct and standard access on and off the bus. Other important issue of the bus stop design in the interface between the platform and the vehicle. Drivers need to park vehicles close and parallel to the kerb. This sometimes is not possible due to illegal parking, an issue that needs being addressed. A guidance system should be specifically designed according different bus stop layouts to help drivers to achieve the correct position to the bus stop. The EXCALIBUR project describes in detail several elements that compound different bus stop layouts. See Caiaffa & Tyler (1999) and Tyler & Caiaffa (1999a).

Vehicle and bus stop environment still will not help if the user cannot reach the bus stop. A footpath network needs to be adopted in terms of infrastructure and information signs. The aim here is to promote full access free of obstacles - the perspective of having access to the whole journey chain begins with information. If the system is not capable to cope with the needs of users in other words if the system acts as barriers to them (bad design, lack of contact with the community expectations) it should at least be able to point clearly, which and where these barriers are located. Provide and inform existent alternatives or have a very clear plan to produce reasonable alternatives (worked out close to the community expectations) is responsibility of the local authorities and members of the community and constitute the very first steps of the re-inclusion process.

The network is other but more complicated element. If one considers that the road and rail infrastructures are fixed and interchange points will not be altered, the only part that can be changed in an integrated approach is the bus network system. Bus services with high frequency, oriented to integrate with other modes and inject people on the main stream system could be the aim of an integrated approach in transport.

5 CONCLUSIONS

Transport is only one element of many in any policy aimed at reducing the effects of social exclusion. There is a need of a cross-sector and a cross-agency approach involving health, employment and housing organisations as well as transport bodies, local authorities and, crucially, the affected local communities.

Traditional methods to look at bus systems were focused in a traffic-oriented approach. Basically the core of the problem was to study the impact on traffic flows. A step forward was introduced within the concept of bus priority lanes.

The Disability Act (1995) introduced in the UK a new way to look at the same problem. It changed dramatically the centre of the question from the traffic impacts and performance of operators to the satisfaction of all users.

The integrated approach is based on a set of compromises. It involves people, their needs, restrictions, and conflicting points of view, discussions, decisions and partnership.

Integrating land use planning and transport decision-making has been the core of the UK Government policy for several years, in the quest of achieving a more sustainable pattern of development and reducing the growth in car use/dependency. The promotion of major developments within public transport corridors and other areas where good public transport exists or can be provided have occupied a central place in recent policy statements.

The Best Value concept, recently introduced by the UK government (DETR, (1999a)) indicates that the local plan process demands its own target and indicators against which local authorities performance will be assessed. In a recent Audit Commission, it was pointed new indicators: cost per passenger km of subsided bus services; local bus service vehicle per year; local bus service passenger journeys per year; percentage of users satisfied with local provision of public transport information; and percentage of users satisfied with local bus service.

But some issues may arise: are corridors' proposals being developed in ways which will reduce car dependency and overall traffic levels? Are they being developed with a high level of local service provision? Are they involving the community affected? Are the local authorities able to obtain the additional data to measure performance? Do they know how to measure users' satisfaction?

Within the academic arena there are many studies in development pointing to other directions. There is a group who suggests that services to deprived areas should be improved - perhaps through subsidies - may be more effective than traditional approaches to overcoming social exclusion based around providing more infrastructure, usually roads. The Woman Network Group believes that better infrastructure does not automatically solve exclusion problems. There is also a need to look at different requirements of various excluded groups. Current transport patterns, for instance, do not take enough account of women's circumstances. Hurdle (1999) underlines in his study about accessibility in East London that the needs of disabled people are still at the bottom of the pile. And finally Tyler (1999b) in his recent work introduces the concept of the "Journey Chain Independence" - a revision of the current thresholds of the transport system elements in order to minimise barriers. The idea is an understanding of the limits and a better design can include more and more people that will take the public transport independently.

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Formulation of policy for transportation of Special Needs Passengers

J. Stanbury
GIBB Africa (Pty) Limited, Cape Town, South Africa

J.S. Hugo
Cape Metropolitan Council, Cape Town, South Africa

ABSTRACT: South African institutional policies require that the transportation requirements of persons with disabilities should be addressed. The Cape Metropolitan Council accordingly undertook a study to determine the requirements of disabled passengers (Special Needs Passengers, SNPs), through a literary survey and consultation with SNPs. It was found that SNPs could be categorised in four different groups by their travel characteristics and type of improvements that they would require. The policies formulated included representation of SNPs on a statutory transport advisory board, establishment of a multi-disciplinary intersectoral liaison body, the formulation of a programme to make all transport facilities accessible to SNPs and a campaign to raise awareness of the requirements of SNPs.

1. INTRODUCTION

The public transport system operating within the Cape Metropolitan Area (CMA) serves a population of 2.5 million people (1996). It comprises commuter trains, buses and 16-seater mini-bus taxi vehicles. Although institutional policies state that the transportation requirements of Special Needs Passengers (SNPs) should be addressed, little, if any, provision is made for them in practice. The Cape Metropolitan Council (CMC) acknowledged this responsibility and commissioned a study to determine the needs of these passengers and adopted policies to fulfil these needs.

2. DEFINITION OF SNPs

Many definitions have been used to describe who is mobility disadvantaged. The South African National Department of Transport's definition (Department of Transport, 1998. Moving South Africa: Towards a Transport Strategy for 2020, Report and Strategic Recommendations) which groups passengers into one or more of three categories was accepted for the study, namely:

- *Life Cycle Passengers*: including children between 5 and 14 years old, people with health conditions, pregnant women and the elderly (aged 65 and above).
- *Impairment Passengers*: any customer with physical, sensory, or cognitive impairment, including full or partial impairments in motor functions, sight, hearing, speech, mental or intellectual capabilities, and short people.
- *Signage Passengers*: including people who are not literate and foreigners who are unable to read transport signs and notices and who require non-verbal forms of communication.

3. PREVALENCE OF SNPs

It is estimated that there are at least 700 000 SNPs within the CMA (Statistics South Africa, 1998. Selected data from Census 96), which represents almost 28% of the area's total population. Of these passengers, approximately 100 000 (3.9% of the population) are passengers with disabilities such as a serious sight, hearing, physical or mental impairment.

4. CONSULTATION

To establish the transportation needs of these passengers, interviews were held with 156 individuals with disabilities who spoke about their requirements, problems that they have experienced with trains, buses and mini-bus taxis and suggestions for improving the services. These interviews were arranged with the assistance of ten of the non-governmental organisations providing services for persons with disabilities within the CMA. Questionnaires were also available for completion in response to a newspaper advertisement that was published over a series of weeks.

4.1 *Transportation needs*

Some of the "needs" of the individuals, as expressed in their own words, are reproduced below:

"To be independent, not rely on our families or social services organisations for transport"

"Need to know that there are people around who can help"

"Freedom of movement"

"To be at ease"

"To retain dignity when using public transport"

These needs are best summarised by quoting from the National White Paper (Office of the Deputy President of the Republic of South Africa, 1997. White Paper on Integrated National Disability Strategy), which states that *"People with disabilities should be able to travel, regardless of the purpose of the journey"*.

4.2 *Problems using existing systems*

Many problems were encountered by SNPs whilst using the existing transport systems. Some examples, again given in the person's own words, are recorded below:

4.2.1 *Problems encountered getting to the point of access*

"Distance to the stop is too far."

"Pavements are uneven and have insufficient ramps or dropped kerbs"

"Cars parked on kerbs and pavements and street hawkers block pavements."

4.2.2 *Problems encountered using trains*

"Identifying which train to get on to"

"Too many steps when having to get from one platform to another."

"Knowing which station to get off at and when you reach the particular station."

"Train does not stop in the same place consistently."

"Doors close too quickly – not enough time to get on and off."

"Used to be conductors announcing the routes, stations – whether it was an express or not."

"Need poles on the inside of the train to pull myself up with."

4.2.3 *Problems encountered using buses*

"Problem communicating with the drivers."

"How to find the stop on the pavement?"

"Cannot see the approaching bus, and then I hail it too late for it to stop."

"Steps of the bus are too high."

"Need time to get on and off the bus."

"Driver does not wait for you to take your seat properly before moving on."

"Cannot reach the bell to tell the driver to stop."

"Need the driver to take out the money for the ticket."

4.2.4 *Problems encountered using minibus taxis*

"Problem is knowing where the taxi is going – no-one can sign to tell me."

"Do not wait when they see you coming – and when they see that you are disabled – they just drive away."

"Too rough – driver has no patience."

"People push and are not prepared to wait even though you are disabled – they get impatient."

"No place for the wheelchair in the taxi."

5. FRAMEWORK FOR IMPROVEMENTS

5.1 *Identification of passenger groups*

Based upon the information gathered from the interviews and a literature search of how other countries are improving transport for their passengers, a generalised framework for improvements to the transport system was developed. The framework, given in Table 1 on the following page, defines four different groups of SNPs by their travel characteristics and the type of improvements that they would require. It also gives a proposed timeframe for implementation of the improvements.

5.2 *Types of improvements required*

Four different types of improvements have been identified as being necessary to make the existing transport system accessible to SNPs.

5.2.1 *Type 1 Improvements: General improvements*

General improvements are required to all components of the public transport system to make them more accessible to SNPs who can currently use the existing system to a limited degree. Most of these improvements can be considered as part of an overall process to raise the standard of service provided to all passengers.

The height difference between the floor of buses and taxis and the footpath can be reduced by a combination of peninsular stops (raised if necessary) and reduced step heights. Additional handrails and grab rails can be fixed both at the doors and within the bus to provide support when moving along the aisle. A system of priority seating can be introduced with the seats nearest the doors available to passengers with special needs. The position of bell pushes to make the driver aware that a passenger wishes to alight can be positioned so that it can be reached easily.

5.2.2 *Type 2 Improvements: Better passenger / system interfaces*

Better passenger / system interfaces are required to make the transport system easier to navigate for passengers who are physically able to use it, but hindered by lack of information.

Specific passengers who experience such problems are those with a visual or hearing impairment, mild intellectual or mental impairment and signage passengers.

A detailed report on improving bus accessibility for persons with sensory and cognitive impairments has been published by the US Department of Transportation (United States Department of Transportation, 1993. Improving Bus Accessibility Systems for Persons with Sensory and Cognitive Impairments). The report identifies two areas of major concern for persons with hearing impairments. These are receiving information necessary to make a trip and hearing announcements about the service over a PA system.

Facilities to communicate by approximate modes should be available at key locations throughout the transport system and some staff at major interchanges should be familiar with basic sign language. For assistance in accessing the correct vehicle, visual signs with clearly written instructions and displays of announcements are useful.

The report identifies that there are three areas of major difficulty for persons with visual impairments. These are receiving information, locating and using devices associated with a trip and the physical movements through the system. The report suggests that orientation and mobility training can be used to assist the passenger. Some organisations within the CMA provide this service and these should be supported. Information provided by operators should be easily available and of appropriate nature, e.g. large print, high contrast written information, Braille materials, tactile maps and audio cassette information.

A simple solution to enable visually impaired passengers to hail the correct bus or minibus taxi is to use a "bus identifier kit" where a rider displays a large, hand-held sign showing the route number of the service they with to use. For its use in Cape Town, all bus and taxi routes would require to be numbered and these numbers should be clearly displayed on the vehicles together with the destination of the route.

A further improvement that would assist persons with sight impairments is to provide audible traffic signals as a standard feature at signalised intersections and pedestrian crossings. Such signals have been used to a limited degree in South Africa and reported to be successful. Large push buttons should also be standard for all pedestrian calls at signals.

Payment of fares by electronic "smart cards" would assist passengers. Such a system has recently been introduced for minibus taxis elsewhere in the country.

5.2.3 *Type 3 Improvements: Major improvements and special features*

Major improvement and special features are required to make the public transport system accessible to severely physically impaired passengers. Road based vehicles require to be provided with ramps or lifts for wheelchairs and spaces provided within for them so that they can be securely fastened to prevent movement. Similar features are required in trains. However, in addition to improving the rolling stock, access to the platforms is also required. Currently, access to many platforms is via stairs from an over rail bridge.

5.2.4 *Type 4 Improvements: Door-to-door Special Transport Services*

Some SNPs, due to the nature of their impairment, will need assistance to use any mode of transport if travelling alone.

In such circumstances, a Special Transport Service that provides a kerb-to-kerb service, is required. These services are already operated by some service organisations within the CMA. Also, a CMC project to demonstrate its use is currently being operated on a limited scale within the CMA and is proving to be successful.

6. CMC ACKNOWLEDGES RESPONSIBILITY

The CMC acknowledged that it had a statutory duty to provide public facilities and services for people with disabilities, which includes public transport. Not only does the South African Constitution prohibit discrimination on the grounds of disability but the success of other government policies to integrate people with disabilities into the society will also depend upon provision of transport.

Table 1 : Proposed generalised framework for improvements to the infrastructure and transport system

Four groups of Special Needs Passengers:	With the following travel characteristics:	Who require different types of improvements to public transport and infrastructure:	These improvements benefit the following groups:	And could be implemented in the following timeframe:
Group A Aged passengers (65+) Young passengers (5-14) Short persons Pregnant Women Less severe physical impairments Accompanied persons with severe intellectual or mental impairments	who can use the existing transport system to a limited degree	*Type 1* General improvements to vehicles and infrastructure (eg more grab rails, reduced differences in level)	Passengers in Group A and all other general users of the system	Buildings: All new facilities should be planned to be accessible and, if identified key facility within the transport network, should be constructed so. Programme to make existing key facilities accessible should also be prepared, taking into account the relative importance of the location to Special Needs Passengers and when the facility is due for renovation. New and Rehabilitated Vehicles & Carriages: On a continuous basis after a published future date
Group B Sight/Hearing impaired Persons Persons with less severe intellectual or mental impairments Signage passengers	who can use the existing transport system to a limited degree	*Type 2* Better passenger/system interfaces (eg staff training and co-operation, audible-visual announcement systems)	Passengers in Groups A and B and all other general users of the system	Should be on-going
Group C Severe physical impairments but who can travel on their own or with assistance from another person	generally cannot use the existing transport system because it is inaccessible but could do so if it became accessible	*Type 3* Require major improvements and special features to vehicles and infrastructure (eg ramps/lifts and dedicated spaces for wheelchairs or storage) and/or Special Transport Service	Passengers in Groups A, B and C	To be in accordance with a timetable and schedule to be incorporated as part of the regulation and concessioning of public transport
Group D Unaccompanied persons with severe physical impairments Unaccompanied persons with severe intellectual or mental impairments	who need assistance to use any mode of transport but are travelling alone	*Type 4* Require an improved and expanded door-to-door Special Transport Service which is a combination of public intersectoral government and service organisation transport	Passengers in Group C who need assistance to travel but are alone and passengers in Group D	Special Transport Services already exist (eg service organisations, special school transport fleets and CMC Dial-a-Ride). Needs support to function more effectively.

Apart from the obvious financial constraints, there were also certain statutory and policy aspects that impeded or prevented effective and immediate implementation of the adopted policy to proceed with the provision of transport for disabled persons. One of these was the lack of any local level policies. A second was that due to the fragmented nature of the responsibility for transport across the 3 spheres of government in South Africa, the CMC could only carry out planning for road based public transport and influence the standards to which transport interchanges and on-street boarding and alighting facilities are constructed. Importantly, the subsidised bus services and rail commuter service are controlled by other authorities.

7. CMC DECISIONS

In spite of the abovementioned difficulties that had to be considered when making the decision to proceed with the provision of public transport services for SNPs, the CMC adopted the policy principles listed below. Some relate to matters for which it already had the responsibility, while the responsibility for operational aspects still resided with other authorities:

7.1 Representation of SNPs on the local statutory transport advisory board.

7.2 Establishment of a multi-disciplinary intersectoral committee to liaise with the community with disabilities and provide advice to local government departments.

7.3 All new transport facilities to be planned to be accessible and, if it is an identified key facility, to be constructed so.

7.4 Formulation of a programme for making existing key facilities accessible.

7.5 Raise awareness of authorities and service providers to the requirements of SNPs.

7.6 Support existing transport services operated by non-governmental organisations.

8. FUTURE TRANSPORT OPERATIONS

While the CMC does not presently have responsibility for the actual provision of public transport services, it is anticipated that this may change in future, in which case the following policy principles will be applied:

8.1 Accessible transport to be a combination of primary and secondary systems together with a Special Transport Service provided by public service operators and non-governmental organisations.

8.2 Accessibility standards for new road vehicles and rail coaches to be formulated and incorporated within specifications for new services.

9. CONCLUSION

The study highlighted the transport requirements of SNPs, and proposed a framework for improvements to the existing systems. By accepting relevant policy proposals and initiating actions to incorporate these into the transport implementation plan, steps are being taken towards providing accessible transport within the metropolitan area.

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Accessibility and mobility in Cairo: The challenge of public transportation

Accessibilité et mobilité au Caire: le challenge du transport public

C. Barge
CEDEJ-CNRS, Le Caire, Egypt and Université de Reims, France

M. Chesnais
GEOSYSCOM, Université de Caen, France

ABSTRACT. The evolution of accessibility and mobility in Cairo is analysed by two steps : first the potential with regard to accessibility, that is the city's capacity to ease interactions, and second, the actual practices of accessibility, that is the ways in which the population uses this capacity. From the analysis of rich and original data drawn from maps and statistics that allows to compare the development of the different public transportation networks in the period 1987-1998, and since the early 1970s for a number of specific public transportation means.

RÉSUMÉ. L'évolution de l'accessibilité et de la mobilité est analysée en deux temps, d'une part l'évaluation du potentiel d'accessibilité en regard de l'offre, d'autre part la manière dont les usagers exploitent ces capacités. A partir de données originales, traitées statistiquement et cartographiquement le développement du transport public est caractérisé particulièrement au long de la période 1987-1998, mais aussi depuis la mise en œuvre des premiers moyens publics dans les années 70.

1. LE CAIRE, UNE DES VILLES LES PLUS DENSES AU MONDE

1.1. Profonds bouleversements et étalement urbain

Le Caire est sans conteste l'une des plus grandes métropoles d'Afrique et du Moyen Orient. A l'aube du XXIième siècle, elle compte près de 11 millions d'habitants. Le recensement de 1996 confirme un tassement de la croissance démographique amorcé lors des deux décennies antérieures. Le taux de croissance de la région est passé de 3 % pour la période 1976-1986 à 1.9 % pour la dernière décennie. Alors la région du Grand Caire a gagné 228 000 habitants par an contre 277 000 entre 1976 et 1986 et 188 000 entre 1976 et 1966. Désormais, l'essor de la ville n'est plus, pour l'essentiel, que le produit d'un croît démographique, lui-même fléchissant*.

Si «l'explosion » n'est plus à l'ordre du jour, de profonds bouleversements amorcent une nouvelle configuration urbaine. On observe en effet des processus de redistribution et d'étalement urbain. La surface bâtie de l'agglomération du Caire a presque doublé en 10 ans. Cette extension de l'agglomération du Caire relève de plusieurs processus. En premier lieu, on observe un étalement « classique » avec une diffusion de l'urbanisation en périphérie des quartiers déjà agglomérés. Il s'agit du lotissement de terres agricoles ou désertiques en continuité du bâti existant. L'analyse des cartes satellites montre qu'entre 1986 et 1994, l'agglomération s'est ainsi accrue de prés de 6 000 hectares. Cette extension en continuité de l'agglomération est principalement localisée sur la rive gauche du Nil, entre Giza et Imbaba et au nord ouest dans le gouvernorat de Qalyubiyya**. Ce phénomène se traduit également par l'intégration, avec la progression des constructions, de villages déjà existants. Cet encapsulage des villages est surtout visible dans le gouvernorat de Giza. 737.3 ha de village ont ainsi été intégrés entre 1986 et 1994. La création en 1996 d'un nouveau qism, réunissant notamment les villages de Bashtil, Waraq al-Arab ou encore Waraq al-Hadr, est révélateur de ce phénomène. Déjà, agglomérés en 1986, ils ont maintenant un statut urbain officiel.

Ces nouveaux espaces urbanisés correspondent également en partie aux villes nouvelles et aux New Settlement construits à la périphérie, plus ou moins proche, du Caire. Si les extensions physiques de ces nouveaux espaces sont statistiquement difficilement calculables, les observations régulières sur le terrain ne laissent aucun doute sur leur croissance. Au dé-

* DENIS E. 1998. « Le Caire et l'Egypte à l'orée du XXIe siècle. Une métropole stabilisée dans un contexte de redéploiement de la croissance. », *in Lettre d'information de L'OUCC*, n° 48, juin, pp. 4-17.

** CHESNAIS M. 1998. « Evaluation de la croissance urbaine du Caire par télédétection », *in Revue de Géographie de Lyon*, Vol 73, mars, pp. 259-266.

part, la ville du *Six Octobre* s'étendait sur environ 30 km² ; elle couvre aujourd'hui prés de 360 km², dont certes seulement 60 sont lotis, mais ce qui laisse augurer de l'ampleur de sa croissance. On observe des processus semblables à l'est autour des New-Settlements n° 1, 2 et 3, du quartier de New Cairo.

1.2. Redistribution de la population

Cet étalement s'accompagne d'un mouvement de redistribution centrifuge de la population. Le centre se dédensifie au profit des périphéries de l'agglomération, aussi bien celles déjà existantes, par effet de densification, que celles nouvellement créées, par effet de diffusion. Le plus fort taux de croissance de la région est désormais celui des quartiers périphériques planifiés et des villes nouvelles, qui enregistrent 7 % de croissance annuelle. Cela correspond à un doublement de population en 10 ans. La population de la ville du *Six Octobre* est ainsi passée de 527 en 1986 à près de 36 000 h/km² en 1996. A l'est, en bordure du plateau désertique les 2 qisms de Madinat Nasr affichent les plus forts taux avec près de 11 % par an depuis 10 ans. A l'inverse, l'hémorragie de population s'est accélérée dans les quartiers du vieux centre ancien. A Gamaliyya, Muski ou encore Bulaq, les pertes annuelles dépassent 4 %.

Ces processus d'étalement et d'extension de l'agglomération du Caire contribuent à redéfinir les besoins de mobilité des habitants, les flux et les types de flux des habitants, à la fois au départ de ces zones vers le « centre », mais également du « centre » vers ces zones. Cela se traduit à la fois par un allongement des distances et des temps de déplacement, une modification des trajets et des modes utilisés. La mobilité « se déforme dans ses dimensions spatiales, temporelles, modales, et le territoire du quotidien ne coïncide plus strictement avec celui de « la » ville »*.

Dans le même temps, cette redistribution de la population s'accompagne de bouleversements des structures familiales. Ces redistributions entraînent en effet des processus d'éclatement, de dispersion dans l'espace des familles élargies. Une nouvelle géographie des liens sociaux se dessine, fondée notamment sur l'importance et la pérennité des réseaux de solidarité familiale. Le vieillissement du centre ville se poursuit, et de plus en plus de jeunes ménages s'installent en périphérie. Ainsi à l'échelle de l'agglomération des recompositions spatiales et sociales émergent redéfinissant les besoins globaux de mobilité. Les nouveaux flux de déplacement nécessitent la création ou le renforcement des liens existants entre les espaces, mais aussi peut-être une modification de l'offre.

1.3. Ville dense, territoire relativement restreint

Si les densités s'homogénéisent, le Caire, avec 217 h/ ha en 1996, demeure une des villes parmi les plus denses du monde, avec Bombay, Jakarta et quelques grandes villes asiatiques. Si la ville s'étend, Le Caire révèle des configurations très spécifiques, où les phénomènes d'étalement restent encore marginaux. Nous sommes loin ici des dynamiques observées dans les grandes métropoles africaines ou sud-américaines, où la croissance du bâti procède de phénomènes extensifs. Les distances au Caire entre zones centrales et périphéries sont relativement faibles. Les quartiers informels d'Imbaba ou de Bulaq al-Dakrur, par exemple, sont à moins de 3 km du centre fonctionnel. Ainsi, les faibles distances maximisent a priori les possibilités d'interrelations entre les différents lieux de l'agglomération. Ces fortes densités renvoient à des métriques et des besoins de déplacement particuliers. Un espace dense n'implique en effet pas les mêmes utilisations et modalités de gestion qu'un espace où l'urbanisation est lâche. L'équipement de ce type de quartier est d'un coût incomparablement plus faible que celui d'espace à l'urbanisation peu dense et sans bâti élévé. « La densité urbaine est une caractéristique globalement bénéfique car elle garantit aux moindres coûts (économique, environnementaux), et pour le plus grand nombre, les échanges que la ville est censée offrir et symboliser »**. La ville dense autorise les déplacements à pied et rentabilise à priori les réseaux de transports collectifs. Au regard de la configuration spécifique du Caire et des profonds bouleversements qui ont affecté l'agglomération, tant dans son espace que dans son organisation sociale, il a semblé intéressant d'aborder cette ville au travers de son offre de transport. Il s'agit au fond de comprendre comment la politique de transport public s'est inscrite dans la ville durant la dernière décennie.

2. L'ENJEU DES TRANSPORTS

2.1. Ville en développement et enjeu des TC

Les transports en commun sont une nécessité pour les villes du monde entier, car ils sont les seuls à assurer une possibilité d'accès à tous, mais dans les pays en développement ils constituent un enjeu particulier. En effet, en raison des niveaux de vie et d'équipement moins élevés, les captifs des transports en commun y constituent une part importante de la population. Le cas de Hong Kong peut faire figure de "modèle" avec 90 % des 10 millions de déplace-

* ORFEUIL J.-P. 1996. « Urbain et périurbain : qui va où ? », *in Urbanisme*, n° 289, juil-août, pp. 52-57.

** EGAL Y.1994. « Des effets positifs de la densité urbaine », *in Transports Urbains*, n° 83, avril-juin, pp. 27-31.

*** OCDE.1988. *Les villes et leurs transports : Athènes, Goteborg, Hong Kong, Londres, Los Angeles, Munich, New York, Osaka, Paris, Singapour*, OCDE, Paris, 221 p.

ments quotidiens assurés par les transports en commun†. Au Caire, ils assurent prés de 50 % des 14 millions de déplacements quotidiens. Ils représentent ainsi – considérant la part importante des déplacements piétonniers, soit 36 % – le premier mode de déplacement cairote. Si l'on ne prend en compte que les seuls déplacements motorisés, leur part s'élève à 73 % (contre 20 % pour l'automobile).

1. Répartition modale des déplacements (tous modes) en 1998

Marche	Modes mécanisés					
	Bus	Metro	Shared Taxi	Aut.TP	Taxi	Aut.
36%	12%	11%	18%	6%	4%	13%

2. Répartition modale des seuls déplacements motorisés -1998

Shared Taxi	Bus CTA	Metro	Autres TP	Taxi	Auto-mobile	Deux-roues
28%	19%	17%	8%	6%	20%	1%

Source : Enquêtes ménages, Systra/DRPTC, décembre1998.

Les transports en commun jouent ainsi un rôle prépondérant. Cela s'explique en partie par la faiblesse des taux de motorisation. On compte au Caire, en 1998, 4,6 voitures pour 100 habitants ou encore 0,2 voitures par ménage. L'essentiel des ménages cairotes ne dispose pas de moyen de transport individuel et est donc captif des transports en commun. Plus de 80 % d'entre eux ne sont pas motorisés. Le faible taux d'équipement en automobile s'explique en grande partie par le faible pouvoir d'achat des ménages. Plus de 50 % de la population sont en dessous du seuil de pauvreté et ne disposent donc pas du capital nécessaire à l'achat d'une automobile.

Parmi les transports en commun publics, le service des autobus est le plus important, par l'étendue de son réseau et par son rôle dans les déplacements quotidiens. Si sa part dans le transport des passagers diminue entre 1987 et 1998, il demeure toujours le premier mode de déplacement des cairotes.

3. Part et évolution des passagers du secteur public

Mode	Bus CTA	Mini-bus	Tram way	Métro Héliopolis	Bus Nil	Métro
1987	78.3%	5.8%	8%	7.3%	0.6%	
1998	50.5%	8.8%	1.%.	1.9%	0.1%	37.8%

Source : Barge Célame, 1998. (Données tirées des rapports statistiques annuels du CTA, 1987 et 1998)

Ainsi, sans minimiser l'importance des autres modes de transport public, et notamment du métro, l'offre de transport en commun au travers du réseau des autobus du Caire retient d'abord l'attention. Ce service, géré par le CTA (Cairo Transport Authority), se compose de deux types de ligne : les lignes des « bus rouge » directement sous l'autorité du CTA et les lignes des « bus bleus » gérés par le GCBC (Greater Cairo Bus Company), qui est lui-même supervisé par le CTA. Il n'y a pas réellement de différences entre ces deux types au niveau du service proposé. Cependant, leurs tarifs sont légèrement différents et les bus bleus opèrent généralement sur des distances plus importantes. Depuis 1996, le CTA a de plus mis en place de nouveaux types de lignes.

2.2. *Accès à la ville*

La ville, comme espace quotidien, implique une inter-accessibilité suffisante entre les différents lieux qui la composent, et ce, non seulement pour les relations domicile/travail, mais aussi pour les autres mobilités quotidiennes commerce, loisirs, relations interindividuelles. « Une masse de population enclavée, cloisonnée, pratiquant des activités peu variées sera certainement moins urbaine que la même population se mouvant dans un espace intégré, complexe et mixte »*. On peut ainsi parler d'un véritable droit au transport, au même titre que le droit au travail, le droit à l'école, le droit au logement ou encore le droit aux vacances. Les transports peuvent ainsi, par leur organisation, leur financement, leur adéquation aux besoins, constituer un facteur aggravant l'exclusion ou au contraire favoriser l'intégration du tissu social et urbain. Enclavés, isolés, certains quartiers sont à l'écart du mouvement urbain. Daniel BEHAR parle de "relégation géographique", comme traduction spatiale de l'exclusion sociale. « Ce qui produit la relégation, c'est la rupture entre ce qui se passe dans un quartier et au niveau de l'agglomération »†. Quand il y a rupture du lien spatial, il y a production de déséquilibres et d'inégalités. L'analyse des réseaux de transport prend alors toute son importance, et c'est en ce sens qu'elle aide à la compréhension du phénomène urbain dans son ensemble.

3. ANALYSE DU RESEAU DE BUS EN 1987 ET EN 1998

3.1. *Les dynamiques : une offre croissante*

Entre 1987 et 1998, l'offre de transport par autobus s'est sensiblement améliorée, tant sur le plan quantitatif que qualitatif. En premier lieu, on observe une nette croissance du nombre de lignes : de 325 à 412. Cette augmentation s'accompagne de plus de l'accroissement du parc de véhicule. On dénombre ainsi 2416 bus en service par jour en 1998, contre 1597 en 1987. Cela se traduit dans les faits par la croissance, bien que faible, du nombre moyen de bus affectés quotidiennement par ligne.

* LEVY J. 1995. « Paris métropolitain, réseaux et territoires de l'espace parisien », *in* P. LERESCHE, (dir.), *Métropolisation : Interdépendances mondiales et implications lémaniques*, Ed. Georg, coll. LUG, Genève, pp. 58-73

** BEHAR D.1993., *in Déplacements et liens sociaux*, Ministère de l'équipement, des transports et du tourisme, Actes du séminaire n° 14, Oct. 92-Juil. 93, 294 p.

Le CTA a fortement investi dans l'acquisition de matériels neufs et ainsi renouvelé une partie de son parc de véhicules. On peut noter l'acquisition notamment de 22 bus climatisés. La mise en service de véhicules neufs traduit directement une amélioration qualitative. En effet, un des problèmes majeurs de ce mode de transport résidait – et réside toujours en partie – dans la vétusté des véhicules (perte d'efficacité et donc manque de compétitivité face aux autres modes). Un autobus en panne au milieu de la rue, moteur éclaté, vision quasi quotidienne pour qui réside au Caire. Mais la part des bus circulant – par rapport au parc disponible – est en nette croissance. Le service devient plus productif.

Concernant la qualité de fonctionnement, les évolutions semblent plus contrastées. Les temps d'attente augmentent en moyenne sensiblement et les fréquences diminuent globalement. Cependant, on constate une réduction des écarts, entre les valeurs les plus faibles et les valeurs les plus élevées, pour ces deux indicateurs. Ainsi, on peut parler d'une relative homogénéisation des temps d'attente avec une baisse des maxima. Le même constat résulte de l'analyse des fréquences. Si la fréquence moyenne diminue, on observe une augmentation des minima. On assiste ainsi à une amélioration par le bas, qui bien que moins lisible, marque une réelle volonté d'amélioration globale du niveau du service proposé. Cela traduit également les efforts réalisés par la compagnie sur les lignes les moins compétitives. Elles ont été supprimées dans certains cas et renforcées par l'affectation de véhicules supplémentaires dans d'autres. Parallèlement, les nouvelles lignes mises en place sont plus compétitives. Avec une fréquence moyenne de 72 trajets (aller-retour) par jour, le service des bus longue distance offre les temps d'attente les plus faibles, inférieur en moyenne à ceux de 1987.

Ces quelques indicateurs soulignent les efforts entrepris par la compagnie des bus pour développer et améliorer le niveau d'offre publique de transport.

Le CTA a de plus développé de nouveaux types de services. La mise en place de 3 lignes de bus climatisées est l'expression directe d'une volonté d'amélioration de la qualité du transport, et s'inscrit dans un effort de revalorisation de ce mode. Les tarifs sont plus élevés que sur les lignes « classiques », mais en contrepartie seuls les passagers debout sont admis.

On peut noter également, la mise en place et le développement durant cette période d'un service de minibus (création en 1985). Ces véhicules ne proposaient, au départ, qu'un « service assis », de meilleure qualité. Mais, aux passagers assis sont très vite venus s'ajouter les passagers debout, et maintenant surchargés, ils ne sont qu'une réplique en miniature des autobus bondés aux heures de pointe. Au regard des trajets effectués, il apparaît nettement que la fonction des minibus est d'appuyer le service des bus réguliers en opérant sur les mêmes lignes et non pas dans des secteurs mal desservis. Les minibus en captant une partie des passagers du service des autobus ont ainsi contribué à l'amélioration des conditions de transport. Les taux d'occupation ont ainsi très sensiblement diminué entre 1987 et 1998. La mise en place de deux lignes de métro durant cette décennie a également joué un rôle très important.

3.2. Diffusion et déconcentration

De manière globale, le service d'autobus du Caire s'est amélioré, même si certains problèmes majeurs demeurent. Les transports en commun au Caire, étant considérés par les autorités comme un enjeu stratégique et sécuritaire, aucune donnée spatiale n'est disponible. Public et chercheurs ne disposent pas de plans du réseau. Depuis quelques années, on trouve, parfois, un descriptif succinct des trajets au niveau de certains arrêts, mais le plus souvent ce n'est qu'une liste de numéros, sans sens pour le novice. L'information se transmet essentiellement oralement, soit par le biais d'usagers, amis ou parents, soit, aux stations principales par l'intermédiaire d'un agent chargé d'aiguiller les passagers en fonction de leur destination. Pour notre étude, afin de pouvoir comparer le réseau de bus en 1987 et en 1998 et montrer les types d'évolution, nous avons entrepris la cartographie des lignes de bus du Caire à ces deux dates. Ce travail fut indispensable à la compréhension des évolutions qui marquent le réseau durant cette décennie.

4. LES FLUX DE PASSAGERS : 1987 ET 1998

4.1. Réseau des bus et extension spatiale de l'agglomération : phénomène de diffusion

Nous l'avons vu plus haut, la surface bâtie du Grand Caire a presque doublé en 10 ans. Durant la même période, l'offre de transport par autobus s'est également sensiblement accrue. La longueur totale du réseau a été multipliée par 1,6 entre 1987 et 1998, soit une croissance de près de 65 % en 10 ans. Il s'agissait alors de voir si – dans quelle mesure et comment – l'offre de transport a accompagné l'extension de l'agglomération.

La cartographie de la croissance du nombre de ligne entre 1987 et 1998 montre très clairement une augmentation des liaisons en direction des périphéries et des nouvelles zones planifiées. Cette diffusion du réseau procède de plusieurs types d'évolution. En premier lieu, on observe de nombreux prolongements de lignes : 45 lignes, existantes en 1987, ont ainsi été prolongées vers des quartiers périphériques. Certains quartiers comme Munib au sud, ou encore Zaahra et Nuzha al-Gadida au nord-est, sont ainsi devenus d'importants pôles de transport. Par ailleurs, de nouvelles liaisons ont été mises en service. Elles concernent en premier lieu les nouvelles zones planifiées sur des terrains désertiques en marge de l'agglomération. Il s'agit d'espaces développés dans le cadre des schémas directeurs d'aménagement du Grand Caire et qui, pour la plupart, ont été mis en chantier depuis le milieu des années 1980. Ces zones affichent les plus forts taux de croissance démographique entre 1986 et 1996, signe de leur expansion. De plus, elles concentrent une part croissante d'activités, dirigeant ainsi une partie des migrations alternantes. Elles n'avaient cependant, jusqu'à présent, fait l'objet d'aucune politique en matière de transport public. La mise en place de liaisons par autobus marque ainsi une volonté nouvelle d'intégration de ces espaces au reste de l'agglomération. Ainsi, les villes nouvelles du *Six Octobre* et d'al-Ubur, la nouvelle communauté de Shuruq ou encore Suq al-Ubur sont à présent reliées à l'agglomération.

4. Types de liaisons

En nombre et %	1987	1987	1998	1998
Centre Périphérie	126	53	121	37
Périphérie-Périphérie	110	47	205	63
Total	236	100	326	100
Liaison passant par le centre	151	64	175	54
Liaison sans passer par le centre	85	36	151	46
Total	236	100	326	100

Source : Barge Célame, 1998.

De même, le réseau s'est très fortement étendu vers les villages en périphérie de la ville : 20 « villages » ont ainsi été reliés au centre. Certains d'entre eux font aujourd'hui partie intégrante de l'agglomération - dans le sens continuité du bâti.

L'extension physique de l'agglomération s'est ainsi accompagnée d'une politique de transport et donc de mise en place de liens entre les différents espaces qui composent aujourd'hui la ville du Caire. Ce processus de diffusion du réseau souligne les efforts entrepris par le CTA pour accompagner la croissance urbaine.

Cependant, les périphéries sont aussi les zones les plus faiblement reliées au reste de l'agglomération. En 1998, la plupart des quartiers et espaces périphériques sont desservis par moins de 10 lignes de bus. On y observe les plus faibles fréquences et les plus forts temps d'attente. Si des efforts notables ont été réalisés en direction de ces espaces, ils restent néanmoins encore mal desservis.

4.2. Organisation du réseau : phénomène de déconcentrations

Les phénomènes de diffusion observés plus haut sont de plus renforcés par des dynamiques de déconcentration du réseau. Le réseau des bus du Caire est très fortement organisé, en 1998 comme en 1987, par les places centrales. Elles polarisent l'essentiel des lignes de bus et organisent un réseau « classique » en forme d'étoile. En 1987, 78 % des lignes passent par les grandes places centrales ou secondaires du Caire. En 1998, la part diminue légèrement avec 71 %. Cependant, si le centre dirige toujours le réseau, l'analyse comparative montre plusieurs types d'évolution qui traduisent une « dépolarisation » du réseau de bus.

En premier lieu, on observe une redistribution des lignes transitant par les grandes places du Caire. La part des places centrales diminue au profit des places secondaires (en périphérie du centre). Ainsi, en 1998, 68 % de ces lignes transitent par les places centrales contre 80 % en 1987. En revanche, la part de celles qui transitent par les places secondaires augmente sensiblement, passant de 20 % à 32 % entre 1987 et 1998. Cette redistribution des lignes en périphérie s'inscrit dans une volonté de décongestion des grandes stations centrales et plus généralement des flux transitant par le centre ville. Les deux plus grandes gares de bus du Caire, Tahrîr et Ramsîs, ont de plus fait l'objet de réaménagements. La place Tahrîr a été entièrement débarrassée de ses stations de bus. Elles ont été déplacées sur la place attenante d'Abd al-Manheim Ryad. De plus, une partie des lignes ont été transférées vers la place Falaky. De même, la place Qulali a accueilli une partie des lignes de Ramsîs. Ces opérations visent à réduire le poids des stations centrales en terme de trafic par une meilleure répartition des lignes au centre ville.

5. Les places centrales

	1987		1998	
Place	Nb lignes	%	Nb lignes	%
Tharir	70	32	59	21
Ataba	42	19	46	16
Ramsis	29	13	28	10
Abbassiyya	23	10	46	16
Qala'a	15	7	14	5
Giza	10	5	17	6
Sayyiada Zaynab	10	5	19	7
Roxy	9	4	13	5
Opera	5	2	0	0
Lazughly	3	1	1	0
Munib	3	1	15	5
Falaky	1	0	19	7
Qulali	0	0	7	2

Source : Barge Célame, 1998.

Par ailleurs, on assiste à un renforcement des liaisons entre les périphéries, et principalement des liaisons directes, c'est à dire ne transitant pas par le centre ville. En 1987, 53 % des lignes sont de type centre-périphérie, contre 37 % en 1998. Les liaisons entre les périphéries constituent ainsi aujourd'hui l'essentiel du réseau. De plus, les liaisons directes (entre les périphéries) sont très nettement renforcées. En 1998, 46 % des lignes reliant les périphéries ne transitent pas le centre, contre 36 % en 1987.

Le renforcement des liens directs entre les périphéries s'inscrit dans un souci d'adaptation de l'offre à la demande. En effet, si le centre, principal pôle d'emploi, polarise une grande partie des mouvements pendulaires, les autres déplacements (non liés au travail) exigent le développement d'autres types de liens. Plus cohérents, les déplacements gagnent en qualité. Cette nouvelle organisation assure également une meilleure accessibilité entre les différents quartiers de l'agglomération. Le réseau y gagne en cohérence, la ville en compacité.

4.3. Les flux : du bus au métro

Le bus, nous l'avons vu, représentent le principal mode de déplacement des cairotes. Il prend en charge, en 1998, plus de la moitié des passagers transportés par le secteur public. Depuis dix ans, sa part a cependant très sensiblement diminué. Le nombre de passagers transportés quotidiennement est resté stable, aux alentours de 2,5 millions, alors que dans le même temps le nombre global des déplacements a très nettement augmenté.

L'analyse comparative des flux en 1987 et en 1998 met en avant l'apparition de nouveaux axes de déplacements en relation directe avec les lignes nouvellement créées. Les lignes en direction des périphéries, et notamment des nouvelles zones construites sur le désert accusent en effet les plus fortes croissances, en terme de flux. En revanche, sur les axes existants en 1987 et en 1998, on relève globalement peu de variations. Le centre draine toujours les plus importants flux de passagers. On peut noter cependant, en 1998, un net renforcement et un étalement des flux en direction de l'est et du nord-est de l'agglomération, vers les nouveaux espaces bâtis sur le désert. Ces flux traduisent la forte croissance de ces zones, en termes de population et d'activités ; croissance multipliant les besoins d'échanges avec la « ville centre ».

A l'opposé, certains axes ont perdu un nombre important de passagers. Ces axes correspondent pour certains aux tracés des deux nouvelles lignes de métro[*]. Apparaît ainsi un premier axe sud est-centre qui se superpose à la première ligne Hilwan-al-Marg et un second au nord, le long de la rue Shubra qui coïncide avec la deuxième ligne entre Shubra et Giza. On peut supposer que le métro a capté une partie importante des passagers utilisant traditionnellement le bus. Le métro est devenu le deuxième mode de transport public, avec près de 2 millions de passagers transportés par jour*[†]. Si dans le même temps, le nombre de déplacements quotidiens a considérablement augmenté, il est indéniable qu'on assiste à un transfert de passagers des autres modes de transport public vers le métro. Une analyse plus fine serait utile à la compréhension du fonctionnement global du réseau de transport public, et notamment du formidable potentiel que représente le métro.

CONCLUSION

Le réseau des autobus, durant la dernière décennie, s'est sans aucun doute amélioré, tant sur le plan quantitatif que qualitatif. Cependant, le bus reste un mode de transport peu compétitif. Les temps d'attente sont trop longs, les conditions de trajet difficiles… Les passagers ne s'y trompent pas. Ils lui préfèrent le microbus, mode de transport en commun semi-privé, beaucoup plus rapide, confortable et qui, plus souple, a su bien avant adapter son offre à la demande. Il prend en charge près de 30 % des 14 millions de déplacements quotidiens. Le challenge des transports en commun public se situe bien ici. Les solutions ne sont pas simples. Elles doivent s'inscrire dans une réflexion générale d'aménagement urbain. Et c'est ici justement qu'apparaissent de façon exacerbée les dysfonctionnements des villes des pays en développement en matière de transport. Les choix en matière d'accessibilité et de types de liaisons – priorité à l'automobile ou développement des transports en commun, réseau en étoile ou concentrique, intermodalité… – sont en effet déterminants. De ceux-ci dépendent l'intégration des nouvelles zones planifiées et surtout les conditions d'accès à l'ensemble urbain. Les politiques de planification s'appuient sur des modèles qui ne sont pas toujours adaptés aux besoins immédiats de la population ou aux réalités locales. En effet, les aménagements en cours visent à développer une ville au service de l'automobile (autoponts, ring road, parkings souterrains, tunnel d'al-Azhar, diminution des taxes…), alors que cette dernière reste encore un mode de déplacement secondaire. Les choix ne sont pas neutres. La volonté d'aménager se situe à une frontière difficile à définir entre les impératifs économiques de modernisation et les impératifs sociaux.

Ce n'est qu'au travers d'une réflexion globale, prenant en considération l'ensemble des paramètres affectant la mobilité, que les transports publics optimiseront les potentialités d'interactions et rendront par la même la ville plus urbaine. En ce sens, le métro ouvre sûrement la voie à une nouvelle manière d'envisager la ville.

[*] La première ligne fut mise en service à la fin de l'année 1987 et la seconde ligne entre 1996 et 1999 : un premier tronçon fin 1996 et un deuxième tronçon début 1999.

[†] 1,4 millions de passagers par jour pour la première ligne et environ 600 000 pour la deuxième.

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Mobilité motorisée et environnement urbain au Maroc: Le modèle générique et ses effets pervers

Ahmed Bencheikh
L'Institut National d'Aménagement et d'Urbanisme, Rabat, Maroc

ABSTRACT : The control and the management of the technical urban networks constitue the major skakes for moroccan towns the years to come. Collective services in the most important towns (Casablanca, Rabat-Salé, Fès and Marrakesh) and especially urban transports cannot avoid this new and difficult process.

Key-words: Morocco, motorised mobility, urban environment, towns, planification, prospective, management, urban and technical networks.

RÉSUMÉ: La maîtrise et la gestion des réseaux techniques urbains constituent des enjeux majeurs pour les villes marocaines dans les années à venir. En effet, les services collectifs dans les plus importantes agglomérations (Casablanca, Rabat-Salé, Fès et Marrakech) et plus particulièrement les transports urbains n'échappent pas à ce nouveau et difficile processus.

Mots-clés: Maroc, mobilité motorisée, environnement urbain, villes, planification, prospective, mode de gestion, réseaux techniques urbains.

Introduction :

Les perspectives sont aussi contradictoires que la réalité de l'urbanisation au Maroc est critique. Les dernières décennies furent pourtant fertiles en politiques urbaines plus ou moins volontaristes mais les observateurs avertis s'accordent pour reconnaître le déphasage entre les desseins politiques et différents projets d'aménagement urbain d'une part, et pratiques urbaines réelles d'autre part. En effet, de nouveaux facteurs multiples et complexes viennent désormais compliquer une situation de mal-développement des agglomérations marocaines. Parmi les différentes difficultés que les collectivités locales, les élus et les administrations publiques doivent surmonter rapidement nous pouvons citer : la forte croissance des tranches d'âges actif, la forte croissance de banlieues, le vieillissement et la dégradation des infrastructures, la pollution, la spéculation foncière, le gaspillage des ressources, etc.

Comment alors a été pensée ou non la prise en compte de l'impact de la mobilité et plus particulièrement la mobilité motorisée sur l'environnement urbain au Maroc ? Les limites de l'environnement urbain sont-elles pas en train de changer au point de compromettre l'accessibilité à la ville dans les conditions économiques et environnementales satisfaisantes à beaucoup de ses habitants (banlieues notamment) ? Comment concilier mobilité motorisée et développement urbain durable dans les grandes agglomérations marocaines ? Quelles politiques de la ville et des services collectifs urbains auront-elles quelques chances de succès à l'avenir ? Comment évolueront les formes techniques, économiques et gestionnaires de ces grands réseaux de transports urbains qui couvrent de manière inégale les villes marocaines ? Dans quelle mesure les collectivités locales auront-elles les capacités financières, juridiques et administratives d'encadrer et d'infléchir leur offre de services de transports urbains, compte tenu de leur niveau de développement ?

Le modèle générique, son développement et ses effets pervers.

La mobilité motorisée, tête de liste des préoccupations environnementales urbaines, pose des difficultés majeures et incontournables à l'ensemble des grandes agglomérations urbaines marocaines tant au niveau de la qualité de l'air et de la santé publique, du nombre élevé des accidents de la circulation, que du fonctionnement urbain ou du développement économique. Or, le principal problème auquel devront faire face les opérateurs publics, et les planificateurs au Maroc dans les deux prochaines décennies, c'est celui du modèle générique de transports urbains et son développement. En d'autres termes, comment ce réseau technique des transports urbains est-il encore aujourd'hui capable d'intégrer la croissance des villes marocaines et de la concentration des populations dans les banlieues pauvres ou riches dans ces mêmes villes ? Dans ce contexte se posent des problèmes d'offre de services urbains qualité, équité, coûts et l'accessibilité à la ville pour les habitants des grandes agglomérations marocaines.

Une «tradition» de planification urbaine des transports

Le Maroc est connu pour avoir été l'un des pays d'expérimentation coloniale d'avant-garde. Plusieurs réseaux techniques modernes ont vu le jour dans ce pays. On peut citer le cas exemplaire de l'hydraulique et le système des périmètres irrigués des année 40-50. Il est essentiel d'avoir à l'esprit que la création du Bas-Rhône-Languedoc (BRL, Nîmes, France) s'est faite au moment de l'indépendance du Maroc en 1956. Les savoirs appris par les ingénieurs et techniciens de cette entreprise étaient appris dans l'expérience coloniale marocaine ! Le système de la planification urbaine moderne mis en place par Lyautey et Prost dans les années 10-20 est aussi exemplaire par sa grille territoriale uniforme et son réseau viaire orthogonale servant de structures portante à la création des premières villes nouvelles de Casablanca, Marrakech, Port Lyautey, Safi, Fès. L'omniprésence du réseau viaire était très forte dans ce modèle de planification urbaine lors de la fondation des villes nouvelles coloniales. Il est tout simplement devenu ultérieures dans les agglomérations marocaines.

Les effets pervers de la planification technique

Après un simple examen rapide des différents Schémas Directeurs d'Aménagement et de l'Urbanisme (SDAU) des principales villes marocaines on se rend compte que la grille territoriale a engendré une «tradition» de planification des réseaux techniques de transport au Maroc! Cette tradition de la planification des transports urbains s'est «enracinée» d'abord au cours des années 70-80 dans les villes comme Casablanca, Rabat-Salé, Marrakech et Fès pour s'étendre ensuite aux autres villes moyennes marocaines. Or ce modèle est aujourd'hui confronté à sa propre limite. On se rend compte que l'application automatique de la même grille territoriale comportait au moins deux risques pour ne pas dire effets pervers : d'une part, l'étalement et la fragmentation désordonnée des territoires des villes marocaines ; et d'autre part, le rallongement des distances qui a entraîné et accentué les problèmes de transit, les déplacements des per sonnes et le transport des marchandises dans les plus grandes agglomérations marocaines. A ces risques majeures, les solutions proposées dans les documents d'urbanisme ou les plans de circulation sont encore fortement imprégnées par le modèle générique. A la lecture de la nouvelle génération des documents de planification des réseaux de transports, on ne fait que reconnaître l'existant auquel on apporte des correctifs en termes de projets de rocades concentriques intérieures ou extérieures, créations de grandes artères semi-circulaires, axes structurants, voies de pénétration, etc.

Mobilité motorisée et environnement urbain

Deux constats se sont imposés à nous dans l'étude de la mobilité motorisée dans les grandes agglomérations marocaines depuis une décennie. D'une part, la mobilité motorisée est restée exclusivement confinée dans une analyse pur et simple du trafic. Souvent confiée à des cabinets d'études spécialisés dans l'investigation technico-économique sur la circulation en milieu urbain ; ces études sont trop connues pour être fragmentaires, incomplètes et sans point d'appui social. En un mot, elles sont tout simplement déterritorialisées. D'autre part, la mobilité motorisée est aujourd'hui fortement associée chez le grand public au Maroc aux deux principaux problèmes des transports urbains : les accidents de circulation et la pollution de l'air. En effet, les grandes agglomérations urbaines (Casablanca, Rabat-Salé, Fès et Marrakech) sont tristement célèbres comme des villes polluées et foyers d'un nombre élevé d'accidents de circulation de la route ces dix dernières années.

Des accidents fréquentes en agglomérations

Au plan de sécurité routière en milieu urbain au Maroc, le nombre d'accidents est resté constant et relativement élevé et ce depuis 1987. En effet, les taux globaux relatifs aux accidents de circulation en agglomération ont constamment dépassé les 70% alors que les accidents en rase campagne sont situés autour de 25%[1]. Ce taux n'a pas connu de décroissance notable pendant une décennie d'observation (1987-1997) assurée par la Direction des Routes et de la Circulation Routière. En 1997, les accidents se répartissent comme suit :

- 10367 accidents (soit 25.4%) en rase campagne dont 1620 cas.mortels ;
- - 30415 accidents (soit 74.6%) en agglomérations dont 940 mortels.

Pourtant plusieurs campagnes de sensibilisation étaient initiées par l'Etat par le biais du Comité National de la Prévention des Accidents de la circulation ou encore les différentes opérations de contrôles techniques des véhicules. Car, si les accidents en agglomérations sont moins meurtries que ceux en rase campagne, c'est que leur nombre élevé est d'abord lié l'état mécanique défectueux des véhicules, au non respect du code de la route, au mauvais état du réseau viaire etc. Casablanca vient en tête liste du bilan des accidents corporels de la circulation routière et de ses victimes avec 11226 accidents.

Les émissions polluants

Dès 1985, le Programme des Nations Unies pour l'Environnement avait constaté que «la pollution atmosphérique été encore trop négligé au Maroc (...)»alors qu'elle «tend à se généraliser dans les agglomérations urbaines à la suite de l'accroissement des moyens de transport (...)»[2] Après cette première alerte du PNUE, la Stratégie Nationale pour la Protection de l'Environnement et le Développement Durable (1995)[3] et Action 30 (1997)[4] rappellent à juste titre les risques persistants des émissions polluants liés aux transports urbains et spécialement à la mobilité motorisée. Précisément, ce problème représente une importante source de dégradation de la qualité de l'air. Parfois, dans certaines grandes agglomérations urbaines marocaines les effets des polluants contenus dans le gaz d'échappement sont la principal source de pollution. C'est le cas de ville de Rabat, capitale du Royaume du Maroc dont la pollution par émissions de polluants des véhicules dépasse les normes internationales. Or les coûts de la dégradation de l'environnement correspondent à 8.2% du PIB du Maroc soit un total de 19.739 dirhams (un dollar US est l'équivalent de 10 dirhams marocains). Le coût de la pollution de l'environnement urbain par pollution de l'air est aujourd'hui placé en deuxième « mauvaise » position après l'eau et les déchets avec 4.500 de dirhams soit 1.9% du PIB du Maroc. Ces coûts ne représentent qu'une estimation du coût de la dégradation due au plomb et aux poussières et les coûts réels sont sûrement plus élevés.

Eclatante démonstration, s'il en fallait une, que l'organisation de la mobilité motorisée ne peut être réductible à une grille territoriale de planification,

encore plus aujourd'hui en raison de l'état de mal-développement des villes marocaines. Car, s'il conviendrait de prendre en compte à la fois l'inadaptation du réseau routier et les congestions qui en découlent, les risques environnementaux et sécuritaire dans le contexte actuel marocain ; la gestion des réseaux techniques urbains est au coeur du débat sur le service public et des perspectives du développement durable des agglomérations urbaines marocaines.

La gestion des réseaux techniques urbains

Dans le présent contexte, la gestion des réseaux de transports urbains représente désormais un défi de taille pour le défi de taille pour le développement des villes marocaines non seulement au niveau technique (réseau viaire), mais aussi au niveau juridique (pouvoir réglementaire, d'institutionnel), socio-économique (public-privé), financier (équité de coûts) et, aussi et surtout, environnemental et humain (salubrité de l'air et accidents de la circulation).

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[1] Royaume du Maroc, Ministère de l'Equipement 1997. *Recueil des statistiques des accidents corporels de la circulation, Résultats*

[2] Programme des Nations Unies pour l'Environnement, 1985. *Rapport concernant le projet de loi sur la protection et la mise en valeur de l' environnement au Maroc*, chapitre V : L'air, page.

[3] Royaume du Maroc, Ministère de l'Environnement, PNUD/UNESCO : MOR/90/001. Observatoire National de l'Environnement au Maroc. 1995. *Stratégie National pour la Protection de l'Environnement et le Développement Durable.*

[4] Royaume du Maroc, Ministère de l'Environnement et Ministère de la Santé Publique,1997. *Santé et environnement, Action 30 : 30 millions de marocains entrent dans le XXIème siècle.*

En effet, confrontés aux problèmes liés au dilemme des flux, de transports de marchandises, de déplacements des personnes dans les villes marocaines ; les chercheurs experts et opérateurs publics ou privés marocains sont conscients que la mobilité quotidienne et plus particulièrement la mobilité motorisée n'est plus seulement une question de planification des transports urbains. La maîtrise des problèmes de mise en oeuvre et de gestion des réseaux techniques urbains constituent des enjeux majeurs pour les villes marocaines dans les années à venir. Les services collectifs dans les plus importantes agglomérations marocaines (Casablanca, Rabat-Salé, Fès et Marrakech) et plus particulièrement les transports urbains n'échappe pas à ce nouveau et difficile processus.

De plus une sensibilité nouvelle au développement durable, entendu comme la nécessité d'harmoniser les exigences du progrès économique Urbain, a obligé et oblige le Maroc à ajuster les modes d'intervention dans le domaine des transports pour les rendre plus conformes à une offre de service adaptée aux contextes locaux qui prenne en compte non seulement la satisfaction des usagers mais aussi l'ensemble des éléments constitutifs d'une gestion intégrée des transports urbains en général et de la mobilité motorisée en particulier.

La solution proposée avec insistance depuis quelques années pour régler du moins en partie le problème des transports collectifs urbains, c'est essentiellement de recourir au secteur privé. Les fondements de cette argumentation reposant sur l'idée que les services gérés par le secteur public tendent à être inefficaces et que le secteur privé peut, mieux que le secteur public, atteindre des objectifs fixés dans les délais prévus. Cependant, de notre point de vue, l'extension normative du recours au secteur privé comme solution universelle pour gérer les transports en commun est aujourd'hui à la limite de ce que le privé peut faire faire dans ce domaine. Il est tout simplement atteint par les mêmes syndromes : vieillissement du parc et risques financiers !

Conclusion

Face à l'ensemble des problèmes de congestion de pollution ou d'exclusion liés aux difficultés de circulation, le modèle générique de la grille territoriale a montré ses limites et n'apporte plus de réponses adaptées. La complexité du phénomène urbain et de la mobilité motorisée au Maroc oblige donc à adopter un mode d'analyse plus transversal et de faire des efforts poussées en prospective territoriale du développement. En fait, il convient de partir de la demande sociale (exprimée par les différents usagers) en identifiant: 1) les paramètres de la demande en dégageant les grands profils d'usagers ;2) les grands modes de transports (personnes et des marchandises), coût, réseau viaire disponible et son état ;3) les différentes contraintes et conflits en termes de concurrence entre usagers, modes, difficultés urbanistiques, environnement, etc.

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Dépenses de transport des ménages dans les villes d'Afrique subsaharienne

Household transport expenditures in cities of Subsaharan Africa

Gasto de transporte de los hogares en las ciudades del Africa al sur del Sahara

L. Díaz Olvera, D. Plat & P. Pochet
Laboratoire d'Economie des Transports, Lyon, France

RESUME : Les déplacements quotidiens entraînent une charge financière importante mais difficilement contournable pour les ménages des villes africaines. Selon les méthodes d'enquête utilisées, les estimations moyennes des dépenses-transport des ménages varient de 10 à 20 % de leur budget. Une enquête-ménages réalisée à Niamey nous fournit des renseignements précis sur les dépenses de transport. Ces informations montrent qu'en termes de revenus, de dépenses pour le transport et d'accès aux véhicules, les inégalités sont criantes. La mobilité dans les ménages les plus pauvres, captifs des transports collectifs, représente 20 % de leur revenu en moyenne. Ces résultats constituent, dans le cadre des politiques de transport urbain, des éléments de connaissance de la capacité limitée des usagers à payer. Ils révèlent aussi des perspectives d'ordre méthodologique sur le recueil des données.

ABSTRACT: Travel expenditure is indeed significant but it is a virtually unavoidable expenditure for the African city-dwellers. Depending on the survey methodology, the usually average estimates are 10 to 20% of the household budget. A household survey carried out in Niamey provides specific data on transport expenses. This information shows considerable disparities between households in terms of income, travel expenditure, and motorization level. For the poorest households, reliant on public transport, daily mobility represents 20% of their income in the average. These results constitute a better knowledge of the limited affordability of public transport services for users and they also raise methodological perspectives concerning data collection.

RESUMEN: El gasto en transporte es una carga que los hogares pueden dificilmente evitar y las estimaciones proporcionan valores medios de 10 a 20% del ingreso del hogar. Una encuesta en los hogares realizada en Niamey proporciona información detallada sobre el gasto en transporte. Estos datos muestran que existen marcadas desigualdades entre hogares en cuanto al ingreso, el gasto en transporte y la motorización. En los hogares más pobres, cautivos del transporte público, la movilidad representa 20% del ingreso en promedio. Estos resultados contribuyen a un mejor conocimento de la capacidad financiera limitada de los usuarios del transporte público y ponen de manifiesto algunas perspectivas metodológicas sobre la colecta de datos.

1 INTRODUCTION

Le transport des personnes est une activité intermédiaire permettant la réalisation d'autres activités économiques et sociales. Dans l'ordre des préoccupations des ménages, il est supplanté par des nécessités premières que sont l'alimentation et le logement. Néanmoins, compte tenu des distances à parcourir quotidiennement, il présente la particularité d'être difficilement substituable et représente une charge financière incontournable pour les ménages. Alors que la crise économique touche tout particulièrement les pays africains et se traduit par une chute sensible du niveau de vie, pourtant déjà très faible, des populations urbaines, les ménages sont contraints de s'adapter aux nouvelles conditions économiques et mettent en œuvre des stratégies de réduction des coûts (Godard & al., 1996 ; Malou, 1996 ; Dillé, 1998) : augmentation des déplacements pédestres au détriment des déplacements motorisés, suppression des déplacements non contraints, apparition de nouvelles formes de transport, etc.

Dans un tel contexte, il apparaît de plus en plus nécessaire, pour mener à bien une politique de transport urbain efficace et équitable, de mieux connaître la demande exprimée et la place du transport dans le budget des ménages, et pour cela de produire des données cohérentes sur les conditions de déplacement des citadins et les dépenses engendrées par ces déplacements. En effet, les informations disponibles sur les montants dépensés en transport par les ménages restent assez floues et montrent des disparités importantes.

L'objectif de cette communication est alors d'évaluer le poids des dépenses en transport des ménages dans une capitale africaine, Niamey, pour laquelle nous disposons d'une enquête-ménages récente. Dans un premier temps, un bref survol bibliographique sur les dépenses transport des ménages permet de mettre en évidence la variabilité des estimations moyennes et la diversité des méthodologies utilisées. Puis, nous vérifions la solidité de nos données et examinons ensuite la situation des ménages niaméens. En conclusion, nous revenons sur les principaux enseignements de l'étude, tant en termes de résultats qu'au plan méthodologique.

2 ELEMENTS BIBLIOGRAPHIQUES

Les sources bibliographiques présentées montrent que l'analyse des dépenses en transport des ménages s'organise autour de deux approches méthodologiques différentes.

La première les renvoie à l'ensemble des dépenses du ménage et repose sur des informations recueillies lors d'enquêtes-consommation réalisées le plus souvent au niveau national. Compte tenu des difficultés d'évaluation des revenus (notamment les revenus issus d'activités agricoles) dans les pays pauvres, ces enquêtes globales appréhendent le budget des ménages à partir de l'ensemble des dépenses réalisées au cours d'une période donnée (Deaton, 1997).

La seconde méthode les compare au revenu du ménage obtenu à l'occasion d'enquêtes-ménages sur les déplacements, et leur portée géographique est donc limitée à une ville donnée. Même si l'enquête est réduite au milieu urbain, l'estimation du revenu soulève certaines difficultés, que les individus ne puissent ou ne veuillent pas l'évaluer, voire que certains postes (les transferts d'argent, les rentes...) soient omis. Les estimations du poids des dépenses en transport fournies par ces deux types de méthode divergent assez sensiblement.

2.1 Le poids variable du transport dans les dépenses des ménages

A notre connaissance, un certain nombre d'estimations sont disponibles à partir d'enquêtes-consommation réalisées notamment dans les grandes villes d'Afrique de l'ouest. Les données sont plutôt récentes et certaines ont été produites après dévaluation du franc CFA en 1994 (Tableau 1).

Un premier aperçu montre une forte variabilité temporelle et spatiale de la part des dépenses transport dans l'ensemble, de 6 % à Yaoundé en 1978 à 17 %, toujours à Yaoundé, mais en 1993.

L'évolution temporelle de ce taux ne peut toutefois être retracée que pour les deux villes camerounaises. En 15 ans, la part du transport à Yaoundé aurait été multipliée par 2,8, l'augmentation la plus importante ayant eu lieu entre 1978 et 1984 (coefficient multiplicateur de 2,1). Pour cette même période, l'augmentation est beaucoup plus faible à Douala, avec un coefficient multiplicateur de 1,4. Il est toutefois difficile d'aller au delà de ce constat et d'expliquer les raisons d'une telle croissance du poids des transports.

La variabilité spatiale peut être appréciée en se limitant aux années 90. Trois groupes de villes apparaissent ainsi. C'est à Dakar que la part du transport est la plus faible, de l'ordre de 7 %. Le deuxième groupe correspond à Abidjan, Lomé, Ouagadougou et Dar es Salaam, avec une part variant entre 9 % et 13 %. Enfin, avec près de 17%, Yaoundé présente le taux le plus élevé. Cette dernière valeur peut être rapprochée des résultats d'une enquête ponctuelle à Lagos auprès d'usagers des transports collectifs (Sethi & Bhandari, 1996) et qui situe la part du transport à 23 % des dépenses totales, derrière l'alimentation (36 %) mais devant le logement (21 %). Il s'agit toutefois d'une population très spécifique qui comprend 85 % de pauvres alors qu'ils ne sont que 30 % dans l'ensemble de la population.

Cette forte variabilité des estimations, tant dans le temps que dans l'espace, paraît difficile à expliquer. Elle relève pour partie de différences méthodologiques : ainsi, à Yaoundé, la rubrique Transport inclut également les Communications, ce qui tend à la surévaluer. Mais elle renvoie aussi probablement à d'autres facteurs que les données disponibles ne permettent pas d'exhiber. Si l'on exclut les valeurs extrêmes, c'est une fourchette de 9 % à 15 % qui semble se dégager. A titre de comparaison, le logement, y compris l'électricité et l'eau, représente de 15 à 20 % des dépenses des ménages en Afrique (Arnaud, 1998).

2.2 Le poids élevé des dépenses transport dans le revenu des ménages

Les analyses s'appuyant sur la prise en compte du revenu des ménages sont par contre plus rares et plus anciennes, en ce qui concerne l'Afrique tout au moins. Ainsi, selon les enquêtes réalisées par le TRL dans les années 80 (Maunder & Fouracre, 1987), les ménages de Jos dépensaient 13 % de leur revenu en

Tableau 1 : Part des dépenses transport dans le budget des ménages

Ville	Date	Part du transport (%)	Source	Référence bibliographique
Abidjan	1996	11,0	Indicateurs transport SITRASS	Godard, 1999
Bamako	1985-86	15,1	Enquête sur les dépenses des ménages	Sanogo, 1993
Dakar	1994-95	6,8	Enq. Sénégalaise auprès des Ménages	Ministère de l'Economie, 1997
Dar es Salaam	1993	9,1	Enquête HRDS	Diaz Olvera & al., 1998b
Douala	1978	8,0	Enquête Maetur	Ngabmen, 1997
	1983-84	10,9	Enquête budget consommation	Ngabmen, 1997
Lomé	1996	13,0	Indicateurs transport SITRASS	Godard, 1999
Ouagadougou	1996	13,0	Indicateurs transport SITRASS	Godard, 1999
Yaoundé	1978	6,1	Enquête MAETUR	Ngabmen, 1997
	1983-84	12,7	Enquête budget consommation	Ngabmen, 1997
	1993	16,8	Enquête consommation Dscn/Dial	Ngabmen, 1997

transport et ceux de Dar es Salaam 16 %. A Abidjan, à la fin des années 80, les dépenses en transport collectif étaient estimées à 9 % du revenu moyen et 13 % du revenu médian, mais approchaient les 20 % pour les ménages pauvres (Godard & Teurnier, 1992). A Ouagadougou, ville où la possession de deux-roues moteur est très répandue, le transport représentait 20 % du revenu des ménages en 1992, mais « seulement » 18 % pour le cinquième des ménages les plus aisés et jusqu'à 25 % pour les ménages du premier quintile (Diaz Olvera & al., 1999b).

Une enquête réalisée récemment à Dakar auprès d'une centaine d'actifs pauvres montre que 55 % dépensent moins de 10 % de leur revenu individuel pour les déplacements liés à leur activité professionnelle régulière, les trois quarts dépensant moins de 20 % (Godard & al., 1996). Ces valeurs semblent peu élevées mais elles ne sont que des minima et il faudrait leur ajouter les dépenses liées aux déplacements non professionnels ainsi que les déplacements sans coût pour l'enquêté, soit parce qu'ils sont effectivement gratuits (débrouille, connaissance du personnel des véhicules de transport collectif...), soit parce que les frais correspondants sont pris en charge par des tiers.

Ces différentes études sont donc plus difficilement comparables mais elles laissent entrevoir un poids du transport dans le revenu du ménage aux alentours de 15 à 20 %, dans une fourchette plus élevée qu'avec la méthode précédente.

Ce bref repérage bibliographique montre tout d'abord le manque d'informations disponibles et comparables, soit du fait de méthodologies divergentes, soit faute de repérage des spécificités de chaque terrain. Si la première approche permet un cadrage plus global des dépenses et rend mieux compte d'arbitrages entre le transport et d'autres postes de dépenses, la seconde fournit par contre une estimation plus fine du coût des déplacements et permet de le référer aux pratiques observées de mobilité quotidienne des citadins.

3 LES DEPENSES DES MENAGES POUR LE TRANSPORT A NIAMEY

A Niamey, selon les données recueillies à l'occasion d'une enquête-ménages sur la mobilité conduite fin 1996 auprès de 757 ménages (Diaz Olvera & al., 1999a), la part des dépenses transport dans le revenu moyen s'élève à 18 %. Si ce chiffre paraît cohérent avec les estimations fournies par la littérature, il cache toutefois des disparités importantes entre ménages. Avant d'en présenter certaines, nous revenons sur la méthode de calcul.

3.1. Méthodologie de recueil et qualité des données

Les informations concernant les revenus et les dépenses en transport ont été recueillies directement auprès de chacun des enquêtés. Les revenus des personnes résultent des déclarations des enquêtés concernant leur activité professionnelle ou scolaire ainsi que leur retraite, le revenu du ménage étant ensuite reconstitué à partir des déclarations individuelles. Il peut alors être sous-estimé, en particulier du fait de l'omission possible de certaines ressources (transferts provenant de l'extérieur du ménage...). En ce qui concerne les dépenses, chaque individu devait signaler dans un premier temps, pour les véhicules individuels à disposition, le coût mensuel en carburant puis les coûts annuels liés d'une part à son entretien et à sa réparation et d'autre part à l'assurance et à la vignette. Dans un second temps, il lui était demandé ses dépenses hebdomadaires en transport collectif, en cherchant à séparer taxi collectif et bus. Une fois ces différentes données disponibles, il est possible de calculer un coût mensuel de la mobilité, soit totale, soit par mode, tant au niveau de l'individu que du ménage, et de le mettre en regard du revenu.

Mais, parce qu'il fait appel à la mémoire et qu'il demande le calcul de dépenses moyennes, un tel recueil n'est pas sans risques de biais. Pour tenter de les limiter, nous avons cherché dans un premier temps à tester la vraisemblance de ces évaluations, en les référant non seulement à la mobilité de la veille mais aussi aux déclarations concernant l'ensemble des activités pratiquées hors du domicile la semaine précédente. Puis nous avons comparé les données sur les dépenses aux informations fournies par le recueil des déplacements de la veille, selon deux approches.

Une première approche de la compatibilité des données peut être fournie en observant le pourcentage des individus déclarant, pour un mode donné, une dépense nulle, mais ayant utilisé ce mode la veille (en tant que conducteur dans le cas des véhicules individuels). Ce taux est de l'ordre de 1 % pour les modes individuels mais atteint près de 5 % pour les transports collectifs. A l'inverse, le taux d'individus ayant déclaré une dépense sans avoir utilisé le mode est également de l'ordre de 1 % pour les modes individuels et bondit à près de 50 % pour les transports collectifs. Il y a là, au delà d'une plus ou moins bonne précision des dépenses concernant les transports collectifs, l'effet d'un usage plus intensif des modes individuels dès lors qu'on y a accès tandis qu'*a contrario* l'usage des transports collectifs, pour une part importante de la population, reste beaucoup plus fluctuant et demeure lié à la disponibilité monétaire immédiate, à la capacité de débourser dans l'instant le prix du voyage.

Une seconde approche a reposé sur une régression linéaire de la dépense en fonction du nombre de déplacements en semaine, pour chaque mode (là encore, en tant que conducteur pour les modes individuels). Le coefficient de corrélation linéaire est maximum pour les modes motorisés (0,56 pour la voiture, 0,57 pour les deux-roues à moteur), pour lesquels le coût du carburant est directement lié au nombre de déplacements, et très faible pour la bicyclette (0,23), pour laquelle les dépenses directes liées à un déplacement sont nulles. Il est également minime pour les transports collectifs (0,31), bien que le coût du déplacement soit immédiat. On retrouve là encore le signe d'un usage plus irrégulier des transports collectifs qui complique l'évaluation par l'individu de la dépense moyenne correspondante.

Ces comparaisons montrent donc une meilleure compatibilité des informations lorsqu'elles concernent les véhicules individuels que lorsqu'elles ont trait aux transports collectifs. En particulier, l'usage de ceux-ci mesuré à travers les dépenses est peut-être légèrement surévalué, d'autant que le partage entre taxi et bus apparaît parfois peu fiable. Aussi ne présenterons-nous pas, par la suite, de décomposition des dépenses en transports collectifs par mode.

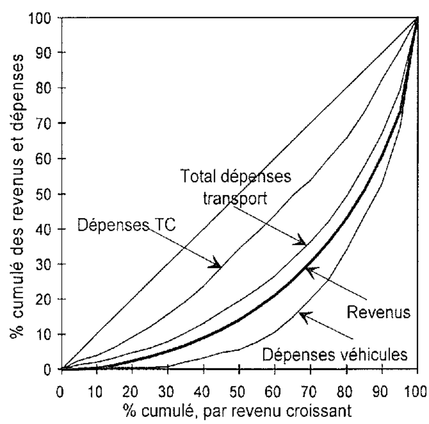
3.2. Des dépenses élevées pour le transport...

La mise en perspective des revenus et des dépenses des ménages pour le transport met en évidence de très nettes concentrations, comme le montre la forte convexité de la courbe de Lorenz des revenus comme des courbes de dépenses-transport des ménages correspondantes. On vérifie tout d'abord que les revenus sont très inégalement répartis entre les foyers niaméens (Graphique 1). La moitié la plus pauvre des ménages se partage 14 % des revenus, alors que le cinquième le plus riche dispose de 57 % des ressources totales.

En reprenant le même ordonnancement des ménages, la représentation de leurs dépenses pour le transport montre que celles-ci apparaissent réparties de façon légèrement moins inégale que les revenus. Cependant, cette courbe de dépenses totales cache des usages très différenciés des modes individuels et collectifs, résultat cohérent avec la rareté de l'équipement en véhicules motorisés.

Les dépenses pour les modes individuels sont en effet bien plus inégalement réparties que les revenus. Les 50 % de ménages les plus pauvres ne comptent que pour 6 % de l'ensemble des dépenses en transport individuel, contre 66 % pour le dernier quintile de revenus, et même 47 % pour le dernier décile.

A l'inverse, les transports collectifs engendrent des dépenses qui se répartissent de façon nettement moins inégalitaire au sein de la population. La courbe est parallèle à la droite d'équirépartition pour les revenus, à l'exception des revenus extrêmes. Les inégalités concernent donc ici surtout les revenus extrêmes (1er et 5ème quintiles). Les 50 % de ménages les plus pauvres réalisent 34 % des dépenses totales en transports collectifs, soit la même part que les 20 % les plus riches. En pourcentage du revenu disponible, les ménages pauvres dépensent donc plus que les ménages plus aisés. Cette répartition relativement homogène des dépenses en transport collectif au sein de la population rappelle le fait que



Graphique 1 : Courbe de Lorenz des revenus et part cumulée des dépenses des ménages pour le transport à Niamey les ménages non motorisés, soit la plus grande partie de la population, sont très majoritairement captifs des transports en commun. En particulier, lorsque l'on habite en périphérie, lot commun d'une bonne partie des ménages pauvres, les distances rendent indispensable l'usage des transports collectifs dès lors que l'on doit se rendre en ville (Diaz Olvera & al., 1999c).

Si l'on raisonne en niveau absolu de dépenses et non plus en part du revenu, ce sont les ménages aisés qui dépensent le plus pour les transports collectifs, et ce même si l'on ramène cette dépense à une taille de ménage légèrement plus élevée (Tableau 2). L'aisance économique du ménage s'exprime à la fois par des possibilités importantes d'accès aux modes individuels pour le ou les actifs, mais aussi par de plus grandes facilités d'usage des transports collectifs pour les autres membres du ménage. A l'opposé sur l'échelle des revenus, les ménages du premier quintile se caractérisent à la fois par de faible dépenses en niveaux absolus, mais aussi par le pourcentage élevé des revenus que cette dépense occasionne.

3.3. ... *et de faibles taux d'équipement*

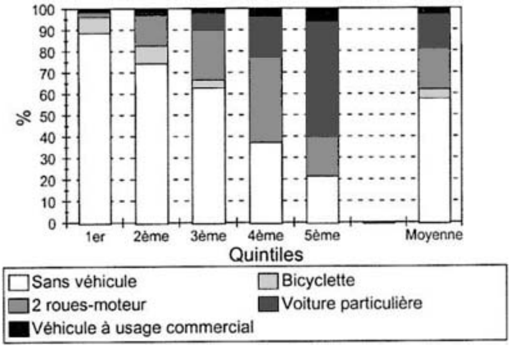
La forte concentration des dépenses en modes individuels reflète le fait que l'équipement en véhicules motorisés apparaît, sinon totalement inaccessible, tout au moins très limité pour les 60 % des ménages les plus pauvres (Graphique 2). L'équipement croît de façon mécanique avec le revenu, mais ne devient la norme que dans les deux derniers quintiles de la population.

La rareté de l'équipement en véhicules se comprend aisément si l'on précise que le coût mensuel moyen d'usage (hors coûts d'acquisition) d'une voiture à Niamey est de l'ordre de 46 000 FCFA, soit une valeur égale ou supérieure à la moitié du revenu mensuel de plus de 60 % des ménages. Le coût mensuel d'usage d'un deux-roues moteur, 12 600 FCFA, montre que ce mode est déjà nettement plus abordable que la voiture. Toutefois le

Tableau 2 : Dépenses en transports collectifs par quintile (% des dépenses et montant en FCFA)

Quintiles (milliers de FCFA)	Taille moyenne des ménages*	% des dépenses pour les TC	Montant pour les TC
Q1 <=25	4,8 (2,6)	97	4 200
Q2]25, 50]	5,9 (3,2)	83	7 400
Q3]50, 90]	6,0 (3,5)	73	9 700
Q4]90, 160]	6,1 (3,5)	47	10 900
Q5 >160	6,5 (3,7)	33	17 100
Tous revenus	*5,9 (3,3)*	*48*	*9 700*

* entre parenthèses : nombre d'individus de plus de 13 ans



Graphique 2 : Equipement des ménages en véhicules selon les quintiles de revenus

deux-roues moteur demeure d'un coût deux fois supérieur aux dépenses mensuelles moyennes pour les transports collectifs déclarées par les individus les ayant utilisés la veille (6 400 FCFA mensuel, soit l'équivalent de 21 allers-retours mensuels en taxi collectif, ou de 32 allers-retours en bus de la SNTN).

Bien que moins coûteux que les véhicules motorisés individuels, les transports collectifs demeurent une charge importante pour les ménages aux faibles revenus, puisqu'ils représentent en moyenne 19 à 20 % du revenu des ménages des deux premiers quintiles.

De tous les modes de transport mécanisés, la bicyclette demeure de loin le moins coûteux à l'usage (500 FCFA d'entretien mensuel déclaré en moyenne), même si l'on peut penser que son coût d'achat, de l'ordre de deux fois le salaire médian, constitue un obstacle financier pour une partie de la population.

4 CONCLUSION

Les analyses présentées ici, même si elles ne sont encore qu'ébauchées, permettent de tirer quelques enseignements concernant le poids du transport dans le budget des ménages. Le cadrage bibliographique a montré les lacunes des données disponibles, qu'il s'agisse d'expliquer des écarts notables entre villes ou d'exhiber un suivi temporel rigoureux. Elles désignent d'abord des divergences méthodologiques dans la production et l'analyse des données mais découlent aussi du manque récurrent de données dans les pays en développement. Un tel problème a tendance non seulement à se pérenniser mais aussi à s'accentuer du fait de la réduction des financements internationaux pour la production de données. Cette situation est d'ailleurs confirmée par le retard pris dans plusieurs pays pour la réalisation des recensements de population, par le manque de continuité des enquêtes-consommation et, plus spécifiquement dans le domaine du transport urbain, par la rareté des enquêtes-ménages sur la mobilité.

Pourtant, malgré certaines difficultés d'appréhension des aspects financiers, des enquêtes auprès des ménages recueillant simultanément la mobilité de la veille et les dépenses permettent de produire des données cohérentes sur le niveau et les coûts de la mobilité. Ces données pourraient toutefois utilement être complétées par le recueil du coût d'achat des véhicules et des autres principaux postes de dépenses des ménages mais aussi par des questions spécifiques sur les stratégies développées par les ménages et les individus pour limiter les dépenses en transport. De même, la prise en compte des revenus pourrait être affinée en intégrant d'éventuels transferts entre ménages. De tels compléments amélioreraient la précision des mesures, sans trop alourdir le coût des enquêtes.

A travers l'exemple de Niamey, une analyse désagrégée par niveaux de revenu du ménage montre que les inégalités structurelles entre ménages vis-à-vis des déplacements quotidiens sont très fortes. Elles reposent d'abord sur les coûts d'usage très élevés des modes individuels motorisés. Mais l'équipement en véhicules apparaissant inaccessible pour la plupart des ménages, les transports collectifs constituent la seule alternative aux longs déplacements à pied pour une majorité de ménages niaméens. Cette alternative représente toutefois un coût difficilement supportable pour les plus pauvres qui les amène à restreindre leur mobilité et, par voie de conséquence, limite leurs possibilités d'une réelle intégration économique et sociale à la ville.

Ces analyses restent à approfondir, qu'il s'agisse de prendre en compte d'autres caractéristiques des ménages ou de mettre en évidence des disparités inter-individuelles. Elles demandent aussi à être prolongées à d'autres villes pour déboucher sur l'élaboration d'outils permettant une meilleure prise en compte du caractère progressif ou régressif des politiques de transport urbain dans les pays en développement.

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Etalement urbain et mobilité à Niamey

Urban sprawl and daily mobility – Case study from Niamey

Expansión urbana y movilidad en Niamey

L. Díaz Olvera, D. Plat & P. Pochet
Laboratoire d'Economie des Transports, Lyon, France

RESUME : Dans les grandes villes d'Afrique subsaharienne connaissant une croissance démographique et spatiale très importante, les extensions urbaines « spontanées » et les « villages » suburbains constituent généralement le point de chute des citadins les plus défavorisés, dont les conditions de déplacement sont particulièrement difficiles. A l'aide d'une enquête-ménages auprès de 2732 habitants à Niamey, nous analysons leurs conditions de résidence, leurs caractéristiques sociales et l'usage qu'ils ont de l'espace urbain. Les résultats rappellent que, dans l'accès à la ville, le revenu individuel apparaît bien plus déterminant que le lieu de résidence. Mais ils montrent aussi que pour les pauvres le manque de moyens est renforcé par le fait de résider en quartiers périphériques à la fois sous-équipés et peu accessibles.

ABSTRACT: In large Sub-Saharan cities, with high rates of demographic growth and urban sprawl, unplanned settlements and suburban « villages » generally constitute the areas accommodating the most underprivileged urban dwellers, whose daily mobility conditions are particularly difficult. Data from a household survey carried out in Niamey on a sample of 2732 individuals make it possible to analyze their housing and social characteristics, and the way they use the urban space. Results show that personal income is a more determinant factor of accessibility to the city than home location, but for the urban poor « lack of means » effects are reinforced by home location in peripheral areas, usually both under provided in urban services and with low accessibility.

RESUMEN: En las principales ciudades del Africa al sur del Sahara, con gran crecimiento demográfico y espacial, las areas periféricas sin urbanizar y los pueblos aledaños son los lugares en donde generalmente viven los habitantes más desfavorecidos, cuyas condiciones de transporte son bastante difíciles. Una encuesta en los hogares, aplicada a 2732 habitantes de Niamey, permite analizar sus condiciones de vivienda, sus características sociales y cómo «usan» el espacio urbano. Los resultados muestran que para la «utilización» de la ciudad, el ingreso individual es más determinante que el lugar de residencia pero para los pobres, los efectos de la falta de recursos económicos son agudizados por la localización de la vivienda en zonas periféricas, sin dotación de servicios y con poca accesibilidad.

1 INTRODUCTION

Dans les grandes villes d'Afrique subsaharienne, la forte croissance démographique et d'importants flux migratoires issus des campagnes ou des villes secondaires se conjuguent depuis les années 60 pour produire une extension spatiale rapide et désordonnée reposant sur l'habitat individuel.

Niamey, capitale administrative et économique du Niger, est ainsi passée de 30 000 habitants environ en 1960 (Bernus 1969) à 600 000 environ aujourd'hui. La jeunesse de sa population - près de la moitié a moins de 15 ans (Rép. du Niger 1994) - est un autre signe de son dynamisme démographique. Pour héberger les nouveaux citadins, les parcelles loties, en nombre très insuffisant, se sont aussi avérées d'un prix trop élevé pour les couches populaires, entraînant l'éviction de la majorité de la population urbaine (Poitou 1984). En réponse, l'auto-production de logements périphériques s'est développée depuis les années 70. Mais, faute de moyens, ces concessions ont été construites le plus souvent à base de matériaux précaires comme la terre séchée (banco) ou la paille et sont souvent situées à l'écart des réseaux d'eau, d'assainissement... Les constructions non loties se sont principalement installées sur des espaces vierges, avec de nombreuses ruptures de continuité au niveau du bâti qui tendent à renforcer l'isolement de certains quartiers. Mais elles ont aussi alimenté la croissance d'anciens noyaux villageois aujourd'hui absorbés par la ville. Actuellement, Niamey s'étire sur près de 20 km de long et sur 15 km de large.

Cette explosion spatiale de la ville ne s'est pas accompagnée d'un développement des infrastructures urbaines à sa mesure. De façon symptomatique, les extensions urbaines sur la rive droite du fleuve ne sont toujours rattachées au reste de l'ensemble urbain que par un unique pont. Plus généralement, les zones périphériques restent marquées par la rareté des équipements de quartier et par une mauvaise qualité de la voirie. L'accès à la ville des populations vivant en périphérie est encore limité par les carences de l'offre de transport collectif, assurée par une entreprise publique, la SNTN (Société Nationale des Transports Nigériens), et un ensemble d'opérateurs privés.

Fin 1996, la SNTN dessert Niamey avec une trentaine d'autobus sur un réseau d'environ 190 km et de 16 lignes. L'offre est d'autant plus limitée que certains bus sont, aux heures de pointe, réservés aux fonctionnaires. L'activité se retrouve très déficitaire, l'Etat ne compensant que très imparfaitement les missions de service public qu'il impose.

Du fait des faiblesses du service public tant en termes de fréquence que de couverture spatiale, les taxis collectifs opérant sur des lignes régulières, en viennent à fournir la plus grande partie de l'offre. Ils sont complétés par des taxis suburbains, les *talladjé-talladjé*, transportant personnes et marchandises entre le centre de Niamey et certaines périphéries. Pour les destinations éloignées, à la desserte routière dégradée ou moins rentables, l'offre de transport privé se raréfie et les tarifs augmentent. La course en taxi collectif coûte 150 FCFA (1,50 FF) et jusqu'à 300 FCFA pour les « villages périphériques » (contre 100 FCFA pour les bus SNTN), tarifs à rapporter à un revenu médian par actif de l'ordre de 35 000 FCFA.

Le secteur artisanal apporte donc un complément indispensable au secteur public, sans toutefois pouvoir assurer sur l'ensemble de la ville une desserte satisfaisante, en quantité et en qualité. La mauvaise qualité de service et les tarifs élevés amènent les usagers à privilégier les déplacements indispensables. Les trajets domicile-travail ou étude comptent pour plus de la moitié de la clientèle des transports collectifs en semaine alors qu'ils ne représentent au total qu'un déplacement sur trois.

Une enquête réalisée en 1996 auprès de 757 ménages niaméens et 2732 individus de plus de 13 ans, a recueilli (notamment) les caractéristiques de leur mobilité de la veille du jour d'enquête (Diaz Olvera et al. 1999a). Elle permet d'analyser les conséquences de ce contexte dégradé sur la mobilité des citadins, et notamment des citadins résidant dans les périphéries éloignées et peu accessibles.

2 HABITER AU CENTRE, HABITER EN PERIPHERIE

Pour mettre en évidence l'influence du contexte spatial sur la mobilité, les lieux de résidence des ménages enquêtés ont été regroupés en cinq grandes zones correspondant à des distances au centre et à des formes d'habitat distinctes (Figure 1) :

1. les quartiers centraux ;
2. les quartiers lotis de 1ère périphérie ;
3. les quartiers lotis de 2ème périphérie ;
4. les quartiers non lotis de 2ème périphérie ;
5. les « villages », situés en 2ème périphérie et qui ont été rattrapés par l'urbanisation.

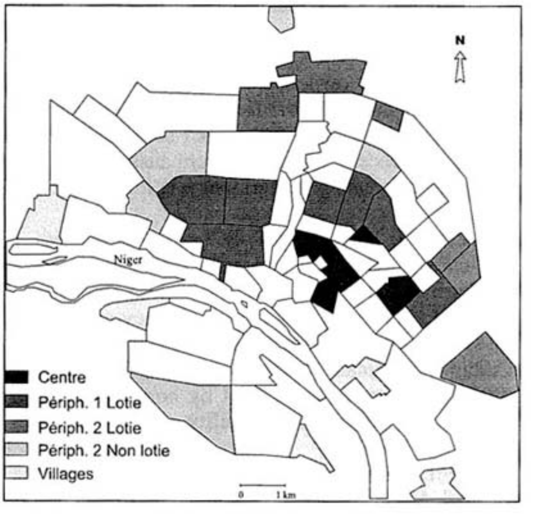
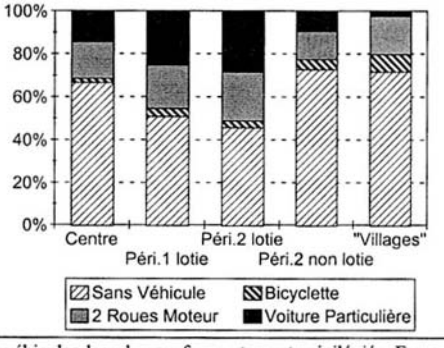


Figure 1. Typologie spatiale des quartiers enquêtés



Les véhicules les plus performants sont privilégiés. Exemple : les ménages possédant une voiture et un deux-roues moteur sont classés dans « au moins une voiture ».

Figure 2. Equipement des ménages en véhicules par type de quartier

Tableau 1. Caractéristiques socio-économiques des ménages et des individus et de l'habitat, par type de quartier

	Centre	Périph. 1 lotie	Périph. 2 lotie	Périph. 2 non lotie	Villages (Périph. 2)
% d'enfants scolarisés (14-24 ans)	68	62	73	58	52
% d'actifs dans la fonction publique	27	29	35	24	18
% d'actifs non-salariés	49	46	48	62	68
Revenu mensuel des ménages (FCFA)	93500	158000	141000	76000	58500
% de logements en banco ou paille	54	28	22	71	83
% en dur, semi-dur ou de villas	46	72	78	29	17
% de logements avec l'eau	57	63	77	22	29
% de logements avec l'électricité	81	65	78	36	44

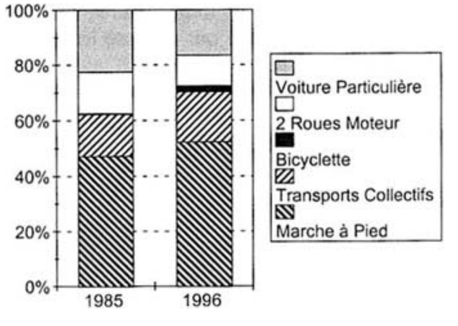
Ces zones présentent des profils socio-économiques différenciés. Les quartiers lotis se détachent largement du lot, tant par les revenus (Tableau 1), que par des taux d'accès aux réseaux d'eau et d'électricité, de confort du logement et d'équipement en moyens de transport (Figure 2) nettement supérieurs à la moyenne. A l'inverse, les quartiers non lotis et les « villages » se caractérisent par la pauvreté et la précarité des conditions de logement. Entre ces deux extrêmes, les quartiers centraux se rapprochent plutôt des zones les plus défavorisées du point de vue des caractéristiques socio-économiques des résidents, et des zones loties du point de vue de leur accès aux équipements et aux réseaux urbains.

3 MOBILITES DE VILLE, MOBILITES DE QUARTIER

L'offre limitée de transports collectifs et les faibles taux d'équipement des ménages en véhicules expliquent que la mobilité des Niaméens, 4,4 déplacements par jour de semaine en moyenne, repose essentiellement sur la marche à pied (68% des déplacements). Cette mobilité effectuée à pied est d'abord une mobilité de proximité : 46% des déplacements pédestres ne dépassent pas 5 minutes, 65% n'excèdent pas 10 minutes. Limité aux seuls déplacements mécanisés, le niveau de mobilité moyen tombe à 1,4 déplacement par personne. Compte tenu de la mobilité élevée des personnes motorisées, un jour donné de semaine, 60% des Niaméens de plus de 13 ans n'utilisent aucun mode mécanisé. Ces chiffres situent Niamey à proximité de Bamako (1,2 déplacement) mais très loin de Ouagadougou qui connaît un niveau exceptionnel de 2,8 déplacements mécanisés du fait notamment de taux d'équipement élevés en deux-roues, motorisés ou non (Diaz Olvera et al. 1998a).

L'usage des modes motorisés serait d'ailleurs stagnant à Niamey depuis une dizaine d'années, comme l'indique le point de repère fourni par l'enquête-ménages réalisée par le BCEOM en 1985 auprès de 694 ménages et 2551 individus de plus de 6 ans (BCEOM 1986). Certes, du fait de différences dans l'échantillonnage et le recueil de la mobilité, le rapprochement des deux enquêtes ne permet pas un diagnostic très précis, mais il semble tout de même que le niveau individuel de mobilité mécanisée a plutôt eu tendance à diminuer (1,3 déplacements en 1985 et 1,1 en 1996 à population comparable). Les déplacements motorisés au moyen de véhicules individuels (voiture ou deux-roues à moteur) tendent à décliner au profit des transports collectifs (Figure 3).

Une telle évolution est cohérente avec l'érosion de la motorisation. 50% des ménages étaient non motorisés en 1985, ils sont 58% en 1996, alors même que la taille des ménages s'est légèrement accrue. Ce tassement de la motorisation a aussi été observé à Abidjan du fait de la crise économique des années 80 (Godard & Teurnier 1992). Une telle évolution traduit les difficultés quotidiennes grandissantes des citadins. Elle accentue encore les effets de la crise, en limitant la capacité à sortir du



1985 : Population de plus de 6 ans (source : BCEOM, 1986)
1996 : Hors déplacements à pied de 10 minutes et moins, intégration des 7-13 ans (23% de la population totale), dont on suppose qu'ils réalisent 1,8 déplacement à pied de plus de 10 mn et 0,2 déplacement mécanisé par jour.

Figure 3. Répartition modale en 1985 et 1996

quartier ou en accroissant la pénibilité de telles sorties.

Ce repli sur le quartier ne touche pas également riches et pauvres, citadins du centre et des périphéries. Une partition des individus entre pauvres et riches a été effectuée en fonction de l'activité professionnelle et du niveau d'études individuels ainsi que du type de logement occupé par le ménage. La méthodologie retenue est la même que celle utilisée pour Bamako et Ouagadougou (Diaz Olvera *et al.* 1998a). Le choix de ne pas retenir le revenu dans ce processus repose d'abord sur le constat que près de 30% des actifs n'ont pu ou voulu fournir ce renseignement. Ce choix permet aussi de prendre en compte une relative permanence des conditions de vie, au-delà de la fausse précision d'un revenu mesuré à un moment donné, alors qu'avec la crise et les politiques d'ajustement structurel, le poids du salariat diminue au profit des activités informelles aux revenus aléatoires (Antoine 1996). Même si les deux groupes sont hétérogènes, la méthode utilisée conduit à des écarts sensibles entre leurs revenus moyens : les actifs pauvres gagnent en moyenne 29 000 FCFA contre 119 000 FCFA pour les 20% de « non-pauvres ». Par abus de langage, nous qualifierons ces derniers de « riches », bien que cette catégorie intègre, aux côtés de personnes très aisées, des actifs aux revenus moyens.

Ces différenciations socio-démographique et spatiale des citadins se traduisent par des écarts perceptibles dans les niveaux de mobilité mécanisée (Figure 4), mais aussi dans la fréquentation de la ville ou l'usage des modes.

La Figure 5 permet ainsi de caractériser chaque groupe par le pourcentage de « sédentaires » (individus ne s'étant pas déplacés la veille), de « mobiles de proximité » (qui ne sont pas allés plus loin que leur quartier ou les quartiers limitrophes) et enfin de « mobiles au long cours », pratiquant une mobilité de ville (qui ont dépassé les quartiers limitrophes de leur domicile).

La Figure 6 distingue parmi les mobiles de

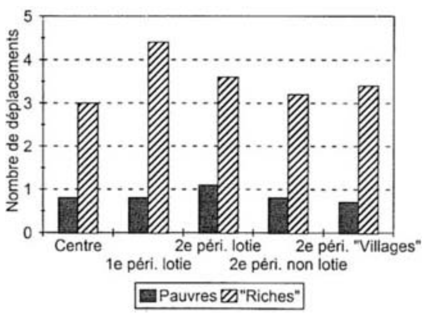


Figure 4. Mobilité mécanisée selon le revenu et le lieu de résidence

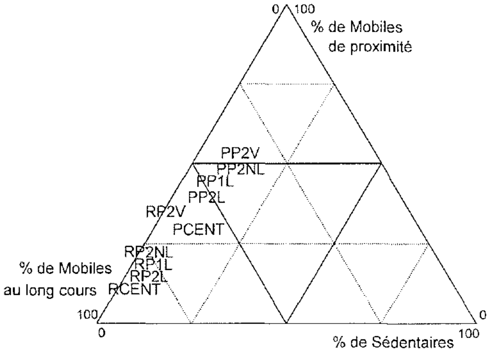
chaque groupe les pourcentages de personnes s'étant déplacées exclusivement à pied, de celles qui se sont déplacées en transports collectifs (et éventuellement, à pied) et enfin de celles qui ont utilisé un véhicule individuel (qu'elles se soient ou non déplacées en transports collectifs ou à pied).

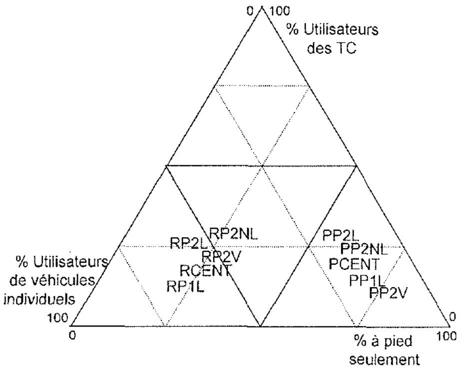
Ces différents indicateurs mettent en évidence une nette séparation des pratiques des riches et des pauvres. Elle porte sur les niveaux, puisque la mobilité mécanisée des groupes de pauvres est très inférieure à celle des riches, mais les écarts de structure sont également très marqués. Le taux de sédentaires est plus élevé pour les pauvres, tout particulièrement pour ceux résidant au centre et en deuxième périphérie non lotie, que pour les riches.

Les écarts entre groupes portent aussi sur la répartition entre mobiles de proximité et « mobiles au long cours », les riches, avec trois quarts de mobiles au long cours constituant cependant une population plus homogène que les pauvres. D'un point de vue modal, les riches peuvent échapper plus facilement que les pauvres à la « fatalité » de la marche, au bénéfice de l'usage des véhicules individuels. Conséquence des insuffisances de l'offre que nous évoquions précédemment, le taux d'utilisateurs des transports collectifs reste faible quel que soit le groupe, et varie peu entre pauvres et riches. Ces écarts majeurs entre groupes relevant de différences socio-économiques entre riches et pauvres ne doivent toutefois pas occulter les effets associés à la localisation de l'individu dans le espace urbain.

Dans les zones loties, les individus aisés, « mobiles au long cours » par excellence, ont généralement accès à la voiture pour leurs multiples déplacements quotidiens en ville. C'est parmi eux qu'on trouve le plus faible usage de la marche, notamment pour les petits déplacements, et en moyenne les trois quarts de leur budget temps-transport (environ 1 heure) sont imputables à l'usage des modes mécanisés. Contrairement aux riches, la quasi totalité des pauvres sont des marcheurs exclusifs, avec cependant un usage des modes mécanisés croissant avec l'éloignement du centre qui les amène à en être les plus forts utilisateurs parmi les pauvres. Ce phénomène concerne toutefois principalement des actifs, voire quelques scolaires, et pèse plus lourdement sur les résidents de la deuxième périphérie.

Les habitants pauvres des villages font en moyenne plus d'un déplacement supplémentaire que leurs voisins des périphéries non loties. Les citadins pauvres des villages comme des périphéries non loties se caractérisent par le recours peu fréquent aux modes motorisés, trait plus net encore dans le cas des villages. La mobilité plus élevée des villageois repose alors uniquement sur un usage plus développé de la marche à pied aux alentours du domicile. Ce repli des villageois sur le quartier





PCENT	Pauvres du Centre	RCENT	Riches du Centre
PP1L	Pauvres en Périphérie 1ère couronne lotie	RP1L	Riches en Périphérie 1ère couronne lotie
PP2L	Pauvres en Périphérie 2ème couronne lotie	RP2L	Riches en Périphérie 2ème couronne lotie
PP2NL	Pauvres en Périph. 2ème couronne non lotie	RP2NL	Riches en Périph. 2ème couronne non lotie
PP2V	Pauvres en Périph. 2ème couronne villages	RP2V	Riches en Périph. 2ème couronne village

Figure 5. Mobilité spatiale des « riches » et des pauvres, selon le lieu de résidence

Figure 6. Formes d'usage des modes de transport des différents groupes

concerne notamment les déplacements liés à la vie quotidienne (achats, religion, démarches, accompagnements), marquée chez les hommes par des taux extrêmement élevés de déplacements liés à la pratique religieuse (1,6 déplacement en moyenne contre 0,7 déplacement dans les périphéries non loties) et chez les femmes par l'approvisionnement en eau (respectivement 0,6 et 0,3 déplacement, l'achat aux vendeurs ambulants étant plus fréquent dans les périphéries non loties que dans les villages).

Par leur mobilité, les résidents du centre apparaissent comme les citadins les plus ouverts sur la ville, alors même que le taux d'utilisateurs des modes motorisés n'y est pas supérieur à la moyenne. Cependant, des différences apparaissent dans les niveaux moyens de mobilité quotidienne, les riches faisant plus d'un déplacement supplémentaire et utilisant plus les modes mécanisés que les pauvres, pour un budget temps de transport à peine supérieur.

Le statut d'actif ne rime pas forcément avec une mobilité de ville lorsque l'on dispose de peu de moyens. La majorité des actifs pauvres travaille dans une zone assez proche de son lieu de résidence, un sur quatre travaillant même à domicile (artisans, petits commerçants, ou encore, dans les périphéries loties, personnel de maison vivant chez son employeur). Un actif pauvre sur deux a une mobilité de ville, généralement réduite à l'activité professionnelle, contre 80% chez les actifs plus aisés. A nouveau, l'éloignement du quartier de résidence au centre de Niamey a bien un effet sur l'usage de l'espace pour les différentes activités. Les actifs pauvres résidant dans le centre et en première périphérie lotie sont un peu plus nombreux à fréquenter la ville, ces déplacements étant aussi moins polarisés par le travail. En revanche, dans les périphéries de deuxième couronne, les actifs, dans l'ensemble plus pauvres, ont une pratique de la ville limitée à l'activité professionnelle.

Pour les citadins aux revenus individuels faibles ou inexistants, la centralité du lieu de résidence permet donc de s'affranchir, en partie, des contraintes financières dans les pratiques de mobilité quotidienne. Densité importante en emplois, en commerces et résidences et position centrale rendent réalisables des activités de diverses natures, les distances encore raisonnables à pied évitant de faire trop souvent appel aux coûteux modes motorisés. Ce n'est pas le cas des périphéries et notamment des périphéries non loties pour lesquelles la pauvreté des résidents est renforcée par le sous-équipement de ces quartiers et par l'éloignement qui limite concrètement les activités réalisables en ville.

4 CONCLUSION

Il apparaît à travers cette analyse que les inégalités de revenus ont une traduction spatiale très nette. Certes, le statut socio-économique (scolaire, actif, inactive mariée ou non...) définit très largement les rythmes et les contraintes quotidiennes qui structurent les modes de vie urbains et l'effet du revenu prime alors nettement sur la localisation de la résidence. Accéder à un revenu conséquent permet d'utiliser un deux roues-moteur, voire une voiture, de s'affranchir au moins partiellement des contraintes spatiales et temporelles et de développer des activités professionnelles et des relations sociales à l'échelle de la ville. Cette situation est le privilège d'une minorité. Le lot courant des pauvres se résume au contraire à une alternative entre marche à pied, parfois sur de longs trajets, et usage des transports collectifs contraint et limité du fait des effets conjugués de la faible solvabilité et des lacunes de l'offre de transport.

Pourtant des différences non négligeables ont pu être notées au sein de la population des pauvres, confirmant et précisant en cela les résultats mis en évidence par des travaux antérieurs sur Bamako et Ouagadougou (Diaz Olvera & Plat 1997 ; Diaz Olvera et al. 1999b). Les résidents du centre sont les plus favorisés, tant du fait d'un plus grand enracinement en ville que de meilleures conditions d'accessibilité au reste de l'espace urbain. L'éloignement du centre joue défavorablement sur les conditions d'accès à la ville, en renforçant encore les contraintes découlant du statut socio-économique, alors que le développement urbain basé sur la spécialisation fonctionnelle des espaces tend à accroître les besoins de se déplacer. C'est ainsi dans les zones non loties que le caractère multi-dimensionnel de la pauvreté urbaine apparaît le plus nettement. Dans ces quartiers, à la fois les plus pauvres par leur population, les moins facilement accessibles et les plus démunis en équipements de base, la pauvreté semble promise à se renforcer et à se reproduire. De même que le fait de ne pas être relié au réseau tend à renchérir le coût de l'eau, l'éloignement des principaux marchés implique d'acheter dans le quartier, vraisemblablement à des prix plus élevés, comme par exemple à Dar es Salaam (Diaz Olvera et al.1998b). Mauvais état des voies d'accès et coût prohibitif des transports motorisés (individuels ou collectifs) ne facilitent pas les échanges urbains, alors même que le sous-équipement des logements et des quartiers tend à en renforcer la nécessité.

Ce contexte défavorable à la mobilité renforce les tendance au repli sur le quartier et contribue à l'adoption par les ménages de stratégies de survie face à la crise présentant un caractère rationnel dans le court terme mais pouvant constituer à long terme un obstacle à la sortie de la pauvreté. Ainsi, par exemple, la sortie prématurée du système scolaire comme conséquence des coûts de transport élevés limite les chances d'accès à des emplois plus rémunérateurs. Néanmoins, ce repli sur le quartier peut être diversement vécu, selon le type de quartier et l'ancienneté dans la ville. La mobilité de quartier est sensiblement plus riche et plus diversifiée dans les villages que dans les périphéries non loties de structuration plus récente, et à la vie sociale moins développée. A la ruralité préservée des premiers, répondrait la citadinité inaboutie des seconds. Mais si elle peut être très diversement vécue selon les quartiers, la localisation très fréquente des pauvres dans les périphéries non loties tend dans tous les cas à pérenniser et à renforcer les inégalités de niveau de vie.

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A causal analysis of public sector working women's mobility in Navi Mumbai: Lessons for policy formulation

S.Gupta & A.K.Sharma
School of Planning and Architecture, New Delhi, India

ABSTRACT: The process of economic & social empowerment in developing countries is not only resulting in the redistribution of household activities and its associated labour on account of increased participation of women in gainful employment but also is setting into motion new arrangements for travel at the household level. The present paper attempts to determine the impact of economic empowerment of urban women on their mobility levels in Navi Mumbai, India. A three-fold change observed between the mobility levels of working and non-working women may have transport planning implications in the developing world.

1 INTRODUCTION

The policy of evolving an equitous society in developing countries has been a major policy thrust of most democratically elected governments in developing countries and International agencies. The national and global efforts in equitous development of gender have largely focussed on the individual empowering of women in conformity with her life cycle needs of literacy, family welfare programme, child development programmes which has enabled them to regulate their fertility levels and participate fully in community development programmes etc. Whilst empowering of women has led to improved quality of life and creation of a social mix characterized by a large middle income group, reduced household size and increasing economic surpluses etc. their issues of mobility, intrinsically linked with income, empowerment and improved literacy, particularly in the context of women, have received little attention in the research efforts in the developing environments.The Indian Government has also prepared a Draft National Policy for the Empowerment of Women whose objective is to change societal attitudes, eliminate all forms of gender biased discrimination, incorporate gender perspectives into policies and ensure active participation of women in all spheres of life. A bold step has recently been taken to increase women's participation in decision making at the local level through the 73rd and 74th Constitutional Amendments. The impacts of these policies on the mobility needs and level have not received the due consideration in mobility research.

The review of the trends in women's development in India does suggest a positive impact of the above-cited policies. The literacy levels amongst the women have risen from 18.7% in 1971 to 39.42% in 1991. Similarly the participation levels of women in the work force doubled from 11.06% in 1971 to 22.30% in 1991. The increasing participation of women in work force has necessitated the need for assessing the mobility needs and levels of working women.

Working women in India are reflective of the changing labor distributions of the household labor. The implications of the women's desire to explore are many and can be addressed separately and do not form a part of this effort. The reported research aims towards identifying the causal factors associated with women's mobility. The paper is based on an empirical study of 200 working women employed in public sector offices in CBD Belapur of Navi Mumbai in Maharashtra State. The selected case study area is component of one of the fastest growing metropolises in India with high female work participation rates and reflects the typical middle income nucleated household structure working women sets.

2 WOMEN'S MOBILITY RESEARCH IN INDIA AND ABROAD

Mobility research in India have been largely dependent upon household travel surveys undertaken for the preparation of long range transportation plans clearly establishing the inequities that existed between genders (SPA; 1990, 1997). The classical analysis undertaken could not enable the identification of causal factors for the observed inequities. Activity diary studies undertaken in India (Sharma

& Gupta, 1996; Gupta, 1990; Gupta, 1995) did confirm that mobility across genders is more closely related to the household labor distributions and thus the women's mobility is confined to her immediate neighbourhood. International comparisons on women's mobility did reflect the inadequacies, limitations and methodological issues observed during the comparative analysis and stressed for a concerted effort at the international level for appreciating the mobility levels in developing environments. Sharma and Gupta (1998) contributions on women's mobility in Indian cities revealed that there were apparent inequities in urban travel in relation to gender which could be alleviated through the development of several non transport solutions rather than improving the transport systems in urban areas. In continuation of the earlier research, the present effort is directed towards the study of mobility patterns of working women in relation to their differential levels of empowerment. The appreciation of these will enable a more in-depth appreciation of the causal factors and their implications on women's mobility and identify issues thereof in order to frame appropriate policy framework.

Several studies in the past decade in developed countries have found that the work trip is shorter for women than men (Gordon et.al, 1989). This result holds across countries, inspite of differences in public transport versus automobile use and in female labour participation rates. Although explanations of this result vary among researchers, the unifying general argument is that women suffer from several constraints that limit the distance between home and work: income and occupational constraints; home & family commitments and labour market constraint travel patterns of working women. In an another study conducted by Gordon et.al (1989) it was observed that women consistently have shorter work trips than men, regardless of income, occupation, marital and family status, mode of travel or location, and that women undertake more non-work trips than men. Further the results did not support the arguments that women cannot afford to take longer work trips because they suffer from lower wages, restricted accessibility, heavy representation in poorly paid but spatially dispersed occupations and the need to allocate more time to family members. A more plausible explanation put forward for the shorter work trip length was in terms of choice, reflecting an optimal allocation of the household's (or individual's) time and resources, compensating for more time spent on non work travel, and taking account of the probability that the income gain from extending the work trip is not large enough to justify the additional commuting costs. Fox (1983) in his study concluded that working women with children have shorter time duration for work, household and leisure trips. Further time and activity patterns study, revealed that given time savings, women might make different travel choices. Gupta (1990) and Sharma & Gupta (1996) and in their studies on time allocation by women in metropolitan city on Nagpur in India observed that employed women prefers to spend less time on personal care, household activities and leisure and prefers to increase time allocations to meet her work obligations. Further examinations and comparative time allocations by working women and men for travel reflects a variation of more than 50 percent. Female workers also generally tend to avoid peak hours by commuting in hours succeeding or preceding the peak hours thus signifying the need for safe support infrastructure for her full participation in economically gainful opportunities.

3 PROFILE OF WOMEN IN INDIA

Women in India accounted for nearly 48% of the total country's population of 846 million in 1991. Nearly 39% of the females in 1991 were literate which in context to males is much lower. As per 1991 census the work force participation rate of women is low i.e. around 23% compared to nearly 52% that of males. Further the majority of female work force (80%) is engaged in primary sector related employment activities compared to 64% in case of the males. There are also spatial inequities in the status of women across the country. According to the office of the Census Commissioner in India, out of a total 452 districts in India in 1991, only 37 districts managed to attain a high level of status for women in terms of female literacy rate, female work force in secondary and tertiary sectors, sex ratio, proportion of females in urban areas to total female population and female mean age at marriage. In another 57 districts women status has been measured as intermediate. Over 350 districts did not score well on the gender equity scale, with the status of women being very low. Table 1 shows the trends in demographic and socio-economic characteristics of women in India.

According to UNFPA while the income levels are low in general, the women's access to income and

Table 1. Trends in demographic and socio-economic characteristics of women in India

Year	Female Population (million)	Female literacy (%)	Female work force participation rate
1971	264.1	18.70	11.06
1981	321.3	24.82	13.99
1991	406.3	39.42	22.30

Source: Census of India, 1991

control over economic resources is even worse. Although most women work, their work tends to be invisible and under-rewarded. As a result fewer women are counted in the labour force and fewer still in the non-agricultural activities.

4 STUDY AREA PROFILE AND DATA BASE

4.1 *Study Area*

Navi Mumbai with a population size of 0.30 million (1991), covering an area of 344 sq. km. and 0.3 million size (1991), is being developed on the mainland across Mumbai harbour as a counter-magnet to Greater Mumbai. The development of Navi Mumbai envisaged a nodal settlement pattern strung out on principal transport corridors. There are about 30 urban nodes, which have been planned in Navi Mumbai, of which only eight have been developed so far.

CBD Belapur, one of the eight nodes developed so far, is located in the centre of Navi Mumbai. The node with a population size of 29298 (1995) has an estimated 46% women population. Nearly 56% of the population are employed in this urban node. CBD Belapur is connected to various parts of Mumbai by the public transport system operated by BEST and MSRTC, besides Central Railways line. There is also an Inland Water Transport service between CBD Belapur and Gateway of India.

4.2 *Data Base*

A primary survey of 200 working women employed in 15 public sector offices in CBD Belapur was conducted out of an estimated 649 women employee. Details of the personal information trip information and activity patterns were collected from the respondents in addition to certain attitudinal information relating to transport system's quality. In addition trip information of 214 non-working women from 150 households in CBD Belapur was also collected for comparison purposes.

5 CHARACTERISTICS OF WORKING WOMEN

5.1 *Socio-economic characteristics*

The salient socio-economic characteristics of working women (Table 2) indicate that 85% of the women are married. One fourth of the women did not have children. Majority of them (78%) are at least graduates. Most of the working women (60%) are employed as 'clerks' in various offices. The average age of the respondent was observed to be 33 years while her average income was Rs. 6259 per month.

Table 2. Socio-economic characteristics of the working women in CBD Belapur, Navi Mumbai

Characteristics	% of women
Age(years)	
<25	18.5
26-30	17.0
31-35	23.0
36-40	28.5
41-45	9.5
>45	3.5
Marital Status	
- unmarried	15.5
- married	84.5
Education	
- below graduate	22.5
- graduate	65.0
- post graduate	12.5
Occupational Status	
- clerk	60.0
- officer	24.5
- professional	13.5
- others	2.0
Number of children	
0	25.0
1	37.5
2	35.0
2+	2.5
Vehicle ownership	
0	68.0
1	31.0
1+	1.0
Personal income(Rs./month)	
<5000	21.5
5001-7500	52.0
7501-10000	20.5
>10000	6.0

5.2 *Activity time allocation*

Many interesting patterns of social life are associated with the temporal distribution of human activities. The activity participation behaviour is responsive to the complex needs and desires of individuals and households. Time budget studies of activity patterns provides an insight into relative importance of different activities in terms of time spent and the constraints to which people are subjected. Table 3 shows the time allocations of working women in the case study area to various activities. It is evident that nearly 57% of the daily time available to working women is utilised in meeting obligatory duties. The activity time allocation of working women in the study area compares favourably well with that observed for Nagpur, a metropolitan city in India

Table 3. Time allocations of working women to various activities in CBD Belapur, Navi Mumbai

Activities	% of daily time allocated
Work	34.0
Household activities	19.0
Child care	4.0
Personal care (incl. Sleep)	32.0
Leisure and Recreation	7.0
Travel	4.0

Table 4. Salient Mobility Characteristics of the working women in CBD Belapur, Navi Mumbai

Characteristics	Work Trip	Non-work Trip	Overall
Per capita rate	2.0	2.5	2.1
Average trip length(km)	12.1	7.6	10.8
Average trip time(min.)	26.9	20.4	25.1
Daily travel distance(km)	24.2	19.0	22.6
Daily travel time(min.)	53.8	51.0	52.8
Trips by mode(%)			
- car/two wheeler	2.0	22.3	8.5
- auto/taxi	1.0	13.2	4.9
- bus	20.5	23.3	21.4
- train	65.5	12.7	48.6
- walk	6.5	27.4	13.2
- others	4.5	1.1	3.4

(Gupta, 1990) wherein about 50% of the daily time was spent by the working women on obligatory duties. The time spent on travel in CBD Belapur accounts for only 4% of the daily time available as compared to 2.4% in Nagpur, the difference primarily on account of long home to work travel distances in CBD Belapur compared to Nagpur.

5.3 *Mobility Characteristics*

The salient mobility characteristics of the working women in the study area are shown in Table 4.

It can be seen that a working woman on average travels for 23 km spending 53 minutes on travel every day. Majority of the women (82%) commutes for distance exceeding 10 km for their work trip. The maximum trips to work (76%) are made using mass transport systems like train and public bus followed by 10% using chartered and institutional buses which clearly indicate the preferences for mass transport systems by working women for long work journeys. The average trip lengths for train, public bus, chartered bus and company bus for work trips were observed to be 15km, 7km, 11km and 9km respectively However for non- work trips, the priority modes are personalised modes like cars and two wheelers (50%), mostly accompanied trips, followed by buses (23%) and train and IPT modes with a share of 13% each. The study also revealed that unmarried working women prefer more of safe and reliable transport systems like train and buses.

5.4 *Impact of socio-economic factors on mobility levels*

The variations in mobility levels of working women on account of various socio-economic factors are shown in Table 5. It is observed that with increase in age, the mobility rates of working women decline and so do her daily travel distance and time. Further increased educational status does effect the spatial search areas of these women in terms of increased travel distance and time, though inconsistently. In particular 'Post Graduate' working women trip rate is 26% more in comparison to an average working women trip rate. However it also observed that more literate working women also travel less distance daily possibly on account of their close proximity to work and other activity areas from their place of residence.

Table 5. Variations in mobility levels of working women by demographic and socio-economic factors

Factors	Per capita Trip rate	Daily travel distance (km)	Daily travel time (min.)
Age(years)			
<30	2.1	24.6	53.1
31-40	2.2	22.2	54.2
>40	1.9	22.0	50.4
Education			
- Less than graduate	2.2	21.2	52.0
- Graduate	2.0	24.4	56.0
- Post graduate	2.7	17.5	40.0
Marital status			
- unmarried	2.1	20.0	46.0
- married	2.1	23.1	54.0
Number of children			
0	2.2	21.1	48.8
1	2.2	21.2	52.6
2	2.0	23.8	56.0
2+	2.2	29.5	61.8
Monthly income (Rs.)			
<5000	1.8	26.1	57.1
5000-10000	2.2	22.4	53.3
>10000	2.6	16.9	39.8
Average	2.14	22.6	52.8

Married women in comparison to unmarried women are more mobile in terms of their spatial search areas. The study also observed that working women's mobility does not seem to decline with increasing number of children she possesses, on the contrary it shows an upward trend particularly in terms of total travel distance which in '2+ children' category is 31% more than the average working women's daily travel distance. This is strikingly in contrast to the popular belief (Gordon et.al.) that with increasing number of children, the time for obligatory duties for working women increases thus releasing little time for her to undertake travel. It is also observed that per capita income does significantly affect-working women's mobility. In particular the highest per capita income category (Rs. 10,000 +) working women's trip rates are 22% more than the average working women's trip rate. However working women belonging to higher income category also travels lesser distance (25%) and spends lesser time (25%) in traveling compared to an average working women possibly on account of factors such as her proximity to work and activity areas from place of residence and her ability to purchase higher speeds for commuting. The average trip lengths for work trips are highest in case of lowest per capita income group (14 km) compared to highest group (8.5 km) indicating spatial mismatches between distribution of low paid female jobs and locations where low income women live.

6 COMPARATIVE ANALYSIS OF WORKING & NON-WORKING WOMEN'S MOBILITY

A comparison has been made in the mobility levels of working and non-working women in order to assess the likely effects of economic empowerment of women (Table 6). It can be observed that there is a threefold increase in the mobility levels on account of economic empowerment.

While the per capita trip rate of working women in case of work trip is 3.5 times that of non working women, the daily travel distance and travel time are 12.5 and 8.5 times that of non-working women. The differentials in mobility levels are marginally less in case of non-work trips but still significant enough indicating that with economic empowerment, the mobility of women could improve substantially.

7 ISSUES IN POLICY FORMULATION

The implications of literacy and economic changes due to economic empowerment are significant on the mobility levels of working women. Further a more detailed enquiry is still warranted in the case of working women 'with and without children' as the observed finding appears to be in contrast to the generally agreed understanding that motherhood restricts the mobility levels in the case of working women. This may be attributable to her enhanced economic capability of developing non-transport arrangements for the welfare of her children in family and in society.

Table 6. Mobility comparison of working and non-working women in CBD Belapur, Navi Mumbai

Mobility Indicators	working women	non-working women	% variations
a. All trips			
Per capita rate	2.14	0.61	+ 250.8
Average trip Length (km)	10.70	3.00	+ 256.7
Average trip Time (min.)	24.80	10.00	+ 148.0
Daily travel Distance (km)	22.60	1.80	+1155.0
Daily travel Time (min.)	52.80	6.10	+ 766.0
b. Non-work trips			
Per capita rate	2.50	0.61	+ 309.8
Average trip Length (km)	7.60	3.00	+ 153.3
Average trip Time (min.)	20.40	10.00	+ 104.0
Daily travel Distance (km)	19.00	1.80	+ 938.0
Daily travel Time (min.)	51.00	6.10	+ 678.7

The comparative analysis of working & non-working women's mobility in this study reveal that economic empowerment coupled with improvement in literacy levels could result in three to four fold increase in an average women's mobility. Women's empowerment should therefore be both an objective in itself and a mechanism to achieve government's welfare goals. In order to assist in empowerment of women and free them from some of their gender related shackles, it will be necessary to provide support services like crèches, working women's hostels and other benefits.

The time and activity patterns study of the working women reflects greater obligatory time requirement which in this paper reflects lesser time for travel in comparison to those observed in more developed societies. Given time saving it is quite possible that working women might make different travel choices. Further it is observed that there are spatial mismatches between distribution of low paid female jobs and locations where low income women live resulting in longer commuting for more trips incurred by low income women compared to high income women. However this aspect of spatial mismatch and its implication on working women's mobility needs to be further examined. The study also reveals that working women are greatly dependent on the safe, reliable & affordable mass transport systems for their long work trips journeys indicating the need for policy planners to incorporate their mobility needs while planning for improvement in the mass transport systems.

Finally in order to fulfill her travel demands, women not only need proximity of employment and community service and available transportation, they need new timing policies for work and household in order to release time for travel. Also in light of the improvement in mobility levels observed on account of the empowerment of women, it is necessary to evolve appropriate analytical methods and policies, which incorporates transport requirements of working women in urban areas.

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Les pauvres dans leur quartier d'habitation: localisation, fréquentation et représentations

Living areas of the poor: Location, frequenting and mental représentations

Los pobres en su barrio: Localización, frecuentación y representaciones

C.Clement

Laboratoire d'Economie des Transports, Lyon, France

RÉSUMÉ: L'étude de la mobilité urbaine quotidienne associée à celle des représentations spatiales permet de mettre en évidence certaines relations des citadins avec l'espace urbain, en termes d'activités pratiquées ou de critiques de l'environnement. Les deux approches permettent notamment de comprendre des logiques comportementales par rapport à des contraintes socio-économiques fortes. Ainsi, nous montrons ici que la population pauvre d'une capitale d'Afrique de l'Ouest voit la plupart de ses déplacements restreints au quartier d'habitation. Or ce dernier se situe généralement à la périphérie des quartiers lotis et centraux, c'est-à-dire de ceux qui possèdent les services urbains. En conséquence, alors que leur quartier d'habitation regroupe l'essentiel de leurs lieux de fréquentation, il ne peut satisfaire des besoins liés à la vie en ville et les exigences exprimées à son égard reflètent les représentations de ces populations sur cet espace spécifique.

ABSTRACT: The study of the daily urban mobility, linked to the analyses of spatial representations enlighten some of the relationships between citizens and urban space, in terms of the activities or value judgments concerning the environment. Both of these approaches permit us to understand notably the behavioural logic in relation to strong socioeconomic constraints. Thus, we show here that the movements of a poor population of an West-African capital are restricted to the district in which they live. Moreover, generally, the latter is located in the outskirts, far from the developped areas and the town centre, that is to say far from urban services. Consequently, while their living districts bring together the essential of their meeting places, they can't satisfy the needs linked to town life and the demands made upon their district reflect the representations of these population to these specific locations.

RESUMEN: El estudio de la movilidad cotidiana urbana, asociado al de las representaciones espaciales, pone en relieve las relaciones de los habitantes con el espacio urbano, en términos de actividades practicadas o de críticas al entorno. Estos dos temas permiten comprender las lógicas de comportamiento con respecto a las obligaciones socio-économicas. Así, mostramos que la población pobre de una capital del Africa Occidental ve sus desplazamientos restringidos a su barrio de habitación. Pero éste se encuentra generalmente en la periferia de los barrios urbanizados y centrales, es decir, aquellos con servicios urbanos. En consecuencia, el barrio de habitación constituye el principal lugar de frecuentación pero no puede satisfacer las necesidades de la vida urbana y los requerimientos que le son demandados reflejan las representaciones de los habitantes a su respecto.

1 INTRODUCTION

1.1 *Le quartier d'habitation : un espace particulier dans la ville*

Au quotidien, les relations hommes-espace urbain peuvent être abordées sous deux aspects, le premier relatif à la pratique de la ville, le deuxième aux représentations spatiales qui lui sont associées. Tout d'abord, l'étude de la mobilité quotidienne urbaine permet de mettre en évidence les activités journalières des citadins hors de leur logement. Celles-ci se déroulent généralement dans le périmètre de la ville mais ne s'y répartissent pas aléatoirement. En fonction, non seulement du contexte urbain, mais également des caractéristiques socio-économiques des individus, les citadins privilégient certains lieux dans leurs déplacements. Ensuite, le second aspect se rapporte aux représentations spatiales dont le rôle est de juger, de critiquer et d'interpréter constamment l'environnement (Richard & Richard 1993). En ce sens, elles sont directement associées à la mobilité urbaine, par des liens de cause à effet : les représentations aident au choix des lieux fréquentés et la mobilité modifie elle-même les jugements portés sur les lieux. En somme, les représentations spatiales, la mobilité quotidienne et leur articulation constituent le noeud des rapports journaliers de l'homme avec son espace.

Or, ces derniers dépendent du lieu sur lequel ils portent. Le centre-ville, le quartier des affaires, celui des lieux de sorties par exemple, seront interprétés différemment. C'est pour cela que, dans les pratiques quotidiennes comme dans les représentations, le quartier d'habitation tient une place particulière.

Car une grande partie des usages de l'espace urbain se déroule dans le quartier d'habitation. Celui-ci, entre domicile et espace urbain, constitue « un espace de contact » entre l'individu et la ville, entre le citadin et la société (Frémont 1982). Dans ce cadre, loin d'être une réalité concrète sans valeur, il est chargé affectivement et socialement de connotations particulières, dépassant sa simple fonctionnalité. *A priori*, il est un endroit familier où l'individu a des repères facilement identifiés et qui sert de miroir à sa propre identité (Noschis 1984). Mais les situations sociales et économiques, les contraintes financières modifient les relations des citadins à leur quartier.

En particulier, des études sur la mobilité quotidienne en Afrique de l'Ouest ont montré l'importance du niveau de revenus, que ce soit Godard (1997) en général sur le sous-continent ou Diaz Olvera et Plat (1997) sur Bamako et Ouagadougou par exemple. C'est également le cas pour les représentations spatiales, notamment parce qu'elles dépendent des modes de transports utilisés et donc de la richesse de l'usager (Bailly 1977). En conséquence les pauvres vont élaborer des relations particulières avec leur quartier par rapport aux populations plus favorisées : c'est cette spécificité que nous tentons ici de mettre en lumière.

1.2 *Lieu de l'étude et recueil de données*

Notre étude porte sur la ville de Niamey, capitale du Niger en Afrique de l'Ouest.

Une enquête ménages a été réalisée auprès de 750 ménages de la ville (Diaz Olvera et al. 1999). Elle a permis le recueil d'informations sur la composition démographique des ménages et sur les caractéristiques des logements. Pour chaque individu de plus de 13 ans, elle indiquait également, entre autres :

- des caractéristiques socio-économiques classiques, les possibilités d'accès au(x) véhicules du ménage ;
- les déplacements (motif, horaire, mode de transport, origine-destination) réalisés la veille du jour de l'enquête, qu'il s'agisse d'un jour de semaine ou de week-end ;
- les trois qualités principales d'un quartier d'habitation parmi huit proposées ("on a des parents et des amis comme voisins", "le quartier est à proximité du lieu de travail", "le quartier est sûr", "on dépense peu d'argent pour se loger", "il y a de la place dans les concessions", "on est raccordé aux réseaux d'eau et d'électricité", "le quartier est calme").

Dans le document présenté ici, les données sur la mobilité quotidienne font référence aux déplacements de la veille et ne concernent que les jours ouvrables.

2 LES PAUVRES DANS LA POPULATION ETUDIEE

Nous n'étudions ici que les chefs de ménage (hommes ou femmes) et leurs épouses éventuelles, puisque ce sont eux qui ont en charge l'entretien du ménage et qui prennent les décisions le concernant. Leurs relations à l'espace de proximité en termes de représentations et de pratiques sont particulièrement intéressantes.

Globalement, nous étudions une population de 726 femmes (dont 92 chefs de ménage) et de 634 hommes. Nous avons distingué trois niveaux de revenus en fonction du revenu moyen déclaré et de la répartition des individus autour de cette moyenne. Il est à noter ici que, 278 individus n'ayant pas déclaré leurs revenus, ces derniers ont été reconstitués après enquête en fonction de leur catégorie socioprofessionnelle. En définitive, les individus "pauvres" gagnent moins de 50 000 FCFA par mois, les individus "modestes" entre 50 et 100 000 FCFA et les individus "aisés" plus de 150 000 FCFA. Ainsi, plus de la moitié des individus sont pauvres, alors que 10 % seulement sont aisés.

La répartition des femmes selon le niveau de revenus montre que seules 13 ont des revenus élevés et peuvent être classées parmi les individus aisés (tableau 1). L'effectif est ici trop petit pour que nous puissions effectuer des traitements statistiques et nous comparons uniquement les femmes à revenus modestes et les pauvres. L'importance de ces dernières s'explique par le fait que le taux d'activité des épouses est faible puisque moins d'un tiers d'entre elles occupent un emploi. Leur revenu mensuel est dans ce cas de 52 000 FCFA en moyenne. Ce chiffre cache en réalité de profondes disparités entre les actives puisque seules quelques épouses sont aisées alors que la majorité de cette population tient de petits commerces lui rapportant uniquement des revenus d'appoint. Ces épouses pauvres représentent ainsi plus de 60 % des épouses actives et ne gagnent en moyenne que 26 000 FCFA par mois. En ce qui concerne les femmes chefs de ménage, leur situation financière est encore plus défavorable puisqu'elles sont généralement pauvres. Or leurs ménages reposent uniquement sur leurs revenus alors que, pour les épouses, les dépenses du ménage et du logement sont assurées en partie par le salaire de leur mari.

Pour les hommes, les situations sont plus variées, puisqu'ils sont plus largement actifs (86 % de l'échantillon masculin l'est effectivement) et ils occupent dans ce cas tout type d'emploi dans tous les secteurs, que ce soit dans le formel ou dans l'informel, dans le public ou dans le privé. Ainsi, la répartition des revenus dans ce groupe est telle que nous pouvons comparer les trois catégories de revenus (tableau 1). En moyenne leurs revenus s'élèvent à 106 000 FCFA, il est donc deux fois supérieur à celui des femmes. De plus, les hommes actifs sont plus riches que les femmes actives puisque seuls 46 % des premiers sont pauvres. De même, quel que soit le niveau de revenus, l'écart entre ceux des hommes et des femmes reste à l'avantage des premiers.

Les pauvres sont ainsi majoritaires dans la population étudiée. Ils occupent donc une vaste part de l'espace urbain. Mais les contraintes financières auxquelles ils sont soumis ne leur permettent pas un accès à tous les quartiers de la ville, ainsi que le montre l'étude de la localisation de leur habitat et celle de leur mobilité quotidienne.

3 LOCALISATION DE L'HABITATION DES PAUVRES

3.1 *Typologie des quartiers de la ville*

Afin d'effectuer l'enquête ménages à Niamey, il a été réalisé un découpage géographique de la ville. Ce dernier s'appuie sur les travaux de Jambes (Jambes 1996) ainsi que sur les données du recensement de la population de 1988. Il permet de distinguer 5 types de quartiers identifiés par leur position géographique, l'ancienneté de l'urbanisation, la composition sociale de leur population et les caractéristiques de l'habitat (Diaz Olvera et al. 1999). Ces groupes sont les suivants (fig. 1) :

- le centre, bien desservi et bien équipé regroupant les anciens quartiers denses. Il comprend les deux grands marchés de la ville et la mairie centrale ;
- le péricentre, également dense et populaire, proche des voies bitumées ;
- la périphérie lotie rassemblant des populations de classes moyennes et pauvres éloignées du centre ;
- les quartiers riches constitués de zones où la population est globalement plus riche que la moyenne ;
- la périphérie lointaine à habitat spontané peu accessible par la route, très éloignée du centre-ville et hébergeant les habitants les plus pauvres de la ville.

3.2 *Des pauvres repoussés loin du centre-ville*

Cette typologie, confirmée par les données de l'enquête ménages, montre la ségrégation économique et géographique entre les plus riches et les pauvres, ces derniers se retrouvant dans les nouvelles périphéries et notamment sur la rive droite du fleuve.

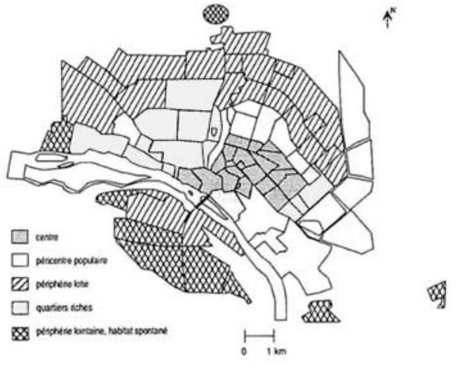
En particulier, en ce qui concerne les hommes, les individus aisés habitent plus largement dans la périphérie lotie ou les quartiers riches. Les hommes modestes logent également plutôt dans le péricentre mais peu dans les quartiers riches ou la périphérie lotie. Enfin, les plus pauvres habitent quant à eux les périphéries lointaines et le péricentre, et ils sont pratiquement exclus des quartiers riches. Si 6 % d'entre eux y résident, c'est qu'ils occupent des métiers de gardiennage dans les villas. En conclusion, plus les individus sont pauvres, plus ils sont éloignés du centre-ville.

Pour les femmes pauvres, ce phénomène est atténué puisque leur quartier d'habitation ne dépend pas totalement de leur propre revenu mais principalement de celui de leur époux éventuel. Elles habitent donc plutôt le centre-ville, les périphéries loties ou lointaines et le péricentre. Elles sont donc quasiment exclues des quartiers riches mais elles habitent dans tous les autres quartiers.

Cette exclusion des quartiers centraux entraîne des difficultés dans l'accès aux services administratifs tels que la Mairie ou aux grands marchés de la ville par exemple puisque le transport coûte cher. Ce dernier exemple montre comment la pauvreté est à l'ori-

Tableau 1. Répartition de la population en fonction du niveau de revenus (en %) et revenu moyen individuel par catégorie.

	Nombre d'individus	% / total par sexe	Revenu moyen déclaré de l'individu en FCFA
Femmes			
Pauvres	626	86	4 000
Modestes	87	12	91 000
Aisées	13	2	226 000
Hommes			
Pauvres	329	52	24 000
Modestes	236	37	97 000
Aisés	69	11	320 000
Total	1 360	100	47 000



Source : Laboratoire d'Economie des Transport, Enquête ménages Niamey, 1996

Figure 1. Typologie des quartiers de la ville de Niamey.

gine non seulement d'une localisation du quartier d'habitation spécifique mais également d'une fréquentation relativement plus exclusive de cet espace, ainsi que le confirme l'étude de la mobilité des pauvres.

4 FREQUENTATION DU QUARTIER D'HABITATION

L'analyse de la pratique quotidienne du quartier d'habitation passe à la fois par une approche en termes de répartition spatiale des déplacements et de modes utilisés, que nous l'analysons dans un premier temps, mais également de motifs de déplacements, étudiés dans une seconde partie.

4.1 *Rétrécissement de la zone pratiquée dans le quartier*

A priori, le quartier d'habitation est d'abord un lieu où l'on se déplace à pied, cependant la richesse permettant l'accès à des modes motorisés, il existe des disparités, même sur des petites distances, entre les modes de déplacements utilisés par les pauvres, les modestes et les aisés.

L'offre de transport public à Niamey est faible, les bus sont peu réguliers et principalement destinés aux fonctionnaires, les taxis restent chers pour les plus pauvres et ne desservent que rarement les quartiers de la périphérie lointaine. Sans accès aux modes motorisés, les plus pauvres se trouvent en conséquence contraints à se déplacer globalement moins mais proportionnellement plus dans leur quartier d'habitation que les autres. Cette observation se vérifie pour les hommes (tableau 2) comme pour les femmes. Cette importance relative est également vérifiée quant au nombre de déplacements dans le quartier : les individus, hommes ou femmes, se déplacent plus dans leur quartier d'habitation que les autres (voir le tableau 2 pour les hommes).

Enfin, en termes de modes utilisés dans les déplacements internes au quartier d'habitation, il existe également des différences entre les pauvres, les modestes et les aisés, notamment chez les hommes puisque ce sont eux qui ont accès, dans un ménage, aux modes motorisés. Ainsi, les individus aisés vont utiliser leur véhicule particulier dans près de la moitié de leurs déplacements internes ce qui ne sera jamais le cas pour les individus modestes ou pauvres qui n'en ont pas (fig. 2).

Tableau 2. Mobilité urbaine totale des hommes et part de la mobilité interne au quartier d'habitation en fonction du niveau de revenus (en %).

	Mobilité urbaine quotidienne (depl./jour/ind.)	Mobilité interne (depl./jour/ind.)	Part de la mobilité interne (%)
Pauvres	4,9	2,6	52
Modestes	6,7	2,0	29
Aisés	6,6	1,3	20

Cette observation montre que non seulement les individus pauvres sont contraints de concentrer une part de leurs activités sur le quartier mais sans doute également sur une partie plus restreinte autour de leur logement, celle accessible à pied.

4.2 *Concentration géographique des activités*

Les motifs de déplacements ont été repartis en trois catégories : la première se rapporte à l'exercice de la profession, et est notée "motifs professionnels" ; la deuxième est relative à l'entretien des relations sociales par les visites rendues, la participation à des événements collectifs et les loisirs (bar, cinéma...), elle est notée "motifs de sociabilité" ; la troisième concerne l'entretien quotidien du ménage grâce aux achats ou à l'approvisionnement en eau ainsi que la pratique religieuse, elle est notée "motifs domestiques".

A l'intérieur du quartier d'habitation, les différences les plus frappantes s'observent chez les femmes (tableau 3). Cependant, quel que soit le motif, les pauvres se déplacent plus dans leur quartier que les non pauvres.

En ce qui concerne les motifs professionnels, les hommes pauvres se déplacent plus que les autres dans leur quartier d'habitation. En fait, ce dernier a sans doute été choisi en fonction de contraintes financières qui impliquent des impératifs de proximité. Comme les deux ne sont pas toujours conciliables, le taux de déplacements internes pour ce motif reste peu important. En revanche, pour ce motif, les déplacements des femmes pauvres se déroulent autant dans le quartier que ceux des femmes modestes. En effet, ces dernières travaillent essentiellement dans la fonction publique, ce qui les oblige à aller dans les

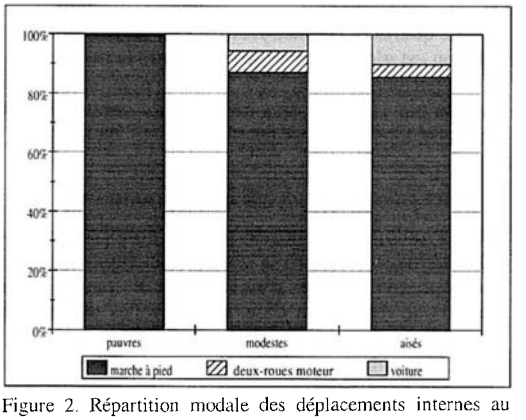


Figure 2. Répartition modale des déplacements internes au quartier d'habitation des hommes.

Tableau 3. Proportion de déplacements internes au quartier d'habitation dans la mobilité urbaine totale par motifs de déplacements (en %).

	Motifs professionnels	Motifs de sociabilité	Motifs domestiques
Femmes			
Pauvres	32	51	73
Modestes	32	40	27
Hommes			
Pauvres	21	44	77
Modestes	12	32	60
Aisés	8	23	39

quartiers centraux regroupant les services administratifs. Cependant, du fait de leur relative richesse elles ont plus accès à ces zones. Les actives pauvres sont, quant à elles, de petites commerçantes pouvant exercer leur métier à proximité de leur quartier mais cherchant également des lieux de passage comme les marchés centraux.

En outre, plus les individus sont riches, plus les déplacements pour motifs de sociabilité ont une extrémité hors de leur quartier. Mais le nombre moyen de déplacements pour ce motif par jour et par individu est le même quel que soit le niveau de revenus. En conséquence, la possibilité de se déplacer en ville implique bien un "éclatement" géographique de réseau social qui ne se restreint plus à la proximité du logement. Les pauvres au contraire, soit qu'ils aient cherché à se rapprocher des amis ou des parents, soit que les relations se soient créées après leur emménagement, privilégient leur quartier pour rendre des visites ou voir des amis.

Enfin, les déplacements des femmes pauvres et des hommes pauvres ou modestes pour motif de vie quotidienne, se déroulent majoritairement dans le quartier d'habitation. En fait, les individus aisés ont, à proximité de leur logement, peu de commerces puisqu'ils préfèrent les quartiers résidentiels tandis que les individus plus pauvres habitent des lieux plus populaires où, à cause des contraintes financières, ils favorisent la prospérité de petits commerces.

En conclusion, on observe une réelle concentration des activités et des lieux pratiqués de la part des populations pauvres sur leur quartier d'habitation. Une des corrélations en est le développement de représentations spatiales particulières, dans lesquelles cet espace occupe une place privilégiée.

5 L'IMPERATIF DE PROXIMITE

Les exigences exprimées vis-à-vis du quartier d'habitation varient également avec le revenu. Ainsi, le désir de déménager est plus important chez les aisés que chez les pauvres, notamment chez les hommes (tableau 4), ce qui s'explique en partie par le développement d'un sentiment fataliste pour ces derniers qui se sentiraient démunis et impuissants à modifier leur situation. Cependant, ce peut être aussi la conséquence de l'existence d'un réseau de relations dense sur le quartier, qui augmente l'ancrage affectif.

De plus, comme le désir de déménager est lié à la volonté de monter dans l'échelle sociale, les destinations envisagées dépendent du niveau de revenus : les plus pauvres désirent se rapprocher du centre ou du péricentre, les individus modestes préfèrent la périphérie lotie tandis que les aisés désireraient habiter ou rester dans les quartiers riches.

Les représentations spatiales sont également le reflet de l'importance du revenu dans les relations des citadins pauvres avec leur quartier d'habitation. Quel que soit le sexe, habiter un endroit peu cher reste une des priorités des pauvres : 31 % des hommes ou des femmes pauvres désigné ce critère comme étant important pour un quartier d'habitation alors que ce n'est le cas que d'environ 20 % des hommes et des femmes modestes et de 13 % des hommes aisés. Cette forte contrainte implique donc des exigences différentes entre les pauvres et l'autre partie de la population.

Ainsi, les hommes pauvres s'intéressent plus à leur quartier que les individus aisés en termes de services de proximité, ou de sociabilité par exemple, sans doute parce qu'ils souffrent plus des lacunes de leur environnement à ce niveau. De fait, si 64 % des hommes pauvres déclarent qu'il est important d'avoir des parents ou des amis comme voisins, ce n'est le cas que de 48 % des hommes modestes et de 29 % des hommes aisés. En conséquence, les individus aisés ou modestes ayant plus les moyens de se déplacer en ville ont des exigences relatives à la qualité de leur habitat et à son confort intérieur : un tiers des hommes pauvres pensent qu'être raccordé aux réseaux d'eau et d'électricité est important contre 46 % des hommes modestes et près de 60 % des hommes aisés par exemple.

C'est également le cas des femmes pauvres mais sur un autre aspect. En effet, elles cherchent surtout à éprouver un sentiment de sécurité et de calme là où elles habitent : 37 % d'entre elles choisissent le calme du quartier comme étant l'une des trois qualités les plus importante contre 31 % des femmes modestes. Ce désir vient du fait que les femmes pauvres se sentent sans aucun doute isolées dans leur quartier, elles désireraient avoir des relations de proximité plus denses qui les rassureraient et qui auraient l'avantage de représenter une assurance en cas de problème : les deux tiers des femmes pauvres déclarent qu'avoir des parents et des amis est important contre 56 % des femmes modestes. Or, plus que tous les autres, les pauvres sont ceux qui ont le plus de difficultés à entretenir des relations sociales basées sur les réseaux traditionnels car, d'une part, leurs capacités d'accumulation et de redistribution sont compromises et, d'autre part, ils ne peuvent pas aller chercher l'aide dont ils auraient besoin. Sur ce dernier point, nous avons en effet vu que pour les pauvres les déplacements pour motifs de sociabilité se déroulent plus dans le quartier d'habitation. De fait ils sont plus isolés socialement que les aisés puisqu'ils sont également isolés géographiquement.

6 CONCLUSION

Les ménages pauvres sont ainsi confinés à l'intérieur de leur quartier. Cette situation est liée au manque de moyens de transport et à la localisation de leur habitat dans les périphéries. Elle les empêche de fréquenter une ville qu'ils connaissent peu et vers laquelle ils ne voudront en conséquence pas obligatoirement aller. Ce cercle vicieux induit une représentation spatiale repliée sur le quartier d'habitation, de type villageoise où la proximité des services, des amis et des parents est primordiale. C'est elle qui, notamment pour les femmes, est la garante d'une certaine sécurité.

Au contact même de cet environnement, plus fréquemment que les ménages aisés, ils en ont une représentation concrète, avec des exigences pratiques (notamment chez les femmes). L'attachement au quartier est inhérente à cette situation car, du fait d'une fréquentation importante et quotidienne de son quartier « l'identité des habitants aura plus d'occasions pour se nourrir et les liens émotionnels avec le quartier pourront être forts » (Noschis, 1984, p.143). Mais il faut noter que cette attitude est aussi la conséquence d'un espace urbain plus subi que choisi, compte tenu des contraintes financières auxquelles ils doivent faire face et qui réduisent les choix du quartier d'habitation : on ne reconstruit « qu'après coup » un environnement sécurisant. Si, pour les aisés, il est plus facile de le faire, les pauvres, par exemple, ont besoin de faire référence à des repères plus traditionnels basés sur la solidarité.

La mobilité quotidienne qui en est à la fois une conséquence et une cause porte le reflet de ces représentations : le quartier d'habitation est un lieu de vie activement pratiqué. Ainsi, si ce quartier n'est pas pourvu en services, que ce soit en réseaux d'eau ou d'électricité, en dispensaires ou en écoles par exemple, les pauvres seront exclus d'une partie des avantages urbains. On peut ici supposer alors que les besoins de déplacements hors du quartier existent parce que les individus doivent aller travailler ou s'approvisionner par exemple. Mais ils ne peuvent que difficilement être satisfaits. Or les pauvres représentent la majorité de la population urbaine. Les solutions à proposer sont multiples pour limiter le développement de cette exclusion. Si l'on veut développer une politique en transports publics efficace en répondant aux besoins des populations et si les aménageurs veulent favoriser le développement d'une réelle cohérence urbaine en évitant la ségrégation sociale entre quartiers, il faudrait, par exemple, augmenter l'accessibilité des différentes parties de la ville pour ces populations isolées ou enclavées. L'amélioration du réseaux de transport public en termes de desserte et de coût en constitue sans aucun doute l'un des meilleurs moyens. Une autre solution peut être de favoriser le développement de petits centres à l'intérieur des quartiers, comprenant en partie des annexes des services urbains, tout en améliorant la qualité de desserte des réseaux d'eau et d'électricité. Elle permettrait l'accès à une certaine qualité de vie liée à la ville du plus grand nombre, et notamment des femmes pauvres, généralement inactives, pour qui ces services de proximité sont primordiaux.

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Mobility in the livelihoods of poor people
Mobilité pour les pauvres
Movilidad para la gente pobre

P.W.D.H.Roberts
Department for International Development, London, UK

P.R.Fouracre & D.A.C.Maunder
Transport Research Laboratory, UK

ABSTRACT: This paper examines the transport constraints of the urban poor, and reviews interventions that have been targeted specifically at these problems. Hence it identifies how transport contributes to the sustainable livelihoods of the urban poor, and what transport policy actions and initiatives can be implemented in support of urban poverty relief programmes.

RÉSUMÉ: Cet article analyse les problèmes de déplacements des pauvres urbains, et évalue les interventions qui visaient à atteindre ces problèmes. Il demontre le contribution de transport en la vie durable des pauvres urbains, et des politiques et des statégies de déplacements urbains pour réduire la pauvreté.

RESUMEN: En este articulo se presentan las limitaciones del transporte de la gente pobre en regiones urbanas y se examinan las medidas que se han tomado. Tambien se enfatiza la importancia del transporte para la vida del este sector de la poblacion y las acciones necessarias para aligerar los problemas.

1 INTRODUCTION

The British Government's policy on international development underlines a commitment to the elimination of poverty, in line with internationally agreed development targets (DFID, 1997). The strategy adopted by the Department for International Development (DFID) to achieve this aim has three main components:
- Policies and actions which promote sustainable livelihoods
- Better education, health and opportunities for poor people
- Protection and better management of the natural and physical environment

A sustainable livelihoods analysis is particularly useful for targeting poor people's needs. This approach is centred on people and their assets, and seeks to identify strategies by which they can improve their livelihoods through better access to basic needs and opportunities. A multi-sectoral approach is required to understand a community's livelihood strategies (based on their assets and opportunities) and the livelihood outcomes they are struggling to achieve. Transport is but one component in this framework, and its application may vary greatly with developments in other sectors.

In order to ascertain the best means of improving the transport network to the benefit of the urban poor the following issues need to be considered:
- The problems which the urban poor face regarding their access and mobility (including factors such as availability of transport, cost, safety, frequency of service, etc.), and how these impact on their livelihoods.
- The role for transport development as a means of benefiting the poorer members of society, and the experience in adopting these means.

Thus this paper examines the particular transport constraints of the urban poor, and assesses interventions that have been targeted specifically at these problems. Hence, it identifies how transport contributes to the sustainable livelihoods of the urban poor, and what transport policy actions and initiatives can be implemented in support of urban poverty relief programmes, and to what effect.

2 THE CHALLENGES

'Urban development can be a very positive element in a country's overall economic and social development.' Furthermore 'opportunities [in development] may be easier to take up in urban rather than in rural areas, whether because of economies of scale or because urban society is more fluid, less fixed in its ways, or more modern.' 'The success of many of the key objectives of development strategy are tied up in our approach and follow-through on urban issues.'(Various speakers from 'Cities in the 1990s', Harris, 1992.)

Urban areas are growing rapidly in the developing world. However, much of this growth is among the poorer sections of the community, many of whom have moved to the city in order to obtain employment and improve their living standards. In reality both migrants and indigenous urban poor are faced with the prospect of bleak livelihoods, and they may be forced to live in peripheral areas with few basic amenities and poor services. With continuing urbanisation it is likely that the sector of society known as the urban poor will increase substantially.

Within this context of increasing urbanization, the agenda for urban development contains three key challenges (Cohen, 1992), namely:

- Ameliorating poverty
- Enhancing productivity
- Protecting and improving the environment.

Ameliorating poverty requires an increase in the demand for labour (perhaps through encouraging labour intensive measures), investing in health and education, and providing 'safety nets' and compensatory payments to redress transitional problems. Enhancing productivity is constrained in the extent and provision of urban infrastructure, the enabling (regulatory) environment for the provision of infrastructure and services, the administrative capacity of local government, and the sourcing of finance. Safeguarding the environment, including aspects such as road safety, is of concern because it impacts directly on individual performance and productivity, and is clearly connected to urban poverty. Longer-term issues such as global climate change are also a major concern.

Improvements in access to employment opportunities, health-care, schools and other basic amenities are one means of addressing this urban agenda. As Gannon and Liu (1997) note, most direct policy-targeted interventions (schools, health clinics, social services, etc.) are dependent upon transport for their effectiveness. They argue that there is a need to strengthen the direct role of transport policy intervention in order to help reduce poverty.

The World Bank (1996) have suggested that the transport problems of the poor, particularly the urban poor, need to be addressed through:

- Directly targeting these problems
- Improving physical access to jobs and amenities and reducing "excessive" walking times.
- Reducing barriers to informal supply of transport (subject to reasonable safety levels).
- Enabling greater use of non-motorised transport by eliminating fiscal and financing impediments to vehicle ownership and improving infrastructure.
- Eliminating gender biases by integrating the transport needs of women into the mainstream of transport policy and planning.

More recent work to understand poverty, eg for the World Bank (1999), has underlined the need for employment. It has also stressed the importance of cost reduction and of greater security in eliminating poverty.

3 THE CONTEXT

Third World cities present a range of development characteristics, dynamic growth patterns, transport infrastructure and operations, and social customs that defy all but the broadest generalisations. Even so, it is important to understand the processes and interactions that drive transport demand if transport planners are to contribute positively to the general debate about urban development.

As cities expand travel demand grows at a disproportionately higher rate, mostly from the urban poor. It is also evident that trip movements become focused on corridor travel feeding into the city centre; once a city reaches a population of about 2-3 million, corridor flows may reach up to 20,000 passengers per hour per peak direction. Corridors and city centres which have to handle this level of demand are prone to endemic and prolonged road traffic congestion, because of the inadequate capacity of the infrastructure to carry both private and public vehicle flows. Public transport is potentially the most efficient carrier and that which serves the majority of travellers, but it cannot deliver an effective service in these conditions; journey times and waiting times become long and unreliable. In addition to the reduced productivity of vehicles, resulting in lower revenue earning potential, the financial position of operators is often weak. In these circumstances the prospect for improved public transport services is grim; operators cannot afford new investment when they can scarcely cover the depreciation on existing stock.

From the traveller's viewpoint the main concerns are adequate access to facilities in reasonable time at an acceptable service standard and at an affordable cost. Even in the short-term, transport planners and operators are struggling to satisfy these needs. In doing so they face mounting costs as central area access and congestion problems worsen with increasing city size.

The urban poor are very much at the centre of this environment, because they and are so dependent on public transport for their access and mobility. They have little option but to suffer the deteriorating service whilst all the resulting costs are disproportionately high for poor people in relation to their very limited assets. The very poorest of the urban poor, together with other transport disadvantaged like women and children, may not even have access to public transport to meet their access and mobility needs.

This situation will only deteriorate further as cities grow and options for further infrastructure development are limited by available finance and environmental concerns. Ultimately, if the transport system cannot respond to these pressures, then other land-use developments may take control, leading to unstructured and diffuse city growth, and even the atrophy of the city centre.

Various transport policy options have been adopted by different cities to address these issues, though there is little empirical evidence as to what effects these measures have had, particularly with regard to the travel needs of the urban poor. In any case, it is not always evident what the objectives are in introducing these measures, and hence it is difficult to judge their effectiveness.

4 IMPROVING THE ACCESSIBILITY OF THE URBAN POOR

There is a range of measures that could be adopted, either individually or as a package, to meet these objectives. They broadly fall within the categories of supply-side techniques (influencing the capacity and efficiency of services and infrastructure) and demand-side management (influencing travellers' demand and use of the available services).

4.1 *Public transport deregulation and liberalisation*

Many authorities have suggested that tight regulatory control of the public transport sector restricts competition and choice. These measures, which may specify market entry qualifications, route allocation, and prescribed fare levels, are often imposed to protect a publicly owned incumbent. The resulting monopoly service is likely to be inefficient and financially unsound. However, some form of regulation may still be helpful in order to rationalise the use of infrastructure capacity in relation to the demand level of different routes (White 1990).

4.2 *Institutional and ownership issues*

By-and-large, it is now generally agreed that publicly owned transport operators are likely to be particularly inefficient, and there has been a world-wide movement towards privatising such capacity. However, privately run concerns are equally prone to corruption, monopolistic practice (and resulting inefficiency) and to generally bad operating practice which is not in the users' interest. Examples abound of the monopolistic powers of union-organised public transport (e.g. Fouracre et al, 1994), and the power of such groups to curtail market entry and force up tariffs (e.g. Darbera, 1993). Maunder and Mbara (1996) argue strongly for some form of regulation and control, even within a liberalised operating environment, to safeguard the interests of users.

Community participation in bus operations has long been tried and tested in rural communities of the developed world. A few interesting developments along these lines are beginning to emerge in developing cities like Faisalabad and Lahore in Pakistan (Russell and Anjum, 1998), and Cape Town (Cronje, 1998).

4.3 *Public transport fare subsidy*

A common policy where the urban public transport system is publicly owned is to encourage artificially low fares, as a means of supporting the urban poor. This may be achieved in some cases by cross-subsidy from more profitable routes, or more likely, and more directly, from government (local or central) sources as a blanket subsidy. However, artificially low fares result in problems such as overcrowding, loss of revenue from better-off passengers, reduced incentive to operate competitively and lack of vehicle replacement, because of insufficient investment provision (Parker, 1983).

Many observers (e.g. Gannon and Liu, 1997), have noted that public transport subsidy can be open to abuse, and is a source for encouraging inefficiency within the bus industry. If subsidy is justified on policy grounds, then careful design and monitoring are required to ensure that the policy objective is achieved. (Brazilian cities have a novel system, vale-transporte, whereby employers must, by law, buy and distribute public transport tickets to their employees. Employers can, as an alternative, provide staff transport. They can also withhold up to 6 per cent of salary to help defray the cost of purchasing the tickets.)

4.4 *Investment in public transport*

Investment in urban public transport has a recent history of high financial risk, and a strong likelihood of loss making. Operating conditions within the urban environment restrict the possibility of high vehicle output, and the level of fares is equally restricted (usually for political reasons), discouraging investment. Where private capital is invested, risk is minimized by focusing on high demand routes, or on contracted routes and services (for which local authorities guarantee a subsidy) and also by avoiding or neglecting weak markets (which might well include the communities). Private entrepreneurs will also be attracted where capital investment is minimal (the price of an old saloon car, say) and operating costs can be contained by using very cheap and often untrained labour, as for example in setting up the many paratransit services on offer.

The capital costs of many of the mass transit systems which require substantial dedicated infrastructure are usually high and therefore may not present a viable option in improving accessibility for the urban poor. This is particularly true of Light Rapid Transit (LRT) and Metro schemes, which have been used in developing cities, but need to be targeted at higher income areas, where the necessary high fares are affordable.

4.5 *Improving public transport output*

Rationalising the use of the capacity of existing road and bus networks requires relatively modest capital investment and will usually constitute a much more economical investment than new high cost schemes such as LRT. Possibilities include bus priority measures and segregation. Busway transit has also been used in a number of developing cities. Its performance can equal that of most LRT systems and many metros.

These measures deliberately resolve the conflicts for the inadequate capacity of the main urban routes in favour of public transport. This can improve transport in several ways:

- efficiency and capacity of public transport operations are substantially improved.
- disadvantages to private traffic are significantly or wholly offset by the more organised regime.
- reduction of congestion brings major environmental benefits as well as operating economies.

4.6 *Investment in infrastructure*

A large proportion of the population of developing cities depend upon walking, cycling or using public transport, and hence it seems appropriate to target investment towards these forms of transport. The World Bank (1975) stated that in order to improve accessibility, making "better use" of the existing network is more appropriate than building more roads.

Many have noted that traditional non-motorised transport (NMT) modes such as bicycles, carts and rickshaws have been ignored by transport planners in favour of more costly modes, when non-motorised transport may provide a more appropriate solution to some transport problems (Replogle, 1991). Experience has not always matched expectation. For example in Pune, India, there is a segregated cycle-only lane, but it is used more by motorcyclists than cyclists. Cycleways are also provided in Harare, Zimbabwe and again they are not very well utilised. This is because culturally, cycling in Zimbabwe as elsewhere in Africa, appears not to be a socially acceptable mode of transport.

4.7 *Integration of transport and land-use planning*

There is a continuing debate as to the preferred nature of urban development and also the contribution that transport development can make in this context. There have been very few successful examples of transport planning being integrated with urban development. One such is that of Curitiba in Brazil (Fouracre, 1975), with its high density development spines built around public transport corridors.

That the city should be managed to influence travel has long been advocated. Dadoma, the new capital city of Tanzania is an example. However, its development has been exceedingly delayed, and so it is difficult to comment on the impact of the design on travel demand. Chandigarh in India is another, earlier example of planned development whose transport effectiveness has not been seriously analysed.

Aside from building new towns, there is the question of whether, how and to what purpose established cities can be restructured. Restructuring seems to be a particular concern of many South African cities, trying to redress the inequities caused by apartheid planning. Cape Town, for example, is developing an integrated Metropolitan Spatial Development Framework (MSDF), which sees as one key plank the intensification of development at selected commercial and residential activity nodes and along connecting activity corridors (Naude and Crous, 1998).

5 THE WAY FORWARD

'Much remains to be learned about the dynamic links between transport and poverty, particularly in the areas of regulation, subsidy and cost-effectiveness of transport interventions compared with other sectoral interventions (for example, in education and health care). A systematic effort is needed to undertake case studies to improve our understanding [of the direct impact and final incidence of net benefits of transport projects].' (Gannon and Liu, 1997)

The literature demonstrates very clearly that there is a problem in respect of the access and mobility of the urban poor. The empirical evidence indicates the nature of the problem in terms of unacceptable travel conditions, high expenditure, and long and unreliable journey times. There is some evidence of interventions that have been adopted by authorities to try to redress these travel problems of the urban poor. These range from subsidies (in various forms) to sector restructuring, and from transport infrastructure investment to new town development. What is largely missing from the literature, however, is an explicit examination of how these and other urban planning and transport developments have impacted on the urban poor. Neither does the literature examine how the poor continually adjust over time to a changing living and working environment, and how transport adjusts in response. As a result, the literature is not particularly instructive in what measures could be adopted to support the accessibility of the urban poor, and what are the likely implications of these measures, based on case-study evidence.

Main areas of research which would contribute to policy development, fall into two categories, namely:
- A basic understanding of activity patterns of individuals, households and communities;
- Impact studies of transport interventions.

5.1 *Activity patterns*

- There is a need to better understand the activity patterns of the urban poor, relating these to household attributes, as well as to different patterns of social organisation and urban structure. The aim would be to identify how access and mobility needs are related to differences in these attributes, and hence the extent to which policy initiatives (e.g. different approaches to health care provision) influence travel generation.
- Urban-rural linkages are important aspects of urban livelihood. There is a need to understand these linkages in the urban context, and to examine the role of transport in supporting them.
- Sustainable livelihoods analysis is being assessed for urban development; within this approach the role of transport must be clear.

5.2 *Impact Studies*

- Impact of urban restructuring (eg development of new towns and satellite cities, or internal restructuring directly aimed at the urban poor. There are many examples of such developments, but little awareness of the role of transport and with what the impact. Even less clear are the dynamics of urban poor settlement, and how transport reacts to these changes over time.
- Impact of major infrastructure development (e.g. a metro, a major urban road or perhaps a bicycle network). DFID has funded a impact study of the Cairo metro impact on the travel of the poor, but this is an isolated example of such an enquiry concerning a major urban transport development. Despite financial concerns over metro development, there is continual pressure from city authorities (particularly the larger cities) to invest in such schemes. The benefits to the urban poor of these capital intensive projects need verification. Likewise, the benefits of less costly schemes that may be better targeted at the urban poor, like bicycle paths and pedestrian facilities, need to be objectively assessed.
- Impact of public transport restructuring (such as the privatisation of an urban bus sector). TRL has earlier looked at the initial impacts of structural changes in the bus industry that have taken place in Harare (Zimbabwe). These changes initially involved public intervention in a privately run bus company. More recently other changes have been taking place including deregulation (to allow private sector competition from paratransit), and now there are proposals for returning the bus company to the private sector. The latter developments are now more typical of world-wide trends in transport operations, and could have significant impacts on the travel conditions of the urban poor.
- Impact of policy and operational interventions (such as subsidies or new services) directly targeted at the urban poor. DFID is supporting research in this field in Karachi, Pakistan, where a community-based transport programme is being developed by an

NGO. Other measures, like the Vale tariff subsidy system in Brazil, also deserve examination.

6 CONCLUSIONS

Transport can make important contributions, both direct and indirect, to reducing urban poverty. To do this effectively improvements in transport services need to be associated with other investments and key policies which will:

- Increase security of land tenure for the urban poor to underpin their benefits from targeted measures;
- Optimise labour employment in the delivery of key services and provision/maintenance of infrastructure, for example through public-private partnerships.
- Facilitate local markets, which can supply basic household needs.
- Strengthen basic health-care and education services for the community.

DFID is using a sustainable livelihoods approach to better understand how policies related to the delivery of transport and other services affect the lives of poor urban people. This work is informing DFID's policy for human settlements and is contributing to the World Bank's current review of urban transport strategy.

The paper has drawn attention to opportunities for increasing the availability of transport for poor people by giving priority to public transport in the use of available road space. When matched by appropriate measures to restrain private vehicle use such an approach can deliver significant overall benefits through reductions in congestion. Field assessment is required to validate good practice for implementing such measures and to confirm their impact.

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How changes in the economy of large metropolitan regions will affect mobility: The case of New York City

J. Llanos
INRETS (The French Institute for Transportation and Safety Research), France & Urban Infrastructure Institute, Polytechnic University, New York, N.Y., USA

ABSTRACT: This paper presents the first results of a project that aims at analyzing how changes in the economy of large metropolitan regions will affect mobility, particularly journey-to-work trips. For each zone of the New York City metropolitan region under the jurisdiction of the New York State, the changes in population, economy and employment are examined. The paper shows that the long trend towards a de-concentration of jobs, population and production from Manhattan, the core of the region, has been reversed. Productivity indicators that can be viewed as indicators of the attractiveness of each zone are constructed. It is demonstrated that journey-to-work trips are determined first by the proximity of the job location from the zone of residence, secondly by the attractiveness of Manhattan. Finally, the method used in this paper is applicable to other metropolitan regions including developing ones that are facing economic and technology changes.

RÉSUMÉ: Cet article présente les premiers résultats d'un projet qui a pour but d'analyser comment les changements dans l'économie des grandes régions métropolitaines vont affecter la mobilité, en particulier la mobilité vers le travail. La partie de la région métropolitaine de New York située dans l'Etat de New York a été divisée en zones de densités contrastées. Pour chaque zone, les changements en population, production et emploi survenus de 1969 a 1996 ont ete étudiés. Il est montré que la tendance au desserrement de Manhattan, le centre de la region, en population, production et emploi, a été inversée. Un indicateur de productivité a été construit pour chaque zone; il peut être considéré comme un indicateur de l'attrait exercé par chaque zone. On montre que les déplacements domicile-travail sont déterminés d'abord par la proximité entre lieu de travail et lieu de résidence, ensuite par l'attraction exercée par Manhattan. Enfin, la méthode utilisée peut être appliquée à d'autre régions métropolitaines, de pays développés ou en voie de développement, qui sont confrontées à des changements économiques et technologiques.

1 INTRODUCTION

Since the beginning of the 90s, there has been a renewed concentration of population, employment and activities in Manhattan, the center of the New York metropolitan region while the Paris metropolitan region has been, until recently, exhibiting the opposite trend. To understand the mechanisms that are at work under these phenomena of renewed concentration (re-concentration) or de-concentration, it is necessary to analyze the changes in the economy of the regions. This paper presents the first results of a project that aims at analyzing how changes in the economy of large metropolitan regions will affect mobility, particularly journey-to-work trips.

The New York metropolitan region extends over three States, New York, New Jersey and Connecticut. The region studied herein is the part of the New York metropolitan region under the jurisdiction of the New York State; it will be referred to as the *Region*. 20 million inhabitants live in the New York metropolitan region. 12 million inhabitants live in the Region; that accounts for 5% of the total U.S. population (Census 1990) on 0.1% of the national territory. While the New York metropolitan region was offering 10.7 million jobs, New York City alone was offering 4 million public and private jobs (almost 40% of the metropolitan jobs) and the County of Manhattan with 1.5 million inhabitants (7.5% of the metropolitan population) was offering 2.5 million jobs or 23% of the metropolitan jobs.

From 1969 to the mid-90s, several restructurings changed the economy of the Region (Moss 1997, Llanos & Leiber 2000). The Region operates almost as an "autonomous" region for the Journey-To-Work Trips (JTWT) as shown by the following indicators:

1 96% of the Region residents who are engaged in JTWT commute within the Region;

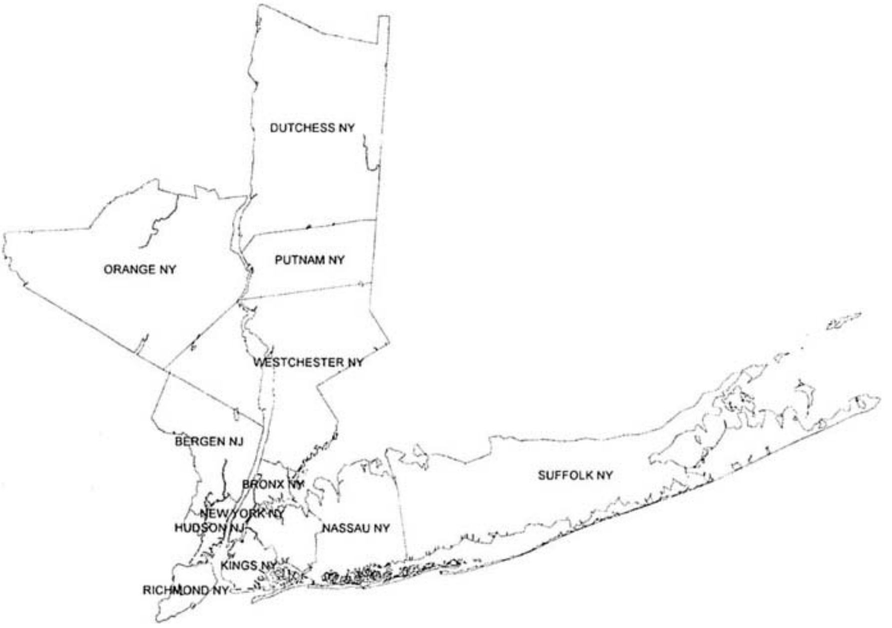

Figure 1. New York counties

2 93% of commuters who commute to the Region to work are residents of the Region (the rest come from mainly New Jersey and secondly Connecticut).

From 1969 to 1996, the changes in population, economy, employment and, productivity in the Region are analyzed respectively in sections 2, 3, 4, and 5. The consequences of these changes on JTWT are shown in section 6. Conclusions will be drawn in section 7.

2 THE EVOLUTION AND DISTRIBUTION OF POPULATION

Within the Region, 4 zones of different densities have been delineated:

Zone 1, the center of the Region, consists of the island of Manhattan; density: 21,010 inhabitants/km²;

Zone 2 consists of the outer boroughs of New York City (except Staten Island): The Bronx, Brooklyn, Queens; density: 9,520 inhabitants/km²;

Zone 3, the suburbs, consists of the counties of Nassau and Suffolk on Long Island, the counties of Rockland and Westchester on the continent, and the county of Richmond which corresponds to Staten Island; density: 890 inhabitants/km²;

Zone 4, the exurbia, consists of the counties of Dutchess, Orange and Putnam; density: 140 inhabitants/km².

The average density of the Region is 1,170 inhabitants/km²: 8.5 times less than New York City's density (9,940 inhabitants/km²) and almost 20 times less than Manhattan's. The population of each zone, and the distribution of regional population between the four zones are given for 1969 and 1996 in Table 1. The percentage points of regional population lost by Zone 2 (5 points) have been gained by Zone 3 (3 points) and by Zone 4 (2 points). However, these results obscure the different trends occurred during the period:

1 It is mainly during the 70s that Zones 1 and 2 lost population while population increased in Zone 3 and 4 at a higher rate.

2 Since 1993 the population of Zone 1 has grown the most and at the highest rate in the Region (Census and annual estimates do not capture a part of the illegal immigration; that leads to underestimating population in Zones 1 and 2. Zones 1 and 2 are already developed and new housing is very limited. The difference in the cost of housing can also explain the distribution of population: the cost in Zone 1, except in some restricted areas, in much higher than in the other zones).

3 THE EVOLUTION OF THE REGION'S ECONOMY

From 1969 to 1996, the regional economy has grown at an average annual rate of 1.4%. The pro-

Table 1. Evolution and distribution of population in the *Region* from 1969 to 1996

Zones	Population 1996	ΔV*	Share** 1969	Share** 1996	PPV***
Zone 1	1,527,270	-1%	13%	13%	0%
Zone 2	5,408,996	-10%	50%	46%	-5%
Zone 3	4,226,762	8%	33%	36%	3%
Zone 4	678,270	38%	4%	6%	2%
Region	11,841,298	-1%			

* ΔV – Variation from 1969 to 1996
** Share – Share of regional population
*** PPV – Population Variation in Percentage Points.

Table 2. Evolution and distribution of public and private Production in the *Region* for 1969 to 1996

Zones	Earnings* 1996	ΔV**	Share*** 1969	Share*** 1996	PPV****
Zone 1	136,051,353	52%	54%	57%	2%
Zone 2	35,144,575	1%	21%	15%	-7%
Zone 3	62,086,109	73%	22%	26%	4%
Zone 4	7,247,774	54%	3%	3%	0%
Region	240,529,811	46%			

Earnings* - Earnings in thousands of dollars of 1992
ΔV ** - Variation from 1969 to 1996
Share *** - Share of regional production
PPV **** - Production Variation in Percentage Points.

duction of each zone (The earnings from the public and private sectors have been used as a proxy for the production in each zone), and the distribution of regional production between the four zones are given for 1969 and 1996 in Table 2. The percentage points of regional production lost by Zone 2 (6.6 points) have been gained by Zone 3 (4.1 points) and by Zone 1 (2.3 points).

As for population, these results obscure the different trends that developed during the period:

1 During the 70s, production declined in Zones 1 and 2 while it increased in Zones 3 and 4.
2 During the 80s, production increased in Zones 1, 2 and 4 at an average annual rate higher than 3% while in Zone 2, the average annual rate was 1.7%.
3 From 1990 to 1996, production has been stagnating in Zones 2 and 3, has decreased in Zone 4 and, has increased in Zone 1 at an average annual rate of 1.8%.

3.1 *The changes in the regional economy*

The regional economy is now driven by *the sector of Services* and by *the sector FIRE* (Financial and Insurance industries and Real Estate) which represented respectively 38% and 27% of the regional private sector production in 1996. This was not the case in 1969: Services represented 24% of the regional production equal to the Manufacturing sector, and FIRE represented only 14%. The Manufacturing sector began declining in the 50s (Moss 1997, Orr 1997), continued declining through the studied period and, its production reached 10% of the regional economy in 1996. The other sectors of the regional economy maintained their level of production (Transportation, Wholesale Trade, Retail Trade).

3.1.1 *The Manufacturing and Services Sectors*

During the 80s, restructuring in Manufacturing resulted in transfers of activities to Services. These two sectors together represented 49% of the regional production in 1969 and still 49% of the regional production in 1996.

The transfers of production from Manufacturing to Services is more advanced in Zone 1 than elsewhere in the Region, and more advanced in the Region than in the rest of the Metropolitan region. Both Manufacturing and Services accounted for 20% of the Metropolitan production in 1970 while they accounted respectively for 12% and 30% in 1995 (data from the U.S. Department of Labor, Orr 1997).

3.1.2 *The FIRE Sector*

Three trends can be observed from 1969 to 1996:

1 The regional economy relies increasingly on the FIRE sector.
2 The production of FIRE is increasingly concentrated in Zone 1, Manhattan.
3 In Zone 1, from 1990 to 1996, the average annual rate of growth in FIRE has been 10 times higher (6.69%) than the average annual rate of growth in Services (0.67%).

4 THE EVOLUTION AND DISTRIBUTION OF EMPLOYMENT

From 1969 to 1996, the Region gained 421,000 private jobs at an average annual rate of 0.3%: that is lower than the national average (2.2%), and lower than the average for the whole Metropolitan Regions of the USA (2.2%) during the same period. During the period, as shown in Table 3, the percentage points of the Region's private employment lost by Zone 1 (9 points) and by Zone 2 (3 points) were gained by Zone 3 (10 points) and by Zone 4 (2 points). As for population and production, these results obscure the different trends that developed during the period (Llanos & Leiber 2000); these trends are:

1 It is mainly during the 70s that Zones 1 and 2 lost jobs while employment increased in Zones 3 and 4.
2 During the 80s, employment in Zones 3 and 4 grew at an average annual rate higher than in Zones 1 and 2.
3 The national recession at the beginning of the 90s affected every zone and particularly Zone 1.
4 Since 1993 employment in Zone 1 has grown at the highest rate in the Region.

Table 3. Evolution and distribution of private employment in the *Region* from 1969 to 1996

Zones	Number of jobs 1996	ΔV*	Share** 1969	Share** 1996	PPV***
Zone 1	2,076,047	-12%	47%	38%	-9%
Zone 2	1,297,926	-5%	27%	24%	-3%
Zone 3	1,835,054	56%	23%	34%	10%
Zone 4	254,729	77%	3%	5%	2%
Region	5,463,756	8%			

ΔV* - Variation from 1969 to 1996
Share ** - Share of regional employment
PPV *** - Private Employment Variation in Percentage Points.

4.1 *The structural changes in employment*

From 1969 to 1996, Manufacturing exhibited the highest decrease in jobs while Services exhibited the highest increase in jobs. As for production, part of the jobs lost in Manufacturing were transferred to Services (Or 1997, Moss 1997). Except for Zone 2, job creation in Services has outweighed job losses in Manufacturing (Llanos & Leiber 2000).

In the FIRE sector, while production has increased at an average annual rate of 4% from 1990 to 1996, employment has only increased at an average annual rate of 0.7%. In Manhattan (84% of the FIRE production), production increased at an average annual rate of 7% from 1990 to 1996 while jobs decreased at an average annual rate of 2%. This reflects the increase in productivity due to the use of the new technologies of communication and data processing. In FIRE, restructuring continues spurred by the development of "on-line" services.

On the whole, the restructurings that took place from 1969 to 1996 led to permanent job losses in the Region.

Table 4. Indicators of private sector productivities per zone from 1969 to 1996

Zones	Productivity* 1969	Productivity* 1996	ΔV**	r***
Zone 1				
Manufacturing	35	65	84%	2.3%
FIRE	38	108	185%	4.0%
Services	30	48	56%	1.7%
Total Private Sector	34	62	81%	2.2%
Zone 2				
Manufacturing	26	28	7%	0.2%
FIRE	16	28	78%	2.2%
Services	22	25	13%	0.5%
Total Private Sector	25	26	7%	0.2%
Zone 3				
Manufacturing	34	48	39%	1.2%
FIRE	18	28	58%	1.7%
Services	24	29	19%	0.7%
Total Private Sector	27	30	14%	0.5%
Zone 4				
Manufacturing	32	45	38%	1.2%
FIRE	14	14	-3%	-0.1%
Services	20	22	7%	0.2%
Total Private Sector	26	23	-9%	-0.3%
Region				
Manufacturing	32	48	51%	1.5%
FIRE	30	72	140%	3.3%
Services	27	35	31%	1.0%
Total Private Sector	30	41	39%	1.2%

Productivity* - Earnings per year per sector in thousands of dollars of 1992
ΔV** - Variation from 1969 to 1996
r*** - Average annual growth rate

5 THE EVOLUTION OF THE REGION'S PRODUCTIVITY

The restructurings also led to a 39% increase in the Region's productivity (as output per year per employee) over the period. As a proxy for output or production, the earnings by sector have been used.

However, the productivity increase in the Region is mainly due to the productivity increase in Zone 1 (81%) (Table 4). Productivity increased only by 14% in Zone 3 and by 7% in Zone 2 while it decreased by 9% in Zone 4.

The productivity indicators can be viewed as indicators of the attractiveness of each zone of the Region.

6 THE EVOLUTION OF THE REGION'S MOBILITY

From the Journey-To-Work-Trips survey data, the origin-destination matrices from zone to zone have been constructed (Llanos & Leiber 2000).

6.1 *The increase in the Region's mobility*

In 1990, 5,370,000 residents of the region were engaged in Journey-To-Work trips. From 1970 to 1990, mobility, defined as the number of persons who commute to work per day, has increased in each zone. While the Region's population decreased by 1%, the number of residents engaged in journey-to-work trips increased by 26% over the period; that can be attributed, to a large extent, to the much larger involvement of women in the work force. In each zone, the ratio of commuters to population has increased as shown in Table 5.

Table 5. Evolution of the number of residents by zone who make Journey-To-Work Trips

Zones	Commuters 1990	Variation per Period Δ70-80	Δ80-90	Δ70-90
Zone 1	754,148	16%	11%	28%
Zone 2	2,254,850	-1%	12%	11%
Zone 3	2,049,431	32%	14%	50%
Zone 4	311,606	45%	30%	89%
Total Region	5,370,035	11%	14%	26%

Table 5. Evolution of the number of residents by zone who make Journey-To-Work Trips (Continued)

Zones	Commuters 1990	Ratio of Commuters / Population 1970	1980	1990
Zone 1	754,148	38%	48%	51%
Zone 2	2,254,850	34%	38%	41%
Zone 3	2,049,431	34%	44%	50%
Zone 4	311,606	33%	41%	48%
Total Region	5,370,035	35%	42%	46%

6.2 *Where do commuters go?*

The number of commuters who make Journey-To-Work Trips within their zone of residence has increased in each zone from 1970 to 1990 (Table 6).

Table 6. Proportion of the commuters who make J-T-W-Trips within their zone of residence

Zone	Year 1970	1980	1990
Zone 1	85%	84%	84%
Zone 2	49%	48%	53%
Zone 3	68%	70%	71%
Zone 4	85%	76%	70%
Total Region	60%	63%	65%

The distribution of residents-commuters between the 4 zones of the Region corresponds to the distribution of jobs between the 4 zones (Table 8); it also corresponds to the attractiveness of each zone as measured by the indicator of productivity established in section 5.

The number of residents of the Region whose J-T-W Trip destination is the rest of the Metropolitan region has increased slightly from 2,4% to 2,8% from 1980 to 1990 as shown in Tables 7 and 8 (the destination of the Census J-T-W Trip data for 1970 are not reliable).

Table 7. Work destination of the resident commuters of the *Region* in 1980

Place of Residence	Commuters	Zone 1	2	3	4
Zone 1	679,599	84%	10%	2%	0%
Zone 2	2,008,018	44%	48%	5%	0%
Zone 3	1,802,352	16%	11%	70%	0%
Zone 4	239,523	4%	2%	12%	76%
Region	4,729,492	37%	26%	30%	4%

Table 7. Work destination of the resident commuters of the *Region* in 1980 (Continued)

Place of residence	Commuters	Total NY Region	Rest of Metro Region	Rest of the World
Zone 1	679,599	96%	3%	1%
Zone 2	2,008,018	98%	2%	0%
Zone 3	1,802,352	97%	2%	0%
Zone 4	239,523	93%	4%	3%
Region	4,729,492	97%	2.4%	1%

Table 8. Work destination of the residence-commuters of the *Region* in 1990

Place of Residence	Commuters	Zone 1	2	3	4
Zone 1	754,148	84%	9%	3%	0%
Zone 2	2,254,850	38%	53%	6%	0%
Zone 3	2,049,431	14%	11%	71%	0%
Zone 4	311,606	4%	2%	15%	70%
Region	5,370,035	33%	28%	31%	4%

Table 8. Work destination of the residence-commuters of the *Region* in 1990 (Continued)

Place of residence	Commuters	Total NY Region	Rest of Metro Region	Rest of the World
Zone 1	754,148	96%	3%	1%
Zone 2	2,254,850	97%	2%	0%
Zone 3	2,049,431	96%	3%	0%
Zone 4	311,606	91%	6%	3%
Region	5,370,035	96%	2.8%	1%

The residents-commuters of the Region commute:

1 First, within their zone of residence.
2 Second, to an adjacent zone.
3 Third, to Zone 1 if Zone 1 is not the zone of residence nor an adjacent zone.

Among the persons whose J-T-W Trip destination is the Region, 5.5% were residents of the rest of the Metropolitan region (New Jersey mainly and Connecticut) in 1980 and 6% in 1990. In 1980, 9% of the commuters to Zone 1 were residents of New Jersey, they were 11% in 1990.

The J-T-W Trips within the Region and to the Region follow a proximity pattern disturbed by the attractiveness of Zone 1.

7 CONCLUSION

From 1965 to 1996, the Region's economy moved from a Manufacturing to a Service economy dominated mainly by the Services and secondly by the FIRE sector. The restructurings that took place during the period led to permanent losses in jobs in the Region, and to an increase in productivity mainly in Zone 1 (81%), in Zone 3 (14%) in Zone 2 (7%) and to a decrease in productivity in Zone 4 (9%).

The trend towards a de-concentration of population, jobs and production from Zone 1 has been reversed. Since 1993 Zone 1, Manhattan, has been attracting more population and jobs, creating more production and at a faster pace than the other zones in the Region.

The ratio of commuters to population has increased in every zone from 1969 to 1996. The J-T-W trips to the Region are determined by two factors:

1 The proximity of the job location from the zone of residence;
2 The attractiveness of Zone 1: concentrating 38% of employment and 57% of production on 0.7% of the Region's territory, it functions as a magnet.

It should be noticed that from 1969 to 1996, there was no important change in the transportation system or infrastructure transportation in the Region. So, for a constant portion of time allocated to transportation, this incites the commuters to minimize the distance between the place of residence and the place of work.

Finally, the economic restructurings and the emergence of the new technologies resulted in strengthening the position of Zone 1, Manhattan, as the core of the Region.

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7 Technologies – Energy and alternative fuels
Technologies – Energie et combustibles alternatifs
Tecnologías – Energia y combustibles alternos

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Autobus ou trolleybus en transport public urbain?

Bus or trolleybus in the urban public transport?

¿Autobús o trolebús en el transporte urbano?

D.C. Popescu
L'Union Roumaine de Transport Public, Bucharest, Romania

RÉSUMÉ: Pour les millieus urbains la pollution de l'air a dépassé les limites admissibles à cause de l'augmentation du niveau de motorisation ainsi que du renforcement de l'activité de transport. Le transport public urbain est une importante source de pollution et de même un grand consommateur d'énergie. L'utilisation des trolleybuses au lieu des autobuses peut contribuer à améliorer la qualité de la vie urbaine en diminuant la pollution du millieu et, en même temps, réduire le consommation spécifique d'énergie ainsi que les frais d'exploitation.

ABSTRACT: In urban areas environmental pollution has begun to exceed the admissible limits because of the motorizing rate and intensifying the transport activity. The urban public transport is an important pollution source as well as a great energy consumer. Trolleybuses operating instead of buses may contribute in growing the urban life quality by reducing the environmental pollution and also decreasing the specific energy consumption and operating costs.

RESUMEN: La contaminacíon del aire de los medios urbanos ha empezado exceder las límites admisibles y unas de las causas son la aumentacíon del grado de la motorizacíon y la intensificacíon de la actividad del transporte. El transporte público urbano es una fuente importante de contaminacíon y un gran consumidor de energía. La utilizacíon de los trolebúsos en lugar de los autobúsos puede contribuir a la augmentacíon de la calidad de la vida en la ciudad, por la diminuacíon de la contaminacion del ambiente y, en el mismo tiempo, reduce lo consumo específico de la energía y los gastos de exploatacíon.

1. INTRODUCTION

"La paix, le développement et la protection de l'environement sont interdépendants et indivisibles"

La Déclaration de RIO'1992

L'activité de l'homme a toujours affecté les facteurs de l'environement. Actuellement, à cause du développement considérable de toutes les activités humaines, malheureusement on est arrivé à dépasser les seuils limite de régénération de la nature.

La pollution produit à présent un déréglage parfois irreversible des facteurs de l'environement. Si l'on ne prend pas des mesures pour limiter, voire éliminer le processus de pollution, la vie des hommes sera elle même en danger.

Voilà pourquoi la protection de l'environement est l'un des problèmes majeurs de l'humanité.

Voilà pourquoi, parmi les objectifs les plus importants stipulés à la réunion de Rio, on a mentionné aussi celui de "minimiser les risques et de maintenir l'environement dans un état qui ne menacera pas ou ne préjudicera pas la santé et la sûreté des hommes".

2. LE TRANSPORT - SOURCE DE POLLUTION

La qualité de l'environement, et surtout celle du millieu urbain, est fortement affectée par l'activité de transport.

Dans la mesure du développement des activités économiques ainsi que l'augmentation du niveau de confort du voyage, la pollution de l'environement et son effet nocif sur la santé de la population ainsi que sur les bâtiments, s'intensifient.

L'impact considérable des moyens de transport sur l'environement est produit par les émissions nuisibles: NOx, CO, des composés organiques volatils, Pb et d'autres particules en suspens. Ces émissions affectent la qualité de l'air et produisent le phénomène de "smog".

Depuis les années 70, le transport est devenu un consommateur majeur d'énergie obtenue par des combustibles fosils et continue à se développer.

Dans ces conditions, le problème permanent est de distribuer les sollicitations aux différentes modalités de transport, ainsi que de prendre les mesures adéquates en vue de diminuer la pollution de l'environement.

Les pays de l'Union Européenne ont déjà pris des mesures pour réduire les émissions polluantes en baissant le poids propre des véhicules, en améliorant le rendement des moteurs et en assurant périodiquement des vérifications techniques. Les standards concernant les nouveaux types de moteurs tiennent compte des niveaux suivants pour les émissions polluantes:

Évolution		Émissions			
Type	Année	HC (g/kwh)	CO (g/kwh)	NOx (g/kwh)	P (g/kwh)
Pre EURO I	1982	3.50	14.00	18.00	-
Pre EURO I	1988	2.40	11.20	14.40	-
EURO I	1992	1.10	4.50	8.00	0.36
EURO II	1995	1.10	4.00	7.00	0.15
EURO III	2000	0.70	2.50	5.00	0.10
EURO IV	2005	0.50	1.00	3.00	0.08
EURO V	2010	0.50	1.00	1.50	0.08

Des companies de prestige dans le domaine des constructions des voitures ont alloué des fonds importants pour réaliser des moteurs non polluants ainsi que pour utiliser d'autres sources d'énergie que le pétrole.

Des solutions ont été trouvées et des prototypes ont été réalisées. Mais, jusqu'à présent, le coût d'une voiture non polluante est loin d'être compétitif.

Au long de la dernière décennie, dans les pays de l'Europe Centrale et de l'Est, le degré de pollution de l'air est considérablement élevé à cause du développement de l'activité de transport routier ainsi que de l'augmentation rapide du degré de motorisation.

En Roumanie, l'atmosphère est soumise à une pollution locale intense par les installations industrielles aux technologies anciennes, sans épuration, mais aussi par le trafic considérable, surtout dans les grandes villes.

À Bucarest, dans le centre ville, les années 60 ont marqué l'éloignement des tramways qui ont été remplacés par des véhicules à pneux.

En conséquence, les mesures effectuées aujourd'hui par les organismes habilités montrent des dépassements quant aux valeurs standard admissibles concernant les concentrations des particules lourdes (0.2...0.3 mg / m^3 pendant 24 heures) et des concentrations importantes de NO_2, NOx et SO_2 dans la zone centrale de la ville, sur les principales artères de communication.

La contribution des autobus dans le cadre du transport public urbain est assez importante et pas du tout négligeable. Pour un roulage journalier de 230 000 km de 1 000 véhicules, dont seulement 45% équippés par des moteurs EURO I, on consume 90 tonnes de gas - oil. En conséquence, l'atmosphère est empoisonnée chaque jour avec plus de 3 200 kg CO, 1 000 kg NOx, 3 000 kg HC et 300 kg particules en suspens.

3. LE TROLLEYBUS - MOYEN DE TRANSPORT

En vue d'être agréé, un moyen de transport public urbain doit cumuler plusieurs qualités, la priorité de celles ci étant accordée par rapport au point de vue duquel on le considère, comme suite:

- le passager: le confort
- la communauté urbaine: la manque de pollution
- le conducteur: la sûreté
- l'opérateur de transport: le coût d'exploitation
- l'économie nationale: la consommation d'énergie

Choisir entre deux moyens de transport public urbain si semblables, comme le trolleybus et l'autobus, est une affaire asez délicate.

Il faut éviter une généralisation hasardeuse, sans tenir compte des corrections de nuance nécessaires pour chaque cas particulier, constitué, au fond, par chaque réseau de transport urbain.

Les avantages et les inconvénients du trolleybus sont bien définis. Parmi les avantages essentiels, on peut remarquer au premier abord le niveau réduit du bruit et l'absence de la pollution de l'air. Le moteur est robuste, avec une bonne reserve de puissance et développe un important effort de traction. L'entretien est minime et simple. Les équipements électroniques modernes permettent le réglage progressif des démarrages et des freinages. Pendant le freinage, il récupère une quantité importante d'énergie. L'inconvénient majeur du trolleybus est sa dépendance d'un réseau bifilaire de contact, coûteux et parfois peu esthétique. Les prises de courant, bien que simples et sûres, sont toutefois assez délicates et limitent la liberté de mouvement en circulation.

Mais on doît souligner qu'aujourd'hui les critères de choix du trolleybus sont essentielle - ment fondés sur les deux préoccupations dominantes que sont la sauvegarde de la qualité de la vie en ville ainsi que l'utilisation d'une énergie indépendante du pétrole.

Il faut aussi souligner, quand même, que, depuis le choc pétrolier, les avantages du trolleybus sont plus incitatifs et parfois même prépondérents.

Ces avantages se font appréciés de plus en plus, au fur et à mesure que l'intérêt concernant le coût et l'épuisement des resources d'énergie augmente et les préoccupations de préserver l'environement et maintenir une certaine qualité de la vie en millieu urbain deviennent importantes.

4. LE TROLLEYBUS À BUCAREST

À Bucarest, le trolleybus n'est pas une nouveauté. La première ligne de trolleybus avait été mise en opération il y a 50 ans. À présent on fonctionne avec plus de 300 véhicules.

La nouveauté c'est la dernière génération de trolleybuses mise en exploitation pendant les années 1997-1998. Examiné par rapport aux critères ci-dessus mentionnés le nouveau type de trolleybus présente les qualités suivantes:

a) le confort offert aux passagers ne présente aucune différence par rapport à l'autobus, étant donné le fait que le trolleybus et l'autobus ont la même carrosserie;

b) la façon de conduire est simple: les pédales de marche et de freinage ne transmettent qu'une simple valeur de consigne du courant à un contrôleur électronique qui limite automatiquement les variations de l'accélération et bien sûr aussi les maxima autorisés; il en résulte par des moyens automatiques et sans aucune difficulté pour le conducteur, un confort de marche remarquable pour les voyageurs, ceci d'autant plus que, du fait des surchargées admissibles, les qualités de démarrage restant pratiquement constantes, quel que soit les efforts de traction;

c) quant à la communauté urbaine, le trolleybus est le véhicule idéal: pas de bruit ou de vibrations et aucune pollution chimique;

d) les conditions de sûreté pendant la circulation sont aussi de mêmes que celles de l'autobus; en plus, le trolleybus freine normalement avec le frein électrique, tandis que les freins mécaniques interviennent seulement pour des basses vitesses, (moins de 7km/h), commandés par la même pédale; l'aménagement du poste de conduire du trolleybus ressemble à celui de l'autobus: deux pédales, disposition standard des boutons de commande, etc.; les différences qui subsistent sont minimales et résident en quelque lampes de signalisation et boutons poussoirs;

e) le coût d'exploitation est plus réduit pour le trolleybus que pour l'autobus: d'une part, suite à la différence de prix entre le gas - oil et l'énergie électrique et d'autre part grace au fait que le moteur électrique ainsi que les circuits électroniques, n'ont pas besoin d'entretien; en même temps, le freinage électrique détermine une usure des mécanismes de freinage plus faible; on obtient aussi une diminution des coûts pas du tout négligeable, en récupérant d'énergie pendant le freinage;

f) au niveau d'une économie nationale, le trolleybus comporte aussi des avantages importants, étant donné que:

- l'énergie électrique est produite par de grandes centrales électriques qui utilisent de différentes sources (charbon, eau, vent, nucléaire, etc.) pas seulement du pétrole;
- le régime de combustion dans les grandes centrales thermoélectriques peut être contrôlé et optimisé de manière que la pollution soit minimale, fait irréalisable pour l'autobus en trafic urbain;
- les systèmes techniques modernes permettent d'obtenir un haut rendement concernant la livraison de l'énergie électrique et en même temps le moteur électrique et l'électronique de puissance du véhicule donnent des pertes d'énergie réduites; le rendement énergétique total pour le même effort de traction est donc supérieur pour le trolleybus par rapport à l'autobus;
- la consommation spécifique d'énergie est plus réduite pour le trolleybus que pour l'autobus, vue que pendant le stationnement du véhicule (arrêts, intersections) le moteur électrique ne consomme pas d'énergie et, pendant le freinage, une partie d'énergie cinétique est récupérée dans le réseau.

Tous ces avantages offerts par le trolleybus balancent abondamment ses inconvénients qui restent:

- le coût d'acquisition plus élevé que celui de l'autobus;
- un investissement initial assez important pour le système énergétique d'alimentation (sous - stations de redressement et réseau de contact).

Concernant l'exploitation économique du trolleybus, on peut dire qu'il est très convénable en général pour les lignes caractérisées par une charge élevée de transport et relativement régulière toute la journée, donc pour les situations où les fréquences entre les heures de pointe et les heures creuses changent peu. C'est souvent le cas des lignes urbaines desservant les zones d'activités commerciales et culturelles ainsi que celles assurant la liaison entre les grandes quartiers d'habitation et le centre ville. Dans ce cas, on préfère le trolleybus comme moyen de transport, le choix étant justifié par plusieurs facteurs:

- d'une part, du point de vue commercial, les investissements supplémentaires pour les installations fixes sont utilisés et rentabilisés au mieux;
- d'autre part, concernant la sauvegarde de l'environement (bruit et pollution chimique) il est légitime que les moyens financiers disponibles favorisent les zones fortement urbanisées;
- enfin, plus le coéficient de remplissage des véhicules est constant et élevé, plus les qualités de traction électrique (démarrage rapide, économie d'énergie) sont significatives.

À Bucarest, la situation est particulièrement favorable, car le réseau de traction électrique avait été jadis plus étendue et, par conséquant, la puissance installée dans les sous - stations de redressement est utilisée seulement dans une petite mesure et les poteaux sur les grandes artères de communication sont d'usage commun.

5. L'ÉQUIPEMENT DE TRACTION DU TROLLEYBUS

5.1 *Généralités*

Le moteur de l'autobus avec ses annexes, ainsi que la boîte de vitesses automatique sont remplacés par les équipements électriques suivants:

- un moteur électrique, robuste et fiable, de courant continu jusqu'à présent et asynchrone pour les générations qui suivent;
- un hâcheur de courant pour alimenter le moteur à tension variable;
- un contrôleur électronique qui assure la commande automatique, la diagnose des défauts et la surveillance quant à la relation homme - voiture;
- un jeu des contacteurs pour commuer le schéma de fonctionnement (marche avant-arrière, frein, etc.);
- les systèmes de protection pour les circuits électriques;
- les prises de courant;
- l'appareillage du conducteur pour les circuits de traction.

5.2 *Les services auxiliaires*

Le compresseur et la pompe hydraulique sont actionnés par des moteurs asynchrones. Pour charger l'accumulateur (24 V.c.c) et alimenter les moteurs auxiliaires (380 V.c.a.) le trolleybus est équippé d'un convertisseur statique en technologie IGBT.

5.3 *Le contrôleur automatique*

Grace au contrôleur automatique fourni par la Companie GANZ Ansaldo de Budapest, Hongrie, qui monitorise les paramètres et commande les appareils du système de traction, le démarrage ainsi que le freinage se réalisent sans aucune variation d'accélération, quelle que soit leur valeur.

Le contrôleur commande le régime de fonctionnement du moteur, conformèment aux informations reçues du poste de conduite ainsi que du circuit commandé. Il est responsable de toutes les commandes données aux contacteurs et à l'électronique de puissance pour alimenter le moteur ainsi que pour limiter les valeurs maximales admises de courant, accélération et vitesse.

En même temps, il interdit le démarrage du trolleybus pour le cas où toutes les portes ne sont pas fermées et veille les systèmes de protection au cas où des défections sont produites, y compris l'isolation de la carrosserie.

En vue de faciliter les opérations de dépanage, le contrôleur automatique est prévu d'un système de diagnose à trois niveaux de signalisation: conducteur, personnel d'entretien courant et personnel spécialisé capable d'utiliser un programme sur l'ordinateur. La mémoire du contrôleur enregistre les défauts produits et les erreurs éventuelles de conduire. Le contrôleur peut être accouplé à un ordinateur mobil pour lecturer et régler les paramètres.

5.4 *L'électronique de puissance*

L'électronique de puissance en technologie IGBT, ainsi que les filtres et le convertisseur statique, sont fabriqués par la Companie ICPE - SAERP de Bucarest, Roumanie, dans une conception propre et avec un haut niveau de fiabilité. Tous les éléments contenus dans le schéma de traction sont ensemblés en des blocs à protection IP 54 qui peuvent être attachés facilement à la carrosserie sur le toit et sous le plancher.

Le hâcheur offre la possibilité que le moteur soit alimenté à tension et courant variables pour obtenir le démarrage en douceur, et le réglage de la vitesse à la valeur qu'on désire. Il permet aussi de maîtriser le régime de freinage électrique à récupération ou rhéostatique.

L'emploi d'un tel système de traction protège l'équipement des sous - stations de redressement car, au démarrage, le courant absorbé par le trolleybus s'élève progressivement jusqu'à la valeur du régime choisi.

L'électronique de puissance embarque sur le trolleybus à cause du fait qu'elle est sans mentenance, apporte une contribution sensible à la diminution des frais d'entretien et, en même temps, à élever le degré de disponibilité du véhicule.

5.5 *Les contacteurs*

Pour obtenir les connexions nécessaires au circuit de puissance en but de réaliser les régimes de marche avant au arrière ainsi que pour le freinage électrique, les contacteurs LTHS - 320 (350 A, 1500 V.c.c.) produits par la Companie MICROELETTRICA SCIENTIFICA SpA de Milano, Italie, ont été préférés.

Réalisé d'une conception particulière et avec des matériaux de très bonne qualité, ce type de contacteur a les plus petites dimensions et le poids minimal par rapport à d'autres contacteurs de cette catégorie, un avantage très important spécialement pour un véhicule comme le trolleybus.

Le choix, basé sur l'examen des caractéristiques techniques, sur le niveau de qualité ISO 9001 et aussi sur des importantes références, c'est averé le meilleur, car après plus de deux ans de fonctionnement (cca 75.000km/véhicule, an) aucune défection ne s'était produite, en démontrant donc un haut niveau de fiabilité.

En plus, les coûts nécessaires pour l'entretien de ces contacteurs sont très réduits.

5.6 *Les valideurs des billets*

En but de valider les billets de voyage, des appareils automatiques fournis par la Companie Tecnotour-Eltec SpA d'Italie, ont été installés à l'intérieur du trolleybus. Ces appareils marquent le billet avec la date, l'heure et le numéro du véhicule. Ils sont très appréciés par les passagers ainsi que par l'opérateur de transport. Les mêmes appareils peuvent être utilisés avec beaucoup de succès en vue d'obtenir des diagrammes de charge au long d'une journée.

À la fin, on peut affirmer que le trolleybus réalisé avec les équipements ci - dessus décrits est un véhicule moderne qui, pour ses qualités, est très agréé par les usagers, par son conducteur et par l'opérateur de transport et qui, en protégeant l'environement, protège la vie dans la ville.

6. CONCLUSIONS

Étant donné le fait que, à cause du développement considérable de toutes les activités humaines, on est arrivé à dépasser les seuils - limites de régénération de la nature, des mesures énergiques dans tous les secteurs d'activité sont nécessaires.

Les plus affectés sont les zones fort - urbanisées dans lesquelles le transport est devenu une source importante de pollution et aussi un grand conssomateur d'énergie.

En dépit des grands efforts déposés dans tout le monde, des véhicules non - polluants ne seront pas disponibles à des prix résonables dans le futur très proche.

Le trolleybus est un véhicule absolument non polluant mais, il nécessite des frais d'investissement assez grands pour le système énergétique d'alimentation.

Il est légitime que les moyens disponibles favorisent les zones fortement urbanisées.

L'industrie est capable qu'elle fournisse les équipements nécessaires pour réaliser des trolleybuses à des prix accessibles.

Les avantages offerts par le trolleybus balancent abondement ses inconvénients et les investissements supplémentaires pour les installations fixes s'amortissent par la diminution des coûts d'exploitation.

Faire le choix du trolleybus comme moyen de transport urbain est une affaire délicate et en même temps le problème spécifique pour chaque réseau de transport public urbain.

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Compressed natural gas as an environment friendly fuel for urban transport: Policy lessons from a developing country

L'usage du gaz natural comprimé pour un meilleur environnement en milieu urbain: les leçons à tirer d'un pays en voie de développement

El uso del gas natural para un mejor medio ambiente en area urbana: Experiencias a seguir de un país en vías de desenvolvimiento

Ali S. Huzayyin & Omar Osman
Faculty of Engineering, Cairo University, Egypt

ABSTRACT: Egypt is now undertaking a programme aiming at converting mainly urban taxicabs into CNG. More than 15,000 vehicles converted into CNG, mostly in the last three years. However, this is still below the set targets. This paper tries to find ways to augment the current programme through revealing the needs of the various actors involved. Interviews and questionnaires were conducted with decision-makers and taxi drivers. Several polices are suggested and lessons transferable to other developing countries are extracted.

RÉSUMÉ: L'Egypte mène actuellement un programme de mise en place de Taxis roulant au GNC, plus de 15,000 vehicles ont ainsi été convertis au GNC, pour la pluspart dans les trois dernieres années. Cependant ce nombre n'atteind pas les objectifs fixés. Ce document tente de trouver les moyens d'accélérer la mise en place de ce programme à travers l'identification des besoins de chaque acteur concerné. Des enquêtes ont été menées auprès des décideurs et des chauffeurs de taxi. Plusieurs politiques sont proposées, et les enseignements applicables à d'autres pays en voie de développement sont extraits.

RESUMEN: Egypto esta implementando un programo de conversion de los taxi por el uso del GNC. Nas de 15,000 coches fueron convertidos a el GNC durante las tres ultimos anos por entanto, este numero no alcanza los objectivos iniciales. Este documents trata de investigur los medios de crecer este programo tras la identificacion de las necesidudes de cada actor. Encuestas fueror procesados con los dedidoned y los conductors du taxi – politicas y experiencas a seguir en otos pais en via de desenvolinmients for propostas.

1 INTRODUCTION

Compressed Natural Gas (CNG) is an environment friendly fuel used to replace conventional liquid fuels for road vehicles. This has been successfully achieved in many countries over the last two decades. Egypt started to follow suit since the early 1990's after developing the required infrastructure for natural gas production and use in domestic purposes. The country is now seeking opportunities to export natural gas. It is, therefore, important to promote current policies to further encourage the utilization of natural gas in all possible local uses, particularly in road transport.

Few years ago the government introduced a policy for encouraging taxicabs and business sector vehicles to switch to CNG. To achieve this, a programme that comprises a financing scheme to help the drivers to payback the conversion cost coupled with a relatively attractive fuel pricing option is promoted. Also some private firms are established to participate in the provision of CNG fueling stations and engine conversion. As a result, the percentage of converted taxis in Greater Cairo (GC) reached about 7% after five years of launching this programme. This means, however, that many taxi drivers are still reluctant to join the conversion programme for various reasons that should be revealed.

The paper concentrates on the policy for switching of taxicabs to CNG operation in GC. It includes a description of the adapted financing and pricing schemes and tries to answer the following questions: who are the various actors involved? what are the needs of each of these actors? what factors encourage/discourage conversion? and how to make financing schemes more attractive?

In doing so, the research is based on conducting a questionnaire with a sample of taxi drivers who have already converted to CNG and those who are yet reluctant. Also interviews with CNG policy-related persons is undertaken. Hence, recommendations are given on how to enhance the existing policy and to make it more successful. Lessons from the current experience and the findings of the paper will be discussed bearing in mined transferability to other developing countries.

2 COMPRESSED NATURAL GAS, A PREFERRED ALTERNATIVE VEHICLE FUEL

By far, natural gas in its different forms is the most successful among all other fuel alternatives available today. The vast majority of natural gas vehicles (NGVs) in use today operate on CNG. It is reported that NGVs achieve many reductions in pollutants compared with those operating on gasoline. These reductions can be as listed below (Pacific Northwest Pollution Prevention Resource Center, 1999).

- 65 - 90% of CO.
- 87% of NO_x.
- 87% of non-methane organic gas.
- 20% of CO_2.
- 50% of the evaporating emissions during fueling and use.

In addition, it is evident that the use of CNG as an alternative to gasoline brings about reductions in vehicle maintenance needs and required spare parts and lubricants, merely due to its cleaner burning. As for the price of CNG compared to gasoline, it has been reported that the cost of one gallon of the latter is nearly seven folds of that of an equivalent gallon of the former. It is clear, therefore, that CNG is incomparably a superior fuel for motorized vehicles.

CNG as an alternative fuel for transport, however, is known to have some disadvantages (Pacific Northwest Pollution Prevention Resource Center, 1999). Lack of engine power during acceleration and on hilly terrain is one of the most pronounced disadvantages. The relatively long time required for refueling is another disadvantage that usually entails longer waiting time at gas stations and need for more fueling infrastructure. Also the big investment and land space required to develop CNG filling infrastructure make it uneasy to install sufficient stations to cope with the increasing demand.

Nevertheless, there are more than one million NGVs in use today around the world, including buses, trucks, vans, taxis and passenger cars (NGV Communities 1999). More than 600,000 NGVs are currently on roads in Europe, 300,000 more are in use in Latin America. The US alone has more than 85,000 NGVs with expectation that this number will increase rapidly as the infrastructure expands.

3 NATURAL GAS IN EGYPT

3.1 *Natural gas for general purposes*

Natural gas is an abundant natural resource found in Egyptian deserts with increasing reserves. Recently, the government gave great attention to natural gas production and use. Accordingly, production of natural gas has increased from 12 trillion ft3 in 1992 to more than 37 trillion ft3 in 1999. Moreover, investment in natural gas production reaches US$ 3.9 billion, which is going to increase production by 50% starting 2000. It is anticipated that within the next 5-10 years, about 15-25% of gas production will be in excess of the domestic needs and can then be exported. Furthermore, the national gas network for domestic use reaches now 3,000 km compared with 650 km 17 years ago and is expected to double to 6,000 km by 2017. Currently, one million flats are fitted with natural gas in addition to 6,000 commercial establishments, 24 electrical power stations, 545 bakeries, and 100 industrial factories.

3.2 *Natural gas for transport*

Egypt has started in 1992 to use CNG vehicles for the first time in Africa and the Middle East. A policy of encouraging petrol driven vehicles to convert to CNG has effectively started at that time. The effort has been directed mainly to urban taxicabs in major cities. As a result, in 1996, Egypt ranked the 37th among 43 countries worldwide in the extent of use of CNG as transport fuel. At that time the number of vehicles operating on CNG reached 200. Currently Egypt is the 8th country in that list which contains now a total of 49 countries using NGVs. The number of NGVs on Egypt roads is presently approaching the 15,000.

Similar efforts are underway to encourage the conversion of public bus fleet operated by Cairo Transit Authority into CNG (a pilot project sponsored by USAID). Also some experimental effort are carried out to device suitable techniques for converting diesel-operated shared taxi microbuses in a more economic way. Cairo and Giza Governorates are trying to impose a time limit on shared taxi drivers to convert. However, it seems that this is not an easy task to implement on time.

4 EVOLUTION OF CNG CONVERSION POLICY FOR TAXICABS

4.1 *Objectives*

The policy undertaken by the Egyptian government to encourage the conversion of vehicles into CNG has two main objectives. The first is to reduce local use of its petrol oil products so as to direct it to exports and other essential uses. This should also reduce the dependency on imported diesel fuels, most of which is used in the transport sector. The other objective is to improve the urban environment in large cities suffering from overcrowded roads and highly polluting vehicles. Interviews with policy makers, however, reveal some relative importance of the above objectives in favor of economic targets.

The government set some targets in 1996 to convert all the passenger transport fleet (public buses, taxicabs, and shared taxis) by 2001. Only the conversion rate of taxicabs was pronounced. Conversion of other vehicle types did not proceed either due to shortage of fund (buses) or technical problems (shared taxis running on diesel).

4.2 *Description of different policies and pricing/financing schemes*

The conversion of vehicles into CNG in Egypt is performed by retrofitting engines so that they run on both CNG and gasoline (bi-fueled). Converted vehicles can switch from CNG to gasoline, usually until the CNG tank is refilled. The price of this conversion is fixed by the Ministry of Petroleum at L.E. 5000 (US \$1460). This price includes the cost of parts (mostly imported), customs and sales tax imposed on imported parts (more than 40%), labor cost, and some marginal profit.

To encourage the conversion of passenger cars, a system was devised that encompasses: 1) financial assistance and incentives to owners wishing to convert, 2) conversion and maintenance facilities, and 3) filling infrastructure.

As for the financial assistance and incentives, the conversion programme had two different time periods from this viewpoint. These are as follows:

A) Formerly, no financial assistance was provided. The whole cost of conversion was paid in cash. Moreover, taxes and fees related to vehicle license were subject to rules similar to those for diesel vehicle, at twice the rate for gasoline vehicles. The only incentive was the price of CNG that was fixed at L.E. 0.45 per m3 (US \$0.13), i.e. 50% of the price of a liter of regular gasoline. Knowing that a vehicle can run a little longer on one cubic meter of CNG as compared to one liter of gasoline, these prices clearly gave good incentive from the viewpoint of fuel cost. CNG price however, was more than 10% higher than the price of diesel fuels.

B) In the current time period, license renewal fees and taxes are reduced to a level similar to those for gasoline vehicles. Fuel prices are kept as in the previous period. A special scheme designed to help drivers to pay back the cost of engine conversion is available. Drivers have one of the following three options:

- Option 1: L.E. 5000 in cash – receives 500m3 of free gas coupons.
- Option 2: L.E. 1000 in cash as down payment + 16 monthly installments of L.E. 250 each.
- Option 3: no down payment + 24 monthly installments at 7% interest rate.

A maintenance scheme is also available under the current scheme as summarized below.

- First year: free checks and maintenance.
- After first year: L.E. 5.5 per check plus cost of repair and spare parts.

Regarding conversion and maintenance facilities, two private enterprise companies were given the right to operate in vehicle conversion. Engine retrofits are performed at workshops operated by these two companies. Periodical maintenance of the fitted parts is also carried out at the same workshops. Conversion of taxicabs usually takes few hours with almost no technical problems. The financial schemes are fully covered by the enterprise.

As for the filling infrastructure, the policy also allowed the above two companies to open and operate special fueling stations which are mainly annexed to the ordinary gasoline stations and are usually very crowded with long queues of waiting CNG taxis. This demonstrates the increasing numbers of converted taxis and the need for additional fueling stations. The total number of these stations reached 37 in 1999 and is increasing rapidly.

The system seems to create reasonable incentives to gasoline-operated taxis as they run for long distances so that fuel cost savings can cover the conversion cost in a short period. However, it is clear that there is not enough incentive for other passenger cars and diesel-operated taxis to convert into CNG.

Recently, the two companies are facing some cash flow problems and seem not to be able to continue the financing schemes. A proposed alternative is to finance conversion through the Social Fund for Development and the Syndicate of Taxi Drivers as will be explained later.

5 QUESTIONNAIRE AND INTERVIEWS

5.1 *Taxi drivers questionnaire*

Two questionnaires were conducted, one with a sample of 50 taxi drivers who have already converted to CNG (*denoted "C"*) and the second with 40 drivers who have not converted (*denoted "NC"*). Well-trained engineers carried out the survey, and the form was finalized after the evaluation of a pilot questionnaire. The form consisted of general questions, e.g. car age, model, engine capacity, fuel consumption, ownership and working hours per day. Otherwise, the forms of the "C" and the "NC" drivers included different sets of questions. The "C" form included inquiries about source of information about conversion, time period passed until conversion was done, conversion date, payment option used, fuel/maintenance cost before and after conversion, problems faced after conversion, suggestions for improving the CNG programme and suggested measures to encourage more conversion.

The "NC" form included questions about whether the drivers knew about the CNG programme or not, the source of information, knowledge of the payment scheme, intention to convert, suitable payment option, planned date of conversion, problems believed to be faced after conversion, conversion advantages and suggestions to encourage conversion.

5.1.1 *General characteristics of the respondents*
The average car age of the "C" sample was 15.1 years compared with 16.7 years for the "NC" sample. Engine capacity ranges between 1300 cc and 1800 cc, with an average of 1500 cc. About 83% of the "NC" respondents were driver owners, whereas the counter percentage for the "C" sample was 64%. Maybe taxi owners who hire others to drive it do not place much confidence on their driving behavior and go for CNG in order to minimize operating costs and maximize the net revenues. Averages working hours per day were very close for the two samples reaching 9.8 hrs and 11.1 hrs per day, respectively. The average of the two samples combined is 10.3 hrs per day, with a daily minimum of 4 to 5 hrs and maximum of 18 hrs on two shifts.

5.1.2 *Results of the "C" sample*
Cited sources of information about the conversion programme are colleagues, fuelling stations and the media, respectively. About 75% of the respondents indicated that they converted to natural gas within 6 months, or less, after knowing about the CNG programme. The highest number of interviewed drivers (about 36%) had converted to CNG since 12 to 18 months ago. Those who had converted since 6 to 12 months were less (about 30%). Only 22% converted in the last 6 months, indicating a slow down in conversion rate.

Among the three options available for paying the cost of conversion mentioned earlier, the most popular one seems to be Option 3 where no premium payment is necessary. About 57% of the respondents indicated that they selected this option. Option 2 was the second with 26% and only 17% indicated that they followed Option 1. Examining these results indicate that still no payment option is overwhelmingly favored. Hence, it is important to note that maybe a new and more attractive payment method is to be adopted in this respect.

As expected, considerable savings due to using CNG compared to gasoline operation were reported. On the average, the reduction was from LE2.6 to LE1.2/hr after conversion, which is nearly a 52% saving on fuel cost. Surprisingly, about 42% of the respondents indicated that maintenance cost increased under CNG and only 9% indicated a decrease, and 47% reported no difference. The main problems faced after conversions are: lack of engine power, long queues at fuelling stations, loss of space in the trunk due to the CNG tank, and engine wear. Very few drivers indicated no problems. About 85% of drivers asked for more fuelling stations, 15% are for improving maintenance, and 8% go for solving the problem of the large-size gas tank. Surprisingly, however, reducing the cost of conversion appeared only in 1% of the replies. Finally, reduction of conversion cost is the first recommendation to encourage more conversion (64%), more fuelling stations (17%), better maintenance (6%) and increasing environmental awareness (6%).

Crossed analysis of answers indicates that drivers of newly converted vehicles complained more often about lack of engine power and trunk space. As time passes they complain less about these problems but more often about engine wear. Analysis also reveals that drivers of older vehicles complained more about power loss, engine wear, and increased maintenance cost and they also achieved less fuel cost savings than drivers of newer vehicles.

5.1.3 *Results of the "NC" sample*
The majority of the respondents indicated that they knew about conversion programme from colleagues. Far behind is from fuelling stations and the media. Nearly, 83% indicated their awareness of the available payment schemes, and 60% intend to convert. But when asked about when they will actually do so, 67% stated they would convert in more than one-year time. It may, therefore, be concluded that the former result (i.e. the 60%) is somewhat exaggerated, and that perhaps the 33% who would convert in less than one-year are closer to reality.

As for the preferable payment scheme cited by the 60% of respondents who indicated they intend to convert, payment Option 2 was selected as the best option by 42%, with the same percentage for Option 3. Whereas, Option 1 ranked third with merely 16%.

Nearly 66% indicated they expect problems after conversion similar to those reported in the "C" sample. Main advantages of conversion to CNG are fuel savings with 77% of the vote. Only 20% of the respondents indicated that one of the advantages of conversion is better environment. The first suggestion to encourage conversion is to increase the number of fuelling stations (49)%. The second and third are solving engine problems (20%) and reducing conversion cost (17%). Dedicated CNG vehicles ranked fourth (14%). Then came advertising and imposing environmental tax on those who do not convert to CNG operation, scoring 9% each. It is extremely interesting to obtain a recommendation on taxation from those drivers who did not themselves yet converted their vehicles.

5.2 *Interviews with policy-related persons*

Interviews with policy-related persons were carried out. In addition to the information on the current programme and its objectives and incentive schemes presented in Section 2, some other relevant views were obtained.

Regarding incentives to encourage conversion, it is proposed to increase the attractiveness of CNG by fixing its price while imposing carbon tax on other fuels. A small price increase for diesel is also a possible policy to consider, with some of the resulting savings directed to subsidizing conversion. Decision-makers at the enterprise companies and the Ministry of the Environment also urge the exemption of parts used in conversion from all taxes and custom duties. Denial of license renewal for unconverted vehicles as an effective tool to augment conversion to meet targets was also suggested.

As for the reaction to the problems cited often by CNG taxi drivers during the questionnaire, some counter views were raised during the interviews. For instance, the engine wear problem is claimed to be unreal. The reason for drivers complains is a misinformation resulting from published news on excessive engine wear for dedicated NGVs used by some oil companies in Egypt in the early 1990's. However, plans for a media awareness campaign that was proposed by the enterprise companies were unfortunately turned down. As for the maintenance problems cited by some drivers, the claim is that the free maintenance programme results in too frequent visits by drivers to the workshops. The outcomes are unnecessary overcrowding and complains.

Current financing schemes (the three payment options) were reported during the interview to be no longer affordable by the private enterprise companies. This issue greatly affected the conversion rate in the last few months. A new financing scheme with the support of the Social Fund for Development and the Syndicate of Taxi Drivers is being studied. In this scheme, the conversion cost will be divided between the two organizations and paid directly in cash. Drivers will then pay back this cost plus some reasonable interest with certain grace period. Concerned parties are currently working out details of the scheme.

5.3 *Conclusions from questionnaire and interviews*

- Taxi drivers awareness of the positive effects of CNG operation on air quality is less than their awareness about fuel cost savings.
- Results obtained in the "NC" sample generally give the same trends obtained for the "C" sample (i.e. generally the same rank of the importance of the replies is obtained). This confirms the results and places a lot of confidence on the relevant recommendations given later in Section 6.
- The most important way of communicating the information about the CNG programme among taxi drivers is by far the word of mouth through colleagues. This is true for both the "C" and "NC" samples. The importance of receiving information from fuelling stations, however, seems more important for the "NC" sample. Surprisingly, sources such as Syndicate of Taxi Drivers and Natural Gas Companies were not mentioned at all.
- The majority of drives seem to be ready to convert soon after receiving the right information about the merits of conversion.
- It is not clear whether vehicle maintenance costs increase or remain unchanged after conversion.
- The insufficient number of CNG fuelling stations in GC is a very serious problem. Lack of engine power is the second most important of the reported problems. Loss of space in the trunk due to tank size and engine wear are other engineering problems that were reported by some of the drivers of the converted vehicles.
- Cited problems due to conversion in the "C" and "NC" samples are generally similar. The only exception is that in the "NC" sample, cost was reported in the list of expected problems of conversion. This contrasts sharply the earlier result of scoring only 1% for reducing the cost of conversion as a suggestion to encourage CNG operation given by the "C" sample respondents. It may be argued, however, that after conversion the cost has no longer been a problem. Whereas, for those who did not yet convert it is still an obstacle to be bridged.
- Current conversion cost is seen as exaggerated. Conversion companies put the blame on custom duties and taxes imposed on parts used in retrofitting engines.
- Clearly there is a conflict in interest between private enterprise companies and the government. While the first party is more concerned with profit, the second is interested in the economy and the environment. Therefore, it is not rational to hope that private companies can sustain attractive financing schemes aiming at protecting the environment.

6 RECOMMENDATIONS AND TRANSFERABLE LESSONS

Based on the results of the questionnaire and interviews, the following recommendations may be drawn out.

- To improve environmental awareness among taxi drivers so as to help the current efforts for increasing conversion.

- To introduce environment earmarked tax (i.e., carbon tax) on gasoline sales to be dedicated to boosting conversion of taxies to CNG operation.
- To adopt a strong and continuous campaign for advertising the benefits of conversion to CNG. Disseminated information has to accurately express the benefits as well as the possibilities for some demerits.
- To urge the Syndicate of Taxi Drivers and CNG producers to encourage conversion and to participate positively in the conversion effort. This should be materialized in, for example, giving financial support to taxi drivers wishing to convert with favorable repayment conditions, to conduct their own awareness campaigns on the merits of CNG operation, etc.
- To raise diesel price without exerting corresponding increase on the prices of other products that depend on diesel, e.g. popular breads. This will increase the relative attractiveness of CNG as an alternative fuel.
- A proportion of the revenue from exporting the gasoline saved due to the use of CNG in converted taxis is to be dedicated to the cause of encouraging more conversion to CNG.
- The government should play a more positive role in providing attractive financing schemes to encourage conversion. This role should not be left to the private enterprise alone. The following three recommendations provide some possible options.
- To reduce fees and taxes on license renewal for converted taxies.
- To reduce taxes and custom duties on parts used in engine retrofitting.
- To attract interested international organizations, funding agencies and interested NGOs to participate in offering attractive financing schemes for conversion.
- To work seriously on seeking solutions for increasing the number of fuelling stations in GC and other big cities.
- To encourage production and imports of dedicated NGVs.
- To help the owners of old taxicabs to buy new vehicles with dedicated CNG engines rather than to convert into CNG. Old taxicabs should not be allowed, even if converted to CNG.
- To improve and increase conversion and maintenance workshops. Proper training of staff is a must.
- It is important to study the problem of increased maintenance cost after conversion. The outcome can help so much in encouraging conversion to CNG if it is proved that the increase in maintenance cost is not related to the conversion and use of CNG. This is particularly important as many other drivers indicated that maintenance cost did not increase after conversion. Similar studies are required to find solutions for lack of engine power especially for old vehicles.
- To consider the establishment of local manufacturing of parts used in retrofitting engines so as to eliminate custom and tax burden and reduce the conversion cost.

7 CONCLUSIONS

Policies for conversion of taxicabs and other vehicles into CNG operation have high potential to offer good solutions for better urban environment, particularly in crowded cities. Egypt is one of the developing countries that have been adapting policies to convert urban taxicabs into CNG operation. The policies achieved many successes and also showed some practices that need enhancement. Based on a taxi drivers questionnaire and interviews with policy-related persons, this paper revealed useful recommendations and learned lessons.

Cost incentives seem to be one of the most effective policies to encourage conversion of vehicles to CNG. Therefore, propre schemes for repayment of conversion cost and fuel pricing are essential. However, without sufficient number of CNG filling stations close to demand locations, such programmes are likely to be less and less attractive. This is particularly true for those who place high value to time like taxi drivers. Governments, therefore, must give all possible encouragement to facilitate the procedures and reduce the cost required for the provision of such facilities. Policies should also include proper information dissemination. Without such effort, it is likely that many owners and operators who are more familiar with the use of conventional fuels will hesitate to convert to the less familiar CNG, or even sometimes will not convert because simply they do not know about it!

Furthermore, the national environmental policies should strongly emphasize the need for national programmes for increasing CNG use in transport. This is of particular importance for natural gas producing counties and those who can import it from neighboring ones. It is also recommended that countries who already apply CNG conversion policies and those who are serious about adapting similar ones, should exchange information and share experience. Many of the learned lessons in this area are transferable.

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Le programme 'BUS PROPRES' pour un environnement de qualité
El programa 'AUTOBUSES LIMPIOS' para un entorno de calidad
The 'CLEAN BUS' scheme for quality environment

Alain Curtil & François Barbier
Régie Autonome des Transports Parisiens (RATP), Paris, France

RÉSUMÉ: Le programme "BUS PROPRES" est déployé selon trois axes principaux :

- meilleur exercice des métiers de conduite et de maintenance,

- traitement des véhicules existants par le choix des carburants et par l'adoption de systèmes de post-traitement des gaz d'échappement,

- utilisation des énergies alternatives pour les bus neufs : le gaz et l'électricité.

Les choix sont issus de la veille technologique constante, de la coopération avec les organisations nationales ou internationales du domaine, et des propres moyens dont s'est dotée la RATP pour valider les nombreuses technologies émergeantes.

RESUMEN : El programa "AUTOBUSES LIMPIOS" está desplegado según tres ejes principales :

- Mejor ejercicio de las actividades de conducción y de mantenimiento,

- Tratamiento de los vehículos existentes por la selección de los carburantes y por la adopción de sistemas de post-tratamiento de los gases de escape.

- Utilización de las energías alternativas para los autobuses nuevos : el gas y la electricidad.

Las selecciones proceden de la vigilancia tecnológica constante, de la cooperación con las organizaciones nacionales o internacionales del campo y de los propios medios de que dispone la RATP para validar las numerosas tecnologías emergentes.

Summary: the "CLEAN BUS" scheme covers three main lines:

- better application of driver and maintenance professions

- processing of existent vehicles by the choice of fuels and by adopting the re-processing of exhaust fumes.

- use of alternative energy sources for new buses: gas and electricity.

The choices stem from the continuous technological watch, the cooperation with national and international groups working in this field and the means the RATP is geared with to validate the numerous emerging technologies.

1 INTRODUCTION

Avec plus de 200 lignes desservies par 4000 bus, le réseau de la RATP assure plus de 2,5 millions de voyages chaque jour. Ce trafic est en constante progression depuis 10 ans, démontrant l'attractivité de son réseau et l'adaptation de ses réponses à la croissance de la demande des habitants de l'agglomération parisienne.
Bien que les bus de la RATP produisent moins de 4% de la pollution générée par l'ensemble des transports de surface, l'entreprise a adopté une politique exemplaire de lutte contre la pollution pour marquer sa détermination à améliorer la qualité de vie en ville.
Le programme permet de diminuer fortement les émissions polluantes du parc actuel, essentiellement diesel, afin d'avoir un impact commercial à cours terme et ainsi améliorer l'attractivité des transports publics. Il doit aussi faciliter les choix technologiques à opérer au cours des prochaines années, époque de diversification où les filières émergeantes actuellement connaîtront un potentiel de déploiement industriel important.

2 LA METHODE

La validation de chaque dispositif se fait selon les étapes suivantes :

1- analyse physique de la solution proposée afin d'en évaluer la crédibilité,
2- mesures au banc moteur sur des régimes stabilisés pour les moteurs thermiques,
3- mesure des émissions polluantes à l'aide d'un bus laboratoire en circulation dans les conditions réelles d'exploitation,
4- essai sur un autobus pendant quelques semaines,
5- mesure des polluants réglementés et non réglementés, de la consommation à l'UTAC selon le cycle urbain Ademe-RATP 21 représentatif d'une ligne urbaine dense,
6- essais d'endurance sur un bus puis sur une ligne pendant 6 mois au minimum.

Ces étapes franchies avec succès, la solution est jugée opérationnelle. L'économie de la filière est alors approfondie.

Dans certains cas, les technologies mises sur le marché par les constructeurs de véhicules peuvent être mises en œuvre sans qu'il soit nécessaire de passer par toutes les étapes du programme de validation. Un marché avec garantie de résultats portant sur l'ensemble des coûts d'usage et des performances écologiques en situation réelle d'exploitation permet de minimiser les risques liés aux filières émergentes.

3 LE TRAITEMENT DES BUS DIESEL

La RATP dispose d'un parc de 4000 bus à motorisation diesel dont le renouvellement s'effectue en moyenne à 15 ans. Il est composé principalement de véhicules Renault VI de plusieurs générations :
- 700 bus "SC10" conçus dans les années 60, acquis jusqu'en 1988 qui ne disparaîtront totalement que fin 2001,
- 1800 bus "R312, PR100 et GX317" acquis de 1988 à 1996, dotés de moteurs modernes avec turbocompresseur, les 780 derniers étant conformes à la directive européenne "euro 1",
- 1300 bus "Agora" acquis depuis octobre 1996, conformes à la directive "euro 2".

Le parc est complété par plusieurs petites séries de véhicules.

Depuis plus de dix ans, de multiples dispositifs devant permettre de diminuer les émissions polluantes des autobus ont été testés avec, comme priorité, la réduction des particules considérées comme la principale nuisance des moteurs diesel.

3.1 *Le choix du carburant*

La solution la plus simple pour réduire les émissions polluantes des autobus consiste à choisir un carburant peu polluant accepté par le moteur et sa pompe d'injection.
Après de multiples essais, le choix de la RATP s'est porté sur l'**Aquazole**, une fine émulsion de gazole et d'eau à 11%, avec environ 2% d'additifs pour stabiliser l'émulsion pendant plusieurs mois et garder le pouvoir lubrifiant du gazole.
Ce produit, développé par le pétrolier Elf Antar , permet de réduire de près de 40 % les oxydes d'azote et de 20 à 30 % l'opacité des fumées émises.

Ces résultats s'expliquent par une diminution de la température dans la chambre de combustion et une meilleure répartition du nuage de carburant. Si l'on souhaite rétablir les mêmes performances dynamiques du moteur, il est nécessaire d'augmenter le débit de la pompe d'injection.
Réservé en priorité aux bus les plus anciens,

SC10 RATP roulant à l'Aquazole

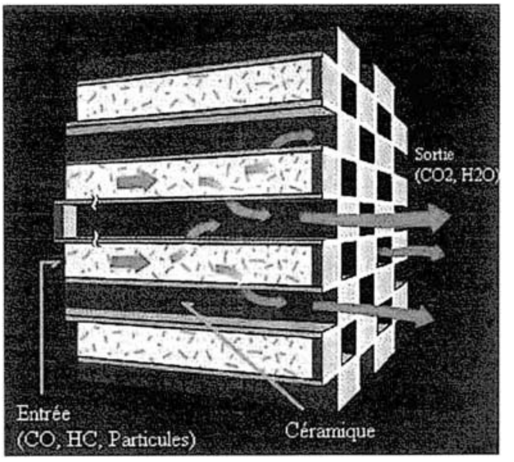


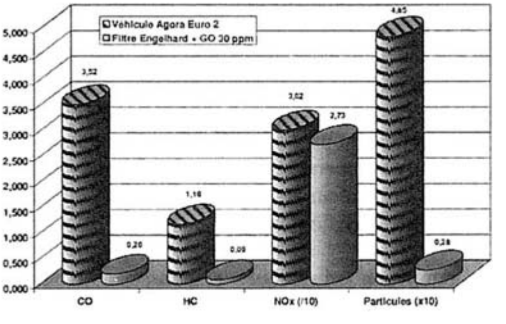
Schéma de principe du filtre à particules

l'Aquazole est utilisé depuis fin 1998 pour les 126 véhicules du dépôt parisien de Lagny.

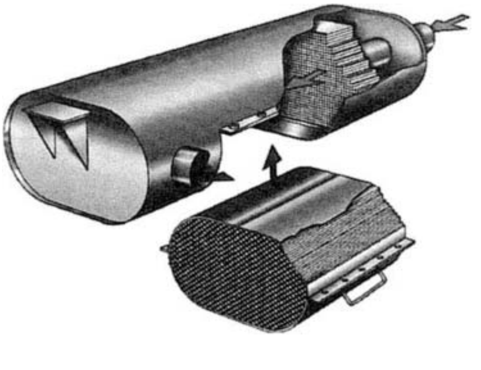
21 bus de la ligne 72 en ont été dotés à partir de juillet 1998 et ont fait l'objet d'un suivi technique en partenariat avec les constructeurs pour tenir compte des spécificités du matériel roulant.

3.2 *Les systèmes de post-traitement*

Le succès de ces techniques dépend fortement des températures observées à l'échappement. Les conditions d'exploitation à la RATP, en milieu urbain dense, sont peu favorables compte tenu des phases de ralenti importantes.
Parmi les nombreux systèmes testés, seuls aujourd'hui **les filtres à particules catalytiques** ont franchi avec succès les étapes successives du programme de validation. Associant un catalyseur d'oxydation et un filtre à particules, ils nécessitent l'emploi d'un gazole hautement désulfuré pour éviter "l'empoisonnement" de la catalyse. La teneur maximale en soufre est de 50 ppm alors que celle du gazole standard est de 500 ppm.



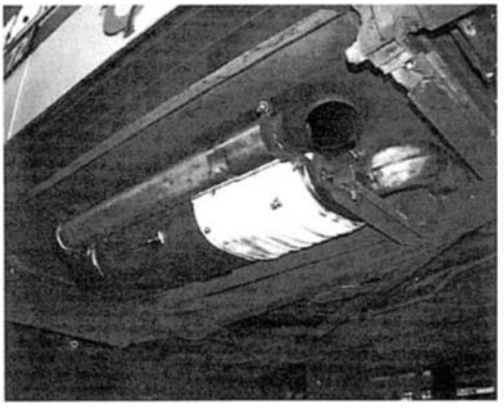
Résultats sur cycle ADEME RATP



Vue d'un filtre à particules catalytique

Compte tenu des résultats obtenus, un appel d'offres européen a été lancé début 99 en vue d'un déploiement de filtres à particules catalytiques dès octobre 1999 pour un objectif de 2200 bus équipés en 2001à raison de 100 bus par mois.
Ce programme bénéficie de subventions de la Région Ile de France et de la Ville de Paris.

Cette technologie s'applique uniquement aux véhicules de moins de 10 ans, l'intégration sur la ligne d'échappement des SC10 n'étant pas possible sans modification lourde de leur soubassement.



Autobus RATP R312 équipé

4 LES TECHNOLOGIES PROPRES POUR LES BUS NEUFS

Pour les prochains marchés de renouvellement des autobus, à passer au deuxième semestre 2000, le choix devra porter principalement entre :

- le moteur diesel qui aura bénéficié des progrès imposés par la future directive Euro 3 (au plus tôt en octobre 2000) avec éventuellement un dispositif de post-traitement à l'échappement et/ou un carburant évolué,
- le moteur au gaz naturel (GNV) ou au gaz de pétrole liquéfié (GPL).

L'acquisition d'autobus électriques en faible quantité pour des services spécifiques permettra d'accompagner le développement de la filière qui, à long terme, supplantera probablement les moteurs thermiques pour un usage urbain.

4.1 *Les bus au gaz.*

En vue de la préparation de ces marchés, la RATP a décidé de tester à l'échelle opérationnelle les bus au gaz naturel comprimé et les bus au gaz de pétrole liquéfié.
Deux marchés ont été passés pour 106 bus au GNV et 112 bus au GPL en deux tranches livrables en 1999 et 2000. Les premières lignes ont été exploitées à partir de septembre 1999.

Caractéristiques des bus au GNV
Les bus retenus sont des Agora Renault VI au gaz naturel comprimé à 200 bars dans 9 réservoirs en fibre de carbone disposés sur le pavillon et d'une contenance de 126 litres chacun.
La technique de charge retenue est la charge rapide à la rentrée au dépôt en fin de service, avec un temps de charge de 2 à 4 minutes selon les lignes.

Les dispositifs de sécurité reposent sur trois principes : *prévention, détection, traitement.*
La *prévention* consiste à éviter les sources d'ignition, à définir des procédures d'exploitation des équipements adaptées, et à effectuer les formations nécessaires.
La *détection* de fuites dans les espaces confinés est réalisée par des faisceaux infrarouges situés en partie haute, le méthane étant plus léger que l'air.
Le *traitement*, en cas de fuite importante, va jusqu'à l'ouverture automatique des portes couplée à l'activation d'une ventilation puissante.

Caractéristiques des bus au GPL
Les bus retenus sont des GX317 GPL Heuliez avec moteur DAF à injection liquide. Le GPL est chargé dans deux réservoirs de 300 litres situés sur le pavillon. L'organisation et le temps de charge en carburant sont identiques au bus diesel.
Les dispositifs de sécurité en atelier sont identiques à ceux mis en œuvre pour les bus au GNV, à la différence des faisceaux infrarouges disposés au sol et dans les fosses, le mélange butane/propane étant plus lourd que l'air.

4.2 *Les bus électriques*

Depuis février 1996, deux midibus (7 m) électriques expérimentaux à batteries nickel-cadmium sont exploités sur la ligne

bus RATP au GNV

bus RATP au GPL

	CO	*HC*	*NOx*	*Particules*
Euro 2	*4*	*1.1*	*7*	*0.15*
Euro 3	*2*	*0.5*	*5*	*0.10*
GPL catalysé	*0.25*	*0.02*	*0.4*	*0.01*
GNV catalysé	*0.7*	*0.1*	*4*	*0.01*

Emissions comparées Euro2/Euro3/GNV/GPL sur cycle R49

Montmartrobus. A chaque tour de ce petit circuit de 6 km à fortes pentes, une charge rapide est effectuée au terminus en 5 à 6 minutes afin de permettre une exploitation sur toute l'amplitude du service.

Très appréciés, ils constituent une excellente solution pour améliorer la qualité de vie en ville : zéro pollution gazeuse et sonore. Leur utilisation élargie se heurte actuellement à une trop faible énergie massique des batteries et à un coût d'acquisition double de celui d'un autobus diesel de même gabarit.

Afin d'en accompagner le développement industriel et de répondre aux souhaits de la clientèle, dans le cadre d'un projet de convention avec la Ville de Paris, le Montmartrobus sera entièrement doté de midibus électriques. De plus, une desserte de quartier avec cinq midibus électriques est à l'étude.

Pour répondre à ces besoins et à des demandes de communes de l'Ile-de-France, un marché pour la fourniture de 20 minibus électriques a été signé.

5 LES BUS DE DEMAIN

Au-delà des technologies précédentes, déjà

Autobus Oréos 55E de Gépébus

Caractéristiques de l'Oréos 55 E
Batteries : Ni-Cd
Longueur : 7.70 m
Capacité : 50 places
Autonomie sans recharge en circuit urbain :54 km
Autonomie avec recharges rapides en exploitation : 95 km

largement diffusées et qui bénéficieront de progrès importants au cours de la prochaine décennie, il est nécessaire d'accompagner les développements qui donneront le jour aux technologies de demain faisant largement appel à l'énergie électrique sous ses différentes formes.

La RATP participe à un programme de préparation à la mise en exploitation progressive des bus à pile à combustible (dans 5 à 10 ans) pour lesquels, en plus des progrès à réaliser au niveau du générateur, il faut travailler à la maîtrise de l'énergie primaire : stockage et transfert du carburant.

Dans cette perspective, le bus hybride série permet de tester ce que pourra être l'environnement de la pile à combustible tout en offrant une solution opérationnelle. C'est pourquoi la RATP exploitera avant la fin de l'année un premier bus hybride de 12 mètres doté d'un moteur diesel de petite cylindrée dimensionné pour fournir l'énergie moyenne consommée par le véhicule et non pas l'énergie de pointe comme pour un véhicule classique.

On obtient deux avantages intéressants :
- faibles émissions polluantes,
- niveau acoustique réduit.

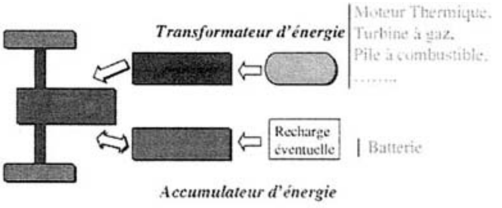


schéma d'un bus hybride

6 CONCLUSION

En attendant le déploiement à grande échelle des bus électriques vraisemblablement dotés d'une pile à combustible, la motorisation diesel composera encore majoritairement le parc grâce aux progrès qui seront réalisés dans les trois domaines complé - mentaires : carburant, construction, et post-traitement. Parallèlement, les bus au gaz naturel et au GPL connaîtront un certain développement dont l'ampleur sera essentiellement conditionnée par la politique énergétique des états.

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The impact of the integral automation adoption in the São Paulo Metro organization

L'impact de l'adoption de l'automation complète dans le Métro de São Paulo

El impacto de la adopción de la automatización total en la organización del Metropolitano de São Paulo

Marcos Camelo Barbosa
Companhia do Metropolitano de São Paulo, METRÔ, Brazil

ABSTRACT: This work is related to the study on the impact of the full automation implantation in São Paulo Metrô. It analyzes the Company's technological evolution, the impact and tools for the success in the adoption of new technologies in São Paulo Metrô, besides describing some experiences of organizational models that wuold be adapted to the organization of a metro with full automation.

RÉSUMÉ: Ce travail concerne l'étude sur l'impact de l'implantation de l'automation intégrale dans le Métro de São Paulo. Il analyse l'évoltution technologique de la Compagnie, l'impact, les outils pour que de nouvelles technologies soient adoptées dans le métro de São Paulo de façon réussie, et il décrit de plus quelques expériences de modéles d'organisation Qui s'adaptent à l'organisation d'un métro avex automation intégrale.

RESUMEN: Este trabajo se refiere al studio sobre el impacto de la implantación de la automatización integral en el Metropolitano de San Pablo. Analiza la evolución tecnológica de la Compañia, el impacto y herramientas para el éxito en la adopción de nuevas tecnologías en el Metropolitano de San Pablo, además de cescribir algunas experiencias de modelos de organización que se adaptarían a la organización de un metropolitano con automatización integral.

1 TECHNOLOGICAL DEVELOPMENT OF THE SÃO PAULO METRÔ

The Technological Development process in the São Paulo Metro, in its 31 years, is basically characterized by the increasing technological maturity of the Company and by the political picture at the implantation time of each line.

In the implantation of the first Metro line, North/South, around 1970, the new Company, with the inexperience of the Brazilian engineering in Metro systems, leaded São Paulo Metro to the contracting of foreign consulting and investing in the qualification of its human resources, performing visits and training periods abroad.

In the project of the second line, East/West, around 1976, the policy at that time was of "Nationalization", that is, with the knowledge get in the first line, it had been possible the nationalization both of projects and of equipment. It is enough to say that, with such endeavours, the nationalization index of the East/West line was of 93%.

In the third line, the adopted policy was that of opening of ports, which means that the commerce globalization started to affect São Paulo Metro.

2 THE LEARNING PROCESS

All those paths already passed by São Paulo Metro show the learning process to which it was subjected. Learning, in the technological development process, is related to several processes of skills and knowledge that are achieved either individually or by organizations. Technological Development, in the context, is used in order to make reference to processes through which companies achieve technical skills and knowledge.

Change in the corporate structure is a prior condition for new kinds of technological capacity. Thus, authors such as Linsu Kim present, in their publications, the development model with 3 stages, which are: Implantation, Assimilation and Improvement.

Automation programs, which include modern computerized systems, provide gains in quality, flexibility, speed, etc. "The implantation of the knowledge on Flexible Systems has been reaching significant reduction in the number of workers and staff, and decrease of the time for launching of new products".*

As we could see above, in order to be able to place the Organization in a shape so as that it may achieve the best results in the use of state-of-the-art technologies, the organization learning process is fundamental.

3 IMPACT OF NEW TECHNOLOGIES IN THE ORGANIZATIONS

A project such as that of conceiving, implanting and operating a fully automatic Metro requires high integration among people, the organization and the technology, otherwise, the adoption of new technologies tends to fail.

The organizations may increase their top (technology, organization and people) integration knowledge. The application of state-of-the-art technologies in the technological integration organizations, has been showing that the companies integrate more effectively the organization and the technological projects when they use the capacities inside their own companies, such as:

- Experts with general knowledge;
- Multi-purpose teams;
- Technical modeling;
- Technological registration.

4 FULL AUTOMATION AND ITS BENEFITS

Metro trains driving technology, with full automatism, without operators, has been firstly successfully performed in 1983, in the Lille Metro (France), which was an important development. There are already several metros in the world with such technology and many projects in progress, including in cities provided with metros with traditional driving. The cities of Lille, Vancouver, Lyon, Docklands (London), Tokyo, Paris (Météor) and Toulouse, among others, already have systems in operation, for several years.

There are also smaller fully automatic metro lines, of the AGT (Automated Guideway Transit) type, systems of the people mover type, in some Japanese cities, interlinking their urban metro with small commercial and residential centers, as well as interlinking in American, Canadian, Australian and European Cities serving the downtown, university campi and airports. The airports of Tampa, Seattle-Tacoma, Miami, Orlando, Pittsburgh, Denver, Frankfurt/Main, Kuala Lumpur, Singapore and others have AGT-type systems in operation or under construction.

Four arguments use to be placed by the people sceptic in relation to the full automation projects for metros:

- They eliminate employment;
- They limit the passengers to a non-human universe, where they are left alone in case of incidents;
- They develop, in the potential users, a fear that appears from the absence of operators on board of the train;
- They are more expensive in relation to the investment.

Such arguments have been evidenced as not fully true, as soon as the first automatic line of the Lille Metro has been implanted.

Automatic metros provide many flexibility and adjustment of service offer to the demand, besides a very small headway, of approximately 60 seconds. This allows, without increasing costs, an exceptional service quality, concerning the offer of places, a perfect adjustment to the demand, regardless of the time, day or non-scheduled events.

Full automatism requires, in some cases, besides their own automation equipment, some special safety measures for passengers, such as doors in the platforms, including in order to minimize perturbation by interference of the users, besides more sophisticated control centers and more developed intercommunication systems between users and operating agents.

The elimination of operators does not obligatorily mean reduction of the staff, since they, withdrawn from their closed position inside the cabins, undertake new service attributions with the users and some technical responsibilities in emergency cases. Thus, it allows, to the contrary of the appearances, higher contract among the users and the company.

For their good performance, automatic metros are provided with tools that allow them to treat

* HAYES, Robert H. E JAIKUMAR Ramchansdram. Manufacturing's Crisis Tecnologies, Obsolete Organizations. Harvard Business Review, September/October 1988.

incidents within minimum times, which do not affect the service quality. Besides, the full automatism is reflected in automation of large part of the systems, such as ticketing, and also a fully automated maintenance, as well as an administrative and operating management in real time, and fully integrated.

Its adoption requires an administrative re-engineering of the operator companies, because it generates a series of functions not foreseen in the conventional metros, besides requiring an evolution in the positions of station agent, control center operator, line agent (former operator), etc.

5 THE HUMAN ISSUE

5.1 *Operators and their new functions*

Public opinion understands any kind of automatism as "reduction of staff". It is the case of the train operation without operators. Such point of view is not true. If it is right that the automatic systems tend to suppress certain jobs, many of the functions are replaced by others with higher technical and human contents.

The train operator and the Operational Control Center operator get new functions. The creation of teams that perform multi-purpose tasks, without existing a previous definition of specific functions for its members, the so-called semi-independent groups, is an idea firstly developed in the coal mines in Durhan, England, around 1948, and the most recent and famous are those which are being developed in the Scandinavian Countries, specifically the experience of Volvo and Saab, and followed in many other modern companies. They have direct application in the automatic metros. Under the individual point of view, it requires the development of multiple skills and special training.

Thus, the metro operator's mission is enriched. In the full automatism, the aspects of safety, of service re-establishing, of service to the users and others, are mixed in a new dimension. The train operator becomes an itinerant presence, and the metro without operator becomes a more human metro.

It must be reminded that in the modern metros, the driver is provided with assistance tools that leave him/her, in the majority of time, without a direct function. Automatic driving limits his/her responsibilities to two main tasks:

- To warrant safety in the exchange of passengers in the stations (arrival in the station, sequence of closing of the train doors, exit).
- To warrant the continuity of service in case of incident (intervention in the rolling stock and/or retaking of manual driving, after a failure of the driving automatism or of the rolling stock).

5.2 *Concerne with the users*

The general trend of evolution of the public transport companies leads them to have an increasing concern and to develop, therefore, new functions that warrant a constant presence of the operator company with the passengers.

The traditional functions of station agents and controllers are then replaced, enlarged and enriched, and may be classified in two categories:

- Technical activities of supervision and of first level of maintenance, such as operational intervention on the system and equipment, technical quality supervision, help in the diagnosis of incidents, etc.
- Activities oriented for the customer assistance, in safety questions, provision of several information, actions for environment improvement, assistance to the users in case of incidents, filing of complaints, fight against fraud, etc.

5.3 *Required personnel and the Trade Union issue*

In case we limit ourselves to the technical functions, the economy regarding the number of employees would be possible, since the number of agents required in line is lower than the number of operators who would warrant a traditional service.

Such economy in the technical operation may, therefore, be used in order to create the new employment of users' service, control and follow-up agents. This is the newest trend appearing.

6 A NEW ORGANIZATION FOR THE SÃO PAULO METRÔ

The proposal for work organization arises from different concepts of productive system. The scientific management starts from a mainly technical conception; on the other hand, the enrichment of positions emphasizes the social system, practically disorienting the production technical conditions.

The model of Semi-Autonomous Groups is a result of the social-technical conception for analysis of the organizations. It also provides that the productivity system will only reach its maximum productivity when the joint operation of the technical system and social system is optimized.

Under the social aspect, it is admitted that the most relevant point is the cooperation required among the elements comprising the group, that is, the support for the inter-relationship among people is the work relations and not spontaneous relations of friendship, as provided for by the defenders of the enrichment of positions. Besides that, under the individual point of view, it requires the development of multiple skills.

Under the technical aspect, the main concept is that of self-regulation. This arises from the concern of avoiding formalization of positions, and allows the production system to be characterized by a large dose of flexibility.

Summarily, in the Model of Semi-Autonomous Groups, the Group receives a task with low detailing level, is provided with resources for performing it and independent to be structured during the work development process. The implicit idea is that *"a group, formed by the lower number of people, capable to perform a full job and comply with the social and psychological needs of its members, is the most satisfactory and efficient arrangement, both from the point of view of the task performance and from the point of view of those who are working".*[**]

However, it may be seen in the modern technologies that there is no more space for low-skilled people, who not have wide view of the system. An example of that is the full automation technology of Metros.

The highest difficulties, however, originated from the resistance developed by the other sector of the Company against the changes, which, unavoidably, results in the introduction of a SIG model in the organizational structure. Firstly, there is a decrease of the hierarchical levels, since the need of external coordination decreases. In second place, there is the reduction of indirect labor force, since the tasks of work planning and control are assigned to the group elements. Finally, *"the changes in the autonomy degree seem to result in changes in the worker's position within the company. In order to define the nature of such change, there is a single expression that seems proper to me, which is the democratization of the work site, (...) democratization of the work relations."*[***]

[**] RICE, A. K. **Productive and social organization.** London, Tavistock Publications, 1958.

7 CONCLUSION

The experience of the fully automatic Metro companies, without operators, converge to state that the full automatism allows, concurrently, an exceptional service quality concerning the service frequency and adjustment, and of offer to demand, as well as an operational economy, which corresponds to the absence of operators, which will more frequently result in creation of users' service and assistance employment.

In addition, there is the gain to the users, brought by the quality of the full automatism specific service, even if such gain may be hardly measured.

The user's service quality brought by the full automatism widely justifies its implementation. At constant cost, developing new functions in the public service operation, and the technical employment introduced by technology, the full automatism of operation allows to reduce the waiting times and improve the service to the public in all its aspects: cleaning, information and safety.

In order to achieve all social and economic advantages of such technology, the companies are required to explain to their employees the interest of the operation functions, which may be developed with constant budget, due to the disappearing of the operator function, which currently does not provide real interest.

It has been shown how the disappearing of the operator function allows to improve the service quality and assign the operation staff for more diversified tasks, which allow to ensure a better service to the users, by the personnel in direct contact with the passengers.

The impact of the integral automation adoptions, not only for the São Paulo Metro but also for the majority of Metros of the world, will have to make a deep organizational study. In such work, we saw a brief study of the main impacts and are to be taken at the time of choice of state-of-the-art technologies.

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Sistema de tranvia para la ciudad de Santiago de Cuba – Una alternativa para el transporte urbano

System of tramcar for the City of Santiago de Cuba – An alternative for the urban transport

Gonzalo Bruzos Bonzon & Royne Govea Pino
Center of Engineering of the Transport of Eastern IT Group, Santiago de Cuba, Cuba

RESUMEN

En la ciudad moderna es cada vez más común el uso de sistemas de transportes guiados, dado a las posibilidades que brindan éstos en capacidad de transportación, confort, protección del medio ambiente y otros.
Estudios realizados en Santiago de Cuba muestran que para esta ciudad el tranvía rápido, en interacción con el sistema de ómnibus urbanos, sería la variante más apropiada en condiciones de crecimiento de la demanda de transportación.
El trabajo incluye aspectos de organización de las transportaciones, parámetros técnicos del material rodante, cantidad necesaria de éstos, inversiones, trazados y cuales serían los beneficios que le reportaría a la ciudad en términos de impacto ambiental y confort de transportación.
En la investigación se emplearon métodos de optimización, pronósticos y sistemas automatizados diseñados a tales efectos. Se realizaron estudios de la movilidad de la población, crecimiento demográfico, desarrollo territorial de la ciudad, así como se tiene en cuenta las características de sismicidad de la misma en las propuestas analizadas del sistema de tranvía.

ABSTRACT:

In a modern city, it is more common the use of system of guided transport, due to the possibilities that they offer in capacity of transportation, comfort, and protection of the environment and others.
Studies carried out in the city of Santiago de Cuba show that for this city the fast train, in interaction with the system of urban buses, it would be the most and proper variant in condition of increasing of the claims of transportation.
The work includes aspects of organization of the transportations, technical parameters of the rolling stock, necessary quantity of these, inversions desingns and which would be the benefits that would report to the city in terms of environmental impact and comfort of transportation.
In the research work was used methods of optimización, and systems, predictions and automatized designs to real effects. Studies of the mobility of the inhabitants were done, demographic growth, development of the territorial city, as well as the seismological characteristic of the same in the analyzed proposal of the system of tramcar.

1. INTRODUCCION

El transporte es uno de los principales problemas de las grándes ciudades e incluso se vislumbra que esta situación existe para las medianas y pequeñas ciudades, donde el transporte automotor de pasajeros no satisface a plenitud las demandasde transporteción. Es por ello que los sistemas de transporte guiados constituyen una alternativa a las transportaciones urbanas de pasajeros. Particularmente el tranvía, luego de un período de decadencia en los años 50 y 60, ha resurgido con nuevas y eficientes tecnologías.
Los estudios realizados en la ciudad de Santiago de Cuba muestran que ésta, por la cantidad de habitantes su movilidad y por las propias

características de la ciudad, requiere como alternativa al transporte por ómnibus de la implantación de un sistema de tranvía rápido, sobre todo para la perisferia de la misma la cual no cuenta con servicios efiscientes de transporte por el déficit de arterias viales que satisfagan los niveles de circulación vehicular.

La experiencia ha demostrado que los sistemas de transporte sobre rieles constituyen un medio capaz de absorber altos volúmenes de tráfico ofreciendo al mismo tiempo gran seguridad para el usuario y un aporte positivo a la preservación del medio ambiente.

2. CARACTERIZACIÓN DE LA CIUDAD DE SANTIAGO DE CUBA.

2.1. Antecedentes.

La perspectiva de desarrollo de la ciudad se enmarca con un área de 266 Km^2 y un crecimiento poblacional de más de 500 mil habitantes para una movilidad de 2.33 viajes de origen a destino diarios por habitante.

De estudios realizados se pudieron pronosticar los volúmenes de transportación que demandará la población en el año 2005, a partir de los datos del desarrollo económico y socio - cultural del territorio.

A la luz de aquellos datos fueron determinados los corredores de flujos que respondieran a los caminos mínimos de transportación entre cualquier par de puntos de la Ciudad, para lo cual ésta fue dividida en 56 zonas de transporte, según se observa en la figura 1.

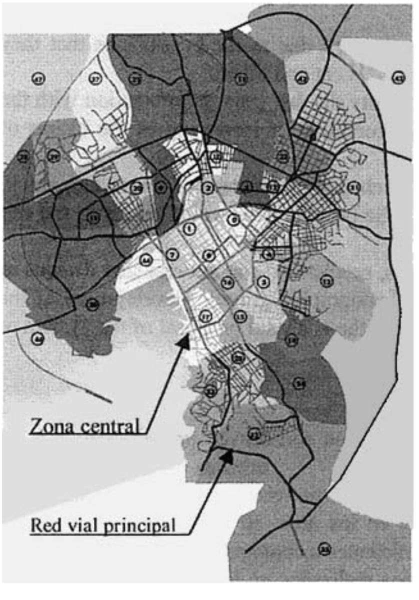

Figura 1. Zonas de transporte de la ciudad de Santiago de Cuba.

Ello exigió del empleo de 4 grupos de modelos económico - matemáticos y de la utilización de un sistema automatizado para estudios de la movilidad de la población y cálculo de flujos de pasajeros.

Como resultado se constató la existencia de tramos en la red vial con una carga de hasta 10 000 pasajeros en la hora punta y en el sentido más cargado.

Dada la extensión territorial y la población de la Ciudad (cercana ya al medio millón de habitantes), se puede concluir en la necesidad de concebir un sistema de transportación de capacidad intermedia, para las que la literatura especializada y la propia experiencia en una gran cantidad de ciudades con las más disímiles condiciones recomiendan el uso de vehículos acoplados guiados.

Por otro lado la técnica actual ha elevado considerablemente los límites clásicos delos sistemas tranviarios, en velocidad, cargas remolcadas, pendientes superables, disminución de los impactos ambientales, consolidando con estos factores las ventajas del tranvía como medio de transportación masivo.

Detallando las ventajas competitivas de este medio se puede decir en términos:

- Ecológico.
  a) Mayor integración al entorno.
  b) Menor ocupación del suelo.
  c) Menor emisión de ruido y polución del aire.
- Seguridad.
  a) Mucho más seguro que otros medios terrestres.
  b) La seguridad puede ser garantizada establemente.
- Consumo energético.
  a) Los consumos son relativamente menores.
  b) Puede aportar energía al sistema energético de la ciudad.

2.2. Concepción del tranvía.

El sistema de tranvía se concibe para evacuar grandes volúmenes de pasajeros, lo cual se logra con el acoplamiento de varios arrastres a un equipo de tracción. Tales sistemas pretenden evacuar fundamentalmente los flujos de pasajeros con distancias de transportación mayores, lo que lleva consigo un mayor distanciamiento entre paradas y prioridad en la circulación.

La utilización de sistemas de transporte urbano guiados como medio de transporte de pasajeros,

ofrece la posibilidad de aplicar una nueva estructura organizativa en la esfera del transporte, la cual posibilitaría la satisfacción de la demanda de transportación de pasajeros en la ciudad de Santiago de Cuba sobre todo al contar esta con muy pocas arterias que permitan un elevado nivel de circulación tanto de vehículos ligeros como ómnibus rígidos y articulados.
La nueva estructura organizativa consistiría en la integración del sistema de transporte de la ciudad alrededor de un elemento estructurador de alta capacidad con lo cual se optimizarían los recursos existentes en dicha actividad.
Las características funcionales de Santiago de Cuba, la necesidad de integrar zonas residenciales densamente pobladas, con escasos puestos de trabajo y estudio, así como con una infraestructura socio-cultural insuficiente y distanciadas de las principales zonas (central, industrial, residenciales) del territorio, inciden de forma decisiva en la adopción de la variante de tranvía.
Esto constituye la base de la concepción del sistema de tranvía en Santiago de Cuba, para cuyo diseño de trazado se utilizó el Cartograma de flujos de pasajeros en la ciudad Santiago de Cuba, según se observa en la figura 2. a partir del cual se definieron y evaluaron a través de sistemas automatizados diferentes variantes de trazado en su interrelación con el transporte colectivo por ómnibus. Como resultado se obtuvieron las direcciones de transportación donde la implantación del tranvía se fundamenta económicamente de acuerdo con los volúmenes de pasajeros a asimilar.

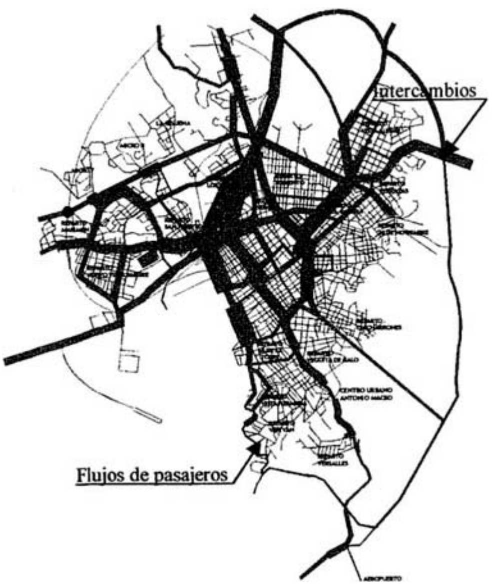

Figura 2. Cartograma del flujo de pasajeros en la ciudad de Santiago de Cuba.

2.3. Trazado.

La longitud total del trazado propuesto es de 32 000 metros, de ellos 200 metros de viaducto. Se prevé en la totalidad del trazado la doble vía con el objetivo de garantizar la frecuencia de línea y la seguridad en la circulación.
Se propone la utilización de dos tipos de superestructura para la vía : vía normal en el caso de sitio propio y vía sumergida en caso de sitio reservado.
En el primer caso se prevén carriles de los usados en vías férreas normales, con traviesas de hormigón a razón de 1 520 unidades por kilómetro y bajo la traviesa una capa de balasto de no menos de 15 cm de espesor. En el segundo caso sería vía en placa mixta con carril sumergido (con garganta) y traviesas de hormigón a razón de 1680 unidades por kilómetro y una losa de hormigón armado bajo la misma de 15 cm de espesor.
Esta propuesta se fundamenta en las posibilidades materiales y tecnológicas con que cuenta el país, facilitando con esto la posible construcción reduciendo la importación de recursos para la construcción de la infraestructura vial. En la figura 3 se observa un esquema del trazado.

Figura 3. Red del tranvía en la ciudad de Santiago de Cuba. Propuesta.

La cantidad de paradas estará en función del uso del suelo, así como de las normas de distancias y seguridad de movimiento. En el centro de la Ciudad sería entre 500 y 700 metros, mientras que en las zonas intermedias estaría entre 800 y 1000 metros. El trazado propuesto comprende nueve líneas. El sistema así concebido asimila el 54.6 % de la demanda de transporte público colectivo.
El sistema se caracterizará por, la disposición de la línea del tranvía en la sección transversal dependerá de las condiciones físicas y de tránsito de la vía. Por lo general se ubicará en el centro de la calzada o en el separador, se prevé la separación normal de vía de 1435 mm, la faja para la doble vía tendrá 7.0 metros de ancho, el valor de la pendiente longitudinal en todo el trazado está por debajo del 10 %, valor máximo recomendado de acuerdo con las características técnicas de los equipos.

2.4. Demanda de transportación.

La demanda de transporte fue calculada en base a los datos de la perspectiva:
Población : 505 000 habitantes.
Indice de movilidad: 2.33 viajes/habitantes en un día.
Magnitud de la demanda en hora punta: 8 %.
Como resultado se obtuvo que la demanda de transportación en la hora de máxima demanda es de 35 086 pasajeros.

2.5. Material rodante.

Se propone la utilización de equipos con dos motores de corriente directa que trabajan con un voltaje de 750 V y desarrollan una potencia de 275 Kw, capaces de vencer pendientes del 10 %.
La capacidad de transportación de las formaciones será de 276 pasajeros, a razón de 8 pasajeros por metro cuadrado.
Los equipos deberán estar dotados del sistema chopper que permita regular el consumo de corriente en el momento de arranque. Cuando la formación emplea el frenado reostático o recuperativo y el motor comienza a funcionar como generador, tiene la posibilidad de entregar energía eléctrica al sistema y alimentar otras formaciones que estén traccionando, lo que se traduce en menor consumo energético del sistema de tranvía. Dicha entrega de energía se efectúa a través de la red catenaria, para lo cual se deben preparar las subestaciones de tracción-reducción.
El ancho de los equipos debe ser igual o menor a 2.40 metros.
Para satisfacer la demanda de transportación en la hora punta son necesarios 40 equipos.

2.6. Afectaciones.

Con la construcción de las nuevas estructuras necesarias para la explotación del sistema de tranvía en la ciudad Santiago de Cuba son inevitables las afectaciones a las redes técnicas.
Las características de las redes eléctricas dentro de la ciudad exigen una reestructuración de las mismas para que estén tendidas por encima de la red catenaria. La red alimentadora del tranvía de 825 V habría que ubicarla al nivel requerido, así como la red telefónica.
Se deberá disminuir la cantidad de cruces de acera a acera en las avenidas y en cada uno de ellos se tenderían mallas metálicas para evitar que los cables telefónicos o eléctricos entren en contacto con la red catenaria en caso de averías.
La red de comunicaciones telefónicas soterradas, por ser en conductos y poco densa, no debe tener muchas afectaciones en cuanto a su desvío, la profundidad mínima de dicha red es de 0.60 m desde la rasante de la vía hasta la corona del conducto.
La red de acueducto, alcantarillado y drenaje es bastante densa en las vías del trazado, coincidiendo con las principales maestras de acueducto, así como drenes y alcantarillado de gran diámetro.
Las limitaciones a las redes pueden ser a lo largo de la vía o en los cruces de vías, por lo que las mayores afectaciones pueden ser precisamente en el acueducto por los desvíos que deben hacerse o por el encamisamiento de las tuberías para su protección.
La profundidad promedio en la red de acueducto es de 1.00 m desde la rasante de la vía hasta la corona de la tubería. Se afectarían 12 viviendas a lo largo del trazado.

2.7. Valoración económica.

Para la valoración de la efectividad del proyecto se emplearon indicadores tecnológicos, cálculos presupuestarios, criterios de expertos y la experiencia en el trabajo de esta tecnología a nivel mundial.
Los elementos tomados en cuenta para el cálculo de los costos fueron : Vías férreas, depósito (talleres), obras de fábrica, red catenaria, subestaciones eléctricas, puntos de tráfico, servicio de vía, material rodante, imprevistos, accesorios, afectación, patente y otros.
En la Tabla 1 se presenta el resumen de la magnitud de la inversión y la estructura de los elementos antes señalados en 3 parámetros fundamentales.
La inversión total asciende a los 77.2 millones de pesos, de ello se deriva que el costo específico por kilómetro es de 2.4 millones de pesos.

Tabla 1. Estructura tecnológica de la inversión.

Denominaciòn	Costos MMP	%
Construcciòn civil y montage	28.30	36.70
Equipos	35.60	46.10
Otros	13.30	17.20
Total	77.20	100.00

3. CONSIDERACIONES FINALES.

1. En condiciones de desarrollo perspectivo de la Ciudad, el sistema de tranvía rápido constituiría una solución que cubriría el 54.6 % de la demanda de transporte público colectivo, con ventajas económicas, sociales y en la protección del medio ambiente.
2. El sistema de tranvía de Santiago de Cuba requiere de un inversión total del orden de los 77.2 MM de pesos, desglosados en: 28.3 MM en construcción civil y montaje, 35.6 MM en equipos y 13.3 MM en otros. El costo específico por kilómetro es de 2.4 MM de pesos.
3. El período de recuperación de la inversión sería de 3.5 años si se aplica una tarifa de 0.20 pesos por pasajeros y de 8.3 años si la tarifa fuera de 0.10 pesos por pasajeros tomando en consideración la fluctuación de los costos de explotación.
4. Para satisfacer la demanda de transportación de la ciudad se necesita un parque conformado por 40 tranvías y 214 ómnibus.
5. Reordenar el sistema de rutas de ómnibus de transporte público con vistas a que tributen al sistema de tranvía.

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LRT: Is it not the Hobson's choice for the developing cities?

K. Kumar & K. Radjamanickam
L. Chennai Metropolitan Development Authority, India

ABSTRACT : The paper describes briefly the fallout of urbanisation taking place across the world and highlights the degradation of environment by the ever-growing traffic plying in the developing cities. After outlining the difficulties in planning and developing MRTS, it makes a case for medium capacity systems particularly the Light Rail Transit system 5LRT). Focussing the virtues of the LRT, it prescribes development of LRT system as the thrust of the sustainable transportation strategy for developing cities.

1.0 INTRODUCTION

Developing cities have to manage the ever-increasing travel demand on the one hand and keep in check the emission caused by the vehicular traffic on the over. In pursuit of this, they have to choose between the bus or rail system. The metros becoming costlier by the day and going beyond the reach of most of the developing cities, a need has arisen for rediscovering the tram or the Light Rail Transit System (LRT).

2.0 URBANISATION AND GROWTH OF MEGA CITIES

2.1 The world population which was a billion in 1804, had increased leaps and bounds in the last 195 years and crossed the 6 billion mark in Oct.'99. Asia accounts for 61 % of the world population. With population keep soaring in developing economies, the urban areas in the developing world, particularly, Asian cities will bear the brunt of the population increases. The mega cities with 10 m or more people are also multiplying like fruit flies. The number of mega cities which was just 2 in 1960, had swelled to 17 by 1999 and is projected to 26 by 2015.

2.2 Of the 20 largest cities in the world in 1990, 16 were in the developing countries and 4 in the developed countries. Again among the 16 largest cities in the developing world, 9 were in Asia. By 2000, 17 largest cities are expected to be in the developing countries (12 in Asia) and 3 in developed countries (Tokyo, New York and Las Angels). By 2000, there will be 3 mega cities in India (Calcutta, Delhi & Mumbai).

2.3 As productivity is high in urban areas, their economies are very vibrant. In India, urban areas accounted for 26 % of the population in 1991 and contributed to over 55 % of the country's Gross Domestic Product (GDP). This proportion is expected to grow to 60 % by 2001 when the urban areas would account for 33 % of the total population.

2.4 The mega cities are growing generally at very high rate and in many cases, they are doubling their population every 10 years. Mega cities are primate and produce 25 to 60 % of the national GDP. Mega cities in general have incomes 35 to 60 % higher than the national average and they are centres of commerce, politics and education.

2.5 Being engines of growth, mega cities are poised for higher levels of investments. Without investments in infrastructure commensurate with the growth of the cities, the quality of life is bound to suffer in urban areas particularly in mega cities where the density of population is relatively high.

3.0 AN TRANSPORTATION AND ENVIRONMENTAL POLLUTION

3.1 Cities, both in the developed and developing countries, are poised for greater concentration of population in the decades to come. The increasing population densities would place a premium on the capabilities of utilities and services in urban areas. The interplay of urban growth, transport and landuse planning would lead to urban sprawl, congestion and declining environmental quality. These problems have a sobering effect on city planners. Often they find themselves patching problems in one part of the city only to worsen symptoms elswhere. A comparative study of 4 world cities viz. London, Paris, New York and Tokyo indicates that the risks for road users are increasing menacingly as the cities grow and this is implied in that a bicycle rider is most likely to be killed in Tokyo, a pedestrian in New York, a commuter having to wait for a metro train during peak hour in Paris and for a regional train at London at rush hour.

3.2 In many cities, there are severe traffic congestion and the quality of air is also consequently deteriorating menacingly. There has been vehicular population explosion in major cities, developed and developing. More than 550 million cars and 150 million trucks, buses and commercial vehicles ply the world's roads. The number of motorised vehicles/population is becoming significant in the developing cities. While USA, Italy, New Zealand, Australia, France and Germany have an automobile for every 2 persons, India has one per 228 people and China, one

Table 1 Vehicle Population in 23 Largest Cities in India (As on 31st March 1996)

Metropolitan City	All Vehicles	TWs	Trucks**	Cars, Jeeps & Taxis	Buses
Ahmedabad	571643	77.31	2.65	11.34	2.52
Bangalore	900541	74.39	3.30	14.52	1.29
Bhopal	222619	71.25	4.10	13.67	1.60
Calcutta *	560538	44.01	4.41	40.89	2.42
Chennai	811916	73.13	2.92	18.67	1.22
Cochin	196559	57.87	1.15	19.12	2.85
Coimbatore	240610	73.59	7.21	14.10	1.36
Delhi	2629645	66.24	5.08	24.62	1.06
Hyderabad *	557404	78.88	4.86	11.48	0.74
Indore	324740	74.45	6.54	10.61	1.58
Jaipur	405499	74.06	5.02	12.33	2.88
Kanpur	246801	78.83	3.97	7.60	0.66
Lucknow	303356	80.09	2.23	11.25	0.58
Ludhiana *	303356	86.20	3.95	8.19	0.34
Madurai	116765	76.37	6.69	6.59	2.61
Mumbai	723632	41.80	6.17	41.12	1.70
Nagpur	213404	81.14	5.54	8.70	0.81
Patna	219533	68.77	5.66	14.40	1.46
Pune	411880	75.79	5.55	10.52	1.41
Surat	330961	84.63	1.55	8.56	0.17
Vadodra	275473	75.79	7.20	12.87	0.64
Varanasi	199516	77.90	4.45	8.54	1.31
Visakhapatnam	183476	86.01	3.11	7.24	0.71

* As on 31.3.1995   ** Includes LCVs (three wheelers)

Source: "Motor Transport Statistics of India, 1996", Transport Research Division, MoST, Govt. of India.

per every 260 persons. The vehicle population in 23 largest cities in India are shown in Table 1.

3.3 The traffic literally crawls along major arterial roads in many Asian cities. (Bangkok : 1.2 kmph, Tokyo : 4 kmph, Kuala Lumpur : 8 kmph, Manila : 10 kmph. Mumbai : 12 kmph, Delhi : 22 kmph.)

3.4 In the beginning of the century, automobile was seen as a clean mode. The virtues of the car have been well brought out in the 'The car Culture », a 1975 book by James Flink which recorded that in New York in 1990, horses deposited 205 m pounds of manure and 60, 000 gallons of urine every day. Every year, the city authorities had to grapple with removing 15, 000 dead hoses from the streets. Notwithstanding the fact that the car has been the most successful form of transport for the whole of the past 100 years, it has become a major source of environmental nuisance now. An overview of air quality in 20 mega cities based on a subjective assessment of monitoring data and emissions inventories indicated that the cities such as Beijing, Mexico city and Seoul had sulphur dioxide (SO_2) pollution exceeding World Health Organisation (WHO) guideline by more than a factor of 2 and cities such as Bangkok, Beijing, Mumbai, Calcutta, Delhi, Jakarta, Karachi, Manila, Mexico city, Seoul and Shangai had suspended particulate matter (SPM) pollution more than twice the WHO guidelines. The lead pollution exceeding 60 dB (A) was experienced in Tokyo, Calcutta, Shangai, Mumbai and Delhi.

3.5 The Central Pollution Control Board in New Delhi, India, estimated the vehicular emission in the 12 largest cities in India which indicated that the pollution load exceeded 1000 tonnes per day in New Delhi. Wile Chennai took the 7thpostion, less populous cities such as Ahmedabad, Pune had pollutions higher than Chennai. The vehicular emission estimated in the 12 largest cities in India are indicated in Table 2.

3.6 Various tools have been developed for air quality management by WHO, World Bank etc. Given the total number of vehicles with their types, registered in a city and also the average trip lengths the vehicle types, it is possible to assess the total vehicular emission of SPM, carbon monoxide (CO) and oxides of nitrogen (NoX). The total number of motorised vehicles registered in Chennai as on 31.10.99 was 1, 076, 799. Using the average trip lengths by different modes established by the Comprehensive Traffic and Transportation Study carried out in 92-95 by Chennai Metropolitan Development Authority (CMDA), it is estimated that the total vehicular

Table 2 Estimated Vehicular Emission in 12 Largest Cities in India

Sl. No.	Name of the City	Vehicular Pollution Load (Tonne per Day)					
		Particu-lates	Sulphur Dioxide	Oxide of Nitrogen	Hydro-carbons	Carbon Monoxide	Total
1	Delhi	13.30	8.96	126.46	249.57	651.01	1046.30
2	Mumbai	5.59	4.03	70.82	108.21	469.92	659.57
3	Bangalore	2.62	1.76	28.22	78.51	195.36	304.47
4	Calcutta	3.25	3.65	54.69	43.88	188.24	239.71
5	Ahmedabad	2.95	2.89	40.00	67.75	179.14	292.78
6	Pune	2.39	1.28	16.20	73.20	162.24	255.31
7	Chennai	2.34	2.02	28.21	50.46	143.22	226.25
8	Hyderabad	1.94	1.56	16.84	56.33	126.17	202.84
9	Jaipur	1.18	1.25	15.29	20.99	51.28	88.99
10	Kanpur	1.06	1.08	13.37	22.24	48.42	869.17
11	Lucknow	1.14	0.95	9.68	22.50	49.22	83.49
12	Nagpur	0.55	0.41	5.10	16.32	34.99	57.37
	Grand Total	35.31	29.84	422.88	809.96	2299.21	3597.20

Source: Central Pollution Control Board, New Delhi - "Urban Statistics", October 1996, TCPO, Govt. of India emission per day in Chennai was 196 tonnes with 4.7 tonnes of SPM, 34.2 tonnes of NoX and 157 tonnes of CO. With the number of vehicles registered per day increasing at the rate of 330 per day and the average trip lengths by different modes are also increasing with the urban sprawl, the quality of air is bound to deteriorate by leaps and bounds.

3.7 Using one of the air quality management tools developed by WHO it is possible to estimate the air pollution health effects. The Tamil Nadu Pollution Control Board puts out a bulletin in the dailies on the pollution obtaining at selected road intersections in Chennai. According to this, the respirable dust particles (PM 10) is 177 Microgram/m^3. Which is more than the permissible levels of 100 Microgramm/m^3. Assuming the annual PM10 concentration of 177 Microgram/m^3, application of the tool suggests that meeting the PM 10 ambient standard of 30 Microgram /m^3 would prevent 11, 510 premature death and 30.10 million days of restricted activities due to respiratory illness each year. Brandon and Hommann (1995) has established monetary values for health damages. Adopting these unit values the health benefits in preventing premature mortality works out to Rs. 391 million (US $ 46.7 m). The cumultative health benefits for meeting PM10 standard in Chennai works out to Rs.2.86. billion (US $ 66.5 m) per year.

3.8 Commuters have to spend increasingly more time to travel to and from work. Reducing travel times has become a major consideration for transport planners in rapidly growing mega cities. The travel time in different cities are indicated in Table 3.

Table 3 Travel Time in Cities

City	Travel Time (min)	Work Trips (%)	Work Trips : Public Trans (%)	Work Trips: Motor Cycle (%)	Work Trips: Foot, Bike (%)	Car Ownership (Cars/1000 pop.
Metro Manila, Philippines	120.00*	15.0	40.0	10.0	5.0	94.00
Lagos, Nigeria	85.00	18.5	53.8	5.2	19.4	4.30
Jakarta, Indonesia	82.00	7.6	37.6	10.6	0.0	68.00
Tbilisi, Georgia	70.00	2.2	97.5	.00	0.3	71.00
Cairo, Egypt	59.50	9.9	58.2	0.6	11.5	59.10
Rio de Janeiro, Braszil	51.00	11.5	66.5	0.2	21.0	177.00
La Bahana, Cuba	41.50	6.5	58.1	0.0	30.0	32.00
New York, USA	36.50	32.5	51.4	0.1	11.0	232.00
Paris, France	35.00	55.0	40.0	3.0	nav	426.00
Curitiba, Brazil	30.00	13.6	71.8	0.0	11.3	286.00
Melbourne, Australia	25.00	73.0	16.0	1.0	5.0	500.00
Lucknow, India	23.00	5.8	0.8	16.0	52.3	129.70
Dubai, U.A. Emirates	17.50	52.5	7.4	0.0	nav	162.00
Des Moines, USA	16.40	90.0	nav	nav	nav	657.00
Kober, Slovenia	15.00	70.9	7.6	1.4	18.7	443.0
Tumkur, India	8.00	0.8	20.5	18.2	53.6	84.8

Source: UNCHS (Habitat) Global Urban Indicators Database, 1996

* According to Metro Manila Urban Transportation Integration Study (MMUTIS), the largest travel time for work is by bus which is 78.1 minutes [5]

4.0 SUSTAINABLE URBAN TRANSPORATATION : GLOBAL INITIATIVES

4.1 Following the Earth Summit held in Rio De Jenero in 1992, every city, developing have pursed various strategies for implementing the Local Agenda 21. Having the advantages of technological excellence, capital resources etc. , the developed cities are far ahead of developing cities in promoting sustainable transport development.

4.2 There are several strategies successfully implemented in many developed and developing cities to promote sustainable transportation. Some of these strategies with city examples are as follows :

- Reduction of sulphur and lead content in gasoline (City example : Bangkok, Alexandria)
- Effective inspection on enforcement of emission control measures (City example : Quezon, Ankara)
- Alternative fuels including CNG (City example : Ethanol in Brazil, particle traps in Ankara)
- Switching from two-stroke to four-stroke engines (City example : Bangkok)
- Developing Compact cities with high population densities (City example : Singapore, Hongkong, Portland, Oregon, Washington)
- Small self-sufficient urban centres linked by a public transport system (City example : Green towns in U.K)
- Channelling urban growth along public transit routes (City example : Brazil)
- Keeping goods vehicles and passing traffic out of the city centre (many cities)
- Road pricing (City example : Singapore)
- Reducing fuel subsidies and increasing fuel taxes (City example : Hungary, Singapore)
- Banning goods vehicles during certain hours (City example : Manila, Bangkok)
- Bus priority measures (City example : Bangkok, Curitiba, Ottawa)
- Introduction of LRT (City example : Manila, Kuala Lumpur)
- Privatising and deregulating bus services (City example : Manila, London, Kuala Lumpur)
- Improving interchange facilities (City Example : China)
- Promoting informal transit system (City example : Manila, Lagos, Turkey & Nairobi)
- Promoting Bicycles (City example : China)

Table 4 Modal Split in Selected Indian cities

City	Year	Mode		
		Mass Modes (Bus/Rail)	Other Modes**	Bicycle
Calcutta	N.A	79*	21	Included in Other
Mumbai	1980	80*	20	Negligible
Delhi	1986	62	35	3
Chennai	1992	42	43	15
Bangalore	1980	54	46	Included in Other
Ahmedabad	1986	22	54	24
Kanpur	1986	24	46	30
Lucknow	1986	6	67	27
Madurai	1986	48	36	16

Table 4 Contd. .

Cochin	1986	55	38	7
Chandigarh	1986	54	31	15
Mangalore	1986	77	21	2

Note : * - Includes Suburban Rail ; ** - Includes Cars, Cycles, Taxis, Auto-Rickshaws Cycle Rickshaws, etc.

4.3 If developing cities have to make substantial headway in the development of sustainable transportation, they may have to enhance the modal share in favour of transit modes particularly rail-based transit modes. The modal share obtaining in different Indian cities is indicated in Table 4.

In view of the fact that there is considerable scope to improve the modal share by public transit modes to more than 50 %, the solution lies in enhancing this share. Further the modal share between rail and bus needs to be tilted much in favour of the rail system. Given the fact that the bus transit in almost all the developing cities are run on gasoline and that its capacity cannot be stretched beyond a limit, it is imperative that the rail-based transit modes are promoted aggresively.

5.0 WHY MRTS IS OUT RECKONING ?

5.1 Though MRTS is a proven and long-lasting solution for managing large volumes of mass transit trips, the resources it requires for construction and operation militate against its choice by many cities . Considering the enormous time and money required for developing the MRTS, it is far beyond the affordability of most of the developing cities. Though the travel densities justify construction of MRTS in many developing cities, they can ill-afford the MRTS option because the annual outlays required for constructing it would mean setting apart a lion's share of the annual budget required for the city Government.

5.2Construction and development of MRTS varies with the type of the structure adopted for the system. The construction cost of an at-grade, elevated or underground system varies in the ratio 1 :5 :20. Except those cities, where well thought-out planning preceded the introduction of the MRTS system, the MRTS option is a choice by compulsion for the mega cities in the developing world for post-crisis management of the worsening traffic situation. Since no preplanning was made, the expensive option of developing the MRTS either underground or elevated becomes the only choice for these cities. By and large, these cities have to plan for an underground or elevated RTS in the city core where travel densities are significantly high.

5.3 Whether elevated or underground construction of the RTS facility necessitates rehabilitation of various structures, utilities and services. It is more in the case of underground system than elevated system. The rehabilitation may include demolition and reconstruction of buildings, shifting of water/sewer mains, relocation of electric/telephone lines, reconstruction of storm water drains, construction of underpasses or overpasses wherever the RTS alignment crosses the city road network, rehabilitation of families affected by the alignment etc. This usually results in enormous cost and time over-runs in respect of many MRTS projects.

5.4 The route selection for the MRTS invariably demands procurement of land and structures. Procurement of land and structures is a cumbersome procedure. In most of the cases, the procedure is so protracted that it results in enormous time over-run in the completion of the project which in turn increases the project cost. In many cases, the owner of the land or building challenges the acquisition proceeding in a court of law thereby delaying the procurement process.

5.5 Where slum families are affected by the MRTS development it calls for detailed rehabilitation and resettlement programme (R&R). The R&R programme by itself is a process defying simple solution. First of all, an alternative site has to be so identified that the present job opportunities of the bread-winners of the affected slum families are not disturbed. Quite often, it would become necessary to rehabilitate the affected families en masse as these families live as a community. As shifting them to a far-flung suburban area would rob them of their employment, it is essential to identify the alternative site as close to the existing one as possible. In a built environment, it is very difficult to identify a vacant site for the purpose.

Alternatively high-rise buildings need to be constructed to rehabilitate the affected families. Though this option would be an expensive one, often this happens to be the only solution. The cost of this would, however, be an additionally to the MRTS project.

5.6 One of the crucial factors which determines the route of the MRTS corridor is estimation of the travel demand. Though there are sophisticated mathematical models available for determining the route selection or the MRTS corridor, it has been found in the case of several MRTS projects the system, on commissioning, does not carry the anticipated travel demand owing to various reasons. There are very few city examples where the trips carried by the system matched the travel projection. In many cases, the density of travel is so low that it questions the very veracity of the decision to construct the MRTS. In the case of Chennai, the MRTS, on commissioning of Phase I, carried hardly 15000 riders per day. This has now lead the city planners to devise ways and means to improve the ridership by appropriate spatial tools .

5.7 The MRTS when constructed induces both positive and negative impacts on land use. In most cases, it results in the appreciation of land and property value. Besides lower order use of land and building getting converted into higher order, there is also an increase in the density of development. For the very reason that MRTS offers high mobility and accessibility benefits, most of the future developments tend to take place around this corridor, thereby saving the cost of providing circulation for the additional developments. The rigidity of the structure used for the RTS track particularly the surface one causes negative impact on the land use by causing a permanent divide on the existing developments. To a large extent, this is overcome if an elevated system is opted for.

5.8 Even if the MRTS system is successfully implemented and operated, it can at best serve only that corridor along which it has been constructed. It cannot per se satisfy all the travel demand generated within a metropolis. City would necessitate expanding the RTS further, of course, with enormous resources or exploring other transit options. While in the case of mega cities certain corridors would absolutely demand implementation of MRTS, other less travelled corridors would dictate development of medium capacity transit options. As for the million-plus cities which are more in number particularly in India and in Asia, the primary arterial roads would dictate exploring busway system or LRT solution ;

5.9 The cost of a MRTS system is beyond the affordability of most of the developing cities. While construction of 8.5 km MRTS (partly surface, partly elevated) cost Rs. 2600 million over a period of 13 years in Chennai, extending the line for a length of 10.8 km (elevated) costs Rs. 10 billion over a period of 5 years. Going by the rule of the thumb, constructing another 45 km of MRTS as proposed in the Master Plan of the Chennai Metropolitan Area would cost Rs. 45 billion. This would mean sitting apart 10 % of the annual outlay for the entire State of Tamil Nadu. The annual outlay for the State of Tamil Nadu in the current year 1999-2000 is Rs. 4.5 billion. Assuming the project could be completed over a period of 8 years, it would require an annual outlay over Rs.5.6 billion. This would mean setting apart 10 % of the annual outlay for the entire State of Tamil Nadu. The annual outlay for the State of Tamil Nadu in the current year 1999-2000 is Rs.4.5. billion. It implies that not even a handful of developing cities can afford MRTS.

6.0 LRT AS MEDIUM CAPACITY TRANSIT OPTION

6.1 Medium capacity systems are those capable of carrying passenger flows varying from 12, 000 to 30, 000 passenger per hour per direction (Boletin 1992). By this definition several technologies can be identified as capable of attending medium flow corridors. Indeed the potential capacity of different transit technologies heavily depends upon how they have to be applied and operated. In general terms any road or light rail based system, designated to cater for medium size transport demand must include a proper combination of vehicle characteristics, type of righ-of-way and regime of operation. Some other aspects such as the type and location of the critical stops or the type of traffic control system are also to be considered if medium flow capacities are to be achieved. In tems or righ-of-way, a mix of the following options is usually considered either for bus or LRT projects :

a) Exclusive righ-of-way, b) Segregated right-of-way, c) Reserved right-of-way, and d) No right-of-way.

6.2 Trams are a basic form of LRT which have limited rights of way for most of the route, sharing road space with other traffic. Trams were first introduced in 1832 in the United States of USA to overcome the poor road conditions experienced by horse-drawn buses . Thus a tram was able to attract more passengers and carry them more cheaply than horse-drawn omni-buses (UNCHS-1993). With the advent of automobile technology in the early part of the century which led to bus design improvement, the tram began to be seen as an obsolete form of transport. Despite availability of cheap diesel fuel and the greater flexibility of bus technology in the past several decades trams staged a comeback in many cities in the post-war period. Most recently the issue of environmental protection has also played an important role in the rediscovery of LRT.

6.3 There are more than 510 trams or LRT systems in use in the world over. The system is widely in operation in Europe and North America. Some of the developing cities have also built either a tram or LRT system. Notable among these cities are Mexico city, Manila, Istanbul, Rio De Jenero, Tunis, Cairo and Alexandria.

6.4 Urban passenger rail transport in the USA has come full circle. The damage done during the 1950s and 1960s when scores of US cities abandoned their often-extensive urban rail networks in favour of the private automobile, is now being repaired. At the nadir of US urban rail contraction, only nine cities had rail systems. Today the number has reached25, and it is still rising.

6.5 One of the characteristics of LRT which distinguishes it from metro is that the minimum radius of curvature is as low as 10 m which allows the planning of the systems in tight and sinuous rights-of-way. Further LRT can also run on steeper gradients (upto 8 %) than matro systems. Passenger loads can be vary from 200 to 250 in the modern LRT car. Some modern LRT cars have low floors which improve low level access. Further delays at stops are minimised by providing several wide access doors for each car. One of the disadvantages with the LRT vehicles can become cumulative and there is no possibility of one LRT over taking another. Another disadvantage of LRT system is its inflexibility in route network.

6.6 The passenger carrying capacity of LRT system varies between 20, 000 to 30, 000. Measured LRT performance in cities of developing countries indicate that the system in Alexandria carries 11, 600 passenger per hour per direction while the grade separated systems at Manila and Istambul about 25, 000. Peak capacity may be as high as 36, 000 passengers per hour per hour per track. With intensive use of the standing areas (example 8 standing position/m2) and trains at intervals of 90 seconds, upto 30, 000 passengers can be carried with trains 80 m long and over 40, 000 passengers per hour per direction can be carried with trains 120m long.

6.7 The cost of construction of the LRT system is about US$ 10 to 30m per route km against US$ 40 to 90m for metro (1993 prices). Studies on transit systems for curitiba indicated that the proportion of investments required for the provision of one km of busway, LRT line and metro would be 1 :10 :100 respectively (via Urbana 1991). Though LRT systems are more expensive to construct than busway transit, the great advantage of the modern LRT system is in their image and general environmental friendliness. LRT is seen as an example for modern technology which can contribute to civic prestige which invites political support as a high profile gesture towards tackling urban transport problems.

7.0 WHY LRT IS HOBSON'S CHOICE ?

7.1 Transportation choices are often made in the light of the difficulty, cities face coping with the rapid sprawl of suburbs. Urban roads are increasingly congested and any attempt to improve traffic management through road pricing or during peak hour or to expand roads to make more room for cars and buses faces very difficult challenges. Expanding the urban roads to link city centres to suburbs also involves a high degree of inflexibility and capital costs. Time is limited when cities have to come up with solution often light rail become the second best solution. Transportation experts like Clifford Winston are working on solutions to make peak tolls in congested areas an easier tool to adopt but Winston himself accepts the idea that in some cases light rail must be a first best solution even in cities that do not have the high density of Chicago or New York. A well-managed city like Portland, Oregon in the USA is investing in new light rail system. Likewise Dublin is developing a similar system in Europe.

7.2 The main reason as to why the LRT system qualifies for most of the travel corridors both in the mega cities as well as the million-plus cities is :

i. it can be run along the existing travel corridor and thus avoid the need to acquire land for a virgin corridor ;
ii. it can be developed step by step from a modern tramway to a means of transport running in tunnels or at or above ground level. Every development stage can be a final stage in itself ;
iii. it can co-exist with other modes ;
iv. Even if the track for the LRT is laid at grade, it does not cause a permanent barrier as in the case of a MRTS system and permits pedestrians to cross the road.
v. Growing popularity of LRT throughout the world and its image as a new mode ;
vi. Contribution of the system to urban revitalization and development ;
vii. Low costs of construction and operation, in comparison with metro ;
viii. Generation of jobs in rail and construction industries.
ix. The environmental benefits offered by its introduction are quite visible in the sense that with the possible shift in the modal choice by the people from private modes such as car and two wheelers to the LRT system, the air and noise pollution along the corridor are minimised or reversed ;
x. The need for elaborate arrangements for inter-modal interchange does not arise as the system shares the same right-of-way with other modes of travel ;
xi. The very fact that it uses the same right-of-way as for other modes of travel enables it to enjoy the same cost advantages as that of the busway system since the cost for the track laying is very minimal if it is laid on surface.
xii. The fact that it can negotiate sharp vertical and horizontal curves makes it superior to the MRTS option and fit into any city road network.
xiii. In the case of MRTS corridor which does not follow the city road network, any disruption of train operation would greatly inconvenience the commuters. The commuters, stranded midway, have to struggle to find alternate routes of travel for completing the balance of the journey. LRT system does not suffer from such shortcomings as the existing travel corridor would enable the stranded passengers to complete the journey.
xiv. Before the MRTS system becomes operational, it requires all the infrastructure such as the track, the stations, the signalling etc. to be completed. It cannot be introduced overnight. Since the right-of-way of the existing road will be used for movement, LRT has the advantage of being introduced quickly with the shortest gestation period. A corridor where a busway system is already in operation and where its capacity has been saturated, it would be easier to replace it by a LRT system and the buses could be redeployed elsewhere resulting in optimatisation of existing transport infrastructure.

8.0 THE TRANSPORTATION STRATEGY FOR DEVELOPING CITIES : THE ROLE OF LRT.

8.1 While strengthening and expanding the existing urban rail system must be the immediate strategy, planning and developing LRT and Electric Trolley Bus (ETB) should be the future strategy for less dense corridors in the mega cities and primary corridors in million-

Table 5 Corridors Qualifying for LRT in Chennai [12]

Sl. No.	Road	Vehicle Trips	Persons Trips	
		1992	1992	2001
1	Anna Salai	13895	73499	93344
2	Nungambakkam High Road	11901	33688	42784
3	Sardar Patel Road	4253	30250	38418
4	Arcot Road	8318	30159	49159
5	GNT Road	4676	29457	37410
6	Poonamallee High Road	7373	28004	35565
7	Inner Ring Road (IRR)	9316	20326	69718
8	Purasawalkam High Road	3870	20333	25823

plus cities. This could be the thrust of the multi-pronged approach developing cities should follow to achieve alround sustainability in the development of urban transportation.

8.2 Potential cities should identify the corridors for introduction of the LRT and accordingly devise other traffic management measures for the selected corridor or network.. There could be more than one corridor qualifying for introduction of LRT in a million plus city. For example in the case of Chennai at least eight corridors quality for the system right away as indicated in Table 5.

8.3 Appreciating the fact that the balance of advantage lies in operating the LRT system on surface, all the junctions along the selected corridor should be so planned that any grade separated junction improvement contemplated shall have the underpasses or overpasses along the cross roads rather than the selected corridor. This is to ensure that the fly-over proposed does not impinge on the LRT system to be introduced later. Planning -wise it makes a lot of sense if busway along kerb lanes are introduced in the initial years before introducing LRT system because by then the travel density would have been stabilised for operating the LRT reasonably at a high frequency .

9.0 CONCLUSION

The fact that the air pollution is assuming alarming proportions thanks to the ever-increasing vehicular traffic obtaining in all the developing cities is sounding a note of caution to the city managers. Unless appropriate strategies are hammered out to contain or reverse the air pollution, the environmental degradation will go out of hand. The rediscovery of LRT system in many developed and developing cities point to the fact that the LRT system has potential advantages over the MRTS and that every large city, particularly developing ones could include development of the LRT system as part of their overall strategy to promote sustainable transportation.

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Optimization of materials selection and design for car industry in order to increase durability and weight saving

Claude Bathias
CNAM, Paris, France

ABSTRACT : This paper propose some rules for optimization of materials selection and design for car industry order to increase durability and weight saving.

1 INTRODUCTION

Facing the international competition, car industry must increase the optimization of several factors such as costs, quality, durability, weight saving or environmental protection.

In other words, the economical performances must be in good agreement with durability and safety for which design and standardization have to be drasticaly modified.

Now, car components have a fatigue life larger and larger. A typical European car is built to run 150 000 Km. Assuming that the average speed is 50 Km/h that is to say the rotation of the engine about 2 000 t/min ; it is found 5.10^8 cycles for the fatigue life of many components.

In several industries, the required design lifetime of many components often exceeds 10^8 cycles. The requirement is applicable to aircraft, automobile, railway and offshore structures. Although a large amount of fatigue data has been published in the form of S-N curves, the data in the literature have been limited to fatigue lives up to 10^7 cycles. Time and cost constraints rule out the use of conventional fatigue tests of more than 10^7 cycles to check structural materials. A possibility of accelerated testing of specimens is now considered by using high-frequency cyclic loading.

Safe-life design based on the infinite-life criterion was initially developed through the 1800s and early 1900s one of which is the stress-life or S-N approach related to the asymptotic behaviour of steels. Some materials display a fatigue limit or "endurance" limit at a high number of cycles (typically > 10^6). Most other materials do not exhibit this response, instead displaying a continuously decreasing stress-life response, even at a great number of cycles (10^6 – 10^9), which is more correctly described by a fatigue strength at a given number of cycles.

Generally speaking, the fatigue S-N curve for steels is always considered to be asymptotic, i.e. horizontal to the N axis, and so no test were carried out beyond 10^9 cycles in order to check the continued existence of this asymptote. In this work, four low-alloy high-strength steels and a SG cast iron were tested between 10^5 and 10^{10} cycles using a piezoelectric fatigue test machine operating at 20 kHz. The experiments are inexpensive and do not require much time. The S-N curves for the five materials were obtained. The most noticeable conclusion was that failure could occur beyond 10^7, even 10^8 stress cycles, and a fatigue limit could not be obtained until 10^9 cycles. It is therefore important to realise the risk of fatigue failure beyond 10^7 cycles.

In general, fatigue crack initiation is understood to occur on the specimen surface owing to the irreversible process of extrusions and intrusions through slip deformation. Most of the tested materials, however, clearly exhibited two kinds of fatigue initiation. One was at the specimen surface, and the other was in the specimen interior. Subsurface crack initiation was dominant in the long-life range, while the surface fatigue initiation occurred in high-peak stress tests and short-life tests. It is revealed that there is a definite stress range (or cycles regime, 10^7 cycles) where the initiation location changes from the surface to the internal defect (inclusion or porosity).

Table I Chemical composition (wt%) of the five materials discussed in this paper.

	C	Mn	P	S	Si	Al	Ni	Cr	Cu	Mo	V	Mg
42Cr-Mo4	0.428	0.827	0.012	0.024	0.254	0.023	0.173	1.026	0.210	0.224	—	—
Cr-Si (54SC6)	0.535	0.629	0.006	0.016	1.400	—	0.056	0.635	—	—	—	—
Cr-Si (55SC7)	0.545	0.700	<0.035	<0.04	1.400	—	—	0.700	—	—	—	—
Cr-V (60CV2)	0.510	0.850	<0.035	<0.04	0.250	—	—	0.950	—	—	>0.15	—
SG cast iron	3.45	—	0.019	0.13	3.21	—	0.59	0.02	0.024	0.013	—	0.031

2 EXPERIMENTAL PROCEDURE

2.1 *The materials*

The materials used in this study were four low-alloy high-strength steels and a spheroidal graphite cast iron (SGI) supplied by Renault and CREAS (Usinor). The chemical compositions of the five materials properties of the five materials were given in table I.

2.2 *Fatigue testing*

The fatigue tests were carried out under the following conditions at a frequency of 20 kHz on a piezoelectric test facility. The R ratios investigated were –1 and 0 for the SG cast iron, and –1 for all the steels. All the specimens were finished with grades 500, 1200, 2400, 4000 emery papers. The tests were performed at room temperature in air. During ultrasonic fatigue testing, the middle section of each specimen was cooled by compressed air. The temperature at the centre section of some specimens was measured by a thin thermocouple (ϕ = 0.1 mm), carefully attached to the specimen surface. Some specimens of the SG cast iron were used for conventional fatigue tests at Renault with a loading frequency of 25 Hz. Fracture surfaces were observed after testing by scanning electron microscopy (SEM).

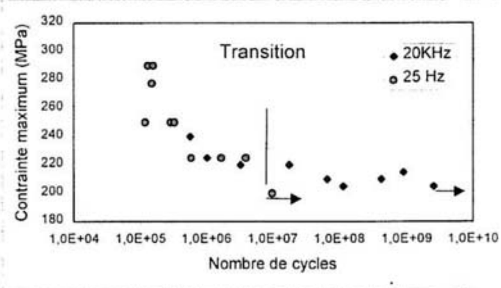

Figure 1. S-N curve for a cast iron R = -1

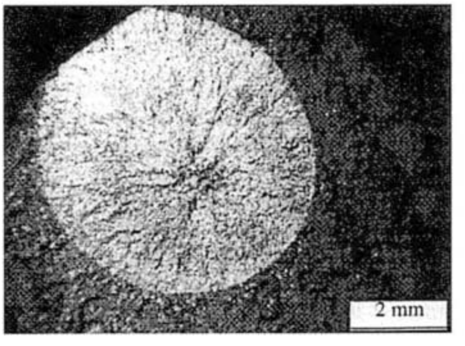

Figure 2. Subsurface fatigue crack initiation in the SG cast iron, S_{max} = 210MPA, R = -1, N_f = 6.71 x 107 cycles. The diameter of the specimen was 10 mm, while the clear section shown in this picture is 6 mm.

3 RESULTS AND ANALYSES

3.1 *The SG cast iron*

3.1.1 *S-N curve*

Results of high-cycle fatigue S-N curves of the SG cast iron with R = -1 and 0 are shown in Figs 1 and 2. The results show no noticeable frequency effect on the fatigue behaviour. For zero mean stress R = -1 [Fig. 1(a)], the high frequency (20 kHz) fatigue data closely matched the conventional frequency (25 Hz) tests results between 105 and 107 cycles, and for R = 0 [Fig. 1(b)], the fatigue strength obtained by the piezoelectric fatigue machine seems to be slightly higher than that given be conventional fatigue loading.

3.2 *Low-alloy high-strength steels*

3.2.1 *S-N curve*

The fatigue strength was determined for the life range 10^6-10^9 cycles as shown in Figs 4 and 5. In the cast of the Cr-Si steels (54SC6), and the Cr-V and 42Cr-Mo4 steels, the S-N diagram was divided into two portions, and revealed two knees for the first steel.

In contrast, the S-N diagram of the Cr-Si steel (55SC7) did not display a second decrease between, 10^6 and 10^9 cycles. The experimental results show that fatigue rupture can occur in all the high-strength steels over 10^7 cycles. Fracture surfaces were observed after testing by SEM. The stages of crack initiation, stable crack propagation, unstable crack

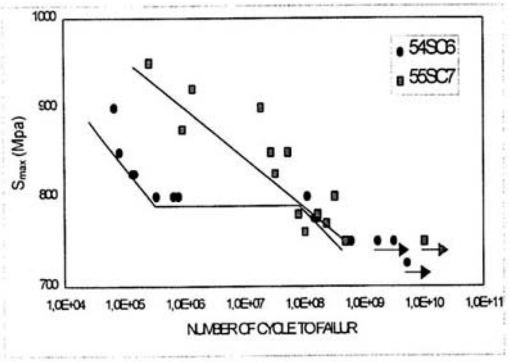

Figure. 4 the S-N curve for the Cr-Si spring steels at R = -1.

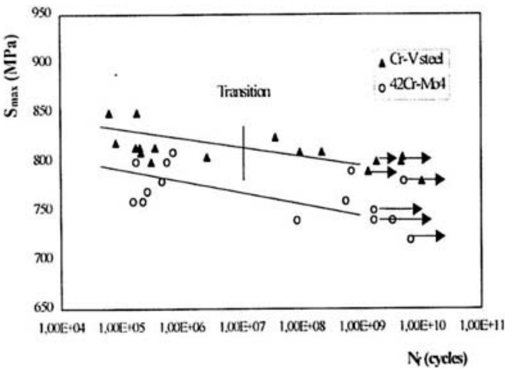

Figure. 5 The S-N curve for the Cr-V steel and 42Cr-Mo4 steel at R = -1.

propagation and final failure are well defined. In the high-cycles regime (> 10^7 cycles), the initiation sites were found at non-metallic inclusions located in the interior of the specimen (Figs 6 and 7). The inclusions range in size from 10 to 40 µm. This initial defect size can be used later to predict fatigue lives. Figure 7(a) shows the fatigue failure initiated well below the specimen surface by as much as 1.1 mm. The origin was identified by the use of energy dispersive analysis. The initiation site was either at a spherical [Fig. 6(b) and 7(b)] or stringer [Fig. 6(a)] inclusion particle. The typical composition of the inclusion is sulphide. In the low-cycle regime (<10^7 cycles), the initiation sites were found at the surface.

In the high-cycle regime, the cracks initiated only at internal defects, as the plastic strain concentrations at or pre-existing pores were not greater than the threshold values needed to nucleate a stable crack. Due to their small population, these defects were located predominantly below the surface in the bulk of the smooth specimen. Therefore, failure resulted from a subsurface origin. In the low-cycle regime, cracks initiated at most

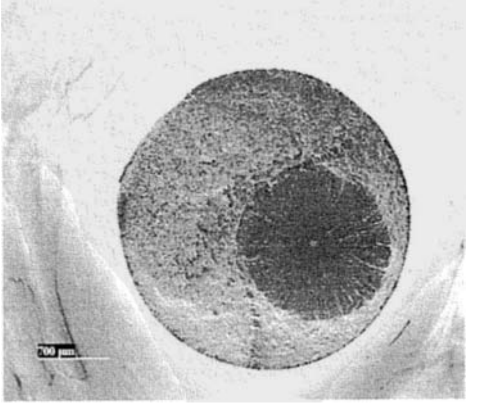

Figure. 6 SEM micrographs of fatigue crack initiation sites in the 42Cr-Mo4 steel. (a) The crack initiation site at a depth of 900 from the specimen surface. Inclusion: aluminium, S_{max} = 700 Mpa, R = -1, N_f = 5.75 x 10^8 cycles, the inclusion size: $\sqrt{area}$ = 20

defects after a relatively small fraction initiated at most defects after a relatively small fraction of the total fatigue life. Cracks located at the surface had greater crack growth rates than internal cracks. As a result, the dominant crack responsible for failure originated on the surface.

4 CONCLUSIONS

The fatigue strength of steels and cast iron at stress ration of R = -1 was obtained in the range between 10^6 and 10^9 cycles which is a typical life time for many components of modern cars for the next century.

For Cr-V steel, the S-N curve becomes quasi-horizontal beyond 10^6 cycles. On the other hand, the S-N curve of Cr-Si steel a 4041 steel continue to drop without plateau, between 10^6 cycles and 10^9 cycles.

But in both cases, the experimental results show that fatigue fracture can occur beyond 10^7 cycles in steels.

It means that the design of new cars must be derived taking into account the gigacycle fatigue strength.

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The electric car: A sustainable technology option for urban India

O.P. Agarwal
Department of Transport, Government of Assam, Guwahati, India

ABSTRACT: The rapid growth of cities has been accompanied by congestion, pollution and uncontrolled urban sprawl. Adverse effects of these have been felt on the health of the people, their quality of life and the productivity of the economy. The IC engine, once considered a boon to mankind, is being increasingly viewed as a curse, due to the severe pollution it has caused. The search for alternative fuels has yet to produce an acceptable option. The commercialization of one such option, the "Electric Vehicle", has been constrained by its perceived limitations of "range", "speed" and "acceleration" performance.

This paper argues that these limitations are not relevant for urban use, particularly in developing countries like India. The electric car holds tremendous promise for most oil importing countries, typically those where the demands of a consumer are guided by operating economy, rather than speed and power.

AUTOMOBILE DEMAND IN INDIA

There are about 35 million registered motor vehicles in India. Another five million are projected to be added each year. Of these, about 25 million are 2/3 wheelers. During the past decade, the number of two-wheelers has increased by 561%. Almost all of them have two stroke engines which, due to inadequate combustion, spit out up to 40% of the fuel as hydrocarbon emissions. They not only account for over 70% of the vehicular population, but also for 60% of the petrol consumption and 70% of the total hydrocarbon emissions. Most of these 2/3 wheelers are used in urban areas.

ENVIRONMENTAL IMPACT

The rapid increase in the number of motor vehicles in urban areas, particularly the high percentage of two stroke engines, has had a damaging impact on the air quality. Most of India's metropolises rank among the most polluted cities in the world, with Delhi being the 4th most polluted city. As an example, the table below compares the actual pollution level of three major pollutants, with the permissible level, at two selected locations in Delhi.

Pollutant	Permissible Level	Actual at Location -1	Actual at Location -2
Carbon Monoxide	2000 µmg/cum	3680 µmg/cum (Ashram)	19000 µmg/cum (Shahadara)
Nitrogen Oxides	80 µmg/cum	121.6 µmg/cum (Red Fort)	516 µmg/cum (Punjabi Bagh)
Suspended Particulate Matter	200 µmg/cum	346 µmg/cum (ISBT)	946 µmg/cum (Shahadara)

The impact of this pollution on public health and health care costs has been enormous. According to a World Bank study, the health cost of ambient air quality in Delhi alone is US $100-400 million per year. For the country as a whole, it might run into billions of dollars.

The virtual explosion in the number of motor vehicles in urban India, coupled with the dire environmental situation that has emerged, calls for urgent remedies. Although policy makers have long debated the environmental and economic impact of air pollution, they have not yet arrived at a consensus on resolving the problem. It seems quite clear that the Electric Vehicle (EV) is one alternative that is likely to have a significant impact both on air quality as well as India's dependence on foreign oil. Yet this technology has made little headway in being commercialized. Why is this so? What are the constraints and how relevant are they in the Indian context?

SHORTCOMINGS OF THE ELECTRIC VEHICLE TECHNOLOGY AND ITS RELEVANCE TO INDIA

The current electric vehicle technology uses lead-acid batteries to run an electric motor. The rotation of this motor is transmitted to the wheels. Several shortcomings of this technology have been cited, around the world, as the reason for it not being commercially viable. Some of the important ones, along with their relevance to India, have been analyzed in the following sections.

Range and Speed

Range of travel is the major concern for electric vehicles. The technological question is whether it would be possible, at reasonable cost, to design vehicles that can reliably travel the desired distance, at an acceptable speed, before their batteries must be re-charged. The problem of providing electric vehicles with a "range" is rooted in a fundamentally physical reality: the batteries required to power electric vehicles are enormously heavy and store very little energy per unit of weight. The energy density of a lead-acid battery is about 35 watt-hours per kilogram, as against 12,000 watt-hours per kilogram in the case of petrol. As a rule of thumb, one liter of petrol, weighing about 0.75 kgs, has the same energy content as 50 kgs of lead-acid batteries. Thus, the problem is a basic conflict between the weight of a vehicle and the distance it can move before its batteries would need recharging.

Yet another problem is in the speed and acceleration of the vehicle. Electric vehicles are not able to move at very high speeds (generally below 100 km/h) and have comparatively slower acceleration.

The range, speed and acceleration, however, depend on the weight of the vehicle as well as other demands on the power system. A lighter vehicle would draw less power and be able to travel further and faster than a heavier one. Similarly, a vehicle without air conditioning or heating facilities would have better range and speed performance. Besides, range and speed become critical issues only if the vehicle is required to travel more than 150 kms in a day or move at speeds above 100 km/h. In case this is not so, range and speed should not be major constraints.

Unlike in the developed world, personal transport in India is largely used within a single urban area. Inter-city or long distance travel is more commonly undertaken through public transport rather than by using personal vehicles. In the three metropolitan cities of Bombay, Calcutta and Delhi, which account for a large share of the total number of motor vehicles in the country, the average daily travel by personal vehicles is only about 25-30 kms. The situation in the other cities, in not very different. The average speed of the Indian traffic is also low because of narrow roads and poor road quality.

Unlike in the developed world, again, the Indian consumer is also not very concerned with factors like the power and the speed of a vehicle. A car is more of a utility than a status symbol. Maruti, the most common passenger car in India, is a small, 800 cc vehicle, having a very low weight. Besides, most cars do not have air conditioning or heating facilities. In fact, two wheelers are often an Indian family's first and only personal transport.

Thus, given the nature of mobility demand in India, the range and speed limitations of the currently available EV technology does not seem to be a constraint.

Power Generating Capacity

Reliable power supply, at a reasonable price, is a must for the electric vehicle industry to develop. An argument generally advanced against electric vehicles is that India is already short of electrical power and needs substantial additions to generating capacity to meet existing shortfalls. Introduction of the electric vehicle technology would only need further additions to generating capacity. This, in turn, would cause more pollution.

It is true that India has been suffering from power shortage. Since the liberalization of economic policies, beginning in 1991, the demand for power has been growing steadily without corresponding growth in the supply situation. The current shortfall in system capacity is said to be up to 25% of the demand and more than 10% of the total energy requirement.

Despite the acute shortage of power, load factors of power plants have only been around 60%. The demand for off-peak power is much lower than the peak demand. This clearly indicates that there is considerable room for developing a system that could use off peak power, at lower cost, without straining the power system capacity. In fact, there is scope for increasing the supply by as much as 30-40% by improving the plant load factor, without adding to the system capacity.

Besides, effective emission control systems could be employed at power plants, which could be located away from urban centers. It would be easier to implement emission control systems on a few power plants than on millions of vehicles moving all over the cities. The total impact on air pollution could, thus, be significantly reduced.

Unsuccessful past experience

The electric vehicle is not new in India. In fact, India was one of the pioneers in exploring the commercialization of electric vehicles in the early

1980s. However, past efforts have not been a big success.

The first electric vehicle prototype was manufactured in India in the 1980s. In pursuance of a national strategy for finding alternative sources of energy for surface transportation, the Ministry of Non-Conventional Energy Sources (MNES) sponsored a project under which, ten prototypes of an 18-seater electric vehicle were designed and manufactured. These were used by different government agencies. A major consumer was the Delhi Energy Development Agency (DEDA). DEDA has been running electric minibuses in several parts of the city using lead acid batteries and a DC motor drive. These vehicles require 10-11 hours of charging overnight. The average speed is 40 km/h and the range, when fully charged is about 70 kms with a less than one year old battery, 60 km with a 2 year old battery and 50 km with a battery that is up to 3 years old. Thereafter the battery needs replacement.

DEDA's experience has been that the electric buses are not commercially viable under ordinary circumstances. Cost per passenger km is almost double that of conventional buses.

As seen from the above, the past experiments seem to have been made in the wrong markets. The biggest potential for electric vehicles lies in the small car and two-wheeler segment of the auto industry and not in the larger vehicle segment. Unfortunately, all past efforts in India have been largely confined to buses and minibuses, not to small cars or two wheelers. It must be recognized that the US and other developed countries have not done much work on EV technology for two-wheelers because the market share of two wheelers in the developed countries is very low. The 2-wheeler segment consumes only about 2% of all available petrol in developed countries, whereas in India, the figure is as high as 60% of the total petrol consumption. In Europe and the US, motorcycles are largely used in sports and cross-country riding, making high-powered engines a necessity.

Thus, attributing past experience to the inadequacies of EV technology would not be correct. Research needs to concentrate on the small car and 2-wheeler segment of the market, especially for urban use.

Cost

The Indian consumer is very price and cost sensitive. A major attraction would be the potential low operating cost of an electric vehicle, given the price differential between petrol/diesel and electricity in India. Though there is considerable variation in electricity prices from State to State and sector to sector, it is rarely more than Rs. 3.00 per kWh ($0.075/kWh). As against this, petrol and diesel prices are around Rs. 25 ($0.625) and Rs. 14 ($0.35) per liter, respectively. With this price differential, the comparative operating cost per km. of an electric car works out cheaper than that of a petrol driven Maruti or even an equivalent diesel driven car as shown below:

	Two wheeler	Petrol Maruti	Diesel Maruti	Electric Car*#
Initial cost (Rs)	60,000	200,000	250,000	200,000
App. daily use	30 Kms	30 Kms	30 Kms	30 Kms
Energy used	1 liter	2 liters	2 liters	4 kWh
Cost/unit	Rs 25	Rs 25	Rs 14	Rs 3
Energy cost per year (Rs)	6,844	18,250	10,220	4,380
Annual capital replacements		Rs. 800		Rs 5,000
Optg Cost/ km	Rs 0.63	Rs 1.74	Rs 0.93	Rs 0.86
Life Span	5 years	8 years	8 years	8 years
Total Cost/km&	Rs 1.72	Rs 4.02	Rs 3.79	Rs 3.14

As will be clear form the above, the comparative economy of the electric car depends on the price of electricity. There are apprehensions that power tariffs may go up due to agencies like the World Bank, Asian Development Bank and other big financiers of the power sector insisting more and more on rational pricing. The need for frequent replacement of batteries would also add to costs.

As stated earlier, power plants in India are faced with very low plant load factors. Off peak demand is much lower than peak demand. This makes a good case for introducing time of day tariffs, with off peak power being priced at lower levels than peak power. This would make available cheaper off peak power for charging electric vehicles. Besides, petrol prices in India are high and the price differential between petrol and power would make an electric vehicle a cheaper option compared to a petrol vehicle, even if power tariffs go up to some extent. In fact, in a study by Walivadekar, presented at an Indo-US workshop held in February, 1995, it was established that even if the initial cost of an electric vehicle is double that of its petrol counterpart, it may be offset by the electric vehicle's longer life and lower operating and

*# Calculations are based on performance expectations of the Reva, a new electric car being commercialized in India

& Includes initial cost and capital replacements amortized for every km.

maintenance costs. The study had shown that with a 20% subsidy on the initial cost, the life cycle cost per kilometer per passenger for an electric vehicle comes to about 35% of an equivalent petrol driven vehicle. If some innovative financing mechanism can be devised, no subsidy would be necessary.

Political Will

Government policy has a tremendous role to play in paving the way for an electric vehicle industry to develop. The enactment of a Zero Emission Vehicle (ZEV) mandate by the California Air Resources Board in 1990 has spurred more progress in electric propulsion technology than was accomplished in the previous 20 years by the automobile industry and the US Department of Energy combined. The mandate requires that by the 1998, at least 2% of the vehicles sold in California by major auto-makers must have zero emissions. The percentage is required to rise to 5% in 2001 and 10% in 2003. Almost totally because of the mandate, every major auto-maker in the US has invested in electric vehicle development.

It is feared that such measures would have a severe political backlash. However, it needs to be remembered that vehicle ownership in India being low, the number of persons that would be affected by such policy initiatives would be small compared to the number of beneficiaries. In any case, most vehicle owners would secure a cheaper alternative and should only welcome such a move. The cleaner air in the cities would also secure a political constituency in favor of such policy measures.

INDIA'S RESOURCE BALANCE

Apart from the fact that the traditional arguments against the electric vehicle are not applicable in Indian conditions, there are specific advantages that the EV technology would have in India.

India's dependence on imported oil, currently at 50%, is steadily increasing with the growth of the conventional automobile industry. India can ill afford to let the conventional automobile industry grow at the current rate. This type of growth will result in a huge incremental demand for oil, which will have to be imported. Not only will it adversely affect India's energy security, it could also mean a significant drainage of precious foreign exchange. With not much addition to the reserves of crude oil expected in the foreseeable future, the dependence on imported oil may go up to 90% within the next few years, if demand for oil continues to grow at its present rate. On the other hand, India has abundant reserves of coal for producing power using clean coal technologies. Besides, there is a huge untapped potential for hydro-electric power in the region, which is both clean and cheap.

Thus, India's resource balance comes out strongly in favor of using a technology that could replace the use of petroleum with the use of electric power.

CONCLUSION

In conclusion, it can be stated that despite its shortcomings in the developed world, the electric vehicle would be a viable option in India, for the following reasons:

- Though electric vehicles are limited in their range and speed performance, the average distance over which a personal vehicle is driven per day is well within the range of the EV technology available today. Moreover the average speed of travel is slow due to poor and narrow roads. Thus, there is a very good match between what an electric vehicle technology can deliver and the mobility needs of most Indians.
- Indian power plants suffer from a very low plant load factor. By introducing time of day tariffs, future electric vehicle customers can be effectively encouraged to charge their vehicles during the off-peak hours at a considerable discount in the tariff. Even if the power tariffs are rationalized and the rates go up, lower off peak tariffs could still make electric vehicles a cheaper alternative.
- Even if, thermal power stations are used to generate additional power for charging electric vehicles, effective emission control systems could be employed and these power stations could be located away from urban centers. Thus, total impact on air pollution would be significantly reduced.
- It would be easy to secure a political constituency for legislative mandates requiring the introduction of electric vehicles, as there would be a much larger number of beneficiaries compared to the number of persons that may be adversely affected by such a policy.
- Due to the heavy dependence on imported oil, coupled with the abundant reserves of coal and hydro-power resources, it would be to India's strategic advantage to develop a technology that could substitute petroleum fuels with electric power.
- A price sensitive market would prefer a lower operating cost electric vehicle to a higher operating cost petrol vehicle.

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Green Project System
Système Green Project
Sistema Green Project

Fernando Lozada Islas
Alstom Transporte, S.A. de C.V., Mexico City, Mexico

ABSTRACT:. The project's objective is rail vehicles future generation construction in such a way that they would produce low emissions during their service life, and be recycled at the end of it, without being harmful to our environment, which can be achieved through a global waste management, ecological product design and new production techniques development.

RÉSUMÉ: L'objectif du projet est la construction d'une nouvelle génération de véhicules ferroviaires de telle manière qu'ils produisent de faibles émissions durant leur vie de service, et qu'ils soient recyclés à la fin de celle-ci, sans nuire à notre environnement, ce qui peut être obtenu au travers d'une politique globale des déchets, d'un design écologique des produits et du développement de nouvelles techniques de production.

RESUMEN: El objetivo del proyecto es la construcción de una nueva generación de vehículos ferroviarios de tal forma que produzcan bajas emisiones durante su vida de servicio, y que sean reciclado al concluir ésta, sin ser nocivos para nuestro medio ambiente, lo cual se puede lograr a través de una política global de desechos, un diseño ecológico de los productos y el desarrollo de nuevas técnicas de producción.

LA FABRICATIÓN DE MATÉRIEL ROULANT FERROVIAIRE ET L'IMPACT ENVIRONNEMENTAL DES PRODUITS.

1 INTRODUCTION

La protection de l'environnement est un problème qui doit tous nous préoccuper. Afin de garantir cette attention nécessaire, nous devons respecter les lois de protection de l'environnement, et plus spécifiquement en ce qui concerne les pressions en matière de règlementation, normes et concurrence, ainsi que les demandes des clients et les implications internationales.

En outre, ce sujet est déjà l'un des principaux facteurs de la concurrence internationale.

Les besoins du marché actuel des transports ferroviaires exigent une réduction de poids et de bruit, qui implique l' utilisation de matériaux qui, du fait qu'ils sont difficiles à recycler et à démonter, sont nuisibles à l'environnement, pendant et après leur cycle de vie. De ce fait, il est urgent d'analyser les problèmes contradictoires entre la construction légère et la protection de l'environnement.

2 GREEN SYSTEM PROJECT: GÉNÉRALITÉS

Alstom Transport a toujours recherché l'évolution de ses prodsuits dans un certain nombre de domaines liés à l'environnement (réduction de la consommation d'énergie, réduction du bruit, compatibilité électromagnétique,...).

Mais aujourd'hui, la composante « environnement » dans la définition d'un produit devient un critère à ne pas négliger. Il suffit d'observer les évolutions des besoins du marché dans ce domaine:

- Évolution des réglementations (Règlement US de l' Environmental Protection Agency sur les émissions gazeuses des locomotives à diesel, par exemple),
- Évolution de la normalisation (série des normes ISO 14000, et plus spécialement la norme ISO 14040 relative à l'analyse du cycle de vie d'un produit),
- Augmentation des demandes des clients et apparition de demandes spécifiques dans les cahiers des charges par rapport aux produits (taux de recyclabilité, listes de produits ou matériaux nécessitant des précautions

d'emploi ou de mise en décharge, procédures de démantèlement,...),
- Incitations financières des pouvoirs publics à travers des programmes de recherche liés à l'amélioration de l'impact environnemental des produits.

Depuis 1992, Alstom Transport a pris en compte dans sa politique générale la composante Environnement. Ceci s'est d'abord traduit par la mise en place d'un management environnemental des sites industriels, et depuis deux ans, d'une politique de prise en compte de l'impact environnemental des produits pendant leur cycle de vie.

Aujourd'hui, l'objectif est d'évaluer les produits d'un point de vue environnemental, selon une grille d'évaluation basée sur 5 niveaux de pertinence pour chacune des étapes du cycle de vie. Cette grille d'évaluation, "Environmental **IM**pact **E**valuation" (Évaluation de l'Impact Environnemental), permet aux chefs de projet de situer leur produit et de définir, si nécessaire, des axes de progrès pour le faire évoluer.

Toujours dans le but d'augmenter la performance environnementale de ses produits, Alstom Transport participe à un projet européen dans le cadre du programme LIFE. Ce projet, intitulé "*Véhicules ferroviaires à démontage facilité et recyclage optimal*", devrait permettre de réduire à 5% la quantité de déchets non-recyclables provenant de la mise hors service des véhicules ferroviaires. D'autre part, l'objectif d'utiliser environ 10% de matériaux recyclés est envisagé. Commencée en septembre 1998, cette étude a permis de déceler environ 200 possibilités d'amélioration qui font l'objet d'études technico-économiques.

Le "Green Project System" s'oriente donc sur deux voies principales, dont nous traiterons dans les pages suivantes:
- Environmental IMpact Evaluation (EIME)
- *"Véhicules ferroviaires à démontage facilité et recyclage optimal".*

3 ENVIRONMENTAL **IM**PACT **E**VALUATION

Alstom Transport a entrepris une démarche de conception environnementale de ses produits, « du berceau à la tombe », basée sur un logiciel d'aide à la conception. Le logiciel EIME retenu permet de:
- garantir le suivi de la politique environnement–produit,
- mesurer les améliorations de l'impact des produits sur l'environnement,
- fournir les bases de la communication interne et externe sur "les produits et l'environnement".

Ce logiciel permet de comparer l'impact environnemental d'un produit de génération n avec un produit de génération n+1, et de s'assurer qu'il s'agit bien d'une démarche de progrès.

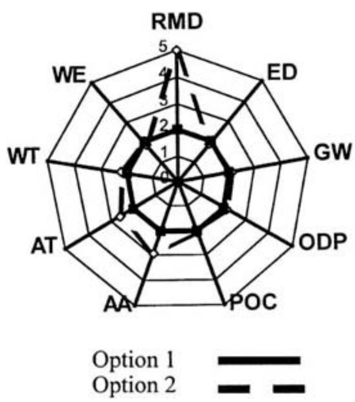
	1	2	3	4	5
Choix des matériaux					
Achats de sous-ensembles et sous-traitance					
Fabrication du produit					
Vie du produit (utilisation normale)					
Vie du produit (maintenance)					
Fin de vie					

Le niveau 1 correspond à un produit **UPL** "**U**nacceptable **P**rotected **L**evel" (Niveau de Protection Inacceptable).

Les niveaux 2 et 3 correspondent à un produit **UML** "**U**nder **M**anaged **L**evel" (Niveau Sous-Géré).

Le niveau 4 correspond à un produit **APL** "**A**cceptable **P**rotected **L**evel" (Niveau de Protection Acceptable).

Le niveau 5 correspond à un produit **HPL** "**H**igh **P**rotection **L**evel" (Haut Niveau de Protection).



- RMD Réduction des Matières Premières
- ED Réduction d'Énergie
- GW Réchauffement Global
- ODP Réduction d'Ozone
- POC Création d'Ozone par Photochimie
- AA Acidification de l'Air
- AT Toxicité de l'Air

- WT Toxicité de l'Eau
- WE Eutrophisation de l'Eau

Comparaison de deux Options de Design.

3.1 *Description générale du programme*

D'une manière générale, on peut décrire le programe EIME au travers de ses principales caractéristiques:

E.IM.E est un outil d'aide à la conception qui permet de:

CONCEVOIR, des produits de plus en plus respectueux de l'environnement, sur une base « multicritères »:
- En identifiant les points faibles du produit,
- En aidant et en orientant le concepteur dans ses choix de matériaux et de procédés, en lui donnant accès à toutes les informations nécessaires: données d'inventaires, réglementation, contraintes des clients.
- Interface "CONCEPTEUR".

COMMUNIQUER, et informer en direct les utilisateurs:
- En informant sur les réglementations, les contraintes des clients,....,
- En appliquant la stratégie d'entreprise, adaptée à la famille de produits.
- Interfaces "EXPERT" et "MARKETING".

GÉRER, pour assurer une application cohérente de la politique environnementale de l'entreprise:
- Management environnemental des projets,
- Stratégie adaptée à la famille de produits.
- Interfaces "EXPERT" et "CHEF DE PROJET".

ANTICIPER, en prenant en compte la fin de la vie du produit dès sa conception:
- Évaluation du potentiel de valorisation du produit lors de la conception,
- Réévaluation lors de la fin de vie.
- Interface "FIN DE VIE".

3.2 *Outils et Status*

La méthode s'appuie sur une base de données environnementales (aujourd'hui 200 modules regroupant les données d'inventaire de l'élément considéré: matériau, procédé, composant,...) et un logiciel convivial.

Outil
- Simple (utilisable par des non spécialistes),
- Rapide et compatible (intégrable dans les procédures existantes de design),
- Complet (intègre l'ensemble du cycle de vie),
- Fiable (actualisation régulière),
- Objectif (indépendant de l'utilisateur),
- Informatif (déclenchement de messages conditionné aux choix du concepteur).

Status

La version en test n'est qu'une étape; des fonctionnalités complémentaires sont à développer. Son utilisation optimale suppose une « personnalisation » de la base de données aux familles des produits ferroviaires.

4 PROJET ALSTOM-LHB: "VÉHICULES FERROVIAIRES À DÉMONTAGE FACILITÉ ET RECYCLAGE OPTIMAL"

4.1 *Description générale*

ALSTOM-LHB compte parmi les constructeurs leaders en Europe sur le marché des véhicules ferroviaires: il est acteur dans ce domaine depuis 1893. En tant que premier producteur de véhicules ferroviaires, la société Linke-Hofmann-Busch GmbH a pris part avec succès à l'audit environnemental européen en février 1996.

Le programme de production comprend:
- Chemins de fer urbains et tramways
- Chemins de fer souterrains
- Automotrices électriques et à diesel
- Wagons de transport de voyageurs
- Wagons pour marchandises de toutes sortes
- Bogies pour wagons de transport de voyageurs ou marchandises
- Réparations de véhicules ferroviaires.

Sur la base d'un projet exemplaire, il est prévu de rendre écologiques la planification des produits et les techniques de production, et ceci à un degré bien supérieur à la norme. Le projet *"Véhicules ferroviaires à démontage facilité et recyclage optimal*", soutenu par LIFE (UE), crée les conditions suivantes: en réduisant à 5% la quantité de déchets non-recyclables provenant de la mise hors service des véhicules ferroviaires, il permet d'élever à 95% la part des matériaux recyclables (voir graphiques 1 et 2).

L'axe principal et primordial de ce projet est la construction des générations futures d'engins sur rails de telle manière que ces derniers soient recyclables au maximum. Selon les chiffres du département marketing, plus de 3000 véhicules de transport de voyageurs devront être remplacés en

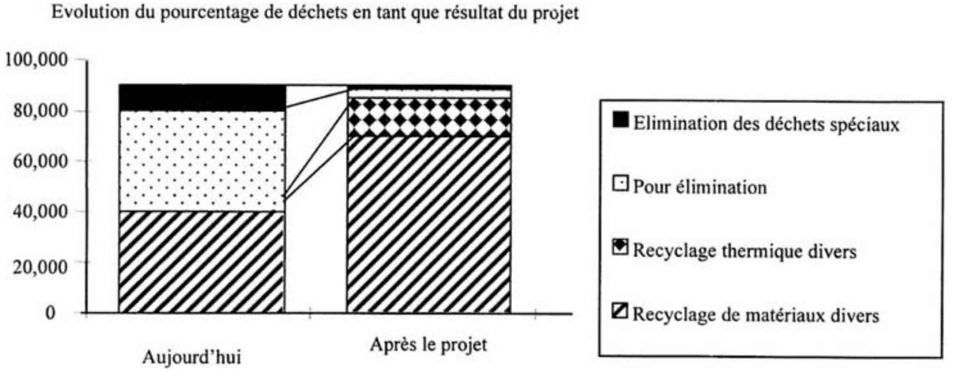
Tableau 1: Profil écologique. Base de calcul: remplacement sur toute l'Europe de 3000 véhicules sur 5 ans.

Déchets	Aujourd'hui	Après application du projet
Quantité totale de déchets	90.000	90.000
- réutilisation matérielle	40.000	70.000
- réutilisation thermique	0	15.000
- a éliminer	40.000	3.500
Élimination de déchets spéciaux	10.000	1.500
Ressources		
Consommation de métaux	50.000	50.000
Consommation de matières premières non renouvelables et limitées	40.000	30.000
Matières premières renouvelables	0	10.000

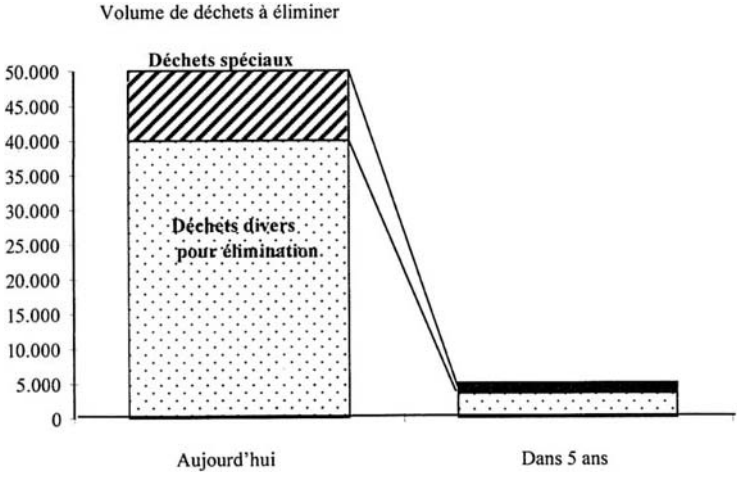
Europe entre 2000 et 2005, et on estime à 30 tonnes le poids de chaque véhicule.

Pour remédier spécifiquement à l'augmentation de la part de déchets recyclables, on requiert d'innovations dépassant les frontières actuelles de l'imagination, afin de développer et d'insérer dans les véhicules ferroviaires des matériaux qui, jusqu'à ce jour, n'ont pas trouvé d'application ou d'utilisation. Ceci est particulièrement vrai étant donné qu'il s'agit d'inclure, pour la première fois dans des proportions significatives, des matériaux renouvelables comme composants des véhicules ferroviaires (cible: 10%).

L'équipe ALSTOM-LHB chargée du projet est prête à relever ce défi. Les attentes au niveau des résultats du projet (inauguré le 1er septembre 1998) dépassent les standards de la profession – ou même ce qui paraît possible -, ce qui tendra à renforcer

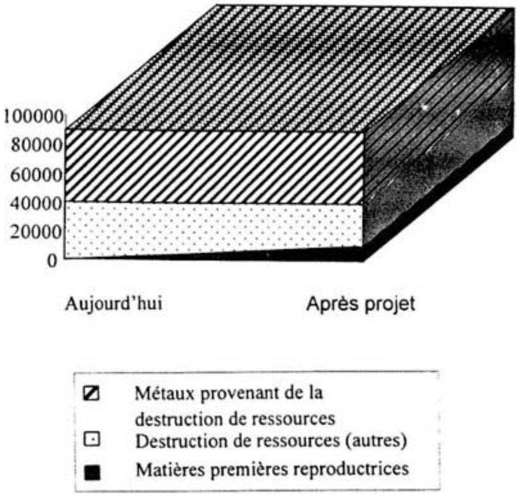


Graphique 1: Evolution générale des déchets résultant de véhicules ferroviaires liée à la mise en place du projet (en tonnes).



Graphique 2: Evolution du volume des déchets non- recyclables pendant la période quinquénnale du projet (en tonnes).

Introduction de matières premières reproductrices dans la construction de véhicules ferroviaires.



Graphique 3: Évolution générale du choix des matériaux avec une part croissante de matériaux renouvelables et une part décroissante des ressources limitées (en tonnes).

nettement sa position concurrentielle sur le marché mondial.

4.2 *Cadre du projet et répercusions sur l'environnement*

L'état des connaissances concernant la récupération et le recyclage des véhicules ferroviaires, ainsi que la fabrication de ces derniers d'après les principes écologiques existants, est bien en retard par rapport à celui des véhicules routiers, puisqu'un transfert latéral n'est pas possible à cause d'exigences différentes.

La récupération de véhicules ferroviaires a d'importantes conséquences négatives sur l'environnement: ceux-ci doivent être fractionnés en différents groupes de déchets, générant d'énormes coûts. Il est en effet difficile de décontaminer certaines catégories de déchets: ceci porte la part des déchets non-recyclables à plus de 50%. La quote-part théorique des matériaux recyclables estimée à 65% du poids, et principalement composée de métaux, n'est pourtant pas atteinte, du fait que les moyens techniques actuels ne permettent pas le démontage complet des parties métalliques. Le recyclage engendre à son tour des conséquences néfastes sur l'environnement, puisqu'avec les procédés conventionnels de construction, les parties métalliques sont irréversiblement liées avec un haut pourcentage de matériaux organiques. Le recyclage de métaux représente une grande partie des sources d'émission de dioxine en Europe, notamment à cause des matières organiques.

Ce projet génère un progrès important en comparaison avec la situation actuelle décrite, puisqu'il résout dans un effort systématique les problèmes répertoriés ci-dessous:

1 Fractionnement théorique d'un véhicule ferroviaire.
2 Vérification du démontage théorique sur le véhicule même.
3 Diagnostic des conséquences écologiques et économiques de la mise hors service de véhicules.
4 Traitement des priorités après inventaire des problèmes.
5 Développement de nouveaux principes de construction et propositions de solutions.

Dans les vingt dernières années, la construction légère fut prônée afin de construire des véhicules ferroviaires réduisant au minimum, au cours de la production, les incidences sur l'environnement, la consommation d'énergie et les nuisances acoustiques. Les procédés permettant de réduire le poids et le bruit nous conduisent pourtant au dilemne suivant: ce sont justement les matériaux légers et / ou réducteurs de bruits (matières synthétiques, amalgames) qui sont néfastes pour l'environnement et qui, après leur cycle de vie, posent des problèmes environnementaux, du fait qu'ils sont difficiles à démonter et à recycler. Il convient donc d'observer et d'analyser les véhicules ferroviaires dans leur totalité pour résoudre les problèmes contradictoires entre la construction légère et l'équilibre environnemental.

Il apparaît clairement que l'objectif du projet est de construire les générations futures de véhicules ferroviaires de telle manière qu'ils roulent avec de faibles émissions pendant leur durée d'utilisation, et qu'ils soient recyclables après leur mise hors service, sans nuire aux différentes catégories composant notre environnment.

5 CONCLUSION

Alstom Transport est engagée dans une démarche de management environnemental. Cette démarche a commencé par le suivi des sites industriels à travers la tenue d'un manuel d'environnement conformément aux recommendations de la norme ISO 14000 et se poursuit par la mise en place d'un suivi de l'impact environnemental des produits.

Par le biais de ces actions, l'enteprise contribuera à l'effort international de préservation des ressources naturelles et de diminution des impacts environnementaux des sites et des produits.

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Historic report, future and importance of electric transport in the Mexico City and the Metropolitan Zone

Evolution, importance et futur du transport electrique dans la Ville de Mexico et la Zone Métropolitaine

Reporte histórico y futuro de la importancia del Transporte Eléctrico en la Ciudad de México y Zona Metropolitana

M.C.Oscar Díaz González Palomas
Servicio de Transportes Eléctricos del Distrito Federal, México, D.F., Mexico

ABSTRACT. This paper resumes the evolution of electric transport in Mexico City including the metro, trolleybus and light rail networks. It also describes traffic jams and geographic conditions that lead to high pollution levels in the Mexico Valley Metropolitan Zone. It concludes mentioning expansion projects, with public or private financing, for electrical transportation till year 2020.

RESUMÉ. On fait une description historique de l'evolution du transport eléctriqué dans la ville de México jusqua l'utilization actuelle du métro, trolleybus et le train léger on note les condition contraires du congestionnement et orographie que rendent dificiles la dispersion des contaminants dans la zone metro politaine de la vallée de México. On conclut en mentionnant quel ques projets déxpansión avec finansements publics ou privés pour que de nouvelles lignes de transport éléctrique en vue de l'an 2020.

RESUMEN. Se hace una reseña histórica de la evolución del transporte eléctrico en la Ciudad de México hasta la operación actual del Metro, trolebuses y tren ligero. Se describen las condiciones adversas de congestionamiento y orográficas que dificultan la dispersión de contaminantes en la ZMVM. Se concluye mencionando algunos proyectos de expansión con financiamientos público o privado para nuevas líneas de transporte eléctrico para horizontes hasta el año 2020.

1 INTRODUCCION

A nombre de Servicio de Transportes Eléctricos del Distrito Federal resulta un honor participar en este evento internacional organizado por CODATU y la

Secretaría de Transportes y Vialidad del Gobierno del Distrito Federal.

Estamos por arribar al tercer milenio, el que va a concluir, especialmente el siglo XX, se ha caracterizado por sus avances espectaculares en todos los campos de la ciencia y la tecnología, el transporte no es la excepción. La Ciudad de México está por cumplir los cien años de los tranvías eléctricos y con ello del transporte eléctrico. El automóvil como tal se puede considerar producto de este siglo y desarrollo de esta generación.

Con el éxodo del campo a las ciudades, la concentración en éstas de personas, vehículos y vialidades, han dado como resultado problemas severos con deterioro grave del hábitat fundamentalmente en materia de contaminación, congestionamiento y accidentes.

2 ZONA METROPOLITANA DEL VALLE DE MEXICO

La Zona Metropolitana del Valle de México (ZMVM), es una de las áreas urbanas más grandes del mundo y se forma con la conurbación entre las 16 delegaciones políticas del Distrito Federal y 28 Municipios del Estado de México. En dicha zona habitan más de 18 millones de personas, casi el 20% de la población nacional, se consume el 17% de la energía generada y por ella circula la tercera parte del parque vehicular del país. Véase la Figura 1.

De la importancia de la movilidad urbana nos hablan los más de 20 millones de viajes persona día que con motivo de trabajo, educación, abastecimiento, recreación, salud y negocios se realizan cotidianamente. Sin embargo, el uso

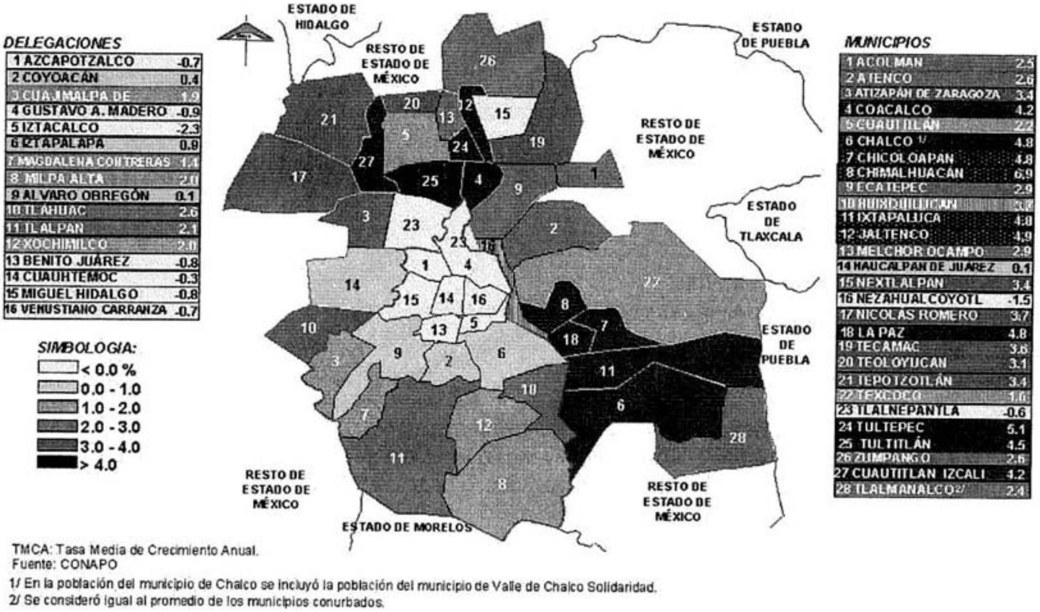

Figura 1. Crecimiento Poblacional por Municipios
Delegaciones en la ZMVM (1995-2000)

indiscriminado del transporte individual aunque sólo traslada menos de la quinta parte del total de los viajes, causa graves problemas de congestionamiento, contaminación y accidentes.

3 CONTAMINACION AMBIENTAL

La ZMVM esta ubicada a una altitud de 2,240 metros sobre el nivel del mar en una cuenca semicerrada cuyo contorno orográfico evita la salida del aire ya degradado, tanto por el hombre, la industria, la circulación de automotores, los servicios domésticos y otros.

El transporte automotor como fuente móvil de la contaminación es responsable del 75% del total de la polución atmosférica, ya que por lo que toca a las partículas sólidas (PST) emite el 71.7%, en cuanto al bióxido de azufre (SO_2) el 26.8% del total, del monóxido de carbono (CO) es casi el total responsable con el 99.5%, en cuanto al óxido de nitrógeno (NO_X) es responsable del 71.3% y de los hidrocarburos HC contribuye con el 54.1%[1]. Véase la Figura 2.

Este nivel de contaminación se debe fundamentalmente al desplazamiento cotidiano de más de tres millones de vehículos en donde predomina el auto particular, cuyo factor de ocupación es de 1.5 personas por unidad, requiriendo cada uno de ellos un motor encendido que genera graves consecuencias a la salud de los habitantes de la ciudad.

Para contrarrestar esta problemática, es necesario dar prioridad al transporte masivo, principalmente eléctrico, además del que opera a base de combustibles alternos limpios.

Inventario de emisiones 1994

Sector	Miles de Toneladas/año						
	PST	SO_2	CO	NO_X	HC	Total	%
Industria	6.36	26.05	8.70	31.52	33.10	105.72	3
Servicios	1.08	7.22	0.95	5.34	398.43	413.01	10
Transporte	18.84	12.20	2,348.50	91.79	555.32	3,026.65	75
Vegetación y suelos	425.34	0	0	0	38.91	464.25	12
Total	451.62	45.47	2,358.15	128.65	1,025.76	4,009.63	100

Fuente: Programa para Mejorar la Calidad del Aire en el Valle de México 1995-2000, Marzo, 1996

Figura 2. Inventario de Emisiones 1994.

4 CONGESTIONAMIENTOS Y ACCIDENTES

Otros dos indicadores importantes que se presentan en la ZMVM, son el congestionamiento y los accidentes. El primero debido a que el 95% del parque vehicular está constituido por autos particulares que requieren mucho espacio para circular y estacionarse y que inciden en el tránsito en las horas de máxima demanda, dejando inmersos en este movimiento a los transportes públicos que no cuentan con derecho de vía propia.

Un viaje en la ZMVM al trabajo y de regreso, constituye para la mayoría de los habitantes 2.5 horas de desplazamiento, esto demerita en calidad de vida quedando inmerso en grandes congestionamientos en que los cada vez mejor diseñados vehículos, circulan a vuelta de rueda.

De acuerdo con estimaciones recientes hechas por la Comisión Metropolitana de Transporte y Vialidad (COMETRAVI), se pierden 3,000.2 millones de dólares al año por este concepto. Véase la Figura 3.

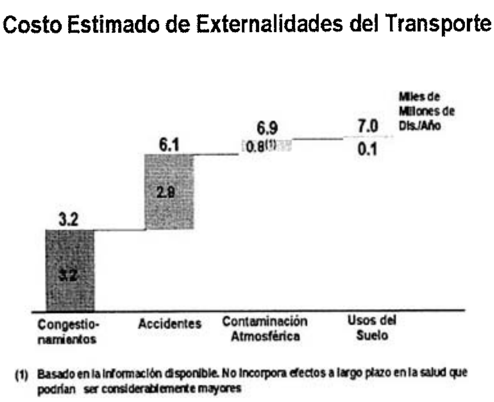

Figura 3. Costo Estimado de Externalidades del Transporte

Por lo que toca a accidentes, de acuerdo con la información del Instituto Nacional de Estadística, Geografía e Informática (INEGI), y los Servicios Médicos Forenses del Distrito Federal y del Estado de México, cada día se producen en promedio 41 accidentes de tránsito con un saldo de 16 lesionados y 8 muertos, esto exclusivamente en el lugar del accidente, es conocido que la cifra de defunciones se duplica con los que fallecen durante su traslado en ambulancias o su atención en centros de urgencias.

Vale la pena reflexionar que el automóvil no obstante ser una herramienta de tanta utilidad al hombre y su economía, al mismo tiempo resulta un arma homicida con la que se han segado más vidas que en todas las guerras en la historia de la humanidad. También debe mencionarse que es un problema universal, ya que la Organización Mundial de la Salud indicó en 1997 que fallecen en el mundo anualmente 700,000 personas víctimas de accidentes de tránsito y resultan lesionados 20 millones de seres humanos en el mundo.

5 TRANSPORTE ELECTRICO EN LA CIUDAD DE MEXICO

En la Ciudad de México, como en muchas otras ciudades del mundo: Londres, Nueva York, Tokyo y San Francisco, comenzaron a utilizarse tranvías movidos por tracción animal durante la segunda mitad del siglo XIX.

El 12 de octubre de 1852, el presidente Mariano Arista expidió la patente que celebraba el contrato y otorgaba la concesión para que José Gómez de la Cortina, mejor conocido como el Conde de la Cortina, iniciará el sistema tranviario de fuego en la Ciudad de México, intentando comunicar las poblaciones vecinas de Tlalpan con algunas de las zonas más importantes de la Ciudad, como San Angel, Mixcoac y Tacubaya, ampliándose dicha concesión en 1856 para construir la línea que ligara el Zócalo con Tacubaya[2].

Los beneficios de la electricidad comienzan a aprovechase para el transporte público de la Ciudad de México a finales del siglo pasado, dando oficialmente los primeros frutos con los primeros tranvías eléctricos para el servicio de pasajeros que comenzaron a operar el 15 de enero de 1900 con una capacidad de 24 a 32 asientos por carro, contando con dos motores General Electric de 19 kW cada uno, siendo la carrocería de madera. Este acto se considera un paso importante de la Ciudad de México hacia la modernidad. Esta primera línea de tranvía eléctrico unió la Ciudad con Tacubaya. En el primer año de este siglo, comenzaron a operar seis líneas más a la Villa de Guadalupe, Belem, Mixcoac, San Angel, Tlalpan y Dolores.

Para mayo de 1927, la red de tranvías alcanza su apogeo con 347.5 km sobre 26 rutas urbanas, 12 suburbanas y cinco ramales donde los trenes recorrían en conjunto diariamente 65,000 km mediante 400 carros de pasajeros, 75 fletes y 25 funerarios.

6 CREACION DEL SERVICIO DE TRANSPORTES ELECTRICOS DEL D.F.

En 1945, con base en la recién promulgada "Ley sobre Transportes Urbanos y Suburbanos del D.F." se crea "Servicios de Transportes Urbanos y Suburbanos del D.F.", quedando en abril de 1947 ya como Servicio de Transportes Eléctricos del D.F.

En agosto de 1953, el Departamento del Distrito Federal autorizó la compra de 91 tranvías tipo PCC que cubrieron las rutas Obregón – Insurgentes y Obregón – Bucareli, inauguradas el 24 de marzo de 1954. El uso del tranvía comenzó a declinar. Entre 1959 y 1968 sólo operaron 11 rutas troncales y dos locales, haciéndose un esfuerzo en 1970 por rehabilitar PCC´s.

El tranvía PCC dio servicio en la Ciudad hasta que se entró en la década de los ochentas al ser eliminado del centro de la capital, dando servicio solamente entre Tasqueña, Huipulco y Tlalpan, hasta que dejó de funcionar en 1984. Esta línea fue el antecedente inmediato del moderno tren ligero que opera actualmente el STE.

Sin embargo, la base de la renovación del STE y que constituiría el símbolo característico de esta institución fue el trolebús. Las primeras 20 unidades con las que contó la Ciudad de México fueron del modelo Westram, compradas en 1945 a una empresa en Nueva York. Debemos resaltar que estas unidades fueron armadas por mexicanos en los talleres de Indianilla durante 1946. Fue hasta el nueve de marzo de 1951 cuando se inauguró el servicio formal en la línea Tacuba a Calzada de Tlalpan.

El crecimiento del parque vehicular comenzó en 1952 cuando llegan de Italia los primeros diez trolebuses Tubocar, adquiriéndose al año siguiente 30 trolebuses más también italianos tipo Cassaro. En 1954, incorporan 50 trolebuses más a la flota vehicular existente. Dos años después se adquieren 117 trolebuses y en 1957 otras 67 unidades.

Con estas constantes adquisiciones de vehículos se llevó a la empresa a constituirse a finales de la década de los sesenta en la columna vertebral del transporte público de la Ciudad con una flota vehicular de 872 unidades entre tranvías y trolebuses, hasta principios de la década de los setenta poco después de que se iniciara la operación del Metro en 1968.

Actualmente, la red de trolebuses tiene una longitud de 412.9 km de instalaciones aéreas operativas. Esta infraestructura conforma un universo de 16 rutas, con un parque vehicular de 432 trolebuses.

Con el propósito de modernizar la flota vehicular y consolidar el servicio, a partir de febrero de 1998 se incorporaron gradualmente 50 nuevos trolebuses Mitsubishi – Masa de la serie 9000 para reforzar las unidades disponibles en operación. En diciembre del mismo año se pusieron en marcha otros 75 trolebuses más. En 1999, el Gobierno del Distrito Federal, efectuando su máximo en términos financieros dotó al STE de otras 75 unidades que entraron en servicio el 14 de octubre.

Otra alternativa innovadora del transporte masivo no contaminante la constituye el tren ligero. Aprovechando las vías de la última línea de los antiguos PCC, se construye en 1986 el primer tramo Tasqueña - Estadio Azteca y para 1988 entra en servicio el segundo tramo Huipulco – Xochimilco.

Actualmente el tren ligero cubre una distancia de 26.8 km con un parque vehicular de 16 trenes articulados de tracción eléctrica, de los cuales 12 son modelo 90 y 4 modelo 1995, operando en 16 estaciones y dos terminales. Actualmente, el tren ligero transporta 65,000 pasajeros en promedio en días hábiles.

Figura 4. Trolebús Mitsubishi Masa de la Serie 9000.

Figura 5. Tren Ligero TE-95

7 SISTEMA DE TRANSPORTE COLECTIVO METRO

En 1967, por decreto presidencial, se crea el Sistema de Transporte Colectivo Metro, previo al inicio de la construcción de las primeras líneas, siendo éstas Zaragoza – Chapultepec inaugurada en 1969, Tacuba – Tasqueña inaugurada en 1970 y Tlatelolco – Hospital General también inaugurada en 1970.

El sistema cuenta actualmente con nueve líneas de Metro y una de Metro férreo que corre de Pantitlán en el Distrito Federal a los Reyes La Paz en el Estado de México. Durante 1999, el Gobierno del Distrito Federal y el STC inauguraron la Línea B de Buenavista a Villa Aragón, que llegará en este año al municipio de Ecatepec en el Estado de México.

El Sistema de Transporte Colectivo Metro a lo largo de sus 30 años de operación ha conformado una infraestructura de 11 líneas tomando en cuenta la línea B, con 201 km de longitud y 167 estaciones, lo que representa a partir de su primera línea haber incrementado 16 veces su distancia construyendo una nueva línea o ampliación cada 2.8 años.

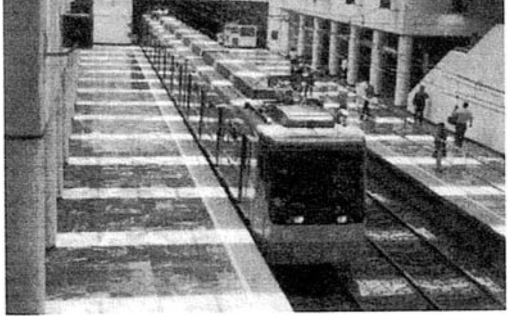

Figura 6. Tren Férreo FM-95 de la Línea A del STC Metro

8 PLAN MAESTRO DEL TRANSPORTE ELECTRICO.

Tanto el STC como el STE se rigen por sus decretos de creación y para su expansión y futuro desarrollo por el Programa Integral de Transportes y el Plan Maestro del Transporte Eléctrico – Area Metropolitana de la Ciudad de México, documento este último que tiene revisiones periódicas y cuya actividad en materia de planeación data desde 1967 con las tres primeras líneas de Metro, elaborándose su segunda versión en 1980.

Este Programa establece para diversos horizontes 2003, 2009 y 2020 la red general de los transportes eléctricos, existiendo una propuesta de configuración definitiva que se compone de 27 líneas incluyendo las 12 ya en operación con 227.8 km (Metro y Tren Ligero).

Al horizonte del año 2020, el Plan Maestro contempla que la red de Metro será de 17 líneas, mientras que la red de trenes ligeros será de 10 líneas, cubriendo en total una longitud de 483 km.

Este mismo plan en materia de trolebuses contempla para el año 2020, adicionar a la red actual de 489 km y pasar de 462 trolebuses que hoy operan a un parque vehicular de 1,100 unidades.

Como se puede apreciar, y ha sido corroborado por "La Estrategia Integral de Transporte y Calidad del Aire" elaborada por el Estado de México, el Distrito Federal y la Secretaría de Comunicaciones y Transportes bajo la coordinación de la COMETRAVI, se tiene la convicción de dar un gran impulso al transporte eléctrico en la ZMVM.

9 PROYECTOS VIABLES PARA LOS PROXIMOS CINCO AÑOS

Dentro del Comité de Planeación y Diseño Integral de Rutas que preside la Secretaría de Transportes y Vialidad del D.F. con base en el Plan Maestro del Transporte Eléctrico y tomando en cuenta los resultados obtenidos de otros estudios, se contemplan al horizonte del 2006 los siguientes proyectos:

9.1 Sistema de Transporte Colectivo Metro:
Línea 7 de Barranca del Muerto a San Jerónimo
Línea 8 de Acoxpa a Indios Verdes
Línea 12 de Atlalilco a Mixcoac

9.2 Servicio de Transportes Eléctricos del D.F. - Trenes Ligeros:
Constitución de 1917 – Chalco
Línea Ecológica Eduardo Molina
Ruta de Tranvía Roma – Condesa
Línea Ecológica Centro Histórico

9.3 Servicio de Transportes Eléctricos del D.F. – Trolebuses:
San Felipe de Jesús a Metro Martín Carrera (línea nueva)
Eje 1 Norte, Metro Guerrero a La Defensa (línea nueva)
Eje 3 Oriente, Metro Mixhuca al Metro Escuadrón 201 (ampliación de líneas F, R1 y R2)
Metro Hidalgo a Instituto Politécnico Nacional (ampliación línea LL)
Metro Constitución de 1917 a Tlahuac (línea T1)

9.4 Trenes Suburbanos:
Complementa este renacer del transporte eléctrico y masivo la impostergable necesidad de materializar los proyectos realizados por la Secretaría de Comunicaciones y Transportes, los Gobiernos del Distrito Federal y del Estado de México, de los "trenes radiales" para conectar la ciudad capital y la zona metropolitana con las ciudades circundantes como Toluca, Cuernavaca, Cuautla, Puebla, Tlaxcala, Pachuca y Querétaro, constituyendo la red de trenes de alta velocidad que entre otros grandes beneficios evitarán que la mancha urbana siga creciendo indiscriminadamente.

Como puede apreciarse, la Ciudad de México y la Zona Metropolitana se suman a otras ciudades como París en el redescubrimiento y optimización del transporte eléctrico.

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El Ferrocarril Suburbano en la Zona Metropolitana del Valle de México

Commuter railroad of the Mexico Metropolitan Area

Reseau Regional du Banlieu Métropolitain de Mexico

Oscar Santiago Corzo Cruz
Transporte Ferroviaria y Multimodal-SCT, México D.F., Mexico

RESUMEN: De conformidad con el Plan Nacional de Desarrollo 1995-2000, así como del Programa de Trabajo del Sector, la Secretaría de Comunicaciones y Transportes, en el marco de la Reestructuración del Sistema Ferroviario Mexicano, está llevando a cabo los estudios necesarios para promover y desarrollar el proyecto "Ferrocarril Suburbano en la Zona Metropolitana del Valle de México", aprovechando los 240 km de vías y derechos de vía existentes en la misma.

Para instrumentar este proyecto, se determinó segmentar la infraestructura disponible de 240 km, en tres sistemas troncales, que cuentan con líneas alimentadoras de menor densidad, Buenavista-Huehuetoca, Ecatepec-Naucalpan y Los Reyes-San Juan de Aragón. El Proyecto iniciará con el sistema formado por la línea Buenavista-Huehuetoca de 46 km. El monto estimado de la inversión total para la puesta en marcha y operación de esta línea, incluyendo gastos preoperativos, intereses y comisiones, asciende aproximadamente a 624 MDD.

ABSTRACT: According to the 1995-2000 National Development Plan, the Ministry of Communications and Transportation, as part of the restructuring process of the Mexican Railroad System, is carrying out the necessary studies and actions to promote and develop the Mexico Metropolitan Area (MMA) Commuter Railroad Project, which would take advantage of 240 kms of existing tracks and rights of way in this area.

The Project will be divided into three systems: Buenavista-Huehuetoca, Ecatepec-Naucalpan and Los Reyes-San Juan de Aragon. Each system will have several secondary lines of smaller traffic density that will feed the main line. The Project will begin with the development of the first system formed by the Buenavista-Huehuetoca line, which has a length of 46 km. This system will require a total investment of approximately US $624 million for new equipment, infrastructure works, pre-operating expenses, as well as interest during construction.

RÉSUMÉ: D'après le Plan du Développement National 1995-2000, le Ministère de Communications et Transport, est en train de proposer, comme une partie du processus de restructuration des Chemins de Fer Mexicains, les études et actions nécessaires pour développer le Reseau Regional (RRBMM) du Banlieu Metropolitain de Mexico qui prendrai avantage de 240 kms de voies ferreés et des droits des voies qui sont disponibles dans cette régione.

Le projet sera divisé dans trois systèmes principals: Buenavista-Huehuetoca, Ecatepec-Naucalpan et Los Reyes-San Juan d'Aragon. Chaque système aura plusieurs lignes secondaires de moindre densité de transportation de pasagers qui nourrira la ligne principale. Le Projet commencera avec le développement du premier système formé par la ligne Buenavista-Huehuetoca qui a une longueur de 46 km. Ce système aura besoin d'un investissement total de $624 million de dolars americains que comprendra le nouveau equippement, les ouvrages d'infrastructure, le confinement de la ligne, les dépenses pre-operationelles, les systemes de control et la construction des nouvelles stationes, aussi bien que les intérêts pendant la construction du projet.

INTRODUCCION

El proyecto del Ferrocarril Suburbano, se ha considerado como un sistema integral de transporte ferroviario conformado por tres corredores principales: Buenavista-Huehuetoca, Ecatepec-Naucalpan, y Los Reyes-Aragón y líneas de menor densidad que actúen como alimentadoras de la línea troncal.

Este proyecto ofrece una oportunidad histórica para aprovechar los 240 km. de infraestructura ferroviaria y de derechos de vía existentes en la Zona Metropolitana del Valle de México (ZMVM), la cual cuenta con una población que rebasa los 17 millones de habitantes. De éstos, el 50% viven en el D.F. y el 50% en los 28 municipios conurbados del Estado de México.

En la ZMVM se realizan más de 30 millones de tramos de viajes-persona al día que hoy se atienden principalmente en combis y minibuses (60.9%), inusual para una zona de estas características. Los sistemas de transportación masiva atienden a menos del 15% del total de viajes en una red de 178 km., construidos y operados en 30 años por el Estado (Metro).

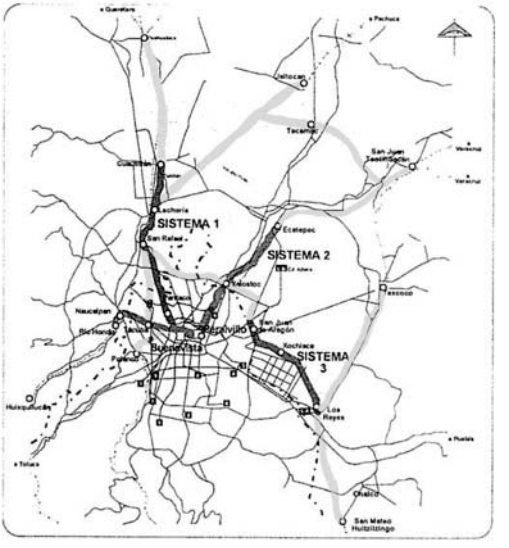
Para iniciar este proyecto, se estima que la opción más conveniente es la de comenzar con el corredor Buenavista-Cuautitlán-Huehuetoca y posteriormente continuar con los otros dos corredores debido que cuenta con una infraestructura electrificada de dos vías férreas para el transporte de pasajeros, tiene un avance importante en el confinamiento de las vías y son prácticamente inexistentes los asentamientos humanos irregulares en el derecho de vía.

Con lo anterior, se reducen considerablemente los montos de inversión y los riesgos, además de que se elimina la posibilidad de confrontaciones sociales por causa del proyecto, al disponer de los derechos de vía correspondientes. Por ello, los resultados que se presentan a continuación se concentran en la línea Buenavista-Huehuetoca. unque debe enfatizarse que este sistema esta conformado por 240 km. de infraestructura y derechos de vía disponibles.

OBJETIVO

El objetivo del Ferrocarril Suburbano es ofrecer un servicio de transporte masivo de pasajeros seguro, competitivo y eficiente, que mejore el bienestar social de los habitantes de la ZMVM, ahorre tiempo de transporte, contribuya en la solución del congestionamiento vial, la contaminación ambiental y el excesivo consumo de energéticos, además de coadyuvar en la conducción del desarrollo urbano de la ZMVM.

CONFIGURACION DEL SISTEMA



LINEA	LONGITUD
SISTEMA 1	
LINEAS TRONCALES	
Buenavista-Cuautitlán	25.0
Cuautitlán-Huehuetoca	21.0
LINEAS SECUNDARIAS	
San Rafael-Tacuba	10.0
Lechería-Jaltocan	21.0
SUBTOTAL	**77.0**
SISTEMA 2	
LINEAS TRONCALES	
Ecatepec-Naucalpan	37.5
LINEAS SECUNDARIAS	
Buenavista-Polanco	6.5
Ecatepec-Teotihuacán	22.5
Teotihuacán-Tecamac	23.0
SUBTOTAL	**89.5**
SISTEMA 3	
LINEAS TRONCALES	
Los Reyes-San Juan de Aragón	15.0
LINEAS SECUNDARIAS	
San Rafael-San Juan de Aragón	25.0
Chalco-Texcoco	33.0
SUBTOTAL	**73.0**

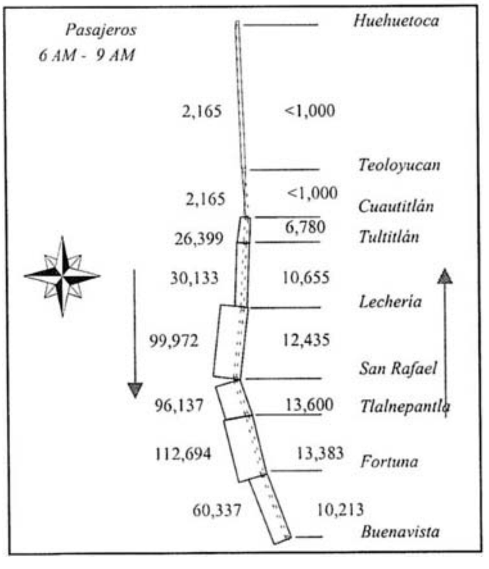
DEMANDA DE TRANSPORTE DE PASAJEROS EN LA LINEA BUENAVISTA-HUEHUETOCA

Los análisis se concentraron en el corredor Buenavista-Cuautitlán-Huehuetoca y en un estudio de demanda realizado por expertos internacionales, el cual estima que en el año 2005 se podrían movilizar, en este tramo, 465 mil pasajeros en días laborales. La densidad de pasajeros que se registra en esta línea es significativamente superior a la que se observa en servicios suburbanos de otras ciudades del mundo.

La mayor densidad de tráfico se registra en las horas pico de la mañana entre las estaciones de Lechería y Fortuna. Aunque en el Estado de México se ubica la mayor parte de la infraestructura ferroviaria, es conveniente considerar que en contrapartida, el principal destino por la mañana y origen por la tarde de los 465 mil pasajeros, es precisamente el Distrito Federal, porque es en esta zona donde desarrollan sus actividades productivas. El estudio de demanda señala que el 51% de los viajes se realizan por motivos de trabajo y el 19% para asistir a la escuela.

ESQUEMA DE CONECTIVIDAD CON EL METRO

TRAFICO POR TRAMOS



Estación Ferrocarril Suburbano	Conexión Metro
Tacuba	Línea 2 Línea 7
Rosario	Línea 6 Línea 7
Fortuna	Línea 6
Martín Carrera	Línea 4 Línea 6
Buenavista	Línea 2 Línea 3 Línea B
Peralvillo	Línea 8
San Juan de Aragón	Línea B
Los Reyes	Línea A

ESQUEMA DE CONECTIVIDAD CON EL SISTEMA DE TRANSPORTE COLECTIVO-METRO

En este contexto, resulta de primordial importancia establecer un esquema adecuado de conexiones entre el Ferrocarril Suburbano y el Metro.

BENEFICIOS PARA EL USUARIO

El Ferrocarril Suburbano ha sido planteado para que sus servicios sean accesibles a la mayor parte de la población de la ZMVM, ya que 56.5% de la demanda identificada tiene un ingreso menor a 5 salarios mínimos, y se aplicaría una tarifa equivalente a la que paga actualmente, pero con un ahorro en tiempo significativo, además de una mayor seguridad.

Origen	Transporte Actual		Ferrocarril Suburbano		Ahorros	
	Tarifa en pesos	Tiempo	Tarifa en pesos	Tiempo	Tarifa en pesos	Tiempo
Cuautitlán	10.50	1h 50 m	$10.50	30 m	=	1h 20 m
Huehuetoca	$14.50	2h 45 m	$14.50	51 m	=	1h 54 m

Nota: El transporte actual se realiza al menos en dos segmentos, el primero en autobús, combi o minibús y el segundo en Metro. Las tarifas y tiempos que se ilustran se encuentran integrados.

Conforme a los resultados obtenidos en el estudio de demanda, el recorrido promedio de un usuario del Ferrocarril Suburbano es de 15 km., lo que a $0.37/km, resulta en una tarifa promedio de $5.55

Considerando este recorrido promedio, el simple ahorro en tiempo por pasajero sería de 48 min, representa en términos de salario mínimo $3.44 que al multiplicarse por la demanda de 465,000 pasajeros, se traduce en 1.6 millones de pesos al día y en 509 millones de pesos al año (318 días efectivos). Este ahorro, podría justificar por sí mismo al proyecto. Adicionalmente, debe considerarse que los resultados financieros muestran que los ingresos son dos veces superiores a los costos de operación.

BENEFICIOS AMBIENTALES

Con la instrumentación del Ferrocarril Suburbano se obtendría una notable disminución del número de viajes que se realizan por medio de vehículos de baja densidad, que equivaldría a unos 26,300 viajes al día, lo que equivale a la disminución de 15,000 combis, 10,000 microbuses y 1,300 autobuses, lo que ayudaría a reducir los congestionamientos vehiculares y la emisión de contaminantes de la ZMVM, particularmente en el Distrito Federal, en donde estos problemas son especialmente críticos.

Considerando 465,000 pasajeros por día, con un recorrido promedio de 15 km, se obtienen 6,975,000 pasajeros-km en el Ferrocarril Suburbano. Suponiendo el mismo recorrido en autobuses, microbuses y combis, con una capacidad de 56, 25 y 10 pasajeros por viaje, respectivamente, se pueden estimar los pasajeros-km que podría substituir el Suburbano con una participación estructural de 15% de autobuses, 53% de microbuses y 32% de combis.

REDUCCION EN LA EMISION DE CONTAMINANTES

Al disminuir el número de viajes por día de vehículos de baja capacidad de transporte, debido al funcionamiento del Ferrocarril Suburbano, se reduciría considerablemente la emisión de contaminantes en este corredor de transporte de la ZMVM, por la substitución directa de estas unidades. Sin embargo, adicionalmente se reduciría el tráfico y los congestionamientos vehiculares con la correspondiente reducción en emisión de contaminantes, aunque este efecto no sea cuantificable.

Reducción de Emisiones Contaminantes Ton/año	
Hidrocarburos	1,246
Monóxido de Carbono	4,112
Óxidos de Nitrógeno	3,102
Óxidos de Azufre	40
Partículas Sólidas	154
Suma	8,654

Nota.- La emisión total de contaminantes en la ZMVM es de 4 millones de toneladas, con 1 millón por parte de la industria y 3 millones de los vehículos.

Según el Programa para Mejorar la Calidad del Aire en el Valle de México 1995-2000, las emisiones de contaminantes del transporte suburbano son de aproximadamente 62,100 ton. al año, por lo que el Ferrocarril Suburbano las reduciría en un 14%.

OTROS BENEFICIOS DE PROTECCION AMBIENTAL

Las características del Ferrocarril Suburbano como un sistema de transporte masivo, electrificado y confinado muestran un conjunto de beneficios adicionales, que permitirían atender de manera más adecuada las consideraciones de protección ambiental en la ZMVM, particularmente en el corredor de transporte suburbano Buenavista-Huehuetoca.

Así, los beneficios adicionales en materia de protección ambiental son los siguientes:

1. Impulso Transporte Masivo. Se privilegian los sistemas de transportación masiva como base de la movilidad urbana y se reordenan los sistemas de baja densidad para que actúen como medios alimentadores.

2. Menor Consumo de Combustibles. Se reduce significativamente el excesivo e ineficiente consumo de energéticos, al sustituirse la utilización de combustibles en motores de combustión in-

terna, en las unidades de baja densidad, por el consumo de energía eléctrica en sistemas de transportación masiva.

3. Menos Ruido. Se disminuye la contaminación acústica, al disminuir considerablemente el número de vehículos automotores en circulación y substituirlos por un sistema eléctrico con un número de decibeles muy inferior al total emitido por el parque vehicular equivalente.

4. Menos Derrames de Aceites. Asimismo, el Ferrocarril Suburbano estará sujeto a la regulación que existe en el seno del TLC, en materia de protección ambiental, y en particular a la normativa mexicana homologada de los ferrocarriles de Canadá y los E.U.A., respecto al manejo y tratamiento de lubricantes, en tanto que los vehículos de baja densidad de transporte como combis, microbuses y autobuses, carecen de un control similar y ocasionan un mayor impacto en el entorno por causa de derrames incontrolados de aceites.

Adicionalmente, existen otros beneficios en materia de protección ambiental como los siguientes:

1. Menor Afectación Vial por Confinamiento. Otros beneficios relacionados con la protección del entorno ambiental que aportará el Ferrocarril Suburbano, se refieren a que la infraestructura ferroviaria se encuentra confinada y ello permitirá que el Ferrocarril pueda operar a su plena capacidad sin afectar el tránsito vehicular ni acentuar los problemas viales.

2. Circulación Vehicular Más Fluida. Un beneficio paralelo del Ferrocarril Suburbano consiste en la construcción de 14 pasos a desnivel para vehículos lo cual permitirá agilizar el tránsito de las vialidades más importantes que actualmente se encuentran congestionadas.

3. Desarrollo Urbano Orientado. La cobertura de los servicios del Ferrocarril Suburbano hasta Huehuetoca, permitirá inducir un desarrollo urbano planeado en zonas específicas y de crecimiento preferencial de la ZMVM, lo cual ayudará a desconcentrar los principales asentamientos urbanos de esta zona, reduciendo los asentamientos irregulares que generan un importante impacto en el medio ambiente.

4. Desconcentración. La construcción de la terminal de pasajeros de Huehuetoca, con un sistema de transferencia de pasajeros eficiente y moderno, entre la terminal de autobuses foráneos y el Ferrocarril Suburbano permitirá desconcentrar de la ZMVM este punto de intercambio y reducirá el acceso masivo de autobuses, conformados por un parque vehicular obsoleto, al centro de la Ciudad de México.

5. Mayor seguridad a la población. Al confinar en su totalidad las vías de carga y pasajeros se evitarán los actuales cruces vehiculares y de personas, que implican riesgos inadecuados para la población.

INTEGRACION DEL FERROCARRIL SUBURBANO AL PROGRAMA PARA MEJORAR LA CALIDAD DE AIRE EN EL VALLE DE MEXICO

Estrategia de integración de políticas metropolitanas (transporte, desarrollo urbano y medio ambiente).

Al respecto, el Ferrocarril Suburbano cumple también con esta propuesta dentro del capítulo de las estrategias y metas del "NUEVO ORDEN URBANO Y TRANSPORTE LIMPIO – Regulación del Total de Kilómetros Recorridos por Vehículos Automotores – en el cual se indica que figuran "Criterios de integración de planes y programas de desarrollo urbano con infraestructura existente o planeada de transporte público"

Entre los objetivos mencionados en este apartado se encuentra el siguiente:

1. Mejorar la infraestructura destinada al transporte público, favoreciendo las vías para trenes rápidos y otros modos de transporte sobre los de uso exclusivo por automotores.

El Ferrocarril Suburbano cumple apropiadamente con este objetivo en varias vertientes:

1. Mejora y moderniza la infraestructura.

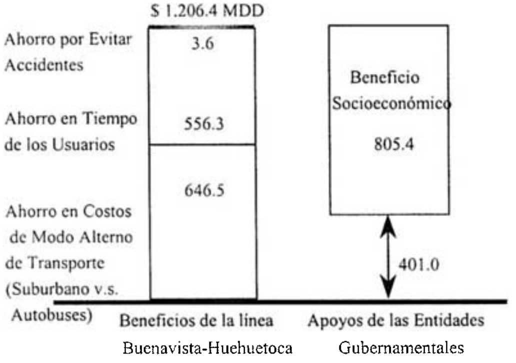
2. Favorece la operación de trenes modernos, seguros, eficientes y rápidos.

3. Desalienta el uso de automotores.

4. Agiliza la utilización de las vialidades al operar confinado y construir 14 pasos a desnivel para vehículos.

BENEFICIO SOCIOECONOMICO PARA LA SOCIEDAD

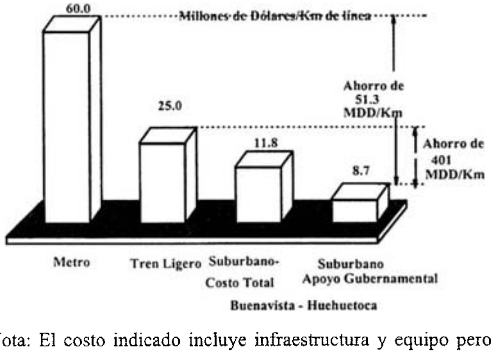
Los beneficios socioeconómicos del Ferrocarril Suburbano para la sociedad corresponden principalmente a los ahorros que se obtendrían en costos al no utilizar un modo de transporte alterno (costos de operación e inversiones en infraestructura y equipo), ahorros en tiempo de los usuarios, así como los que resultarían por reducción de congestionamientos viales y accidentes. Estos beneficios superan con creces los recursos que demanda este proyecto, y su justificación socioeconómica puede observarse al comparar el beneficio social con el apoyo gubernamental que se requiere.



Nota: La metodología utilizada sigue los principios del Banco Mundial y del BID, que consiste en comparar dos situaciones distintas, una sin proyecto, usando un medio alterno de transporte, en este caso autobuses, y otra con proyecto, utilizando el Ferrocarril Suburbano. Se evalúan a valor presente las inversiones en infraestructura y equipo, costos de operación, tiempo de transporte y costos de accidentes. Los resultados a favor del proyecto se asocian a ahorros en costos y beneficios socioeconómicos del Ferrocarril Suburbano.

PROYECTOS ALTERNATIVOS

El Ferrocarril Suburbano constituye una solución de bajo costo para los problemas de transporte, en particular para el corredor Buenavista-Huehuetoca, en virtud a que ya se cuenta con buena parte de la infraestructura ferroviaria. Aún cuando el costo unitario por km de vía es de 11.2 MDD, solo se requiere de apoyos gubernamentales 7.0 MDD por km.



Nota: El costo indicado incluye infraestructura y equipo pero ninguno de los proyectos considera gastos preoperativos, ni intereses o comisiones.

COMPARACIONES INTERNACIONALES

La cifra anual de 148 millones de pasajeros se compara favorablemente respecto a las que se observan en Sistemas de Transporte Suburbano de los Estados Unidos y Canadá. Estos sistemas cuentan con una longitud de vías superior, pero movilizan un número de pasajeros anuales significativamente menor.

Por citar algunos ejemplos, el ferrocarril suburbano de Chicago, en Estados Unidos, dispone de 9 líneas suburbanas con una longitud total de 878 kilómetros, pero transporta solamente 75.6 millones de pasajeros anuales. Caso similar se presenta en el ferrocarril Toronto en Canadá, que con 7 líneas suburbanas con longitud de 361 kilómetros, movilizan aproximadamente 24.8 millones de pasajeros al año.

COMPARACION CON OTROS SISTEMAS

La experiencia internacional muestra que este tipo de proyectos requiere de apoyos gubernamentales por el 100% de la inversión, además de un subsidio anual para su operación.

En el caso del Ferrocarril Suburbano, los costos de operación representan el 50% de los ingresos, lo cual significa que no se requiere subsidio anual y que adicionalmente el excedente operativo permite la contratación de deuda.

COSTO DEL PROYECTO

El monto estimado de la inversión total para la puesta en marcha y operación de la Línea Buenavista-Huehuetoca, incluyendo gastos preoperativos, intereses y comisiones, asciende aproximadamente a 624 millones de dólares. Los conceptos de mayor monto corresponden al equipo rodante (48%), la infraestructura ferroviaria (17%) y el confinamiento de la vía (9%). Asimismo, correspondería un 8% a gastos para cubrir intereses y comisiones, 7% para estaciones, 6% a señales y comunicaciones y un 5% para gastos preoperativos.

ESTRUCTURA DE FINANCIAMIENTO

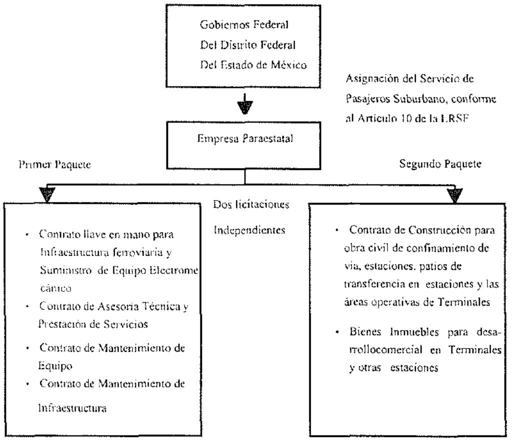
El excedente operativo permite que el proyecto soporte una deuda de 223 millones de dólares (aprox. 40%), por lo que se requieren apoyos gubernamentales por un monto de 401 millones de dólares (aprox. 60%). Parte de estos fondos se aportarían en especie y el resto en recursos frescos.

FLUJOS DEL PROYECTO

Conforme a las proyecciones financieras, durante los primeros 17 años de operación los flujos del proyecto se destinan al servicio de la deuda (intereses y amortización). A partir del año 18, los excedentes permitirían recuperar parte de los apoyos gubernamentales que se aportan al inicio del proyecto.

ESTRUCTURA DEL PROYECTO

La estructura del proyecto, estaría conformada de la siguiente forma:



CONTRATACION DE DEUDA

La empresa ferroviaria deberá contratar créditos o esquemas de arrendamiento financiero que ofrezca el consorcio ganador del Primer Paquete. Además, Banobras sería la institución intermediaria de los recursos. Los Gobiernos del Estado de México y del Distrito Federal, por su parte, podrían otorgar líneas de contingencia que se utilicen como garantía del proyecto, en caso de presentarse insuficiencia de ingresos.

COORDINACION CON LOS GOBIERNOS DEL DISTRITO FEDERAL Y DEL ESTADO DE MEXICO

La consecución del Ferrocarril Suburbano requiere de una importante coordinación con las autoridades del Gobierno del Distrito Federal y del Estado de México, por su relación con el resto del sistema de transporte y por sus efectos en el reordenamiento urbano de la zona metropolitana, a fin de:

1. Establecer un Acuerdo tripartita entre SCT, GDF y Estado de México para el desarrollo del proyecto
2. Concertar con los concesionarios de los servicios de transporte de baja densidad, la planeación de nuevas rutas y el establecimiento de servicios alimentadores y de desalojo de pasajeros para el Ferrocarril Suburbano.
3. Apoyar en el diseño y otorgamiento de licencias y permisos para la realización de las obras de ingeniería civil que deberán llevarse a cabo en el Ferrocarril Suburbano, tales como: pasos a desnivel, cierre de avenidas, obras de confinamiento e interconexiones.
4. Adecuar el Plan Maestro del Sistema de Transporte Colectivo Metro para optimizar recursos materiales y financieros.
5. Desarrollar conexiones eficientes y modernas entre el Metro y el Ferrocarril Suburbano.
6. Establecer un Acuerdo Metropolitano sobre proyectos futuros de transporte masivo.
7. Configurar conjuntamente una política tarifaria ágil y flexible para el transporte en el área Metropolitana.

PASOS A SEGUIR

1. Establecimiento de un Convenio de Cooperación y Apoyo al proyecto del Ferrocarril Suburbano, por parte de los Gobiernos Federal, del Distrito Federal y del Estado de México.
2. Determinar con el Gobierno del Distrito Federal y del Estado de México, lo siguiente:

- La reestructuración del transporte de superficie.
- El diseño y el apoyo para la construcción de pasos a desnivel, cierre de avenidas, confinamientos e interconexiones.
- Los ajustes convenientes al Plan Maestro del Metro en la extensión y planeación de nuevas rutas.
- La obtención de terrenos para la construcción de estaciones con áreas de estacionamiento y patios de transbordo.

3. Constitución de la Empresa Paraestatal Concesionaria, con los activos del Ferrocarril Suburbano. Las funciones principales de la empresa serían las de asegurar la instrumentación del proyecto y la administración de los activos inmobiliarios.

4. Avanzar en la elaboración de la convocatoria, bases generales de licitación, bases técnicas del concurso, estudio de impacto ambiental, documentos contractuales del proyecto, definición del esquema de financiamiento y garantías del proyecto.

5. Publicación de las Convocatorias de los dos Paquetes comprendidos en el Ferrocarril Suburbano:

- Primer Paquete, primer trimestre del año 2000, que incluye 4 contratos: suministro de equipo, obras de infraestructura Ferroviaria, asistencia técnica para la prestación del servicio y mantenimiento de equipo e infraestructura.

- Segundo Paquete, de obra civil, segundo trimestre del año 2000, para construir: pasos a desnivel, estaciones, transferencias e interconexiones, y desarrollo inmobiliario

CONCLUSIONES

Como se puede observar, el Ferrocarril Suburbano para la ZMVM, representa un importante proyecto que generaría la realización de obras de ingeniería civil de grandes dimensiones, que contribuirían a desarrollo de un servicio de transporte masivo de pasajeros seguro, competitivo y eficiente, que mejore el bienestar social de los habitantes de la ZMVM, ahorre tiempo de transporte, contribuya en la solución del congestionamiento vial, la contaminación ambiental y el excesivo consumo de energéticos, además de coadyuvar en la conducción del desarrollo urbano de la ZMVM.

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Certificación de la recepción de 200 trolebuses por la Escuela Superior de Ingeniería Mecánica y Eléctrica

Certification de la réception de 200 trolleybus par l'Ecole Supérieur d'Ingénierie Mécanique et Electrique

Certification of the reception of 200 trolleybuses by the Superior School of Mechanical and Electric Engineering

David Monzalvo López & Rafael Álvarez Torres
Servicio de Transportes Eléctricos del Distrito Federal, México

RESUMEN: En 1996 el Servicio de Transportes Eléctricos del D.F. adquirió mediante licitación pública internacional un total de 200 trolebuses diseñados y fabricados con tecnología de punta, con un motor de tracción de corriente alterna. Para garantizar que las unidades cumpliesen con las especificaciones técnicas de las bases de la licitación, se firmó un convenio de colaboración con la Escuela Superior de Ingeniería Mecánica y Eléctrica del Instituto Politécnico Nacional para que ésta certificara el proceso de recepción de los trolebuses, aplicando diversas disciplinas de la ingeniería.

RÉSUMÉ: En 1996 le Service de Transports Eléctriques du D.F. a acquis par l'intermédiaire d'un appel d'offre publique internationale un total de 200 trolleybus conçus et fabriqués avec la technologie de pointe, avec un moteur de traction de courant alternatif. A fin de garantir que les unités tiennent compte des spécifications techniques des bases de l'offre, un accord de collaboration a été signé avec l'École Supérieure de Génie Mécanique et Eléctrique de l'Institut Polytechnique National afin de certifier le processus de réception du trolleybus, en appliquant des diverses disciplines téchniques.

ABSTRACT: In 1996 the Service of Electric Transports of the D.F. acquired by means of international public bid a total of 200 designed trolley bus manufactured with tip technology, with a traction motor of alternating current. To guarantee that the units fulfill the technical specifications of the bases of the bid, an agreement of collaboration was signed with the Superior School of Mechanical and Electric Engineering of the National Polytechnic Institute to certifie the process of reception of the trolley bus, applying diverse disciplines of the engineering.

1 ANTECEDENTES

1.1 *CONTAMINACIÓN AMBIENTAL: UN PROBLEMA A VENCER*

El acelerado crecimiento de la contaminación atmosférica en las concentraciones humanas de las metrópolis más grandes del planeta ha traído como resultado que diversos gobiernos y organizaciones altruistas y sociales se hayan visto obligados a optimizar los procesos de producción de bienes y servicios que generan algún tipo de contaminación por la combustión de algún derivado del petróleo.

Tal es el caso de la Ciudad de México, en donde el crecimiento galopante de la mancha urbana ha propiciado, por diversas razones, el aumento descontrolado de los niveles de contaminación atmosférica que dañan la salud de sus habitantes.

Por tal motivo, el nacimiento de una cultura ecológica en los capitalinos durante la presente década, influyó en la planeación del desarrollo del transporte público masivo de la Ciudad de México. La Sociedad mexicana que habita la zona metropolitana clama desde hace ya algunos años por condiciones atmosféricas más limpias.

Durante 1996, en 10 de los doce meses se rebasó la concentración establecida por la norma de calidad del aire y en algunos casos se alcanzaron los 175 puntos IMECA. En general, se presentaron mayores valores en 1996 que en el año próximo anterior: durante 1995, se excedió la norma de la calidad del aire en el 29% del total de los días del año, mientras que en 1996 se llegó al 50% del periodo.

Tan sólo en 1998 se registró un nivel histórico de contaminación cuando el 14 de mayo a las 21:00 horas, el Indice Metropolitano de la Calidad del Aire (IMECA) alcanzó los 230 puntos. Entre enero y agosto de ese año , se tuvo que aplicar en 15 ocasiones la Fase I del Programa de Contingencias Atmosféricas. En ese mismo periodo, el nivel promedio de Ozono fue de 127.35 puntos IMECA, siendo que las normas internacionales califican como nocivo para la salud un nivel superior a los 100 puntos. La Secretaría de Salud ha realizado estudios sobre los síntomas que presenta la salud de la población durante episodios de contingencia ambiental. Los problemas comúnmente observados son: disnea (dificultad para respirar), cefalea, conjuntivitis, irritación de las mucosas respiratorias y tos productiva.

1.2 *EL TRANSPORTE ELÉCTRICO: UNA SOLUCIÓN*

Por todo ello es importante, que desde el punto de vista del Sector Transporte de la Ciudad de México, las unidades que prestan el servicio de autotransporte urbano no contribuyan al deterioro del aire que se respira en esta gran urbe.

En este sentido, el Servicio de Transportes Eléctricos del D.F. representa una solución al problema de la contaminación ambiental en la Ciudad de México, considerando que el principio de funcionamiento de las vehículos de transporte se basa en la utilización de la energía eléctrica como medio de propulsión. De enero a septiembre de 1999 el parque vehicular de trolebuses transportó a más de 52 millones de pasajeros.

A partir de las consignas emergentes ya mencionadas, el Gobierno Capitalino, a través del Servicio de Transportes Eléctricos del D.F. decidió adquirir 200 trolebuses nuevos con tecnología de punta que ofrecerían a la ciudadanía ventajas de confort, seguridad y eficiencia. Este impulso coadyuvaría a iniciar una renovación en el uso del transporte masivo no contaminante en la Ciudad de México.

La llegada de estos nuevos trolebuses ha permitido la sustitución de una parte del parque vehicular que ya ha cumplido, por mucho, su vida útil. Esta situación reforzará la cobertura del programa operativo diario que considera una expedición de 344 trolebuses en ruta.

Así mismo fortalecerá el servicio en aquellas rutas en donde la ciudadanía requiere la oferta de un servicio de transporte más eficiente.

2 CERTIFICACIÓN DE LOS 200 TROLEBUSES CON TECNOLOGÍA DE PUNTA Y MOTOR DE CORRIENTE ALTERNA

Estas unidades fueron diseñadas y fabricadas con estándares y normas internacionales lo que garantiza una alta calidad del producto, al contar entre otros con suspensión neumática para un viaje más suave, diseño moderno, pintura anti - grafiti, iluminación interior y exterior de alta categoría, mayor capacidad de arrodillamiento de la unidad para facilitar el acceso a personas con discapacidad física o de la tercera edad y sistemas eléctricos y mecánicos de alta seguridad. Además cuenta con una carrocería semi-integral con perfiles tubulares de acero galvanizado y recubrimiento anticorrosivo para mayor duración y resistencia. La suspensión neumática en las cuatro llantas también se refleja en un menor impacto del peso bruto vehicular sobre el asfalto de las calles de la Ciudad de México.

Para garantizar que los 200 trolebuses cumplirían con estos estándares de calidad, fue necesario verificar que los vehículos satisficiesen íntegramente las especificaciones técnicas establecidas en las bases de la licitación pública que se llevó a cabo para su diseño y fabricación. Para ello, el Servicio de Transportes Eléctricos del D.F. firmó un convenio de colaboración con la Escuela Superior de Ingeniería Mecánica y Eléctrica (ESIME) del Instituto Politécnico Nacional, para que llevara a cabo la Certificación de las pruebas de recepción de las unidades en sus diferentes etapas: pruebas del equipo eléctrico, pruebas estáticas, dinámicas y de recepción provisional.

En este proceso de Certificación participaron diferentes áreas especializadas de la Ingeniería, tales como Ingeniería Eléctrica, electrónica de Potencia, Mecánica, Neumática y de Control. Por otro lado, fue necesaria la intervención de las áreas administrativas, tanto de la ESIME como del STE, para la correcta gestión y supervisión del proceso.

3 PROYECTO DE CERTIFICACIÓN

El proyecto se dividió en diferentes áreas de especialidad, seis en total, correspondientes a los principales sistemas y subsistemas que conforman al trolebús:

Sistema Eléctrico de Baja Tensión
- Convertido estático: 600 VCD a 24 VCD y 600 VCD a 230 VCA, 60 Hz, tres fases
- Baterías de Níquel - Cadmio de 24 VCD
- Protecciones
- Motor de compresor trifásico de inducción "jaula de ardilla" 230 VCA, 60 Hz
- Señalización y Control

Sistema Eléctrico de Control y Tracción
- Sistema de captación de corriente
- Pararrayos
- Fusible principal
- Reactor de Filtro
- Control de velocidad por voltaje y frecuencia variable (VVVF) mediante *Módulos Inteligentes de Potencia* (IPM's por sus siglas en inglés)
- Motor de tracción trifásico de inducción "jaula de ardilla"

Sistema Inteligente de Control Digital
- Sistema de autodiagnóstico por computadora
- Inmunidad y compatibilidad electromagnéticas

Carrocería
- Estructura
- Antropometría y ergonometría
- Ventanillas
- Recubrimientos
- Aislamientos
- Iluminación

Sistema Mecánico
- Diferencial de doble reducción
- Suspensión neumática
- Sistema de frenos neumáticos según norma FMVSS 121

Sistema Neumático
- Compresor
- Puertas
- Arrodillamiento

A cada uno de los sistemas mencionados, le fue asignado personal altamente especializado en la materia, con el fin de determinar, a partir de las bases de la licitación, el número de puntos que debían ser certificados.

De esta manera, el área de ingeniería de STE en conjunto con la ESIME, seleccionaron, a partir de una revisión minuciosa de las bases de la licitación, un total de 1,200 puntos para llevar a cabo la certificación. En este tenor, STE supervisó la fabricación de los trolebuses en planta y ESIME certificó el cumplimiento de especificaciones y pruebas diversas requeridas, que estaban referidas en los puntos mencionados. Para ello, fue necesario revisar los protocolos y procedimientos de pruebas y normas involucradas.

Las pruebas fueron subdivididas en dos tipos: de prototipo y de serie. Las pruebas de prototipo se realizaron en dos trolebuses denominados prototipo y piloto. Estas fueron de carácter especializado, las cuales avalaban el lote completo de trolebuses. Las pruebas serie fueron realizadas a cada vehículo en lo particular.

Por otro lado, en la certificación se incluyeron los puntos que la ESIME considerara necesarios además de los que derivaron de las bases de la licitación. El proceso contempló la elaboración de memorias técnicas que incluyeran la información necesaria para evaluar las condiciones físicas reales en que los trolebuses fueron entregados. Con ello se podrían tomar las medidas adecuadas para corregir los problemas que se detectaran, en los casos donde fuera posible.

4 DESARROLLO DEL PROYECTO Y SUS RESULTADOS

A la fecha, los 200 trolebuses han sido certificados por la ESIME. Durante el proceso, se determinaron 118 desviaciones a las especificaciones técnicas o a las pruebas realizadas por parte del proveedor. Estas desviaciones han sido atendidas por este último, algunas a partir de campañas correctivas sobre la unidad.

Todos las observaciones hechas por la ESIME referentes a la fabricación, resultado de las pruebas e información referente a los trolebuses, han sido plasmados en las memorias, en donde se señala con claridad cómo las especificaciones de la licitación fueron plenamente satisfechas o bien en aquellos puntos en donde hubo incumplimiento por parte del proveedor.

En este sentido la certificación significó un verdadero éxito ya que permitió identificar anormalidades que en su momento fueron corregidas, evitando con ello futuras fallas en los trolebuses y como consecuencia un deficiente servicio de transporte a la ciudadanía del Distrito Federal.

5 BENEFICIOS DE LA CERTIFICACIÓN

El proceso de certificación de los 200 trolebuses, en adición a todas las ventajas antes señaladas, ha aportado toda una serie de beneficios agregados, ya que por primera vez en México se han realizado pruebas y procesos especializados, originados por la aplicación de ingeniería en el STE. Entre otros los más importantes se mencionan a continuación, así como ciertos avances teconológicos que por primera vez se aplican en el diseño y fabriación de vehiculos de transporte urbano:

El trolebús cuenta con un sistema llamado de arrodillamiento, cuya finalidad es la de ayudar a los pasajeros de edad avanzada a subir con mayor facilidad al trolebús. Consiste en un sistema neumático, el cual permite a la unidad disminuir la altura del primer escalón con respecto al nivel de la calle hasta una posición adecuada, para posteriormente, una vez que el pasajero se encuentre en el trolebús, recupere su altura normal.

Las unidades cuentan con un convertidor estático de 600 VCD de diseño especial por parte de GEC ALSTOM, cuya finalidad es alimentar circuitos auxiliares, recarga de batería, alimentación al motor del compresor, etc. Tiene la particularidad de permitir al trolebús arrancar, aún cuando la batería del vehículo se encuentre descargada.

Es el primer vehículo de autotransporte urbano en México que cuenta con suspensión neumática para mayor confort al usuario y reducir el daño a la carpeta asfáltica y estructura del propio trolebús.

El sistema de transmisión mecánica, cuenta con un cople aislante entre el motor de tracción y la flecha cardán, con el cual se logra un doble aislamiento de la carrocería para mayor seguridad de los pasajeros.

Los trolebuses tienen un sistema de protección contra la carrocería energizada. Para ello cuentan con un sensor desarrollado por Mitsubishi exclusivamente para estos vehículos, el cual detecta cuando la carrocería está energizada y activa las protecciones.

La carrocería de estos vehículos, fue diseñada y probada apoyándose en la técnica de elemento finito. Esto se logró con la participación de una empresa privada en San Luis Potosí con los ingenieros especialistas en la materia, en colaboración con el personal de ESIME y MASA.

Es el primera vez en México, hasta nuestro mejor conocimiento, que se realiza la prueba de impacto en un vehículo para transporte público de pasajeros. Para el desarrollo de la misma, unieron esfuerzos doctores, maestros en ciencias e ingenieros del STE, la ESIME, MASA y el Instituto de Ingeniería de la UNAM, quienes mediante cámaras rápidas, lograron medir la velocidad de impacto en la prueba y efectuar los cálculos correspondientes.

6 CONCLUSIONES

El proyecto de adquisición de los 200 trolebuses nuevos es una prueba más de que la ingeniería, en sus múltiples disciplinas, es una realidad en México, que debe reforzarse en instituciones de educación superior y privilegiarse por las empresas que utilizan los servicios de estos profesionistas

La Electrónica de Potencia y la Tracción Eléctrica basada en semiconductores de potencia de estado sólido controlados digitalmente, es el campo tecnológico basado en la ciencia con mayor dinamismo en las economías industrializadas[1]. Los estudios de las Naciones Unidas, a través de la UNESCO, muestran que esta industria es la que más crecerá y participará en el producto interno bruto de las naciones[2]. La electrónica de Potencia en conjunto con la Tracción Eléctrica es considerada por expertos internacionales como la innovación tecnológica más reciente proveniente del desarrollo científico, que ha revolucionado las bases científico - tecnológicas de la ingeniería eléctrica, electrónica y de procesamiento de señales.

Es alentador que instituciones de educación superior, como la ESIME en conjunto con empresas operadoras de servicios públicos, desarrollen ingeniería aplicada en sus diversas disciplinas a pesar del relativo rezago que existe en México con relación a potencias mundiales en el ramo. Es por esto que es necesario que los gobiernos locales y federales en países en desarrollo apoyen este tipo de proyectos en donde la ingeniería se pone al servicio de la patria.

[1] Peter K. Staimer, Horst E. Grüning, Johannes Werninger, and Dierk Schröeder, IEEE Transactions on Power Electronics, *State of the Art Verification of the Hard-Driven GTO Inverter Development for a 100-MVA Intertie; Vol.13 No.6, 1182-1190 ,November 1998.*

[2] Conclusiones del XVII Congreso Nacional Bienal de Ingeniería Mecánica, Eléctrica y Electrónica, *Industrias con mayor participación en el Producto Interior Bruto: 23, 12-13 de febrero de 1998.* México, D.F.

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An overview of the different available clean buses solutions
Un regard technique et économique sur les différentes filières des bus propres
Diferentes soluciones técnicas de motorización limpias para los buses

François Rambaud & Bernard Guellard
CERTU, Département Systèmes Techniques pour la Ville, Lyon, France

ABSTRACT: With good load factors, the energetic efficiency of public transport is not to be proven. Their responsibility in all of the air pollution is very limited in France and Europe; In "Ile de France" the 4000 RATP busses account for 1/3 of the motorised surface trips and contribute to less than 4% of the pollutant emissions (source ADEME 96). However busses in particular are seen as big polluting responsible. These vehicles tend to concentrate the polluting emissions in the massively populated areas, this creating localised pollution, particularly visible and fatal. The image of buses hardly improves. Environmental concerns are becoming for the various political authorities very important, in term of urban quality of life.
The goal of this presentation is to present an overview of the different solutions, which are today available for clean busses.

RÉSUMÉ : Pour des taux de remplissage convenables, l'efficacité énergétique des transports publics n'est plus à démontrer et leur responsabilité dans l'ensemble des nuisances est extrêmement limitée en France et en Europe. En Ile de France les bus de la RATP (parc de 4000 unités) assurent 1/3 des déplacements motorisés de surface et contribuent à moins de 4% aux émissions de polluants (Source ADEME 96). Pourtant le transport public, en particulier les bus, est toujours perçu par l'opinion comme un grand pollueur. Ces véhicules ont tendance en effet à concentrer des émissions de polluants, là où afflue la population et créent inévitablement des nuisances ponctuelles particulièrement visibles et néfastes. L'image du bus ne s'est guère améliorée. Les préoccupations environnementales deviennent aujourd'hui, pour les différentes autorités politiques un enjeu majeur, en terme de qualité de vie en zone urbaine. Cette présentation vise à faire le point sur les différentes filières qui sont offertes aux décideurs dans le domaine des bus.

RESUMEN : No tenemos que demostrar la eficacia energética de los transportes públicos. Su responsabilidad en la contaminación ambiante es muy reducida en Francia y en Europa. En "Ile de France", los 4000 buses de la "RATP" aseguran 1/3 de los desplazamientos motorizados de superficie y contribuyen per menos de 4% a las emisiones de contaminantes (origen ADEME 1996). No obstante, los buses son todavia percibidos como grandes contaminadores por la opinión pública, debido a la contaminación visible que emiten en los lugares centrales y muy frecuentados. Ahora, el medio ambiante y la calidad de vida en zona urbana estan en el centro de las preocupaciones y de los objetivos de las autoridades politicas.
Esta presentación tiene la ambición presentar las diferentes familias de soluciones tecnicas de motorización limpias para los buses.

1. Introduction.

Le secteur des transports occupe aujourd'hui une place importante dans le bilan énergétique et représente maintenant 25 à 30% de la consommation finale (exception faite pour l'Espagne avec 37%) dans la plupart des pays européens. Dans ce secteur, l'efficacité énergétique des transports publics n'est plus à démontrer et leur responsabilité dans l'ensemble des nuisances est extrêmement limitée, même en considérant les taux de remplissage moyens. En Ile de France les bus de la RATP (parc de 4000 unités) assurent 1/3 des déplacements motorisés de surface et contribuent à moins de 4% aux émissions de polluants (Source ADEME 96).

Pourtant le transport public, en particulier les bus, est toujours perçu par l'opinion comme un grand pollueur. Ces véhicules concentrent effectivement les polluants, lorsqu'ils se retrouvent réunis à des arrêts communs ou dans des rues étroites. Ils créent inévitablement des nuisances ponctuelles particulièrement visibles et majeures pour les riverains.

Les préoccupations environnementales liées aux transports publics deviennent aujourd'hui, pour les différentes autorités politiques et les exploitants de flottes, un enjeu majeur en terme de qualité de vie en zone urbaine. La loi sur l'air et l'utilisation rationnelle de l'énergie de décembre 1996 incite une réduction de la voiture en ville au profit de modes plus efficaces sur le plan des nuisances. Les actions en faveur d'un transport public urbain «propre» et économe en énergie ne peut que répondre à ces préoccupations.

Depuis quelques années, les constructeurs de véhicules et les équipementiers engagent des programmes de recherche pour l'utilisation de technologies « propres » et proposent actuellement sur le marché des véhicules correspondant à ces critères.
Plusieurs options sont proposées aux exploitants pour mettre en œuvre ces solutions respectueuses de l'environnement dans leur parc, lors du renouvellement de véhicule ou pour équiper le parc roulant actuel :

- recours à des carburants alternatifs aux énergies fossiles traditionnelles (GNV, électricité) ;
- utilisation de carburants de substitution en partie d'origine renouvelable (Aquazole, diester) ;
- installation sur les véhicules existant d'équipement de post traitement.

Les bus urbains sont particulièrement concernés par cette évolution, pour respecter la réglementation d'une part et satisfaire à la nécessité d'améliorer l'image de ce mode d'autre part. L'objectif de réduction des émissions sonores constitue aussi un enjeu majeur : le bruit étant classé au rang de nuisance majeure en ville.
L'évolution des motorisations actuelles présente aussi un potentiel de développement à ne pas négliger, notamment pour la réduction de la consommation.
La diversité de l'offre technologique actuelle et la disparité des données disponibles résultant des nombreuses expériences pour évaluer les performances des différentes filières émergentes génèrent un certain nombre de difficultés auxquelles les décideurs locaux sont confrontés lors du choix d'une politique de transport propre.
Les expérimentations engagées par de nombreux réseaux, soit individuellement, soit dans le cadre de programmes nationaux pilotés par l'ADEME commencent d'apporter quelques réponses sur la fiabilité des solutions proposées.

L'objet de cette présentation est de présenter un état des lieux des technologies « propres ». Leur potentialité de développement dépendra des conclusions des programmes de validation, dont les premiers résultats laissent entrevoir des perspectives environnementales encourageantes.

2. Les différentes filières mise en jeu

Le tableau suivant récapitule rapidement ces différentes filières en indiquant en première colonne leur situation actuelle en terme de disponibilité immédiate (O) ou en phase de développement (D). La deuxième colonne indique si la filière est opportune, pour le renouvellement (R), la troisième si elle l'est pour le parc existant (E).
Ces filières sont présentées plus en détail aux chapitres suivants.

Filières	Disp.	E	R
Carburants			
Gazole reformulé	**O**	**X**	
Biocarburants (ester méthylique)	**O**	**X**	
Ethanol -Methanol	**O**	**X**	
Aquazole	**O**	**X**	
GPL	**O**		**X**
GNV	**O**		**X**
Traction électrique batteries	**O/D**		**X**
Traction électrique hybride	**D**		**X**
Pile à combustible	**D**		
Dyméthyléther - DME	**D**		**X**
Post traitement			
Catalyseur d'oxydation	**O**	**X**	
Filtre à particules à régénération	**O**	**X**	

3. Quelques chiffres

Le parc français est actuellement d'environ 14 000 bus. Actuellement seulement près d'un quart de ce parc satisfait la norme EURO 2. L'adaptation de la partie restante se fait lors du renouvellement de matériel ou par adaptation d'équipements spécifiques. La durée de vie moyenne d'un bus est de 15 ans et le kilométrage annuel moyen de 30 à 50000 km.
La motorisation standard est de type turbo diesel, consommant de 45 à 65 litres de gazole au 100km.

Il faut noter que la consommation a tendance à augmenter au fur et à mesure que les normes se sévèrisent et que des équipements tel que boîte de vitesse automatique ou climatisation sont couramment installés.

Du point de vue économique, il est délicat de citer des coûts d'investissement ou d'exploitation afin de les comparer à ceux de la filière gazole. En effet cette dernière est aujourd'hui mature avec des coûts optimisés, alors que, pour le gaz et l'électricité, seuls des résultats issus des phases d'expérimentation sont disponibles.

Il faut cependant prendre en compte les effets environnementaux et internaliser leurs coûts dans le bilan économique de ces nouvelles filières, afin que les comparaisons soient cohérentes. La difficulté d'évaluer ces effets en termes économiques, plusieurs modèles sont d'ailleurs proposés par des experts, ne permet pas un jugement objectif, bien souvent guidé par de seule

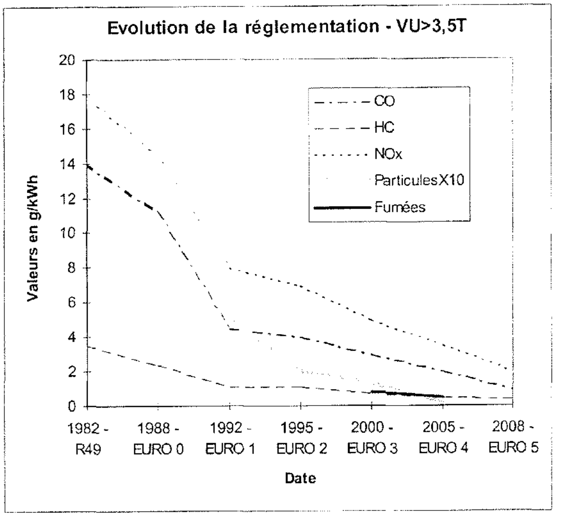
considération de rentabilité à court terme. Mais le marché viendra valider ces filières en tenant compte bien sûr de l'évolution des moteurs thermiques actuels.
Les ordres de grandeurs comparées sont donnés à titre indicatif, sur la base d'un bus de 12 m standard, par rapport à un bus gazole. Il s'agit de prix base 1999.
Les bus électriques ne font pas l'objet d'un comparatif car les coûts actuels sont issus de phase expérimentale non représentative, tant sur le coût du matériel que celui des infrastructures.

Postes	Bus GNV	Bus GPL
Investissement	+17 à 19%	+ 12 à 14%
Station recharge	Dépend du nbre de bus. 60bus : 5MF 60 à 120 : 6 MF	Dépend du nombre de bus alimenté. De 400kF à xMF
Atelier	6 MF	5MF
Carburant	1,45	1,8

(IMF = 153000 Euros ou US$)

Pour une flotte de 40 bus GNV, le budget global est de l'ordre de 30 MF
Le poste atelier intègre notamment la mise à niveau de la sécurité
Le poste carburant concerne la consommation et est exprimé en rapport par rapport à un bus gazole classique.

4. Les normes d'émissions



Ce graphe, qui intègre les valeurs du tableau présenté en annexe 1, récapitule les évolutions de la réglementation européenne depuis l'apparition des premières normes en 1982, et indique les valeurs actuelles (EURO 2) et futures (EURO 3) dont le document final est en cours de signature. Celles en phase de discussion sont EURO 4 et 5. Ces valeurs concernent les véhicules utilitaires de plus de 3,5T.
En regardant ces chiffres depuis l'instauration des premières normes, on s'aperçoit que l'étape Euro 2 actuelle a franchi le plus grand pas. Les progrès futurs envisagés sont plus modestes en quantité, mais certainement plus difficiles à réaliser.
Il est à noter qu'à partir de EURO 3 la procédure de test des performances sera modifiée dans l'objectif d'une meilleure représentativité des cycles de mesures des polluants et d'une sévérisation des seuils.
Cette nouvelle procédure sera basée sur trois cycles : l'European Steady state Cycle (ESC), un test de contrôle normalisé pour les fumées appelé Engine Load Response (ELR), l'European Transient test Cycle (ETC) pour les régimes transitoires.

5. Les actions sur le parc existant

Certaines solutions d'ordre technique peuvent être appliquées sur un grand nombre de véhicules. Elles peuvent être rapidement mises en œuvre et avoir, par voie de conséquence, un impact immédiat sur les émissions et consommation du parc.
D'une part il s'agit des carburants améliorés destinés à remplacer le gazole. Leur formulation est prévue pour réduire les émissions des véhicules. On situe les gains entre 5% et 20% par polluant selon les formulations envisagées et les véhicules concernés. L'impact environnemental est surtout sensible pour les particules, pour les autres polluants les effets restent faibles. D'autre part des dispositifs post traitements des gaz d'échappement, dont l'efficacité est optimum lorsqu'ils sont utilisés avec les carburants améliorés (gazole TBTS ou additif), peuvent être installés sur le matériel existant.

- **Les carburants améliorés**

Deux catégories sont distinguées: les gazoles reformulés et les gazoles oxygénés.

Les gazoles reformulés sont composés d'une base gazole ayant subi des traitements afin de réduire les concentrations de certains composés néfastes aux émissions. Le paramètre le plus représentatif est la teneur en soufre. Actuellement de 500 p.p.m. (soit 0,05% en masse) cette concentration sera réduite pour l'ensemble du pool gazole à 350 p.p.m. en 2000 puis 50 p.p.m. en 2005. L'utilisation de souches à très basse teneur (moins de 50 p.p.m.) permet une réduction modérée des émissions de particules comprises entre 10% et 15% ainsi que des émissions de certains composés toxiques. Le prix au litre est supérieur à celui du gazole traditionnel. Le surcoût variant entre 30 et 60c/litre suivant la nature du carburant et son origine (une part importante de ce surcoût est occupée par le transport qui doit se faire dans des cuves spécifiques). L'utilisation seule de ces carburants n'est cependant pas une solution optimale car leur mise en place nécessite tout de même un certain nombre d'opérations à réaliser au niveaux des infrastructures fixes (cuves..). Utilisés avec des dispositifs post traitements (voir plus loin) ils offrent par contre des performances très intéressantes.

Les gazoles oxygénés sont obtenus en ajoutant des composés oxygénés au gazole traditionnel. Dans cette catégorie entrent les émulsions stables Eau Gazole (EEG) telles que l'Aquazole (Brevet Elf) dont le principe est d'entraîner une baisse de la température de combustion (facteur permettant la diminution des émissions de NOx) par l'ajout de 10 à 15% d'eau et de divers additifs. Ce carburant fait actuellement l'objet de multiples expérimentations, sur plusieurs réseaux de transports en commun, dont la RATP. Sur les autobus les plus anciens ce carburant permet de réduire les fumées de 20 à 30% et les oxydes d'azotes de 40 %. Il permet aussi une réduction des particules. Le surcoût de ce carburant, comparé au gazole standard, est d'environ 10% à valeur énergétique identique. Les premiers résultats de cette expérimentation, relatifs aux émissions polluantes réglementées et non réglementées ainsi qu'à la consommation, font l'objet d'un document de synthèse disponible auprès de l'ADEME.
Le "diester" (Esther Méthylique de Colza) est un composé oxygéné d'origine végétale. Il peut entrer dans la composition du gazole traditionnel jusqu'à 5%. Des concentrations supérieures (couramment 30%) permettent une réduction des émissions imbrûlées CO et HC et une réduction de la teneur en soufre. Les effets sur les polluants restent modérés, sauf pour le CO2. L'intérêt principal étant la valorisation de la production agricole.

- <u>Les dispositifs de post traitement</u>

En complément des actions relatives au carburant, il convient de mettre en œuvre des systèmes de post-traitement efficaces pour la dépollution des bus en circulation (jusqu'à EURO 2). Ces dispositifs permettent d'achever la combustion après la chambre et de réduire ainsi les émissions de produits imbrûlés (CO, HC et particules). On distingue deux types de traitement, pouvant se combiner :

- **Le catalyseur d'oxydation** qui apparaît pour les nouvelles générations de bus, peut être installé pour un coût de 10 à 20kF sur les véhicules anciens avec des gains sur les CO, HC (plus de 60%), ainsi que sur la fraction soluble des particules (30% en masse environ). Ses performances doivent être cependant testées sur la durée. L'utilisation d'un carburant à très basse teneur en soufre est conseillée, même si ce dernier inhibe l'action catalytique.

- **Les filtres à particules ou CRT,** dont la mise au point s'est heurtée à un problème de tenue mécanique lors des régénérations, sont des solutions techniquement satisfaisantes aujourd'hui. Ces dispositifs sont dits à régénération continue (combiné d'un catalyseur d'oxydation et d'une cartouche céramique filtrant les gaz d'échappement. Le concept permet la régénération en continu du filtre - combustion des suies ou particules piégées). Il en existe plusieurs types commercialisés (avec ou sans catalyseur, utilisant ou pas un additif). Ces derniers, aux performances attractives (entre 80 et 90% de réduction des suies), imposent, pour certains d'entre eux, l'utilisation d'un carburant spécifique à très basse teneur en soufre (moins de 50 ppm). Les premiers résultats de la RATP indiquent de très bonnes performances sur les différents polluants, à l'exception des NOx. Une des incertitudes reste la durée de vie de ces filtres, dans de bonnes conditions de fonctionnement. Elle est estimée à cinq ans. La RATP a engagé un programme à court terme pour équiper 2200 bus de son parc, pour un coût de 30 000 F par unité.

La réduction des oxydes d'azote reste le problème sensible qui fait l'objet d'importantes recherches. Il est sans doute exclu de voir apparaître des systèmes de post-traitement de NOx avant 2005. La RATP envisage d'expérimenter l'utilisation de l'Aquazole avec un filtre à particules.

6 Les filières avec renouvellement de véhicules

Le renouvellement du parc doit être accéléré. L'acquisition de matériel d'occasion ou le reconditionnement de vieux matériels, solution trop souvent adoptée dans certains pays en voie de développement, est à proscrire. Cette action permet de remplacer des véhicules anciens, au fonctionnement généralement dégradé, par des véhicules neufs. Les motorisations traditionnelles au gazole subissent actuellement de nombreuses modifications visant à réduire les émissions polluantes (EGR, injection électronique...) Les normes d'émissions vont devenir de plus en plus sévères.

Bénéficiant d'un grand savoir-faire technologique, la filière diesel a fait d'énormes progrès, mais présente encore des inconvénients au niveau des émissions polluantes :

- elle génère des émissions de particules supérieures à celles des autres carburants routiers ;
- le gazole étant un produit lourd, sa combustion donne naissance à des hydrocarbures imbrûlés complexes (HAP) ;
- le moteur diesel émet des NOX en condition de forte charge.

Les travaux de recherche s'orientent donc sur le choix d'autres carburants, ou de carburant de synthèse, permettant par leur nature de diminuer ces émissions.
Les carburants gazeux du fait de leur grande légèreté (GNV ou GPL) présentent par rapport aux carburants classiques des atouts environnementaux incontestables liés à leur composition Ils offrent des caractéristiques qui permettent une bonne compatibilité avec les motorisations à allumage commandé.
Leurs qualités permettent un excellent comportement des véhicules à froid en matière d'émissions (petits parcours,

basses températures) ce qui conduit à une utilisation particulièrement attractive en configuration urbaine.
L'électricité, déjà très présente dans les transports urbains guidés (métro, trolley, tramway), offrira à terme des avantages environnementaux complémentaires, sous réserve que les technologies de stockage de l'énergie dans les batteries ou de production embarquée (hybride) deviennent performantes.

- **Le Gaz Naturel pour Véhicules (GNV)**

Ce carburant gazeux utilisé dans les véhicules réduit de manière très sensible les émissions sonores et olfactives et supprime les fumées noires. Stocké sous forme gazeuse à 200 bars, il autorise une autonomie de l'ordre de 300 km sur un autobus. Les résultats en termes d'émissions polluantes montrent une absence totale de composés lourds et une réduction notable en masse de particules. Les résultats obtenus sur les autres polluants progressent rapidement en fonction de l'évolution technique.

Deux stratégies existent actuellement :

- la filière stœchiométrique (sans excès d'air ni de carburant) permet l'adoption d'un catalyseur 3 voies réduisant dans une forte proportion les émissions de CO, HC, NOX
- la voie "pauvre" (fort excès d'air) très prometteuse en terme de consommation et d'émissions est plus complexe à mettre en œuvre mais n'autorise actuellement que l'utilisation d'un catalyseur d'oxydation.

- **Le Gaz de Pétrole Liquéfié (GPL)**

Ce gaz possède comme le GNV des atouts environnementaux incontestables. L'offre industrielle d'autobus GPL apparaît. Les motorisations utilisent des technologies issues des motorisations essence modernes (injection liquide, mélange stœchiométrique et catalyseur 3 voies). La filière mélange pauvre se développera à court terme en induisant un gain au niveau de la consommation.

- **L'électricité**

Elle présente un intérêt environnemental réel pour des applications telles que les minibus ou midibus en centre ville :
- absence de gaz d'échappement et donc d'émissions à proximité de son lieu de conduite ;
- suppression des émissions sonores ;
- conduite plus souple et sécurisante diminuant les risques d'accident.

Des lignes de bus électriques peuvent être mises en service pour des usages variés ; opérations de desserte de centres - villes ou de sites touristiques, navettes parkings entre parc relais et centre...

L'hybridation consiste à associer dans le véhicule une motorisation thermique et une motorisation électrique. La traction électrique permettant, par la dérivation d'une fraction de la puissance fournie et le stockage de l'énergie dans les batteries, d'augmenter le rendement (réduction importante de la consommation et donc des émissions CO_2). Le fonctionnement en mode électrique pur est possible en zone urbaine dense. La mise en œuvre des systèmes hybrides présente l'avantage de ne pas nécessiter d'infrastructures d'approvisionnement spécifiques. Cette technologie est compatible avec les solutions de dépollution (carburants alternatifs, post traitement...)

7. Conclusion

L'offre réelle des constructeurs européens en motorisation GNV, GPL et électrique est significative d'une évolution vers des bus respectueux de l'environnement.
En France, un dispositif d'aides au développement est mis en place. Ce programme « Véhicules économes et propres » est piloté par l'ADEME. Les bénéficiaires sont les gestionnaires de flottes publiques et privées et les collectivités locales et leur groupement. Des aides financières pour l'étude d'optimisation du parc et le choix des véhicules alternatifs ainsi que leur acquisition complètes ce dispositif incitatif.
Pour les bus propres, l'aide est dédiée à la validation de la solution envisagée avec une mission de conseil pour sa mise en œuvre. Ce programme, basé sur des situations réelles analyse selon une méthodologie reproductible les aspects techniques, économiques et environnementaux des véhicules pendant un an. L'évaluation des performances réelles des véhicules et des systèmes innovants, résultent d'opérations de démonstration avec un programme de suivi pour les filières GNV, GPL et électrique.
Le choix entre ces différentes filières est donc offert aux autorités organisatrices et aux réseaux. Elles ont chacune leurs propres atouts et leurs faiblesses pour des marchés le plus souvent complémentaires. Des études préalables doivent éclairer le choix des décideurs sur la solution optimale à mettre en œuvre pour leur flotte de bus en tenant compte de la taille du parc, de la vitesse commerciale, de la longueur des trajets et des contraintes d'infrastructures et de remplissage inhérentes aux filières envisagées.
Le tableau, présenté en annexe 2, présente le parc actuel des principales filières décrites. Certaines parties du monde ne sont pas représentées, comme la Chine, où le gaz est à certains endroits très présent. La filière GNV reste, a priori, la filière la plus développée, mais dans un proche avenir les autres filières, comme la pile à combustible peuvent très bien émerger au premier plan.

Cependant les progrès à réaliser sur le parc existant sont trop importants, et les taux de renouvellement trop faibles pour attendre les futurs développement, sans améliorer la flotte existante.

Pour plus d'information,
- sur ces filières et les programmes expérimentaux : ADEME : Agence de l'Environnement et de la Maîtrise de l'Energie - 27 rue Louis Vicat - 75737 PARIS Cedex http :// www.ademe.fr ;

- sur le projet UTOPIA[1] qui récapitule une base de données présentant plus de 200 expérimentations innovantes dans le domaine des transports urbains : http :// www.utopia-eu.com,

Bibliographie :

- Texte de la conférence intitulée « Bus non polluants : quelles solutions techniques pour les réseaux ? » préparé par Patrick COROLLER et Jean Loup GAUDUCHEAU du Département Technologies des Transports de l'ADEME.

- Rapport publié par le CERTU et intitulé « Les bus propres en France - les filières actuelles », qui est une synthèse réalisée par Jean Loup Gauducheau de l'ADEME sur la base d'une étude effectuée par François BARBIER et Bernard BERTRAND pour le compte du PREDIT.

[1] UTOPIA - Urban Transport : Option for Propulsion systems and Instruments for Analasis - projet engagé par la Direction Générale pour les Transports (DGVII) de la Commission européenne afin d'évaluer la pertinence des nouveaux systèmes de transports mettant en œuvre des motorisations innovantes. L'objectif final du projet réside dans l'élaboration de conseils pour promouvoir les systèmes les plus prometteurs en matière d'environnement principalement.

Annexe 1 : Evolution des normes en Europe

Règlement	Dates d'application	**CO** g/kWh	**HC** g/kWh	**Nox** g/kWh	**Particules** g/kWh	**Fumées** m^{-1}
R49 01	1982	14	3,5	18	-	-
EURO 0	01/04/1988	11,2	2,4	14,4	-	-
EURO 1	01/04/1992	4,5	1,1	8	0,36 (>85kW) 0,61 (<85kW)	-
EURO 2 *norme actuelle*	01/10/1995	4	1,1	7	0,15 (>85kW) 0,255 (<85kW)	-
EURO 3	01/10/2000-2001					
Diesel (cycle ESC)		2,1	0,66	5	0,10(>85kW)	0,8(ELR)
Gaz (cycle ETC)		5,45	0,78	5	0,16 (<85kW)	-
EURO 4	2005 - 2006					
Diesel (cycle ESC)		1,5	0,46	3,5	0,02	0,5 (ELR)
Gaz (cycle ETC)		4	0,55	3,5	0,03	-
EURO 5	2008	nc	nc	2	nc	nc

(CO : monoxyde de carbone ; HC : hydrocarbures ; Nox : oxydes d'azote)

Annexe 2 : Nombre de véhicules en service selon la filière (09/99).

PAYS	GNV	GPL	Electricité	Biogas	Aquasole
Allemagne	254	-	20	-	-
Australie	1100	-	-	-	-
Autriche	2	550	-	-	-
Belgique	29	2	-	-	-
Brésil	200	-	-	200	-
Canada	200		-	-	-
Danemark	-	176	5	-	-
Suisse	12	-	-	-	-
Egypte	150	-	-		-
France	165	22	7	2	380
Finlande	11	6	-	-	-
Angleterre	74	24	20	-	-
Grèce	120	-	-	-	-
Hongrie	30	-	-	-	-
Italie	76	52	60	-	-
Inde	-	-	-	-	-
Iran	-	-	-		-
Irlande	1	-	-	-	-
Japon	95	-	-	-	-
Luxembourg	7	-	3	-	-
Malaisie		-	-	-	-
Norvège	5	2	-	-	-
Pays Bas	12	150	3	-	-
Pologne	-	48	-	-	-
Portugal	-	1	-	-	
Suède	140	-	1	300	-
Espagne	57	62	-	-	-
Taiwan	60	-	-	-	-
Tchéquie	-	65	-	-	-
Thaïlande	44	-	-	-	-
Etats Unis	1800	-	115	-	-
Total	4644	1160	234	502	380

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8 Transport, safety and traffic techniques

Transport, sécurité et techniques de la circulation

Transporte, seguridad y técnicas de ingeniería de tránsito

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Development of a model to estimate savings from reduction in accidents

Création d'un modèle pour évaluer les économies suite à la réduction d'accidents

Desarrollo de un modelo para estimar el ahorro en la reducción de accidentes

V. M. Puvanachandran
Department of Civil Engineering, PNG University of Technology, Papua New Guinea

ABSTRACT: Accident data and independent variables relating to highway, traffic and environmental factors, in excess of 430 items that are being collected to produce a model reflecting conditions in PNG is presented.

RÉSUMÉ: Donnés des accidents et variables indépendantes en relation avec les routes , le trafic et l'environnement, au -delà de 430 sujets examinés pour modéliser les conditions en PNG

RESUMEN: Datos de accidentes y variables independientes relacionadas con las carreteras el tráfico y factores medioambientales además de otras 430 categorías utilizadas para producir un modelo en PNG.

1 INTRODUCTION

During 1994 to '96, 15300 road accidents were reported in Papua New Guinea (PNG). They resulted in 5700 deaths or serious injuries. Despite the above statistics, benefits from reduction in accidents are ignored in the distribution of funds for transport provision because no accepted methodology exists for accident prediction and evaluation. Procedures developed to reflect the circumstances existing in the country is presented; classified as follows:

- Accident data (dependent variable)
- Highway factors
- Traffic factors
- Environmental factors.

Case studies of several accidents during 1998/99 have been completed to identify primary variables that lead to accidents in the country. The results of the analysis will be discussed in the present paper. A flow chart to estimate benefits from reduction of accidents due road improvements is given in Figure 1.

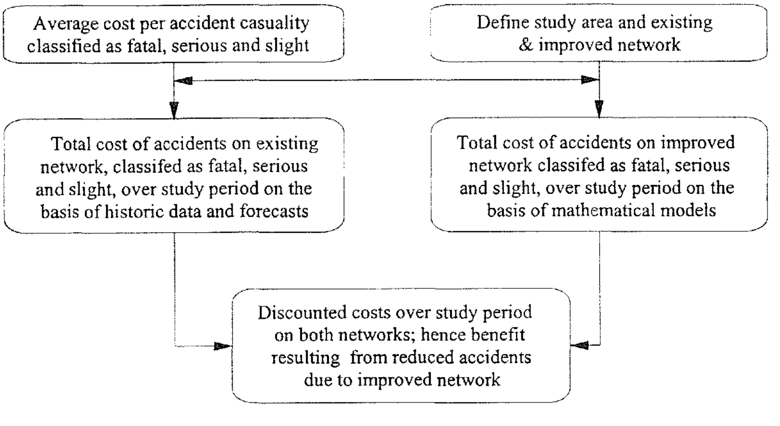

Figure 1. A flow chart for estimation of benefits from reduction of accidents

2 UTILIZATION OF EXISTING MODELS

There are several features in accident prediction and forecasting models used in developed countries that can be utilized for application in PNG, after checking the relevant model for appropriateness of application and calibration (Department of Transport 1981). However there are also several features which are specific to PNG. Additional research is needed to develop an accident prediction and costing model applicable to PNG which reflect the special features.

The needs arise because of the semi-subsistence nature of PNG economy, cultural differences and decline over the years of the expatriate population in the country. Other factors are increasing proportion of older and poorly maintained vehicles possessed by a growing number of middle-class citizen population, poor road construction standards, limited provision of road safety facilities, limited road user education and poor maintenance culture. Research presently being undertaken and findings completed, in order to develop an appropriate accident prediction and costing model will be discussed in the rest of the paper.

3. COLLECTION OF ACCIDENT DATA

Under a long term Cooperative Programme of Road Safety Research between the United Kingdom and Papua New Guinea, data has been collected since 1986. Comprehensive information on the prosecution of offenders and macro level analysis of the data is undertaken using the MAAP accident analysis package developed by the Transport Research Laboratory of the United Kingdom. The data is deficient for undertaking detailed research because of the following reasons:

- Damage-only accidents are generally under-reported.
- Accident locations are not identified accurately.
- Reporting police officers are not adequately trained.

Extensive measurements of accident data and independent variables are being collected since 1997 on Highlands Highway, an arterial road and the Lae to Mumeng road, a provincial highway in order to formulate a set of mathematical models that can be used to forecast accidents in PNG.

3.1 *Corrections for under-reporting*

Award of compensation payment, even for minor offences, is an established tradition in PNG. Generally, parties to a dispute accept arbitration by a policeman to be an acceptable method of determining compensation to be paid by an offender to an aggrieved party. Therefore, it is reasonable to accept that under-reporting of accidents in urban centers is fairly low while limited under-reporting of accidents may occur in remote locations.

In our research, the statement in the last paragraph is being confirmed by the use of time-lapse cameras strategically located at known accident black spots in urban and remote locations. The observations are used to identify near misses at various black spots in order to compare them with the number of reported accidents.

In this respect, one can be fairly confident that nearly all fatal and serious accidents are being reported because it is fairly difficult for an offender to escape after an accident even in a remote area. This is because the number of vehicles is small and alternative passages available for an offender to escape are highly restricted. Also, compensation payments for serious accidents in rural areas of PNG are not by private arrangement between the aggrieved and the offender but will involve respective clans assisted by the police.

3.2 *Identification of accident locations*

Three possible methods were evaluated to identify accident locations. Initially, accident sites were located with reference to nearby culverts, bridges, prominent road furniture and electricity pylons. The location of such features is specified in a road inventory plan. However, in remote locations where road features are not conveniently located, traffic policemen tend to crudely judge the distance for reporting purposes. However, the approach was found to be the only satisfactory method available to locate slight accidents, which are reported by the drivers to the nearest police station instead of the traffic police attending to the scene of accidents. It is possible by interrogation of the drivers to determine the location of the accident with reasonable accuracy and determine the co-ordinates with the aid of the reporting driver.

The second approach is to establish kilometer posts and paint a mark on the road every 200 metres. The markings, especially on gravel roads have limited life and their maintenance was expensive. Therefore, the practice was abandoned.

The third approach is to use GPS instruments to determine the co-ordinates of accident locations. The approach has proved to be successful for use by attending police officers to locate serious and fatal accidents.

3.3 *Training of traffic police officers*

The National Road Safety Council of Papua New Guinea supports the present research project. A requirement of the financial support for the research project is that selected traffic police officers will work together with the research team in accident data collection. At present, four officers are seconded from the traffic police which has proved to be mutually beneficial.

4 COLLECTION OF HIGHWAY FACTORS

The Transport Research Laboratory has suggested that "accidents per million vehicle-kilometers" is related to recovery width, curvature, gradient, surface irregularity, junctions per kilometer, junction type and sight distance. Causal examination of accidents in PNG indicates that the following additional highway factors are significant in causing accidents. Cheap road construction standards and practices, poor maintenance of road network, poor implementation of landuse planning regulations, high speeds on approach to sharp curves and limited provision of road safety facilities.

4.1 *Cheap construction standards and practices*

On the basis of conventional cost-benefit analysis, it is uneconomic to reconstruct or newly construct a large number of roads in PNG to satisfactory engineering standards. Hence, a number of roads are built to sub-standard specifications, for instance provision of limited drainage facilities. Sub-standard practices lead to rapid deterioration of the road which in turn lead to increase in accident rates. Poor road construction practices such as unlit ditches next to road works also lead to accidents.

4.2 *Poor maintenance of road network*

Provision of new roads is politically popular while funds for road maintenance generally do not have the support of politicians. Also, donor agencies do not generally fund maintenance projects. It has become an accepted practice to let even well constructed roads deteriorate well past the design life and then seek funding to reconstruct them. The practice leads to significant increase in accidents as the road progressively deteriorates.

4.3 *Poor implementation of planning regulations*

Roadside markets and landuse development close to new roads lead to accidents. Other factors in this category include slash and burn operations for agriculture in land made readily accessible due to the provision of new roads. They in turn lead to increased road drainage which overflow existing culverts leading to damage of road surface and hence to increase in accident rates.

4.4 *High approach speeds on curves*

Vehicles travelling at high speeds on curved road sections transgress into the opposite lane (Puvanachandran 1995). Transgression has been observed as a cause for accidents. The effects of such accidents are particularly detrimental at short span, single lane bridges which frequently have steep approach gradients and sharp curves. Furthermore, pedestrians and vehicles share a common deck on a number of these bridges.

4.5 *Limited provision of road safety facilities*

Damaged, non-existent or badly designed road signs, safety fences and barriers frequently lead to accidents in PNG. The situation is exacerbated due to non-existent road lights.

4.6 *Collection of highway factors*

158 different features are being collected for in-depth analysis of highway factors on accident causation. In addition to conventional measurements such as gradient and curvature, the following factors are measured: road terrain classification, road type, width, type and condition of pavement, shoulder, verge and batter, recovery width, line marking, sight distance, cross-fall, details of isolated curve on site, details of intersection, pedestrian facilities, road furniture and drainage structures.

5 COLLECTION OF TRAFFIC FACTORS

Accidents due to traffic factors may be due to vehicles, drivers, passengers, pedestrians, domestic and wild lives.

5.1 *Mechanical condition of vehicles*

In PNG, the legal requirement is for vehicles to pass "road safety tests" every six months. Light vehicle testing for the purpose includes the provision of satisfactory lights, signals, brakes, steering and wheel alignment. Additional requirements are specified for public motor vehicles (PMVs), medium and heavy goods vehicles. However, a significant percentage of vehicles operate on the highways without meeting the prescribed safety standards. Following an accident, the following features of the relevant vehicles are investigated as part of our research: vehicle category, condition of brakes, clutch, steering, wind screen wiper, light control arms, lights, reflectors, indicators, mirrors, suspension, tyres, doors and locks, means of restraint and the general repair of the vehicle.

Open-backed vehicles, which carry unrestrained passengers, are a primary cause of accidents. Investigations have indicated that this form of transport is unstable and where accidents occur will lead to a disproportionate number of passenger causalities and a high level of trauma (Puvanachandran 1999,pers. comm, Nelson 1990)

5.2 *Driver efficiency*

Driving tests in PNG are not as stringent as in developed countries. Expatriates arriving from most countries are licensed on production of licenses from their home countries. Also, sophisticated instruments such as red light cameras, radar speed meters and measurements of alcohol intake levels are not fully developed to produce acceptable results for prosecution. Chewing of buai (betel nut) is also considered to be a primary cause of accident.

PMV drivers are generally blamed for a disproportionate number of accidents. There may be some justification in the claims since public motor vehicles are owned privately and the drivers are paid on a percentage of the fares collected.

In our proposed investigation, the following information with respect to the drivers are collected with respect to an accident: age, sex, license category, nationality, driving experience, familiarity with the area, understanding of traffic signs, employment, physical condition and mental state before and after the accident, influence of liquor, buai or other drugs and level of fatigue. Prior traffic offences of the driver are also noted.

5.3 *Information on passengers*

Age, sex, physical and mental condition of causalities, influence of liquor or other drugs and level of fatigue have been considered as important criteria in overseas studies. Additionally, the following factors are considered important in Papua New Guinea: overloading of vehicles, specially open-backed trucks with cargo and passengers, spitting buai from moving vehicles and passengers position of travel. For instance, it has been shown that severity and frequency of accidents are high in the case of unsupervised youngsters travelling in the back-trays of open-backed trucks as unrestrained passengers.

5.4 *Information on pedestrians*

Age, sex, physical and mental condition of causalities, understanding of traffic signs, activity being undertaken and attentiveness prior to accident, influence of liquor or other drugs and level of fatigue have been considered as important criteria in other studies.

Other factors that are important in PNG include weight of head load if any, location of accident and experience of the pedestrian with respect to the environment; for instance a villager in town. A possible cause of accidents specific to PNG is the attitude of pedestrians and limited care they take in moving within a crowd of vehicles. In a number of developing country towns such as in India, the present author has noted that pedestrians give due care and attention to moving vehicles even when they cross on designated crossings. In PNG, it is considered a courtesy for vehicles to wait for pedestrians to significantly complete the crossing-movement prior to the movement of the vehicle to cross a pedestrian crossing. Even otherwise, it is unwise to assume that pedestrians will always give way to a moving vehicle, even when reversing.

5.5 *Information on domestic and wild lives*

In rural areas of PNG, the consequences of meeting a road accident with a pig or other domestic life can lead to serious consequences. Unfenced roads traverse through extensive miles of wilderness. Also wild birds and animals are readily attracted to the roadside to feed on carcasses which have been killed by passing traffic. Information is being collected to identify any accident black spots related to such causes.

6 COLLECTION OF ENVIRONMENTAL FACTORS

On the basis of the pilot study, the following environmental factors were considered to be important: time of occurrence of the accident, natural visibility and climate, level of artificial lighting, environment within the vehicle (e.g.: returning after a football match), surrounding environment (e.g.: tribal fight in progress, roadworks), road location (e.g.: roadside market) and topography. With respect to the environment, specific attention will be given to identify environments that encourage highway robbery and associated accidents.

7 CONCLUSION

Information on 436 independent variables is being collected of which several features are specific to Papua New Guinea. Accident black spots will be identified and case studies relating to these black spots will be completed to identify primary independent variables.

Some of the significant variables so far identified are; influence of alcohol and drugs, approach speeds to single lane bridges, speed of vehicles as they approach isolated curves, sudden changes in pavement conditions and environmental conditions. There is limited evidence that accident rates may be correlated to recovery width, however there is little causal evidence that gradients, curvatures and junction frequencies are significantly correlated to accidents on interurban roads in Papua New Guinea.

In 1988, a brief study undertaken by the Department of Transport estimated the cost of a fatal accident to be Kina 30,000 (US$ 30,000). Data collection to improve the estimate will commence shortly as a separate but parallel project involving the Motor Vehicle Insurance Trust, private insurance companies, hospitals, police, Department of Transport, accident victims and their families.

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Bus accidents: An additional burden for the poor

Accidents d'autobus: un fardeau supplémentaire pour les pays pauvres

Accidentes de bus: Una carga adicional para el pobre

D.A.C.Maunder & T.Pearce
Transport Research Laboratory, Crowthorne, UK

ABSTRACT: Countries of the developing world are characterised by rapid urbanisation, high growth rates in traffic and congestion and decreasing regulation of public transport. Because a majority of the developing world's inhabitants are dependent on public transport services, the need for safe, effective and efficient public transport is essential to ensure adequate and affordable accessibility. The paper highlights the results of studies examining public transport operations in Nepal, India, Thailand, Tanzania and Zimbabwe. The contribution of bus accidents to the accident burden of each country is established and likely causes identified. Finally, recommendations are made to reduce both the severity and number of public transport accidents.

RÉSUMÉ: Les pays du tiers monde se caractérisent par une urbanisation rapide, un taux de croissance du trafic et des encombrements élevé et une dérégulation des transports publics. Comme la plupart des habitants des pays en développement sont tributaires des transports en commun, il est important de prévoir des transports publics sûrs, efficaces et qui fonctionnent et d'en assurer l'accès suivant les besoins et à un prix raisonnable. Cet article expose les résultats d'études sur les transports en commun au Nepal, en Inde, en Thailande, Tanzanie et Zimbabwe. Ces études examinent la contribution des accidents d'autobus à la totalité des accidents enregistrés dans chaque pays et tente d'en identifier les causes. Enfin, il propose des recommendations pour réduire la gravité et le nombre d'accidents de transports en commun.

RESUMEN: Los paises en desarrollo se caracterizan por: rapida urbanisacion, altas tasas de crecimiento del trafico, y congestion. La mayoria transporte publico, por lo tanto, se necessita depender del servicio seguro, efectivo y eficiente.
Este articulo presenta los resultados de varios estudios que examinan la operacion del transporte en Nepal, India, Thailand, Tanzania y Zimbabwe. Estos estudios investigan la proporcion de los accidentes de bus en el total de accidentes de cada paiz, y los posibles causas. Finalmente, se hacen recomendaciones para reducir tanto el numero como el gravedad de los accidentes de transporte publico.

1 INTRODUCTION

Worldwide, there are estimated to be up to 1 million road accident fatalities and 10 million people injured annually, many with long term disabilities (World Health Report (1999) Tables 2 and 4). Almost 70 per cent of these occur in the developing or emerging world. Whilst there is a general decline in the number of fatalities in industrialised countries the opposite is true elsewhere. If account is taken of levels of motorization by expressing accident statistics as rate per registered vehicle, then less developed countries (LDCs) have rates at least 10 to 20 times higher than the best industrialised countries. The worst countries in these terms have fatality rates 100 times higher (Ghee et al 1997).

Fouracre and Jacobs (1976) calculated that, for any country, the cost of road accidents was equivalent to approximately one percent of its Gross National Product (GNP) although currently it is thought to be between one and three percent. However, using the 1 percent figure gives an estimated annual global cost of road accidents of the order of US$230 billion, with the cost to LDCs being around US$36 billion, a sum that they can ill afford.

Countries throughout the developing world are characterised by rapid urbanisation, high growth rates in traffic and, consequently, congestion and decreasing regulation of public transport. Because the majority of the developing world's inhabitants are dependent on public transport the need for safe, efficient and effective public transport services is essential to ensure adequate and affordable accessibility, for sustaining livelihoods and rural and urban development.

This paper, describing work funded by the British Government's Department for International Development (DFID) Knowledge and Research (KAR) Programme, aims to establish the current operational environment of the public transport sector in each of the countries, the extent and the likely causes of accidents. The study has been undertaken in a number of countries [Nepal, Zimbabwe, Thailand, Tanzania and in the Indian State of Maharashtra], which are assumed to be representative of the emerging nations. Data have been collected from official sources in the countries and interviews undertaken to obtain opinions as to the causes of bus accidents. In addition, vehicle condition and driver behaviour was monitored. Conclusions and recommendations are discussed to reduce both the severity and number of public transport accidents in the future.

2 NEPAL

The first bus services in Nepal commenced in 1957 and since then the fleet has grown substantially, especially since 1992. By 1996 there were a total of 7800 conventional buses and 2752 minibuses operating public transport services throughout the country (Maunder et al 1998).

About 95 per cent of buses are owned and operated by the private sector, the remaining 5 percent being owned by the public or semi-public sector. Although vehicles are mainly operated on an individual basis, the "Dial system" predominates as Associations or Syndicates manage routes on behalf of owners. The "Dial system" ensures equal operational trip making for each operator in the Association/Syndicate, as vehicles have to wait in a queue prior to departure. It does however, constrain the number of trips made by each bus. Thus although the supply of permits is liberalised, the actual provision is constrained throughout the country. In addition, owners who do not belong to an Association /Syndicate frequently encounter operational difficulties at bus parks.

During the period July 1995-June 1996, 479 serious bus accidents [14% of the total] resulted in 365 fatalities and 1751 injured persons. The totals represented 39 percent of all road fatalities during the 12 month period and 60 percent of all road casualties (figures for the 18 month period of November 1996 to April 1998 are similar in terms of the percentage of bus accidents and fatalities). Bus accidents therefore represent a significant proportion of all road accidents and injuries in Nepal. Figure 1 illustrates the predominance of injuries and accidents caused by bus only accidents.

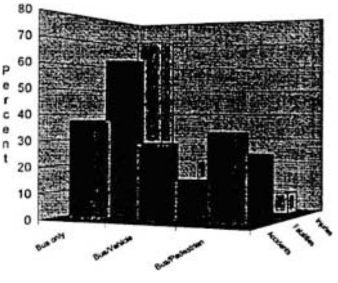

Figure 1 Bus accidents in Nepal (1995/6)

Bus only accidents are defined as those in which the driver loses control and the bus either leaves the road or overturns.

From comments made by the diverse groups interviewed, the likely causes of bus accidents can be categorised as follows:

- Drivers and driving habits
- Vehicle condition
- Road condition
- Other factors

Data for the 18-month period [Nov 1996 - April 1998] recently analysed suggests that driver error was the major factor in 74% of bus accidents, external factors in 18% and vehicle condition in 8%. Everyone agreed that one single factor was unlikely to cause an accident and that a combination of causes was the likely explanation. The factors raised in respect of drivers and their driving habits were:

- Ease of obtaining an Heavy Vehicle licence
- Lack of knowledge of the Highway Code and road
- Driver fatigue due to long working hours
- Overloading of vehicles to maximise revenue
- Night drivers consuming alcohol, drugs or speeding

Surveys of vehicle condition noted that 65% of buses had one or more faults in terms of tyres, wheel fixings, and front/rear lights yet all had passed a Vehicle Fitness Test and were legally fit to operate.

The poor condition of roads resulting from deficiencies in maintenance, alignment, traffic signs and safety features were all identified as possible accident causes. Weak enforcement of traffic regulations and a lack of road sense by pedestrians in rural areas especially when herding animals on the road or generally crossing the road were also mentioned as contributory factors.

3 INDIA

Public transport in India is characterised by a wide range of vehicle type from non-motorised modes such as cycle rickshaws to surface rail and metro. Both public and private ownership exists; the scale is immense with 64 public sector road transport undertakings operating a fleet in excess of 110,000 representing just 30% of the national bus fleet.

Because of the size of India [1/4 million reported accidents leading to 60k fatalities and over 1/4 million casualties in 1995] it was decided that the study should be restricted to the State of Maharashtra. During the period 1961-1996 the registered motor fleet in the state grew by over 40 times whilst the road network increased by 3.5 times; thus the growth in vehicles far outpaced the quantum of road network and other infrastructure. As a consequence, over the two decades 1975/95 the number of road accident fatalities increased by 282% and injuries by 220%. Data for 1995 shows that buses and HGV's were involved in 35% of accidents, taxis cars and jeeps in 32%, two wheelers in 22% and other vehicles in 11%.

Data were obtained from the State-owned Maharashtra State Road Transport Corporation (MSRTC) which operates bus services throughout the State in competition with privately owned and Municipal bus companies. The MSRTC is the second largest operator in India with a fleet of 17,073 buses, employing110,073 staff and carries 7.5 million passengers daily. During the operational year 1996/7 MSRTC buses were involved in 4149 accidents and 688 fatalities ensued. Of these, the MSRTC management assess that their driver was at fault for almost 50% of accidents. Driver inexperience appears to be a probable cause as 37% were aged between 24 and 32 and 46% had been driving for less than 4 years.

The opinions of the various drivers, conductors traffic police, passengers interviewed throughout the State suggested that the same probable causes relate to the Indian situation as they do in Nepal and for the same reasons.

4 ZIMBABWE

Urban public transport services are provided by the Zimbabwe United Passenger Company (ZUPCO), now wholly owned by the government, which operates both conventional buses and minibuses (Maunder et al 1993). There are also privately operated commuter omnibuses, introduced in 1993, consisting of various vehicle types and capacity (Maunder et al 1993,1995,1996) which have been allowed to proliferate with few controls. Long-distance bus services (inter-city and rural) are provided by ZUPCO and the private sector.

The police collect accident data in Zimbabwe and the Zimbabwe Traffic Safety Board analyses the data. In 1992 there were a total of 27,150 reported accidents leading to 1,066 fatalities and 13,458 injured persons and by 1996 the totals had increased to 38,777, 1,205 and 18,070 respectively. Table1 shows that, most bus accidents [and consequently injuries] take place in urban areas but most fatalities result from long distance services.

Table 1 Bus accidents in Zimbabwe [1996]

	Bus Accidents	Fatalities	Injuries
Long distance/ Rural	28%	74%	22%
Urban	72%	26%	78%

Police statistics of bus accidents in 1996 showed that 58% of bus accidents were classified as blameworthy [i.e. human error] and led to 76% of bus fatalities and 75% of injuries. The most frequently quoted factors in respect of driver behaviour included reckless driving, inattention and a lack of judgement, speeding, driver fatigue and the use of unqualified and inexperienced drivers. One long distance operator suggested that "speed is used as a marketing tool" whereas in urban areas "speed is used to maximise earnings".

External factors include road conditions, stray animals, weak enforcement of regulations and adverse weather such as during the rainy season. Observations of vehicles showed that vehicle condition is generally satisfactory and that genuine spare parts are utilised.

5 TANZANIA

The organisational structure of the bus industry in Tanzania can broadly be categorised into urban operations and long-distance [including rural services].

Urban operations presently comprise conventional buses and minibuses [Daladalas]. The fleet of the state run bus company, "Usafiri Dar es Salaam (UDA)", has dwindled and now comprises few conventional buses and minibuses. Privately owned Daladalas operate in almost all municipalities in the country and are generally capable of carrying 16 passengers. The Daladala fleet has grown considerably since their legalisation in 1983. Methods of remunerating the Daladala drivers encourage speeding, overtaking, poor parking and frequent vehicle stop-pages to pick up or drop passengers on their way to anticipated destinations.

The routes operated on trunk roads [long distance] are long with the longest within the country being approximately 1425 km. The services operated are:

- Inter-regional, which are services between cities/towns within the country on paved and gravel roads
- Urban-rural comprising a high proportion of services on gravel roads
- Cross-border services

The operational environment for long distance services changed recently. Quantity and fare controls on routes have been liberalised and entry into the industry is now very much dependent on the road-worthiness of the vehicle. The most common buses are 45 - 65 seat capacities. Driver turnover is high and due to an increasing passenger fleet buses compete for passengers by employing touts. It is alleged that, buses race against each other in order to pick up intermediate passengers along the route, on the other hand, the competition for passengers has resulted in some operators introducing semi-luxury and luxury coaches on selected routes to attract more passengers.

The total number of reported accidents increased from 12595 in 1993 to 14335 in 1997 i.e. by 14%. The total number of fatalities increased each year from 1993 to 1996, but declined by approximately 10% to 1625 in 1997 and 1583 in 1998 [injuries were 12490 and 11381 respectively]. Measurable injuries have remained at a fairly constant level compared to reported accidents. It should be noted that national figures for 1998 have shown a decline; it is likely that this is due in part to the effects of the global recession as well as increased safety awareness and enforcement.

Table 2 summarises accident statistics by vehicle type for 1997 and 1998.

Table 2 Road accident statistics, Tanzania [1997/8]

	Average (97/98) % distribution		
	Vehicles involved	Fatalities	Injuries
Private Cars	50.7	24.5	28.0
Pick-Ups	16.0	19.8	17.9
PSV Buses	0.3	16.1	17.5
PSV Daladala	23.6	23.2	21.0
Private Hire	0.2	0.3	1.3
HGVs	4.2	4.5	4.6
Motor Cycles	2.4	6.8	5.4
Pedal Cyclists	2.6	4.8	4.3
TOTAL	**100%**	**100%**	**100%**

In total, conventional buses and Daladalas accounted for 24% of vehicles involved in accidents during 1997/98 but generated 39% of fatalities and injuries. On average each long distance bus involved in a road accident resulted in 5 fatalities and 39 injuries while the approximate unit fatalities and injuries for other vehicle classes was insignificant. Within the public transport sector, long distance buses represented 1.3% of vehicles involved in accidents yet generated 41% of fatalities and 45% of injuries whereas Daladalas represented nearly 98.7%, 59% and 55% respectively, indicating the lower severity of urban road accidents.

As per police analysis the causes of all road accidents [bus accidents reflect the same trends] can be divided into three main categories:

- Human factors = 76%
- Vehicle condition = 17%
- External factors = 7%

Interviewees perceptions were that human errors are the principal contributory cause of road accidents. The causes of bus accidents as revealed by respondents are similar to the above but also includes an additional factor " lack of enforcement"

The human factor is perceived to be the principal cause of most bus accidents with factors similar to those found in Nepal. The contribution of human error in causing accidents is not only confined to drivers as passengers and pedestrians also contribute to accidents. It is common for passengers to try to disembark from a bus while it is in motion or to distract the attention of the driver. Some fatal bus accidents may occur when drivers take irrational decisions and attempt to cross flooded rivers. Drivers are often encouraged by passengers to cross flooded bridges and as a result make errors in judgement resulting in the bus being washed away.

The travelling public blames deregulation of the public transport system for the increased number of accidents occurring on both urban and long distance services. Inevitably this has led to an increase in the number of buses servicing the network although demand has not similarly increased.

In 1995, according to statistics from police records, approximately 20% of bus accidents were caused by bus defects. By 1997 this had declined to approximately 17%, due, in part, to ongoing economic reforms that have led to a growth in vehicle sales and hence a younger bus fleet being operated.

6 THAILAND

The conventional public transport sector in Thailand comprises fixed and non-fixed routes [nationwide mainly for tourists] with the fixed routes operated by the entire fleet as follows:

- Urban: the bulk of which are operated in Bangkok and a handful of provinces [27%]
- Inter-city: [23%]
- Rural services operated within provincial boundaries [50%]

The total conventional bus fleet in 1998 comprised 93061 vehicles [0.5% of the total motor vehicle fleet] of which 94.5% were privately owned and operated and 5.5% publicly owned. The industry is strictly regulated by the Department of Land Transport in terms of standard of bus, route operated, timetable, fares etc.

Accidents peaked in 1994 at 102610 and fatalities and injuries in 1995[16727 and 50718 respectively] since when reductions have ensued. During 1996/7, 70% of all accidents occurred in the Bangkok region and buses and trucks were involved in 10% of all accidents.

The number of bus accidents has declined since 1993 when there were 6895 buses involved in crashes to 3717 in 1998 but still represents 5% of all accidents and generates an estimated 1500 fatalities and 5400 injuries.

According to Police records, 74% of all accidents on the inter-city and inter-district highways in 1997 were due to driver behaviour, with the remaining causes due to external and vehicle defects. During 1998 the national newspapers reported a total of 32 major bus accidents resulting in 65 fatalities and 692 injuries of which 50% constituted single vehicle accidents.

In 1998 the state owned Transport Company fleet was involved in 377 accidents of which 20% were single vehicle crashes and 80% multi vehicle. The management considered that their own vehicle was the cause of 58% of these accidents and other vehicles in 42%. Of the former the driver was considered at fault in 79% of the accidents, external factors in 18% and the vehicle in 3%.

As the above shows, driver error was the overriding factor involving Transport Company vehicles and this is likely to be the same throughout the industry. Interviews with operators and drivers confirmed this view. Vehicle condition was not cited and surveys of vehicles generally showed that vehicles were in a reasonable condition.

7 DISCUSSION

In all five countries, were studies have been undertaken by TRL, road accidents are increasing over time and overwhelmingly driver behaviour is the major factor. Public transport vehicles appear to be involved in a higher proportion of accidents than their numbers warrant. However, this is principally because buses cover a high annual mileage through their duty cycles. Considering the number of passengers transported a safety culture should be active and evident, however, it does not seem to be the case at the present time.

Public transport in Nepal and Thailand has not undergone the same stresses of privatisation as elsewhere in the world but the existing situation does indicate some of its consequences. In India, Zimbabwe and Tanzania, public transport services are increasingly being owned and operated by the private sector as liberalisation is encouraged. This has inevitably lead to a philosophy, by the private sector, of profit maximisation by minimising costs rather than increasing efficiency. In Thailand, although 95% are privately owned there is strong regulation. Driver behaviour appears to suffer under the auspices of liberalisation and low enforcement.

Figure 2 compares fatality and injury rates across the five countries. The need for high standards of driver behaviour and vehicles in Nepal, where nearly all the public transport sector is privatised, is emphasised by the significantly higher severity of accidents with a fatality rate twice as high and an injury rate over three times as high as Tanzania. Some of this difference may be due to the difficult terrain over which buses are operated Interestingly, Tanzania and Thailand appear to have similar fatality and accident rates although the operating environment differs greatly.

Subjectively, there does appear to be a link between the degree of privatisation and the amount of regulation or enforcement that is present. Figure 3

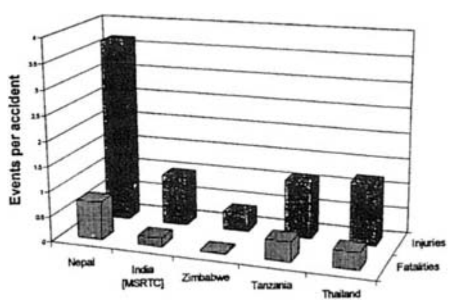

Figure 2 Comparison of fatality and injury rates.

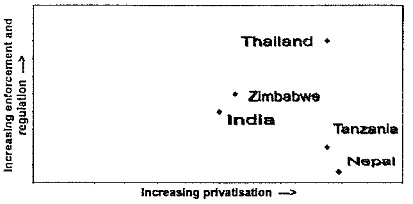

Figure 3 Comparison of privatisation status and enforcement levels

attempts to illustrate this by plotting estimates of privatisation and enforcement for the five countries. It is recognised by the authors that these estimates are not quantifiable.

8 SUMMARY AND RECOMMENDATIONS

Clearly the overriding factor to be addressed is how to improve bus driver behaviour. Suggestions to improve bus driver behaviour are listed below. It is clear however that drivers need to be better educated and trained when initially learning to drive but in particular:

- They should be taught technical skills but also social and psychological skills to be a safe, responsible professional driver.
- Bus drivers, like all HGV drivers, should participate in refresher driver training courses so that bad habits can be eliminated rapidly.
- Owners should provide financial incentives for drivers who have been 'accident free' during the previous 12-month period.
- Medical and health checks need to be provided regularly for all but especially ageing drivers.
- Drivers should be encouraged to work within existing legal maximum hours.

These may increase costs but are likely to be less expensive in the longer term than the cost of human tragedy, vehicle replacement and other third party costs.

As well as improving the behaviour of the bus driver, road safety campaigns need to be funded and encouraged so that all road users are better educated as to how to behave when crossing and using the road and when herding animals on the rural road network.

Owners and operators need to be encouraged to maintain their vehicles to a much higher standard than at present. Preventative maintenance can improve performance and productivity and extend the operational life of the vehicle. A safe, smart vehicle is also more likely to attract passengers than an unsafe and poorly maintained vehicle and also passengers might be encouraged to afford a slightly higher fare for such a vehicle/service. Owners/operators also need to understand that regular vehicle maintenance is a cost effective business practice which can minimise vehicle downtime and costly, time consuming breakdowns whilst in service.

Improvements in bus safety cannot be achieved by one individual or discipline, they are a collective responsibility and a collective spirit is required of all those involved including:

- Bus owners, drivers, conductors and mechanics
- Operator associations/unions
- Police and government departments
- Road Safety Associations/
- Driver training schools
- Manufacturers and repairers of vehicles, spare parts and tyres
- ALL road users

Hence, whenever liberalisation is being considered in respect of the provision of public transport services, enforcement of existing (and new) legislation in terms of vehicle condition, numbers allowed to operate etc needs to be strictly enforced. Operational regulations and procedures must also be implemented rigorously to ensure that safe and effective service provision prevails for the benefit of passengers.

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Reduction of the roundabout capacity due to pedestrians or cyclists

Influence des piétons et/ou des cyclistes sur la sécurité et la capacité des giratoires

Disminución de capacidad y seguridad del rondo por los peatones y bicicletistas

T.Tollazzi

Faculty of Civil Engineering, Road and Traffic Centre, University of Maribor, Slovenia

ABSTRACT: Single-lane roundabouts may face the problems of getting crowded and empty in their circulatory roadway and also of traffic safety due to a stream of pedestrians and/or cyclists. The paper presents the possible methodology of calculating the reduction of the roundabout capacity due to the pedestrians and/or cyclist stream, used in Slovenian roundabouts. The methodology of calculating the reduction of the roundabout capacity may be used in urban areas, where the strength of the cyclist or pedestrian streams is high.

RÉSUMÉ: Des problèmes de capacité et de sécurité des giratoires a voie unique dans l'anneau de circulation peuvent intervenir lorsqu'une des branches du giratoire est coupée par la circulation intense des piétons et/ou des cyclistes. Le présent rapport présente une methode de résolution de ce probleme, pratiquée dans les giratoires slovènes, et servant de mesure de limitation de la circulation en milieu urbain.

RESUMEN: En los rondoes con un solo canal con gran corriente de circulacion, pueden presentarse problemas con la capacidad y el seguro de trafico en caso, cuando haya una gran cantidad de peatones y/o bicicletistas corta uno de los lados del rondo. En este contribucion esta presentada la manera de salvar los problemas en los rondoes Slovenos, que son la mayoria conocidos como prevencion para calmar el trafico en la parte urbana con gran numero de peatones y bicicletistas.

1 INTRODUCTION

In Slovenia lately, the increasing interest for roundabouts is obvious, from both designer's and investor's points of view. Ten years ago we had not any experiences, only few examples of roundabouts and almost no guidelines for designing them.

From the very beginning we have been paying a lot of intention to comparing the foreign methods of designing and structuring the roundabouts, as well as assuring the requested relations between capacity and safety (usage area, diameter of the central island, capacity, consideration of the cyclists and pedestrians influence on the capacity, etc.).

Most of Slovenian roundabouts are located in build-up areas where the strength of the cyclist or/and pedestrian streams is not negligible. That was a main reason for researches about the influence of strong pedestrian and bicycle flow on the capacity and safety of roundabouts.

2 PROBLEM DESCRIPTION

Single-lane roundabouts may face the problems of getting crowded and empty in their circulatory roadway due to a strong stream of pedestrians and/or cyclists.

Vehicles at the roundabout entries or exits have to provide the right of way over pedestrians and/or cyclists. Therefore, it comes to disturbances.

If the stream of vehicles is directed to the entry, it will be uncertain to reach the minimum capacity.

If the stream of vehicles is directed to the exit, the maximum capacity is exceeded (Fig. 1)

When the length of vehicle platoon at the exit is so long that it reaches the precedent entry, the roundabouts suffer from getting fully overcrowded.

How far does the strength of the pedestrian/cyclist stream influence the roundabout safety and capacity or How far do the crossing streams of pedestrians and cyclists disturb the stream of vehicles?

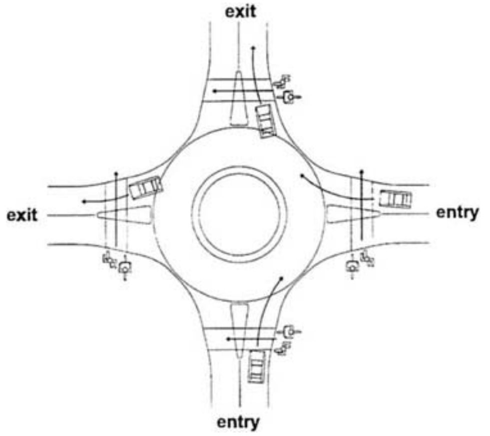

Figure 1. Disturbed streams in roundabouts

3 THE REDUCTION OF THE ROUNDABOUT SAFETY

Generally, in Slovenia, we used recommendations of Technical Memorandum H.7/71, which introduced smaller roundabouts with flared approaches (Brown,1995).

The crossing should be sited as far back from the junction as pedestrian convenience will alow. Crossing provision was preferably to be included in the deflection island, either, as an unmarked crossing place with lowered kerbs, or incorporated into a marked pedestrian crossing. Crossings located before the give-way line should allow two to three passenger cars to queue in each lane, between the give-way markings and the pedestrian crossing.

But, becouse we had not experiences at the start, we did not use the recommendations for pedestrians from current design guidance of Great Britain (crossings away from the flared entries, unmarked crossing places and other forms of controlled crossings with or without a central refuges). In Great Britain the type of facility selected depended upon the expected volumes and movements of both pedestrians and traffic, and should be designed in accordance with the current recommendations and requirements (Brown, 1995). But we started with rule: zebra crossing in flared entrance is necessity.

And the similar situation was with cyclists. Roundabouts have an impressive overal safety record for most vehicle types, but this does not apply equally to two wheeled vehicles. Research in Great Britain has shown that on four-arm roundabouts on Class A roads, injury accidents involving two-wheeled vehicles constitute about half of all those reported. The proportion of accidents involving pedal cyclists is about 15%, although they typically constitute less that 2% of the traffic flow. DOT, guidelines on the geometric design of roundabouts observes, that roundabouts are a particular hazard for pedal cyclists. The operational perfomance and safety factors have been monitored at a number of experimental schemes aimed at improving cyclists safety at roundabouts in Great Britain. Evaluation has concluded that once a cyclist has entered a roundabout it is difficult to reduce the risk, and that the use of shared facilities have limited use, depending on the volume of pedestrians and cyclists.

That was the reason why we prefered the facilities which take cyclists out of the circulatory carriageway at roundabouts, starded with rule: shared use by pedestrians and cyclists of a peripheral cycle/footway.

4 THE REDUCTION OF THE ROUNDABOUT CAPACITY

Becouse a crossing giving pedestrians and cyclists priority and it is located close to the entry/exit point of a roundabout, there will be inevitable consequences for the operation of the roundabout.

Marlow and Maycock quantified the reduction of junction capacity from the siting of uncontrolled marked crossings (zebra) close to junction, including the effect of "blocking-back" by queues on exit. The theoretical approach is based on random arrivals at "two servers in series". The application is limited to ratios of real crossing capacity to entry capacity greater than 1. If the ratio is less then 1, the real crossing capacity will dominate and segregation of pedestrians would be needed.

The reduction in capacity due to the blocking effect was found to be similar (or greater) than the approach crossing effect (Brown, 1995).

In 1987 Marlow looked into the question of traffic signal pedestrian crossings (pelicans) at or near to entries to mini roundabouts, and the effect on the traffic operation of the roundabouts, including resulting queues "blocking-back" into the junction. The recommendation in Great Britain suggested that Pelican crossing should be sited at least 20 m from the junction, to avoid this interaction (Brown, 1995).

Becouse zebra crossing in flared entrance is necessity in Slovenia and crossings are located before the give-way line approximately 10 m (to allow two passenger cars to queue between the give-way markings and the pedestrian crossing) in some single-lane roundabouts with a strong stream of pedestrians and/or cyclists we have a problems of getting crowded and empty in their circulatory roadway (blocking-back effect).

The possible methodology of calculating the reduction of the roundabout capacity due to the strong pedestrian and/or cyclist stream used in Slovenian roundabouts is presented below.

4.1 *Emptying the roundabout*

The stream of vehicles is directed to the roundabout exit and it is crossed by a strong pedestrian/cyclists stream (Fig. 2). In this case vehicles are hindered once.

When a strong pedestrian/cyclist stream crosses one of the roundabout arm, disturbances in vehicular flow at the first adjacent entry occur (opposite the traffic movement in the roundabout). It leads to vehicle delays.

The flow disturbances are carried over to the next entry and entering or leaving the carriageway is possible only on remaining two quadrants. Accumulation of vehicles on one of the two remaining quadrants results in delays on all entries. Thus, the whole roundabout is totally blockaded.
The blockade of a roundabout, which may occur or not, depends on the strength of the traffic flow and on the way (distribution) how pedestrians or cyclists enter the roundabout.

4.2 *Filling up the roundabout*

The similar situation occurs when vehicles enter a roundabout. However in this case vehicles are hindered twice (Fig. 3). Vehicles enter the roundabout entrance which is intersected by a flow of pedestrians/cyclists.

Gaps between two successive pedestrians/cyclists are so long that vehicles at the entry use them and drive into the roundabout undisturbed. If there is no circulation carriageway in the roundabout or the gaps between vehicles in the circulation carriageway are big enough, vehicles drive into the carriageway undisturbed.

By increasing the flow of pedestrians/cyclists, gaps between traffic flow units decrease. There are situations when particular gaps are shorter than it is acceptable. In this case the vehicle is queued before pedestrian crossing. If the flow of pedestrians/cyclists is strong, a platoon of vehicles appear at the entry of the roundabout. A platoon also takes place at the entry if there is a strong circulation carriageway. In this case one or two vehiclec delays between inscribed kerb of the circulation carriageway and the kerb of the pedestrian crossing, while other vehicles queue up at the entry of the intersection.

A delay at the roundabout entry occurs also in the case of the vehicles delay on a circulation segment which results from disturbed flows at the next roundabout exit.

4.3 *Emptying and filling the roundabout at the same time*

In practice there is usually the combination of both examples at the same time, that means the roundabout gets filled or emptied at the same time.

It is also usual that the intensive flow of pedestrians/cyclists intersects only one of the roundabout arm. However, there are occasions when a stream of pedestrians/cyclists intersects all the legs, the consequence of which is that the blockade occurs earlier.

The paper presents the analysis of the situation where a strong pedestrian/cyclist stream intersects only one of the roundabout arm.

Vehicles are leaving the roundabout (Fig. 4). They must give priority to the stream of pedestrians/cyclists. If the gaps between the units of pedestrians/cyclists are big enough, drivers at the exit use them for the exit operation. If the crossing stream of pedestrians/cyclists is stronger, there are some de-

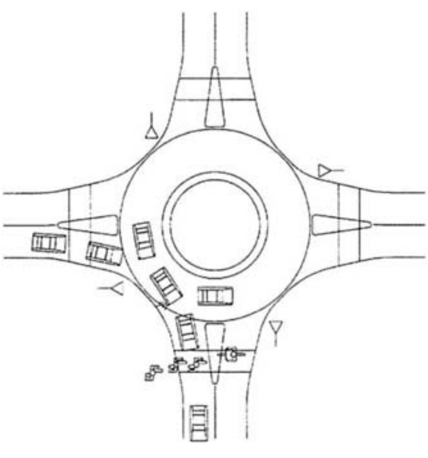

Figure 2. Disturbances in vehicular flow at the first adjacent entry occur (opposite the traffic movement in the roundabout).

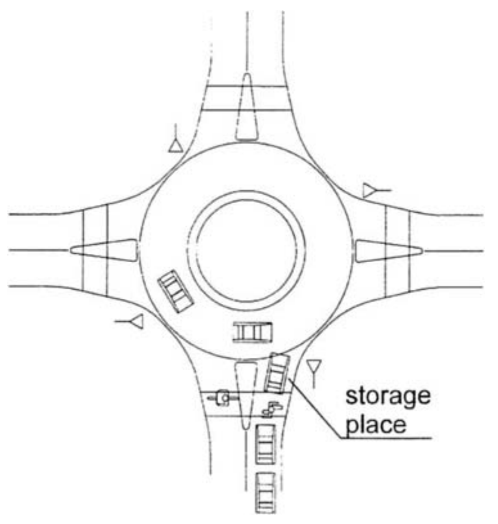

Figure 3. Filling up the roundabout

lays in the holding line. If the following vehicle is directed towards one of the next exits, there will be no delays in the circulating carriageway as the vehicle continues to move. If the following vehicle is directed towards the same exit (the exit where a vehicle already waits) there is an accumulation of vehicles in the circulating carriageway. If vehicles are entering more intensively, a platoon occurs. If the platoon of waiting vehicles stretches to the preceding entry, there are problems of filling the roundabout with vehicles at the preceding entry.

In a single-lane roundabout with a storage place (between the give-way marking and the pedestrian crossing) for one waiting vehicle three situations occur:

- gaps between particular units of crossing stream satisfy the moving of the vehicles and there are no vehicles in the storage place;
- gaps between particular units of crossing stream still satisfy the moving of the vehicles although there are some delays with one vehicle;
- gaps between particular units of crossing stream are too small, the storage place is occupied all the time and every entering vehicle queues in the circulating carriegeway.

5 REDUCED ROUNDABOUT CAPACITY DUE TO DISTURBED STREAMS

The problem of disturbed streams in roundabouts can be solved by using the theory of mass service, as a single channel open system:

The entering/leaving units (vehicles) into the system (roundabouts) are coincidental. The system is single-channeled, as in a certain moment only one unit (vehicle) may be serviced (crossing). The system is open as the units (vehicles) enter the system (the roundabout) from the surroundings (Fig. 5).

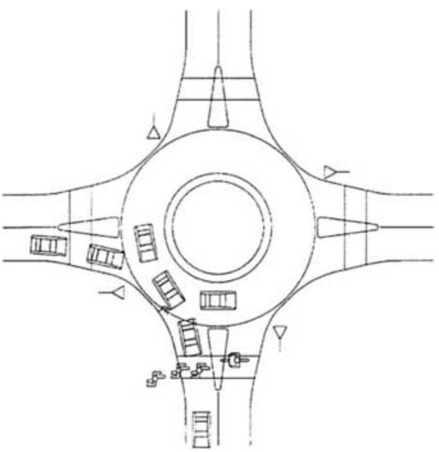

Figure 4. Emptying and filling the roundabout at the same time

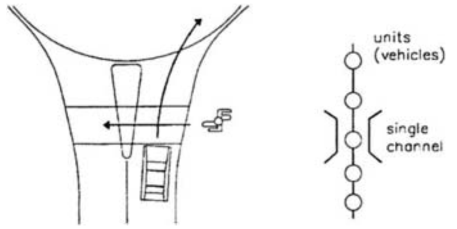

Figure 5. Roundabout entry = single-channaled open system of mass service

The entering/leaving of the vehicles follows the Poisson's law of distribution, as the following is accomplished:

- the probability of entering/leaving of a vehicle $p_n(t)$ depends on the length of gaps and the number of entering/leaving vehicles, and not from the beginning of its measuring;
- the probability of entering/leaving of a vehicle $p_n(t)$ does not depend on the number of entering vehicles before gap measuring - flow without consequences;
- in a sufficiently long gap two or more vehicles cannot enter.

Stream disturbing may be defined with the factor of operation:

$$\rho = \frac{\lambda}{\mu} \tag{1}$$

where λ = intensity of entering vehicles at the entry/exit; and μ = operating intensity at the roundabout entry/exit.

The value of the operating factor can be $\rho < 1$ (the stream of the vehicles is undisturbed) or $\rho \geq 1$ (the stream of the vehicles is disturbed).

We define the criterion for the blockade of the roundabout exit with single-lane circulating carriageway:

The roundabout exit is blockaded in the case when a vehicle reaches the exit, but the vehicle reaching it before has not left the holding line yet.

In this case we deal with a single-channeled system of mass operation with a limited holding line.

If the possible number of vehicles in the holding line is marked with m and considering that in the system there may be from 0 to m + 1 vehicle, then a roundabout with a single-lane circulating carriageway applies as $0 \leq m \leq 2$.

The probability of a particular system state is calculated with:

$$p_n = \rho^n * p_0 \tag{2}$$

while p_0 depends on the value of the operation factor.

$$\rho > 1;\ p_o = \frac{\rho - 1}{\rho^{m+2} - 1} \tag{3}$$

$$\rho \leq 1;\ p_o = \frac{1 - \rho}{1 - \rho^{m+2}} \tag{4}$$

It must be stressed here that the counting of traffic should be done in the rush hour in a short gap. At the same time we must calculate the time a vehicle needs to enter the circulating carriageway. This result must be compared with other measures of an acceptable gap for to turn right in the crossing.

The following steps are:

- the probability of blockade (if m=2):

$$p_{block.} = p_2 \tag{5}$$

- the probability of constant service:

$$p_{service} = r = 1 - p_{block.} \tag{6}$$

- absolute capacity of system (the entering/leaving units into the system are coincidental):

$$R = \lambda * r \tag{7}$$

- nominal capacity of system (vehicles are leaving in constant sequences):

$$R_{NOM.} = \mu \tag{8}$$

6 CONCLUSION

In calculating the real capacity of a roundabout with a single-lane entry, a single-lane circulating carriageway and with a strong cross stream of pedestrians and cyclists it is necessary to take into consideration the decrease of the roundabout capacity due to disturbed flows at the roundabout entries and exits.

Disturbed flows appear when the pedestrian/cyclist stream is strong and the gaps are too small to enable the vehicles to pass. Vehicles at the roundabout entries and exits have to give way to pedestrians/cyclists. Therefore there are disturbancies in flows and delays.

The problem of disturbed streams in roundabouts can be solved by using the theory of mass service, as a single channel open system:

The methodology of calculating the reduction of the roundabout capacity with the disturbed streams may be used for the roundabouts in urban areas, where the strength of the cyclist or pedestrian streams is not negligible.

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Intelligent transport systems (ITS) and parking management: The case of Brazil

Les systèmes intelligentes de transport et la gestion des parkings: le cas du Brésil

Los sistemas inteligentes de transporte y la administración de estacionamientos: El caso de Brasil

M. M. B. Vianna, L. S. Portugal & R. Balassiano

Transport Engineering Group, Federal University of Rio de Janeiro, PET/COPPE/UFRJ, Brazil

ABSTRACT: The unbalance between supply and demand of parking spaces in urban areas can be seen in many cities. The main objective of this paper is to discuss the importance of adopting policies at "integrated parking management". Another objective is to discuss the potential of utilising Intelligent Transport Systems (ITS) in this process. The Brazilian city of Niterói will be considered as a case study in the paper.

RÉSUMÉ: Le désequilibre entre l'offre et la demande pour les places de parking est une réalité dans la plupart des grandes villes. L'objectif principal de cet article est le débat de l'importance d'adopter politiques de gestion intégré de parkings. Un deuxième objectif est le débat du potentiel d'utilisation des systèmes inteligents de transport dans le processus. L'étude de cas porte sur la ville de Niterói au Brésil.

RESUMEN: El desequilibrio entre la oferta y la demanda por espacios de estacionamiento en áreas urbanas puede ser caracterizado en varias ciudades. El objetivo principal de este artículo es discutir la importancia de adoptar políticas dentro del concepto de administración integrada de estacionamientos. Otro objetivo es discutir el potencial de utilizar "Sistemas Inteligentes de Transporte" en este proceso. El estudio de caso que será considerado en este trabajo es la ciudad de Niteroi, Brasil.

1 INTRODUCTION

Problems resulting from an imbalance between supply and demand of parking spaces have become increasingly more frequent in several towns, specially in denser areas which are poorly served by public transport and where planning and use of existing parking spaces is inadequate (Valleley, 1998). Consequently, traffic jams become more frequent and travel times become longer, resulting in less accessibility, and poorer quality of life and environment for the population. Different authors have highlighted the repercussion and losses, both economic and social, generated by these factors (Verhoef *et al.*, 1995; Coombe *et al.*, 1997; Miles *et al.*, 1998), re-stating the importance of developing parking control and management policies in tune with transport planning and social and economic development.

In this context, this paper intends to highlight the importance of adopting "integrated parking management" policies that provide not only a more sensible use of available parking, but also a greater harmony between performance of road and transportation systems, and urban land use. It also aims at uncovering the potential of the use of Telematics in such process, taking as reference the Brazil case represented by the city of Niterói.

2 PARKING MANAGEMENT

The present scenario in most urban centres is very complex, with saturated road systems and shortage of parking spaces. According to McDonald and Lyons (1996), and Vasconcellos (1997) this situation has deteriorated, specially in the second half of the 20th century, due to an overwhelming increase in the number of private vehicles. In fact, the last two decades have witnessed a dramatic increase in the world fleet. Records show that the number of vehicles in 1990 was twice the fleet that existed in 1970. Present expectations are for this fast growth to continue, and forecasts estimate the duplication of the present fleet by 2015 (Chick, 1996). Such growth may be even greater in developing countries that have adopted a road-based transportation model. In Brazil, for example, the private car fleet has not only doubled but multiplied by eight, from 2.6 million (in 1970) to about 18.3 million vehicles (in 1990). DE-

NATRAN (the National Transport Department) projections indicate this number may already have doubled by 2005.

According to studies carried out by Axhausen *et al.* (1994), the time to find a parking space may be as much as 40% of the total amount of travel time in certain driver groups, while unsuccessful search for parking spaces may represent over 30% of the traffic generated in midtown streets (Allen, 1993). Therefore, car parking management plays a major role in transport planning, as it directly impacts the transport system of any given area. These factors have boasted the development and implementation of integrated parking management policies for promoting accessibility, reducing traffic jams, accidents, and user frustration, in addition to allowing the harmonious development of cities.

The importance of parking control as a key element to demand and traffic management and the need for an integrated concept has been stated and advocated for some time now (Jackson, 1973; Verhoef *et al.*, 1995; Miles *et al.*, 1998). In order to realise this, it is necessary to ensure that users, traffic controlling agents and other players in the planning process — such as public transport operators and those responsible for parking lots — interact by sharing the information required to schedule trips and control vehicle circulation.

Some services are considered essential to the definition of a first outline of "integrated management'. However, to make it viable, the support of Telematics and its application in transport systems is of paramount importance in developing a concept that may be defined as "intelligent parking" (Vianna *et al.*,1999).

3 THE POTENTIAL OF TELEMATICS

In the field of transportation, the use of Telematics is associated with the development of what has been known as "Intelligent Transport Systems" (ITS), with multiple and diverse applications. The resources of Telematics have been used in several functional areas, including parking management (Nijkamp *et al.*, 1995).

Systems for parking management, also known as *Parking Guidance and Information Systems (PGI)*, or *Advanced Parking Information Systems (APIS)* have been used for the last two decades, having been implemented for the first time in Aachen, Germany. In the years that followed, the utilisation of such systems increased as they became popular for their ability to minimise jam problems resulting from the search for parking. Recent studies report over 50 such systems in operation around the world. (Polak *et al.*, 1990; Axhausen *et al.*, 1994).

Management systems have proved to be useful in the search and selection of available parking spaces, which confirms their operational feasibility. It is now possible to guide users by providing them with updated information (real time) on parking spaces localisation, directions and availability. Access control points on the various units interconnected to the system collect data, reporting the rate of occupation of the several interconnected parking areas to a Central Control where data is processed and handled to be transmitted to the user via cable-connected Variable Message Panels (VMS).

There are two main approaches for information broadcasting strategies: descriptive and prescriptive. In the prescriptive approach, the intent is to provide a user with all the parking information necessary for him/her to decide where to park. Alternatively, the prescriptive approach restricts the amount of information, narrowing down drivers choices in order to make the user adhere to the intents of the system providers. In other words, the objective is to restrict drivers choice and to transfer decision making to the Control System (Polak *et al.*, 1990).

As a whole, such systems can bring great benefits, as Gercans (1984) and Allen (1993) point out:

- for drivers, as it helps a user to search for and choose the most adequate parking space, with savings on fuel and operating costs, as well as reducing travel time;
- for the environment, as it reduces pollutant emission and improves urban areas;
- for traffic, as it reduces delays that result from unsuccessful search for parking, in addition to increasing road capacity by reducing car queues awaiting for parking, thus freeing roads and intersections;
- for parking operators, as it enables a more adequate distribution of demand between the several integrated units, which ensures optimum occupation;
- for managers, as it allows a better monitoring of information, simplifying decision making on the application of restrictive planning or making operation control much easier.

It is important to highlight that in addition to these benefits, such systems can contribute to increasing the number of public transportation users by means of development and implementation of integration strategies such as *Park-and-Ride*, which can reduce the number of vehicles in already saturated midtown areas.

Over the last couple of years a new dimension has been opened by researchers in the field of parking management thanks to advances in Telematics, with the introduction of several new uses (Polak *et al.*, 1990; Stathopoulos *et al.*, 1994; Boltze *et al.*, 1994). Issues that had never before been explored are now included in the listing of the system applications:

- ability to provide custom vehicle guidance, that

is, guidance that is directed to a single user through the use of displays inside the vehicles;
- ability for advance travel planning by providing relevant information on traffic and facilities, (mode integration and parking conditions);
- developing a service scheduling or booking process, by which services can be requested in advance, before or during the ride, via linked connections with the roads;
- automated check-in and payment through developments in the field of vehicle identification, as well as access control;
- integration with other transportation systems and development of proposals such as *Park-and-Ride*.

In Brazil, the use of ITS has been spreading through studies that aim at creating a national program to apply Telematics to transport - Programa Nacional de Aplicação da Telemática nos Transportes (PNATT) - proposing a communication model and designing a plan to be applied nation-wide (Borras, 1999). Although the potential demand for such equipment is high, development and production are still limited due to the economic hardships with which the country is faced. The use of integrated systems in parking management is not yet widespread, being restricted to a few business compounds where they are used for enhancing operation efficiency in individual parking areas; this has hampered the development of an integrated management plan.

Some development has been noted in the academic world, where there has been an increase of interest for the theme. It is worth mentioning the work) developed by Sá (1999) on parking management with her contribution to certain aspects of conceptualisation and identification of basic services and equipment. However, the work focuses basically on analysing individual parking areas, lacking depth in the review of integrated management or implementation methodology (Vianna *et al.*, 1999).

4 PARKING IN BRAZIL: THE NITERÓI CASE

The fast expansion of the Brazilian vehicle fleet may be explained by some major aspects, including: economic stabilization; radical changes in the current social structure (exalting the use of single-user vehicles); lack of land use planning; adoption of a road-based transportation model, and lack of investment in high-capacity transportation systems. Besides the fleet expansion, concentration of job opportunities in central areas, parking space shortage and inefficient enforcement of parking spaces have contributed to increasing problems caused by traffic jams in large and middle-sized towns in Brazil. As a consequence of the increase in the use of private vehicles and the increased demand for parking spaces, traffic conditions were aggravated making limitations of road capacity, inefficiency in appropriating existing spaces and environmental degradation even more evident.

The city of Rio de Janeiro is a typical example of this situation: the city is the scene of high road saturation, which is aggravated by shortage of parking spaces and inappropriate use of the existing ones. According to data collected by DETRAN (the local Transport Department) in 1997, 33% of all those who drive their cars in Rio have no place to park. Because of that, the number of parking-tickets issued has also risen, representing 39.27% of all traffic penalties in the municipality. Currently, mid-size towns such as Niterói have started to experience the same problem, which is a growing concern for transport planners.

The city of Niterói is sited within the metropolitan area of Rio de Janeiro, in the Southeast of Brazil. With a population of 453,285 inhabitants (CIDE, 1998) its economy is based on services and commerce. A large portion of the population works in the neighboring city, Rio de Janeiro, which concentrates greater job opportunities. Similarly to Rio de Janeiro, Niterói has been facing problems with traffic jams in later years. DETRAN data shows an increase in the amount of registered vehicles in the city from 150 thousand in 1997 to around 170 thousand, causing the major roads to be saturated at certain hours of the day.

Traffic problems led the Transport Authority to develop an integrated traffic and transportation plan – "Plano Integrado de Trânsito e Transporte" (PITT). Among the several actions the Plan proposed, some aimed at organizing parking, including: 1) the proposal to build three underground garages in partnership with private enterprises in order to supply the existing need for parking spaces; 2) a new proposal to rule roadside parking — this measure restricted supply and eliminated free parking in many areas, besides increasing in more than 200% the parking fees charged in other sectors; and 3) improved control to inhibit illegal parking, towing away inappropriately parked vehicles that block the normal flow of pedestrians and traffic.

However, these proposals have being object of much criticism. The system implemented as an attempt to rule the use of roadside parking in Niterói is very primitive, making use of parking slips that are checked by authorized keepers. The objective of charging for roadside parking is to gather funds for subsidizing the construction of the proposed underground garages which would have a total capacity for 2,300 vehicles. In addition, the idea behind this service was also to inhibit the use of the automobile in the most critical areas of the city, as well as inhibiting the activities of non-authorized keepers. However, such measures have provoked a negative response from the population who do not agree to be charged for parking along the roads. Users do not see any great benefits in the proposal and the cost of parking (approximately US$ 1,00 for a two-hour period) is too expensive for most users. It is also said that the intervention the Plan proposes does not contemplate the principles of land use that would ensure an improved appropriation of urban spaces by stimulating the use of mass transportation and optimizing the use existing parking spaces.

Considering the potentialities of an integrated system for parking management, the conclusion is for the relevance of its development, which supported by Telematics could effectively contribute to mitigate problems resulting from a shortage of parking spaces in the city. Such approach would allow the streamlined use of parking lots (not contemplated in the original project) as well as roadside parking, not linking the fee to the obligation to fund new parking lots. Also, it would be possible to promote the integration of parking with public transportation, so as to attract the private vehicle user and inhibit private car traffic in the most congested areas.

5 PROPOSALS FOR DEVELOPING THE SYSTEM

Parking must be understood as a system which provides the basis for exploiting the intrinsic relationships between the diverse elements at play in the parking process, thus serving as a link between means of transport and land use. From that we can establish the relevance of adopting more sophisticated controlling, monitoring, management, scheduling and trip planing based on posting real-time information.

Analysis of the international experience has demonstrated the promising potential of Telematics when applied to integrated management. Success of such proposal is conditional to the way information is handled by the various intervening agents involved in the management process. Telematics will enable us not only to identify required core services but also to identify a specific communication pattern.

Thus, a management process base on three different levels of action was developed (Vianna *et al.*, 1999):

- Macro: which consists of a broader characterisation of the problem, in the scope of the city or area where it is located. At this level, it becomes necessary to monitor access roads, traffic in general and also the aggregated availability of parking in each traffic zone. Information from this operation is handled by the Control and Planning Centres, always trying to balance demand and offer, and aiming at keeping road capacity and environment standards. From that point on, it is possible to keep customers posted on free spaces in each traffic zone and inform areas or itineraries to be avoided. At this stage, using variable message displays or broadcasting information by radio waves must be considered;
- Intermediate: in which the problem is analysed for each specific traffic zone and the user is given more detailed data on each parking facility within the area (such as the level of occupation, possible integration and fees). It also allows directing the user;
- and Micro: focused on the local level, it provides information on parking available on a certain street or within a certain parking lot. At this level it may be possible to control local pollution levels and to streamline charging and monitoring processes by identifying illegally parked vehicles that can be located, fined and quickly removed by the teams in charge.

Generally speaking, the technology required to ease operation at these three levels is very similar to that applied to other areas of transportation management, requiring equipment such as AVI (*Automatic Vehicle Identification*); "inductive loops"; CTV (*Closed Circuit Television*); VMS (*Variable Message Signs*), besides transmitters with either one or two-way communication links.

In Niterói, based on the proposal developed by Nijkamp *et al.* (1995) and local specificity, the implementation of a system based on displays and cameras in a closed TV circuit that allowed managing and monitoring the process was considered. At first, only privately owned parking lots located off the roads would be connected to the Central Control (CC) given the high deployment costs that should then be funded by this group of companies. However, plans would allow for future expansion of the system so as to aggregate both new parking lots off the roads and parking spaces along the ways. The latter type of parking would be controlled with parking meters connected to the CC. At this stage, costs pertaining to the system expansion would be run by public agencies partnered with private enterprises.

Regarding displays allocation, they should be placed along the city access roads, allowing a driver to chose his preferred zone based on the number of available spaces and facilities, such as integration possibility. When getting to the chosen area, this vehicle will be directed exclusively to the said zone parking options, receiving broken down and more detailed information as it approached its destination. It is important to keep in mind that, within the chosen zone, a system user will not be informed about the status and location of parking spaces in other zones. This kind of information will become available only at boundary areas or access corridors.

This system allows for access control at off-the-road parking lots, equipped with automated identification devices, where charging may be performed electronically. For roadside parking, payment would be made when parking according to parking meter restrictions. Booking parking off the roads has also been contemplated and could be made in advance or during trip time by mobile phone. Booking for roadside spaces would not be available as they are in a smaller number and should serve as a "prize" to the user. Regarding inadequate parking, it is possible to say it would be strongly inhibited — CCTV cameras would catch any illegally parked vehicle that would receive the corresponding fine; teams would be warned to tow the vehicle as soon as the infraction were consolidated thus streamlining the whole operation.

Initially, pollution monitoring would have only informational purposes, checking air conditions in the area. In the future, based on how the system evolved, messages could be posted so that areas with higher pollution rates could be avoided, and alternative itineraries suggested.

Based on these services, the system will not only guide a driver to the available parking space nearest to his destination, thus improving user satisfaction and parking search efficiency, but also reduce resulting traffic congestion as well as pollution and environmental degradation. Ultimately it will allow for the optimised use of urban space and rational development of the city.

6 CONCLUSION

This paper discussed the importance of adopting transportation policies capable of providing higher levels of integration between parking areas and transportation means, serving as foundation to a system named Integrated Parking Management System, based on the use of the resources of Telematics.

It was possible to conclude that a broader use of Telematics had great potential to help in this process, making its productive routines viable, allowing a more effective management of available parking spaces through precise occupation control. In this approach, an analysis of available parking space in denser urban areas becomes an integral part of transportation system planning and the whole road network. The use of "integrated systems" must be based on the development of standard procedures that enables services to be properly implemented by allowing the identification, regulation and normalization of such services. It is also important to define equipment and technology requirements for an efficient operational integration. In this context, studies must be developed for these requirements to be met.

In practice, in the case of Brazil, some hindrances to the process of integration of the various structures in the transport system may be pointed out requiring special efforts in equating some issues, such as: lack of an integrated transport policy to allow the adequate inclusion of parking in transport planning; lack of integration between operators who manage off-the-road parking lots, and who not always are willing to collaborate to the adoption of integrated plans; lack of integration between government agencies responsible for traffic control and the various parking operators; the diverse conflicting aspects included in the control proposals pertaining to users and operators.

From the perspective of strategic transport planning and technology updates in the sector, it is important to ensure that parking is operated so as to adjust to a new reality. It is necessary for universities and research institutions, the public sector and private enterprises to make a joint effort to overcome any difficulties pertaining to the operational integration in order to allow the fast and broad dissemination of the concept of Integrated Parking Management.

It is worth stressing that the use of such systems must be justified either by insufficient supply or disorderly use of available parking. Results in towns where supply surpassed demand did not yield the expected efficiency. Therefore, it becomes evident that the implementation of this system does not intend to encourage additional trips to the town centres, as one may assume considering that offer would be optimised and therefore virtually "increased". On the contrary, the objective is to encourage a more adequate use of those same existing parking spaces, ensuring a larger number of users accessibility to the city and a more rational appropriation of the road structure, with public transportation system playing a major part in daily trips.

In the specific case of Brazilian towns, this project would represent a possibility of organisation for the road system in denser areas, in addition to serving as a first step towards integration of entities responsible for traffic, empowering them to take action and enforce rules in accordance with public interest.

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Road traffic safety: A log-linear model application to urban area and a proposal of an ANN

La sécurité routière: application d'un modèle log-linéaire et une proposition d'une RNA

La seguridad del tránsito: Aplicación de un modelo log-lineal y una propuesta de una ANN

S.Amoroso & M.Ciuna
Institute of Transportation Studies, University of Palermo, Italy

ABSTRACT: Analyzing road accidents is actually very complex, as they are caused by the interaction of very different factors, as driver behaviour, vehicle characteristics, traffic conditions and infrastructure characteristics. This paper proposes an approach of study about road accidents in urban area using a statistical log-linear model to individuate the main factors determining the seriousness of accidents. Beside the article shows the possibility of using artificial neural network as an instrument to value and classify accidents. The current study has been carried out in urban area using data regarding accidents which happened in Palermo in the last five years. These accidents took place in signalised and unsignalised intersections.

RÉSUMÉ: L'analyse des accidents routières est actuellement trés complexe en étant causée par l'interaction de facteurs très différents comme le comportement du conducteur, les caractéristiques du véhicule, les conditions du trafic et les caractéristiques de l'infrastructure. Cet article propose un premier contact avec l'étude des accidents routières en domaine urbain au moyen de modéles statistiques log-linéaires pour la détermination de principaux facteurs qui déterminent la gravité de l'accident et en plus il individualise la possibilité d'utiliser les résaux neuronaux artificiels comme moyen de appréciation et classification des accidents. Cet étude a été réalisé dans un domaine urbain en utilisant données concernantes accidents advenus à Palerme dans les cinq dernières années en correspondence d'intersections avec et sans feux.

RESUMEN: El analisis de la accidentalidad de carratera es actualmente muy compleya siendo causada por la interacción de factores muy diferentes como la conducta del guiador, las caracteristicas del vehículo, las condiciones del tránsito y las caracteristicas de la infraestructura. Éste artículo propone un procedimiento para el studio de la accidentalidad urbana mediante el uso de modelos estadisticas log – lineales para individuar los principales factores que detérminan la gravedad del accidente y invididua también la posibilidad de utilizar las redes neurales como instrumento de valoración y clasificación de los accidentes. El presente estudio ha sido desarrollado en área urbana utilizando datos relativos a accidentes sucesos en Palermo en los últimos cinco anos en correspondencia de intersecciones con y sin semáforo.

1 INTRODUCTION

The ever-growing mobility demand produced a significant motorization increase, which in addition to the progressive infrastructure saturation and service levels reduction, caused a worrying reduction of safety limits.

Even if the accident level is less serious in an urban environment (according to the consequences not the number) compared to an extra urban environment, accidents are more complex to interpreted as there are many factors to consider.

There are two ways of studying road accidents according to the survey of the accident.

The approach giving us an on-line control of traffic situation and accidents registers, by instruments controlling density and speed variation, the conditions at the moment of the accident.

This way of working has been successful in extra urban areas where a sudden block in the flow and speed values represents an unusual phenomenon. On the other hand it is difficult to adopt this method in urban areas where there are regularly traffic jams, as high traffic levels cannot be so it cannot be connected to the presence of road accidents.

An example is represented by temporally road yards for road works that are put on the roads daily and the most of all causing road jams in most chaotic cities.

Moreover, in urban areas where road networks are very complex, this kind of analysis would result uneconomical.

A second approach to the study is based instead on concerning the accidents and survey shortly after the accidents such as the survey carried out by road police responsible for this work.

Therefore we can study what have caused the accident, the factors might determining the accident seriousness and what links these factors.

The current study has been carried out in an urban area using data regarding accidents, which have happened in Palermo in the last five years. These accidents took place in signalized and unsignalized intersections that present the highest density of accidents reported in the minutes of the bodies in control of surveying.

We have considered as most significant parameters those ones regarding flow conditions (flows, density) infrastructure characteristics (intersection geometry, road surface condition, traffic directions and regulations), car typology, transgressions committed, and meteorological conditions.

2 DATA COLLECTION

This study has been carried out in an urban area analyzing accidents in six intersections, three with traffic lights and three without traffic lights, where there was the highest number of accidents. They are four legs intersections with similar geometric characteristics.

At first we used before a single site approach involving the identification of "blackspot" location on the basis of the number of the accidents, in a single site in a given period of time.

Analysis were carried out for a period of five years to avoid an episodic study.

Then we used a mass action approach for sites characterized by a predominant type of accident for which we determined different kinds of scenarios.

The collected data were put together by direct consultation of records in the office of the Police Department of Road Accidents in Palermo, taking all necessary information concerning each accident.

Such data represent only a part of real accidents because other accidents are often dealt directly with drivers and their assurances.

This kind of research presented some difficulties, for the lost of time and as the consulted information is sometimes not complete especially for those accidents that occurred before 1997, and some record of which are missing.

That caused the exclusion of some of them from the complete analysis. In this analysis we dealt all the categories which will be described later.

For our study we could use only 120 of the350 accidents that have been analyzed.

The data collected are now organized in our data bank as follows:

1 accident description: date, hour, place, seriousness (number of injured people and their prognosis), number of vehicles involved in the accident;
2 intersection description (signalized, not signalized, number of lanes, signs);
3 environmental conditions: atmospheric conditions, lighting, visibility, road surface conditions;
4 kind of manoeuvring causing the accident;
5 driver characteristics: sex, age;
6 kind of vehicle: car, bike, lorry.

3 ORDINAL LOGISTIC REGRESSION

The logistic regression investigates the relationship between a response variable and one or more predictors, when the response variables are categorical. The maximum likelihood estimates of the parameters are obtained by means of an iterative - reweighted least squares algorithm. This method estimates the parameters so that the fit model is optimised.

We obtain maximum likelihood estimates of parameters using an iterative - reweighted least squares algorithm.

This method consists of fitting a linear model (regression model) to the logs of the counts, also using the counts as weights.

This procedure has essentially the same asymptotic properties as maximum likelihood estimation.

For model construction we chose a link function of the logit kind (that is the inverse of cumulative logistic distribution function).

The model is so defined:

$$g(\gamma_{ij}) = \theta_i + x'_j \beta \qquad i = 1, \ldots\ldots, k - 1$$

where

k = the number of distinct values of response or the number of possible events

γ_{ij} = the cumulative probability up to including event i for the j^{th} factor / covariate pattern

$g(\gamma_{ij})$ = the link function

θ_i = the constant associated with the i^{th} event

x'_j = a vector of predictor variables associated with the j^{th} factor / covariate pattern

β = a vector of coefficients associated with the predictors

The logit link function that we used is so expressed as the log of the so-called odd ratio:

$$g(\gamma_{ij}) = \log_e\left(\frac{\gamma_{ij}}{1-\gamma_{ij}}\right)$$

Every categorical variable is divided into levels. For every factor we determined a reference level. The factor level that has been designated as the reference level, is the identified with number zero for all factors.

In the regression analysis we used the following categorical variables, after collecting them when possible and removing those ones we judged in the first approach closely connected with others most significant:

- data, divided into four levels representing the four seasons (spring, summer, autumn and winter);
- time, divided into four levels, representing four intervals (0.00 ÷ 6.00 a.m., 6.01 ÷ 12.00 a.m., 0.01 ÷ 6.00 p.m., 6.01 ÷ 12.00 p.m.);
- vehicles involved in the accident, divided into three levels (only cars, also bikes, also lorries);
- traffic lights, divided into four levels (absent, regularly working, irregularly working, working on intermittent yellow light);
- kind of the collision, divided into five levels (head-on collision, side collision, collision happening when two vehicles draw up alongside, collision with a fixed or moving obstacle);
- road surface conditions (dry, wet surface);
- traffic conditions (intense, normal, poor traffic);
- visibility (adequate, inadequate);
- driver sex (male, female).

The driver's age has been inserted as a quantitative variable.

Weather conditions were not admitted because surface conditions were taken into consideration such as wet roads because of rain and dry roads when the sky is clear or cloudy.

We grouped lighting and visibility together.

As response variable, vehicle damage and prognosis for injured people were considered.

In particular, as the accident seriousness is not related to the number of injured people (this datum is linked to casualty of the presence of one or more people on the vehicle) or the medium prognosis (this variable would change the seriousness level casually), we consider the injured person with the highest prognosis.

For the computation we used the statistical software MINITAB.

After a first analysis we carried out a backward step-wise regression to verify if the additional contribution of one or more predictors was significant.

We started with the complete model, obtained including all the predictors at our disposal.

First we excluded the predictor presenting the highest p-value, i.e. that one causing the lower reduction in the "explanation" of the response variable.

We checked if other parameters had become significant; at this point we considered the reduced model of a predictor and we tried to exclude another predictor.

After excluding the third predictor (in order of importance) we tried to include one of the predictors excluded before, as after excluding the others its contribution might have become significant.

The procedure stops when it is no longer possible to exclude some predictors as the predictors are significant.

In the following table, we present the results of analysis with all the predictors.

The logistic regression table shows the p-value, the odds ratio and a 95% confidence interval for the odds ratio.

Here we consider the odds ratio of the different levels and the reference level for every variable.

Observing the obtained results, as p-values and the correspondent confidence intervals, we noticed that the accident seriousness in urban environment is influenced by the presence of bike involved in the collision and by the hour in which the accident takes place; in particular, in the evening hours we noticed a 41% seriousness increase in comparison with the morning hours.

We noticed the road surface conditions do not influence the accident seriousness, which is likely to be explained by the fact that when the road surface is wet, the speed is lower as the drivers are more careful, therefore the collisions are less serious.

Moreover, we have to notice that most of the accidents happening in urban environment are caused by a transgression of the rules of the road, generally in giving way and in exceeding the speed limit (giving way and respecting the speed limits are the characteristics most respected when the road surface is wet and less respected in the evening hours).

Ordinal Logistic Regression

Link Function: Logit

Logistic Regression Table

Predictor	Coef	StDev	Z	P	Odds Ratio	95% CI Lower	Upper
Const(1)	-3,944	2,139	-1,84	0,065			
Const(2)	-3,880	2,139	-1,81	0,070			
Const(3)	-3,755	2,137	-1,76	0,079			
Const(4)	-3,465	2,134	-1,62	0,104			
Const(5)	-3,154	2,131	-1,48	0,139			
Const(6)	-2,685	2,127	-1,26	0,207			
Const(7)	-2,498	2,126	-1,17	0,240			
Const(8)	-2,071	2,123	-0,98	0,329			
Const(9)	-1,481	2,120	-0,70	0,485			
Const(10)	-0,574	2,116	-0,27	0,786			
Const(11)	-0,487	2,116	-0,23	0,818			
Const(12)	0,473	2,118	0,22	0,823			
Const(13)	0,642	2,121	0,30	0,762			
Const(14)	2,017	2,189	0,92	0,357			
Const(15)	2,719	2,290	1,19	0,235			
Data							
1	-0,3185	0,6024	-0,53	0,597	0,73	0,22	2,37
2	0,6805	0,5290	1,29	0,198	1,97	0,70	5,57
3	-0,2534	0,5297	-0,48	0,632	0,78	0,27	2,19
Time							
1	2,653	1,179	2,25	0,024	14,20	1,41	143,33
2	2,610	1,175	2,22	0,026	13,60	1,36	136,03
3	3,737	1,215	3,07	0,002	41,98	3,88	454,70
Veic.							
1	-1,0720	0,4838	-2,22	0,027	0,34	0,13	0,88
2	-0,5587	0,8463	-0,66	0,509	0,57	0,11	3,00
Traffic lights							
1	-0,6002	0,4908	-1,22	0,221	0,55	0,21	1,44
2	-0,450	1,134	-0,40	0,692	0,64	0,07	5,89
3	0,473	1,385	0,34	0,733	1,60	0,11	24,22
Kind of coll.							
1	0,930	1,470	0,63	0,527	2,53	0,14	45,22
2	2,213	1,736	1,27	0,202	9,14	0,30	274,52
3	2,806	1,676	1,67	0,094	16,54	0,62	441,23
4	1,788	1,845	0,97	0,332	5,98	0,16	222,42
Road surf.							
1	-0,3548	0,6177	-0,57	0,566	0,70	0,21	2,35
Traff.							
1	-0,0617	0,4086	-0,15	0,880	0,94	0,42	2,09
2	-0,1696	0,6713	-0,25	0,800	0,84	0,23	3,15
Vis.							
1	-0,9399	0,5811	-1,62	0,106	0,39	0,13	1,22
Sex							
1	-0,2583	0,3863	-0,67	0,504	0,77	0,36	1,65
Age	0,00059	0,01195	0,05	0,961	1,00	0,98	1,02
Age	-0,00857	0,01515	-0,57	0,572	0,99	0,96	1,02

Log-likelihood = -231,531

Test that all slopes are zero: G = 30,468; DF = 22; P-Value = 0,108

Goodness-of-Fit Tests

Method	Chi-Square	DF	P
Pearson	1477,238	1523	0,795
Deviance	463,062	1523	1,000

4 USING NEURAL NETWORK

One of the most important tools which are spreading in the research field regarding road safety (geographic information systems, expert systems, etc.) is represented by artificial neural networks. They are tools able to analyze problems for which defining a priori the kind of functional link existing between dependent and independent variables is difficult.

Neural network development for road accident investigation seems to be an innovative and promising research field.

This research proposes an artificial neural network as an instrument for the evaluation and classification of accidents.

We tried to obtain mathematical models simulating the operation procedure of the natural neural aggregates and their way to elaborate information.

Neural network structure is represented by elementary logic units (neurons) connected by the synapses cooperating independently through weights which changing on-line, cause the learning process.

That simulates what happens in the human brain where in the synapses electrical phenomena, inhibiting or exciting the received signals, take place.

To operate using neural network we have to recover a set of data of significant dimension.

In our study as input variables we considered the same variables used in the log-linear model and, in particular, we considered for each variable a number of neurons equal to the number of classes and for each accident active and equal to 1 we consider the active variable.

As output variable we considered a variable presenting three levels; one level represents the only material damage (accident without injured people), and the other two levels represent the seriousness of the injured people.

In particular, knowing the prognosis and the medical report, we divided injured people into lightly injured and seriously injured people; therefore when the accidents cause only material damage, we assume the first neuron equal to 0.9 and the other equal to 0.1 and vice versa, having considered as link function a sigmoidal function.

Till now we cannot give the results achievable through neural network, as the network was not able to learn and generalize, being the data quantity too limited.

We are continuing our research in that direction, as we think that neural networks could be useful also when realizing a software able to update on-line accident evaluation.

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A simulation model for the estimation of pollutant emission rate at signalized urban road segments

Un modèle pour l'estimation des taux d'émission des polluants dans les segments autoroutiers signalisés

Modelo de simulación para la estimación de los valores de emisión de contaminantes en un segmento de vía urbana

E.O.Akinyemi & Koan Lai
Institute for Infrastructural, Hydraulic and Environmental Engineering, Delft, Netherlands

ABSTRACT: This paper describes the characteristics of an urban traffic environment model (UTEM). It is a model that can be used to estimate the total rate of emissions of a pollutant emitted by vehicles moving along a signalized urban arterial road segment. In the model, the total rate of emissions is determined as the addition of emissions in four operating modes- cruising, acceleration, deceleration and idling- all of which depend on the traffic, control and geometric conditions of a segment. The model incorporates some unique features such as the ability to: (i) estimate flow rate per lane under different possible traffic and geometric conditions, (ii) deterioration factors based on the age and maintenance level of vehicles and (iii) the results of possible traffic control strategies for a segment. Finally, the model has been designed to be user-friendly and sensitive to any pollutant emitted by vehicles in traffic.

RÉSUMÉ: On présente ici une modèle environnemental de trafic en zone urbaine (UTEM). Ce modèl peut être utilisé pour l'estimation des taux d'émission de polluants dûs à des véhicles se déplaçant le long d'un segment signalisé d'une artère urbaine. Selon ce modèle, le taux total d'émission est donné par la somme des émissions pour les quarter modes suivants: vitesse de croisiére, accélération, décélération et stationnement. Chacun de ces modes dépend du trafic, ansi que des conditions géométriques et contrôle du segment. Les modèles prend en compte des caractéristiques inédites telles que la possibilité de: (1) déterminer les débits par voie pour différentes conditions de trafic et de géométrie, (2) les facteurs de détérioration en fonction de l'âge et du niveau d'entretien des véhicles, (3) les résultats de diverses stratégies de contrôle potentielles pour chaque segment. Enfin, le modèle est conçu de manière conviviale et peut prendre en compte n'importe quel type de polluant émis par les véhicles participant au trafic.

RESUMEN: El documento describe las características de un modelo de ambiente del trafico urbano (M.A.T.U.). Este es un modelo que peude ser usado para estimar el valor total de emisiones de contaminantes emitidos por los vehículos que se mueven a lo largo de un segmento de vía urbana señalizada. En el modelo el valor total de emisiones es determinado como la suma en cuatro modos de operción: crucero, aceleraión, deseaceleración y en ralenti, todos dependen del trafico, condiciones de contol y geométricas de un segmento. El modelo incopora algunas características únicas como la habilidad para: I) estimar el rango de flujo por carril para diferente trafico y condiciones.

1. INTRODUCTION

1.1 Traffic and road engineering actions determine the control, geometric, traffic and surface characteristics of a road. These characteristics affect, among other things, the load imposed on the local environment by traffic on the road. One of the major elements of the traffic-imposed environmental load is the total vehicular emission of pollutants or the total rates at which pollutants are emitted from vehicles on a road segment. Knowledge of these rates is important for two main reasons. First, analysis of traffic-generated environment a load requires adequate knowledge of total vehicular emissions of each pollutant type. This is illustrated in Figure 1. Secondly, compilation of the inventory of total vehicular emissions is an essential component of any evaluation of air quality in an area.

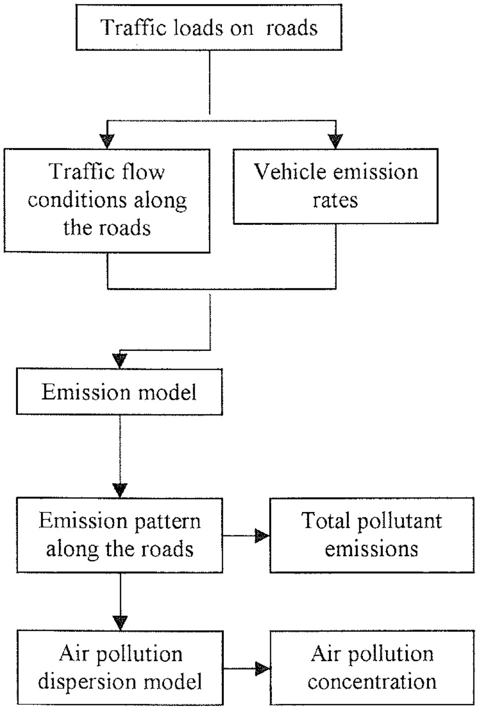

Figure 1. Modelling Air Pollution due to Traffic

1.2 Currently, there are two main methods of estimating the value of total emissions of a pollutant by vehicles on a road segment. The first method involves two steps. The first is to estimate, through field sampling and/or laboratory experiments, the rate at which each vehicle, or class of vehicle on a study emits a pollutant. The second step is to multiply each emission rate by an estimate of the distance traveled by the vehicle and simply sum up for all vehicles. While this method has the potential of producing very accurate results, the main disadvantage is that it is both time and money consuming. The equipment required may be difficult to obtain. In addition, extensive data is required for any meaningful results. Another disadvantage is that it is difficult with this method to analyze the effects of any proposed engineering actions on the total emissions.

The second method is modelling, i.e. use of mathematical models which incorporate major parameters of vehicle emissions to predict total emissions. This method is generally preferred by traffic and transportation engineers as a model can be used to predict the effects of their actions.

1.3 At present, one of the problems is that most of the models available are emission factors models. i.e. models which predict the average emission rate per vehicle. The limitations of the current generation of models, such as EMPAC 9 (CARB), MOBILE (US EPA) and MODEM (TRL), are well recognized and documented [Austin al. (1991); Asif Faiz (1996)]. For example, they reply on speed correction factors and driving cycles that have limited applications. Also, they use and require data that may either not be applicable or be difficult to obtain, especially in developing countries. In addition, they are not adequately sensitive to a vehicle's model events [such as idling, cruising, acceleration and deceleration], and traffic conditions that are affected by control and management strategies.

Furthermore, an emission rate is normally determined in grams per kilometer. This implies that determination of total emissions requires separate estimation of the average distance travelled by each vehicle on a road. Also, the nature and parameters of the models make them more suited for planning than for the purposes of traffic operations analysis.

The second problem area is the validity of the model assumptions. For example, emission factor models are based on assumptions of driving modes and behaviour that are either unrealistic or not valid in many circumstances. In addition, they require inputs of information, which in many applications are difficult to obtain and thus have to be assumed. As a result of these and other deficiencies, there appears to be a significant amount of underestimation of actual vehicular emissions on many roads, For example, the American National Research council (1991) and Guensler (1994) have reported that underestimation of actual on-road HC and CO emissions by MOBILE and EMFACT can be between 20-200%.

The third problem area is the nature of the outputs of pollutant dispersion models. Most produce typical average results while the results of greatest importance for traffic management and control purposes are the magnitude and duration of the most critical concentration levels.

The fourth major problem area is the applicability of the models for traffic engineering purpose, especially in developing countries. Firstly, there is a problem of the integrability of separate emissions and traffic models. It is difficult to integrate the models because of significant differences between input requirements, and between the inputs and outputs of the models. Furthermore, most emission models do not sufficiently incorporate appropriate traffic management and control variables. Partly as a result of these and other problems, some traffic simulation and optimization model packages such as INTEGRATION and TRANSIT-8 have incorporated their own emission estimation models. Unfortunately, however, virtually none of them were developed based on on-road emissions data, or tested and validated for their accuracy and representativeness.

The fifth major problem is the complexity introduced by the diverse vehicle fleets, rapid and unpredictable fleet growth rates, and unavailable or inaccurate basic data in most developing countries. Due to the shortage of measured data on vehicle emissions and air pollution concentrations in road micro-environments, most of the emissions and dispersion models are not based on real-life observations, especially on roads in developing countries. Consequently, significant errors are currently introduced through the application of these models to scenarios which are different from those for which they were validated.

1.4 As a consequence of these limitations, a research project was recently initiated to develop emission models based on what is known as a model approach. This involves models which are based on the operating modes of vehicles on different road sections. According to Miller (1993), this approach is likely to provide the best compromise between necessary model detail and feasibility of implementation. The primary goal of the research is to develop models which can determine the total emissions (and not emission factors) on different types of urban road segments as a function of the geometric, traffic, and control characteristics of the segment.

1.5 This paper describes the major characteristics of a model for an urban arterial segment controlled by a fixed time signal. The model has been develop by using a time-distance diagram of vehicles on the segment and shock-wave analysis. In addition, it incorporates all major vehicle, traffic, geometric, and control variables which are required for analysis of the effects of traffic management on total emissions.

The paper is organized into five sections including this introductory part. Section 2 describes the assumptions and concepts used in the models. In section 3 the major internally derived parameters are determined, while section 4 describes the operational characteristics of the model. Section 5 describes the major advantages and limitations of the model.

2. CONCEPTUAL FRAMEWORK OF THE MODEL

The model is designed to estimate the total pollutant emissions by vehicles on an urban arterial road segment with the geometric, control and demand traffic characteristics illustrated in Figure2.

The model is capable of estimating emission rates for up to five different pollutants, namely: Carbon Monoxide (CO), Hydrocarbons (HC), Nitrogen Oxides (NOx), Lead (Pb), and Suspended Particles Matter (SPM). In addition, it incorporates seven types of vehicles, namely: car (gasoline), minibus (gasoline), bus (diesel), light truck (gasoline), heavy truck (gasoline), two-stroke motorcycle, and four-stroke motorcycle. The basic assumption of the model is that: vehicles of the same type have similar acceleration, deceleration, emissions, and speed characteristics.

The basic approach of the model is to determine the total emissions of a pollutant from a lane as:

$$TE\,(l) = IASE\,(l) + USE\,(l) \qquad (1)$$

where:

$IASE\,(l)$ = total emission at the intersection approach part of lane *(l)*

$USE\,(l)$ = total emission rate at the remaining part of lane *(l)*

Furthermore, since an intersection approach part of the segment can be divide into a number of sections with homogeneous operational characteristics, ***IASE*** can be expressed as:

$$IASE\,(L) = \sum_i \sum_m EA(m,l,i) + ED(m,l,i) + EC(m,l,i) + EQ(m,l,i) \qquad (2)$$

where:

$EC(m,l,i)$ = rate of pollutant emissions by all vehicles of type (m) in cruising mode on lane (l) of section ***(i)***, (gm/sec.)

$EA(m,l,i)$ = rate of pollutant emissions by all vehicles of type (m) in acceleration mode on lane (l) of section ***(i)***, (gm/sec.)

$ED(m,l,i)$ = rate of pollutant emissions by all vehicles of type (m) in deceleration mode on lane (l) of section ***(i)***, (gm/sec.)

$EQ(m,l,i)$ = rate of pollutant emissions by all vehicles of type (m) in idling mode on lane (l) of section ***(i)***, (gm/sec.)

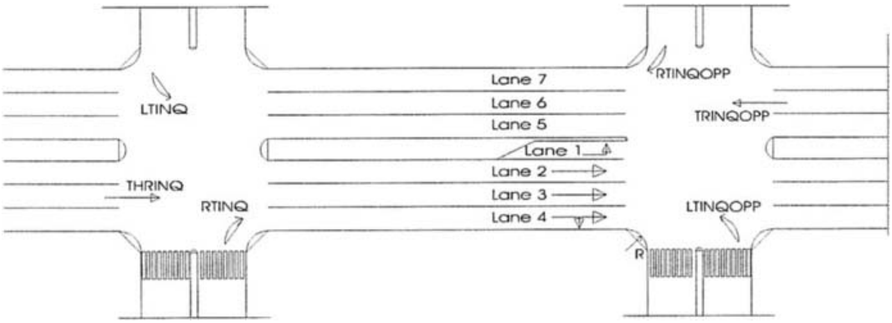

Figure 2. Urban Arterial Road Segment

Also, ***USE*** can be expressed as:

$$USE(l) = \frac{\sum_m Q(l,m).EFc(m).Speed(l)}{3600 \times 1000} \qquad (3)$$

where:

$Speed(l)$ = average speed of vehicles in lane (l), (km/h)

$Q(l,m)$ = flow rate on lane (l) of vehicle type (m), (veh/h)

$EFc(m)$ = emission factor of each vehicle of type (m) when it is in cruising mode, (gm/veh.km)

By considering the basic definitions, it can be shown that $EC(l,i,m)$, $EA(l,i,m)$, $ED(l,i,m)$, and $EQ(l,i,m)$ are as follows:

$$EC(l,i,m) = \frac{AREAc(l,i)Q(l,m)EFc(m).}{3600 \times 1000 \times TC} \qquad (4)$$

$$EA(l,i,m) = \frac{AREAa(l,i)Q(l,m)EFa(m).}{3600 \times 1000 \times TC} \qquad (5)$$

$$ED(l,i,m) = \frac{AREAd(l,i)Q(l,m)EFd(m).}{3600 \times 1000 \times TC} \qquad (6)$$

$$EQ(l,i,m) = \frac{AREAq(l,i)Q(l,m)EFq(m)P(l,m)}{3600 \times TC \times ELV(m)} \qquad (7)$$

where:

$EFq(m)$ = idling mode emission factor for vehicle type (m), (gm/veh.hr)

$EFc(m)$ = cruising mode emission factor for vehicle type (m), (gm/veh.km)

$EFa(m)$ = acceleration mode emission factor for vehicle type (m), (gm/veh.km)

$EFd(m)$ = deceleration mode emission factor for vehicle type (m), (gm/veh.km)

$AREAa(l,i)$ = the total area of section (i), on lane (l) for vehicles in acceleration operation mode, (sec.m)

$AREAd(l,i)$ = the total area of section (i), on lane (l) for vehicles in deceleration operation mode, (sec.m)

$AREAc(l,i)$ = the area of section (i), on lane (l) for vehicles in cruising operation mode, (sec.m)

$AREAq(l,i)$ = the area of section (i), on lane (l) for vehicles in idling operation mode, (sec.m)

$ELV(m)$ = effective length of vehicle type (m), (m).

TC = signal cycle length (secs)

$P(l,m)$ = probability of using mode m on lane(l).

In addition, by analyzing available data from several countries, Akinymi (1998a) has shown that in-service cruising, acceleration, and deceleration emission factors can be approximated as follows:

$$EFc(m) = EFq(m).(RS)^{-0.8}.A_f.M_f \qquad (8)$$

$$EFd(m) = EFa(m) = EFq(m).(0.5 \times RS)^{-0.8}.A_f.M_f \qquad (9)$$

where;

RS = running speed (km/h)

A_f = age factor

M_f = maintenance level factor

Previous research by Ibitoye(1996), Kouzis (1993) and Oketch (1994) have suggested that A_f and M_f are as shown in Tables 1 and 2.

The preceding equations show that two main requirements are the determination of: (a) traffic flow rate per lane for vehicle type (m), i.e. $Q(l,m)$, and (b) the areas of sections for vehicles in different modes, i.e. *AREAc(i), AREAa(i), AREAd(i),* and *AREAq(i)*. These are known as internally derived variables.

Table 1: Determination of age factor

Age (years)	A_f	
	CO	HC
NEW	1.00	1.00
1	1.06	1.06
5	1.25	1.20
10	1.30	1.20

Table 2: Determination of maintenance factor

Level of maintenance	M_f
Good	1.00
Average	1.20
Poor	1.40

3. DETERMINATION OF INTERNAL VARIABLES

Estimation of Expected Traffic Flow Rate per lane- Given the total entry flow into the segment, the traffic flow per lane on the uniform part simply involves an equal distribution of the volume into the lanes. However, the flow rate per lane on the intersection approach is more complex. Simple procedure has been derived by Akinyemi (1998b). It consists of the following steps:

- step 1: Obtain flow rate of each traffic movement [left turn movement flow rate (*QLT*), right turn movement flow rate (*QRT*), and/or the flow rate of through traffic (*QTH*)].
- step 2: Determine the total vehicular flow per lane (Q(l)) as follows:

For an intersection approach with only 1 lane

$Q(1) = QLT+QRT+QTH$ (10)

For an intersection approach with 2 lanes

Lane 1:

$Q(1) = QLT$ (11)
if lane = L[LT]

$Q(1) = QLT+QLTS$ (12)
if lane = L[LT+TH] and lane 2 is not L(RT)

$Q(1) = QLT+QTH$ (13)
if lane =L[LT+TH] and lane 2 is L(RT)

Lane 2:

$Q(2) = QRT$ (14)
if lane = L[RT]

$Q(2) = QRT+QLT+QTH-Q(1)$ (15)
if lane = L[LT+TH+RT]

For an intersection approach with three lanes

Lane 1:

$Q(1) = QLT$ (16)
if lane = L[LT]

$Q(1) = QLT+QLTS$ (17)
if lane = L[LT+TH]

Lane 2:

$Q(2) = Q(1)-Q(3)$ (18)

Lane 3:

$Q(3) = QRT$ (19)
if lane = L[RT]

$Q(3) = QRT+QRTS$ (20)
if lane = L[RT+TH]

For an intersection approach with four lanes

Lane 1:

$Q(1) = QLT$ (21)
if lane = L[LT]

$Q(1) = 0.5QLT$ (22)
if lane = L[LT] and lane 2 = L[LT]

Lane 2:

$Q(2) = 0.5QTH$ (23)
if lane 2 = L[TH] and lane 3 = L[TH]

$Q(2) = 0.5QLT$ (24)
if lane 2 = L[LT] and lane 3 = L[TH]

$Q(2) = 0.5(QTH-QLTS-QRTS)$ (25)
if lane 1 = L[LT+TH] and lane 4 = L[TH+RT]

$Q(2) = 0.5(QTH-QLTS)$ (26)
if lane 1 = L[LT] and lane 4 = L[TH+RT]

Lane 3:

$Q(3) = 0.5QRT$ (27)
if lane 3 = L[RT]

$Q(3) = 0.5QTH$ (28)
if lane 1 = L[TH] and lane 4 = L[RT]

$Q(3) = QTH-QRTS$ (29)
if lane 1 = L[LT], lane 2 = L[LT] and lane 4 = L[RT+TH]

$Q(3) = 0.5(QTH-QLTS-QRTS)$ (30)
if lane 1 = L[LT+TH] and lane 4 = L[TH+RT]

Lane 4:

$Q(4) = QRT$ (31)
if lane 4 = L[RT]

$Q(4) = 0.5QRT$ (32)
if lane 3 = L[RT] and lane 4 = L[RT]

$Q(4) = QRT+QRTS$ (33)
if lane 4 = L[TH+RT]

where:

$QLTS =$

$$MAX\left[0; \frac{QTH + QLT.FLT + QRT.FRT}{NL} - QLT.FLT\right] \quad (34)$$

$QRTS =$

$$MAX\left[0;\frac{QTH + QRT.FRT + QLT.FLT}{NL} - QRT.FRT\right] \quad (35)$$

$$FLT = \frac{1800}{1400 - Qopp} \quad (36)$$

$$FRT = \frac{1 + \frac{1.5}{R}}{\left[0.85 - MIN\left(\frac{PEDS,1700}{2100}\right)\right]} \quad (37)$$

where:

- -Qopp = Opposing flow rate
- -PEDS = number of pedestrians crossing while green time is given to right turn movement
- -R = radius of curve at right-turn movement
- -NL = number of lanes

Areas for Vehicles in Different Operating Modes: Consider a typical time-distance diagram of all vehicles on a signilized road segment as illustrated in Figure 3. If the intersection-approach part of the segment is divided into N sections, then the areas of section (i) for vehicles in cruising, acceleration, deceleration, and idling operation mode on lane (l), can be determined by using simple geometric relationships such as:

$$AREAa(l,i) = Ta.\frac{LG(l)}{N} \quad (38)$$

$$AREAd(l,i) = Td.\frac{LG(l)}{N} \quad (39)$$

$$AREAc(l,i) = \left(\frac{X(l,i) + X(l,i+1)}{2}\right)\frac{LG(l)}{N} - AREAd(l,i) + \left(\frac{Z(l.i) + Z(l,i+1)}{2}\right)\frac{LG(l)}{N} - AREAa(l,i) \quad (40)$$

$$AREAq(l,i) = \left(\frac{Y(l,i) + Y(l,i+1)}{2}\right)\frac{LG(l)}{N} \quad (41)$$

The times spent in deceleration mode T_d and acceleration mode T_a (in sec.) can be show to be:

$$T_d = \frac{RS}{3.6 \times ad} \quad (42)$$

$$T_a = \frac{RS}{7.2 \times aa} \quad (43)$$

where:

aa =Average acceleration rate, (m/sec^2)

ad =Average deceleration rate, (m/sec^2)

- Furthermore, the times spend at section (i), on lane (l), in cruising mode before and after stopping at the intersection $X(l,i)$ and $Z(l,i)$ respectively, and in idling mode $Y(l,i)$ can be determined as:

$$X(l,i) = \frac{3.6 \times i \times LG(l)}{N \times S_1(l)} \quad (44)$$

$$Z(l,i) = TG(l) \times \left(\frac{N-i}{N}\right) \quad (45)$$

$$Y(l,i) = TC\text{-}X(l,i)\text{-}Z(l,i) \quad (46)$$

where:

$S_1(l)$ =speed of stopping wave on lane (l), (km/h)

$LG(l)$ =length of queue which can be cleared in the green time allocated for lane (l), (m)

$TG(l)$ =green time for movement on lane (l), (sec.)

N =number of sections

- The length of the queue on lane (l), which can be cleared in the allocated green time $LG(l)$, and the total length of the queue $L_{que}(l)$, can also be determined as:

$$L_{que}(l) = \left|\frac{S_1 \times S_2 \times TR(l)}{3.6(S_2(l) - S_1(l))}\right| \quad (47)$$

$$LG(l) = \frac{S_2 \times TG(l)}{3.6} \quad (48)$$

where:

$TR(l)$ = red time for movement on lane (l), (sec.)

$S_2(l)$ = speed of starting wave on lane (l), (kph)

- From shock-wave analysis the speed of stopping wave $S_1(l)$ and speed of starting wave $S_2(l)$ can be expressed to be:

$$S_1(l) = \frac{Q(l)}{\frac{Q(l)}{RS(l)} - KJAM(l)} \quad (49)$$

$$S_2(l) = \frac{SATFLOW(l)}{KCAP(l) - KJAM(l)} \quad (50)$$

where:

$Q(l)$ = flow rate on lane (l), (vph)

$KJAM(l)$ = jam density on lane (l), (veh/km)

$SATFLOW(l)$ = saturated flow rate on lane (l), (vph)

$KCAP(l)$ = density at capacity on lane (l), (veh/km) ≅ 0.24 $KJAM(l)$

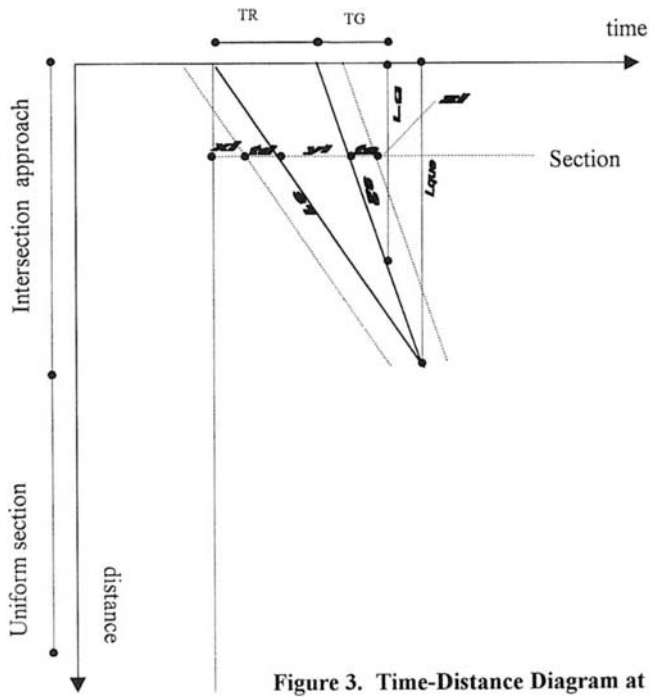

Figure 3. Time-Distance Diagram at Intersection

4. OPERATIOTIONS CHARACTERISTICS OF THE MODEL

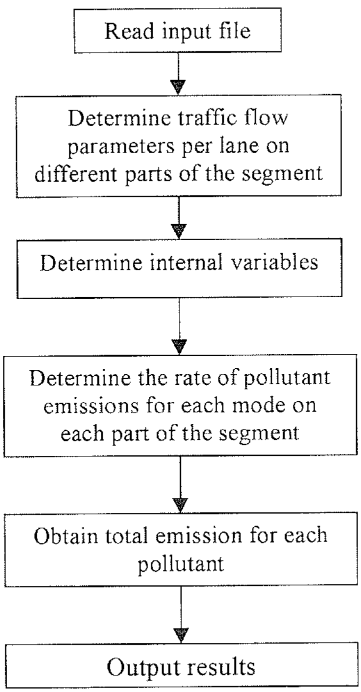

Figure 4: Schematic drawing showing the operational characteristics of the model

5. CONCLUSIONS

The proposed model is an attempt to improve on the current state of emission modelling in three major ways. Firstly, it is based on the modal approach, which is currently considered to be the best approach to emission modelling on urban roads. Secondly it incorporates all major factors which are known to affect the emission characteristics on an urban road. Thirdly, new features such as, restriction of lane use, distinction among different turning movements and differences in the number of lanes at uniform section and intersection approach are also made possible. This flexibility provides the engineer with the necessary tools affect the emission rate. In addition, it can be used for a variety of applications, including traffic analysis and design.

Undoubtedly, there are areas for improvement of the model. One area relates to input of ideal emission rates different types of vehicles. Another area is there is need for verification of the maintenance and other factors used in the model.

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Naive causal analysis and accident prevention strategies

Explications naïves de l'accident et strategies de prévention

Explicaciones ingenuas del accidente y estrategias de prevención

Dongo Rémi Kouabenan

Université Pierre Mendès France, Grenoble, France

ABSTRACT

This paper presents three illustrative studies which aim at showing that naive causal explanations for accidents (i.e spontaneous explanations given for road accidents by laymen) as well as the percepcion people have of risks on the road, could throw some light on the knowledge about accident causality as well as on its prevention. It is stressed that by taking into account the naive causal explanations for accidents given by ordinary people (drivers, pedestrians, policemen, road engineers, etc.), accidents countermeasures could be better understood and more easily accepted because they would integrate the cognitive functioning of those who are directly concerned by their execution.

RESUME

A travers trois exemples d'études, on tente de montrer que les explications naïves, c'est-à-dire les explications spontanément fournies pour les accidents par les personnes ordinairement confrontées aux risques routiers (conducteurs, piétons, ingénieurs, gendarmes, policiers, etc.), ainsi que la perception de ces risques, sont susceptibles d'éclairer les connaissances sur la causalité des accidents et les actions de prévention. Notamment, la prise en compte des explications naïves dans la définition des mesures préventives est supposée les rendre plus accessibles, car intégrant le fonctionnement cognitif des personnes directement concernées par leur mise en oeuvre.

RESUMEN

A través de tres estudios, este comunicado trata de demostrar que las explicaciones ingenuas, es decir las explicaciones de accidentes dadas espontáneamente por la gente que está confrontada habitualmente a los riesgos del tráfico (conductores, peatones, ingenieros, policias, guardias civiles, etc.), así como la percepción de los riesgos viales, pueden aclarar los conocimientos sobre las causas de los accidentes y las acciones de prevención. Particularmente, se supone que tomar en cuenta las explicaciones ingenuas de la gente profana en la definición de las medidas de seguridad, permite que sean más accesibles y más aceptables porque integran en su aplicación el funcionamiento cognitivo de la gente concernida.

INTRODUCTION

Causal explanation for accidents is a fundamental aspect in the designing of road safety strategies. Generally, the actions to be taken to prevent accidents are specified according to the conception we have of their causality. Most of the time, this explanation is alloted to experts, but actually it does concern all the actors who play a part in traffic (drivers, pedestrians, road engineers, safety engineers, policemen, transport companies' managers, insurers, etc...). Indeed, the theories of causal attribution in social psychology show that the explanation for events is a daily concern for everybody (see Kouabenan, 1999).

According to Heider (1958) for instance, a human being needs to feel himself in a regular and foreseeable environment, in which no event happens to occur by chance. He needs to maintain some control over this environment. The explanation for events by organizing and structuring environment gives to the individual a feeling of control. Consequently, we think that the people who are daily confronted with risks on the road are not unsensitive to the explanation for the occuring accidents (Kouabenan, 1999). Causal explanation for an event, an accident in this case, puts one's mind at ease. On the contrary, the lack of any explanation will question and trouble psychologically the individual who faces a risk. The accident explanation thus not only concerns the safety expert but also the various people taking part in road traffic.

Following Heider (1958), we call "naive" explanations, the explanations spontaneously given by non specialized individuals, in oposition to the explanations given by experts using a "scientific" methodology. These explanations, as well as those of experts, are meaningful and can clarify the knowledge of accidents causality and their prevention. Thus, it is shown that the causal inferences the people make are likely to have an influence on their behaviours (Kelley, 1972). Such explanations allow the individual not only to avoid positioning himself as a victim when facing events, but most of all to be able to adapt his behaviour. The explanations, given by both laymen and experts contain different biases (Slovic, Fischhoff & Lichtenstein, 1981).

Through three illustrative studies, we would like to show the presence of such biases in explaining road accidents, and conclude with the interest naive causal explanations could bring to the study and prevention of accidents. Whatever motivational, cognitive or even normative their origin is, the knowledge of these different biases appears very important concerning safety, because they could help to understand why precautions are not taken or furthermore why only a few people feel themselves concerned by the road safety campaigns (Kouabenan, 1999).

STUDY 1:DIFFERENTIAL EXPLANATIONS FOR ACCIDENT GIVEN BY PEDESTRIANS AND DRIVERS

A sample of 120 subjects (Kouabenan, 1990) were asked to give an explanation for the accidents, which generally occur in the country they live, in the present case the Ivory Coast. The sample is composed of 40 professional drivers, 40 non professional ones and 40 subjects acting as pedestrians (of at least 21 years old)[2]. The subjects have been randomly chosen among the driving and non driving population and were volunteers to take part in the experiment without reward. They were asked to fill an attribution questionnaire, which includes 28 factors of accidents ; 14 of which are internal (to the driver) and 14 external. The subjects were asked to tick off the factors, which to their opinion play a part in road traffic accidents.

The hypothesis was that drivers, whatever professional or non professional they were, would consider the causes of road accidents to be external (technical and atmospherical factors, infrastructures, etc.), whereas pedestrians would rather mention factors internal to drivers (excessive speed, carelessness, no respect of traffic rules, dangerous manoeuvres, etc.). The results confirmed the hypothesis. As it was predicted, the drivers, either professional or non professional, tended to attribute the causes of accidents to external factors whereas pedestrians tended to mention factors internal to drivers. No difference of attribution was found between the attributions of both groups of drivers. Table n°1 presents the average percentages of attributions to a few illustrative factors.

[2] This last group includes individuals who don't have a driving licence, who don't drive and have never driven any motor vehicle.

These results confirmed the tendencies of defensive explanations observed concerning accidents (Shaver, 1970), and especially attributional biases in favour with one's group and unfavourable to the exogroup (Cf. Kelley & Michela, 1980 ; Kouabenan, 1999). Kelley and Michela (1980) wrote : "since negative behavior may have negative implications for self-regard unless causal responsibility is attributed externally, such attributions should result from motivation for self-protection" (p 474). The negative nature of accident makes such an interpretation very much plausible.

Table 1 : Examples of causal attributions by drivers and pedestrians

Attributor / Causal factors	Drivers	Pedestrians
Local Authority failing to provide pedestrian crossings	62.00 %	12.00 %
Pedestrian inattention while crossing	94.50 %	52.00 %
Pedestrians not using crossings provided	98.50 %	12.00 %
Fate	44.50 %	7.00 %
Unforseeable mechanical failure	80.00 %	12.00 %
Poor conditions of roads	71.00 %	47.00 %
Lack of signals at intersections	58.00 %	5.00 %
Nonrespect of pedestrian crossings by drivers	9.50 %	85.00 %
Excessive driver confidence	11.00 %	62.00 %
Exceeding maximum payloads	14.00 %	65.00 %
Inadequate knowledge of highway code	25.00 %	95.00 %
Drug and alcohol use	41.00 %	90.00 %
Lightness in applying sanctions for road safety rules violations	45.00 %	70.00 %

STUDY II : CAUSAL EXPLANATIONS FOR PEDESTRIAN ACCIDENTS BY MOTORISTS AND VICTIMS

We analysed spontaneous causal attributions from the testimonies contained in 55 reports of accidents involving pedestrians, considering their source and seriousness (Guyot & Kouabenan, 1999). These reports were randomly chosen among accidents reports involving pedestrians in the years 1990 and 1991 in the Ivory Coast. They were of the same proportions according to the seriousness of their consequences, 27 minor accidents and 28 serious ones.

In conformity with the defensive attribution hypothesis (Shaver, 1970 ; Walster, 1966), we make the hypothesis that drivers involved in the accident (or their close relations) would tend to attribute it to external factors or to factors not implying their responsibility (condition of the road, atmospherical conditions, pedestrian, fate). In the same way, victims of the accident, in this case pedestrians (or their close relations), would tend to attribute the same accident to factors accusing rather more the driver than themselves (excessive speed, lost of control, dangerous manoeuvres, etc.). This discrepancy in causal attributions between pedestrians and motorists should be increased even more by the seriousness of the accident (Kouabenan, 1985).

It must be noticed that in this study we were dealing with real accidents, in which people carrying out the analysis were personally involved. We observed, like previously, an interesting opposition between the explanations given by pedestrians and those given by motorists. In the present case, pedestrian-victims tended to hold in majority the driver responsible for the accident (67,7 % of the attributions), while motorists tended to attribute the accident to the pedestrian-victim (61.5%). Moreover, we observed that if victims make some attributions to the pedestrian-victims, on the contrary drivers didn't make any attribution to the factor "driver", but rather to the conditions of traffic. These results were significantly different ($X2 = 59,81$; $p<.001$). When we analysed the results according to their internal or external localization[3], we observed that the different protagonists of the accident tended to explain it with factors related rather more to other persons or to an external element out of their control (example : fate, the condition of the road). These results were in accordance with the defensive attribution hypothesis, in which the protagonists of the accident make external attributions to protect their self-esteem. As the attributions are mainly external, it was not possible to test the effect of the seriousness of the accident.

STUDY III : BELIEFS AND CAUSAL EXPLANATION FOR ACCIDENT

A sample of 553 subjects having different levels of knowledge concerning accidents and driving risks (students, professional drivers, learner drivers, non professional drivers, gendarmes, policemen, public work engineers, etc.) were asked to complete a questionnaire on accident and risk perception (Kouabenan, 1998). Their were also submitted to a scale measuring their beliefs in fate (fatalism) (alpha = .78). The major results are shown in table n°3.

As shown by table 4, it can be easily observed that fatalistic subjects attribute accidents more readily to factors out of the driver's control (infrastructure, other people, fate) and that they consider as being less important factors implying his responsibility or initiatives (sudden change of direction, carelessness, non-respect of stop signs, contempt for pedestrians, impatience, etc.). This result is not suprising if we considered that professional drivers appeared to be the most fatalistic subjects[4] ($F(7 ; 545) = 6.65$; $P<.001$). Thus, this trend of explanation could well be interpreted in terms of defensive attribution by which fatalists stressed the causal role of factors out of their control and minimized the causal role of factors relevant to their control in order to preserve their self-esteem.

Table 2 : Causal attributions of motorists and victims (pedestrians)

Attributor / Causal factors	Motorists	Pedestrians	Total
Drviver	0	21	21
Victim (pedestrian)	40	7	47
Bad road or vehicle state	23	1	24
Fate	2	2	4
Total	65	31	96

$X^2 = 59{,}81$, $p<.001$.

CONCLUSION

These experiments show that biases were likely to appear in the explanation of the accident. The biases shown in these three experiments were of the defensive type insofar as people tend to explain the accidents with external factors or factors out of their control. But, naive explanations are not only defensive. In a work entitled "naive explanation of the accident and road safety", we describe a number of other biases or perceptive illusions (optimistic bias, illusion of invulnerability, illusion of control, etc.), which are likely to disturb the explanation of accidents, and thus the definition of road safety strategies (Kouabenan, 1999). Defensive biases, in this case, might alter the diagnosis of the causes of accidents as far as they might generate a conflict about the causes considered significant, everyone can be tempted to justify the identified cause if it's perceived to be relevant to one's role.

These biases, and the negative consequences of the accident can deviate from the purpose of analysing the accident insofar as they contribute to create an atmosphere of suspicion, which might bring confusion between the investigations of the causes and of the guilty party.

In the same way, defensive explanations, by

[3] An explanation is considered as internal when a person or his close relations, make attributions to his characteristics or his own fault. It is said to be external when on the contrary, the explanation is related to material factors, traffic conditions, other persons or fate.

[4] Average score for professional drivers is 28.8. The average score for the global fatalism index is 24.0. The least fatalistic subjects were the engineers (AS = 20.3) and the students (AS = 21.1).

Table 3 : Fatalism and accident explanation

Important accident factors for fatalists	F	Eta	P	Less important accident factors for fatalists	F	Eta	P	Factors showing no differenc between fatalists and no fatalists
. Headlight glare	4,39	.17	.002	. Sudden change of direction	6,99	.22	.001	. Bad weather
. Bad road state	4,12	.17	.003	. Drivers carelessness	3,45	.16	.009	. Excessive speed
. Absence of pavements or ver	3,13	.15	.02	. Lack of control	3,36	.15	.01	. Refusal of priority
. Lack of pedestrian crossings	4,25	.17	.002	. Non-respect of the stop signal	5,35	.19	.001	. Pedestrians imprudence
. Lack of signals at junctions	4,97	.19	.001	. Non-respect of pedestrians crossings by drivers	3,03	.15	.02	. Dangerous overtaking
. Traffic lights in bad state	3,65	.16	.006	. Under-estimation of danger by drivers	2,72	.14	.03	. Driving on the left-hand lane
. Bad luck	18,23	.34	.001	. Non-respect of authorized weight	2,45	.13	.05	. Dangerous parking
. Non-respect of traffic lights	3,96	.17	.004	. Lightness in applying sanctions	2,38	.13	.05	. Drivers overconfidence
. Pedestrians neglecting crossings	2,74	.14	.03	. Drivers contempt for pedestrians	3,22	.15	.01	. Insuffisance knowledge of highway code
				. Drivers impatience and irritability	2,79	.14	.03	. Non-respect of regulations
				. Motorcyclists imprudence	5,59	.20	.001	. Drivers fraudulence
				. Mechanical breakdown	2,77	.14	.03	
				. Drug or alcohol consumption	5,08	.16	.002	
				. Pedestrians ignorance of regulati	2,84	.14	.02	

* F indicates the difference of attribution between fatalists and non fatalists subjects.

* Eta indicates the size of the effects (see Rosenthal, R. & Rosnow, R.L., 1991)

* P is the level of significance.

transfering the causal responsability for the accident on elements outside self-control, seem to convince their authors that road safety campaigns or safety measures are mostly directed toward the others, and that they can do nothing on their own to avoid accidents. This type of defensive explanations, so as fatalistic explanations, might lead to feelings of abdication, of not being responsible and of indifference toward safety measures and thus to "regrettable" mistakes. They are also likely to disturb the establishment of adequate road safety measures so far as defense mechanisms can bring a discrepancy in people's point of view concerning the relevance of these measures.

On the opposite, taking into account naive causal explanations could help to create an efficient comunication about accident analysis as far as it is used a language based on the beliefs of the targeted people. Actually, the success of road safety measures depends on their aplication by the target population they are aimed at. To be fully accepted, these measures have to be perceived as useful and efficient. What is most important is not the specific efficiency of these measures but rather that the people who have to bring them into play believe in them and persuade themselves that the messages of prevention are directed to themselves. In order that these people believe that the measures are efficient, they have to perceive them as based on the causal analysis they share.

However, it is shown (Slovic & al., 1981 ; Kouabenan, 1999) that the experts in charge of thinking up safety measures, don't have always the same conception of accidents causality as the ordinary people who then will have to implement these measures.

Finally, we can notice that taking part in the explanation for the accident and in the establishment of safety actions can be reassuring for people who consenquently recover a better feeling of control. Moreover, it can be for them a real source of motivation : the success of measures that they would have contributed to define can appear to themselves as a challenge.

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Integrated traffic solutions and controlling traffic according to environmental criteria

Solutions de la circulation intégrée et contrôle du trafic suivant les critères environnementaux

Soluciones de circulación integrada y el control de la circulación según los criterios ambientales

H.R.Mcharek
Ministry of Equipment and Housing, Tunis, Tunisia

ABSTRACT: During The last 50 years, cities have developed rapidly. If we take the view that economic growth, prosperity and freedom in the World call for high individual mobility, we must take actions to optimally organise traffic immediatly and in the future and, in doing so, then we must integrate all means of traffic available to us and use good and intelligent solutions in order to avoid traffic jams and prevent or reduce their negative impact on the environment.

RÉSUMÉ: Au cours des 50 derrières années, les villes ont connu une expansion très rapide. Si on tient compte du fait que la croissance économique, la prospérité et liberté dans le monde font appel à une plus grande mobilité des individus, l'on devrait prendre des mesures adéquates pour assurer une organisation optimale et immédiate de la circulation et, en faisant ainsi à l'avenir , l'on devrait intégrer tous les moyens de circulation dont on dispose et adopter des solutions judicieuses et intelligentes en vue d'éviter les problèmes d'embouteillage et prévenir ou réduire leur impact négatif sur l'environnement .

RESUMEN: A travès los ultimos 50 años los ciudades han conocido una muy rapida expansión. Si tamamos en cuenta el facto que el desarrallo económico, la prospéridad y la libertad a travès el mundo llaman a permitir una mobilidad más grande a los individuos, se debría tomar todas las medidas adecuadas para asegurar una organización optimal e immediata de la circulación y, haciendo así en el futuro, hay que integrar todos los medios de circulación ya disponibles y adoptar soluciones optimas e inteligentes para evitar los emboutellamientos y prevenir o reducir su impacto sobre el medio ambiante.

INTRODUCTION :

Le monde connaît ces dernières années une extension et un développement considérables des villes. Dans la plupart des pays, les villes proches se sont confondues et se sont transformées en vastes réseaux urbains. Au sein de ces agglomérations, des millions d'individus vivent, travaillent et circulent librement. Grâce aux progrès de la technique et à l'amélioration du bien être, ils se déplacent de plus en plus et réclament sans cesse des libertés de mouvement bouleversant, d'ores et déjà, le paysage urbain : les véhicules et en particulier les voitures, s'engouffrent en flux continus dans les villes ou s'écoulent péniblement au gré des grands axes routiers.

Ainsi, la mobilité des usagers de l'espace urbain, la congestion de la circulation et la pollution de l'environnement deviennent des problèmes communs aux zones et villes à forte densité démographique à travers le monde, et ce n'est pas un hasard que la ville de MEXICO abrite ce congrès puisque sa zone métropolitaire rassemble 17 millions d'habitants et assure 30 millions de déplacements quotidiens d'autant plus que la circulation de 3,2 millions de véhicules est à l'origine de plus de 80%de la pollution de l'agglomération. Seulement et comme ça été avancé par Dominique Voynet, Ministre Français de l'environnement à l'occasion de l'opération «En ville, sans ma voiture » du 22 Septembre 1999, il ne s'agit pas d'instruire le procès de la voiture ou de condamner sans appel le désir de mobilité des concitoyens, il s'agit bien de repenser les déplacements en ville dans le sens d'un meilleur partage de l'espace urbain et des voiries en particulier. Et c'est bien dans ce cadre, et conformément au thème principal de la présente conférence, que s'insère ma contribution centrée principalement sur la gestion intégrée du trafic urbain et son impact sur l'environnement et sur les facteurs associés qui influent sur les conditions de vie des populations urbaines.

PROBLEMATIQUE ET DEFIS:

Depuis son origine, l'être humain a choisi le parti du progrès et de l'autonomie. Dans nos sociétés industrielles orientées vers les loisirs, le besoin de mobilité est extrêmement important.

Cette évolution s'effectue et va continuer, au moins pendant la première décennie du prochain millénaire, à sens unique : davantage de véhicules et circulation en hausse surtout que l'augmentation du trafic est à la fois à l'origine du développement économique et la conséquence de celui- ci.

Ce processus d'interdépendance touche toutefois d'avantage les transports individuels que les transports en commun publics routiers ou ferroviaires. Inévitable : plus l'être humain vit dans une ambiance de confort, plus il a tendance à s'isoler du monde. Il est donc vain de promouvoir exclusivement les transports en commun publics. Pas question de négliger l'automobiliste qui revendique son indépendance.

Ce besoin de mobilité est contre carré par une stagnation de la croissance de l'infrastructure du trafic. Rouler sur autoroute et sur les périphériques ou se déplacer au cœur de villes, l'image d'un entassement de véhicules vient spontanément à l'esprit...

La mobilité sur nos routes et rues a diminué considérablement ces dernières années d'autant plus que la situation actuelle au niveau du trafic de la plupart des villes se caractérise par :

- Un manque d'attrait des transports en commun publics malgré les efforts déployés à cet égard.
- Une saturation des routes et des espaces urbains.
- Une absence de systèmes de régulation du trafic ou une mauvaise coordination de ces systèmes s'ils existent.
- Une pollution élevée associée à une consommation inutile des ressources naturelles.

Pas question de chercher des solutions du côté de l'expansion du réseau routier : celui-ci a atteint ses limites naturelles dans la plupart des cas.

Par conséquent, scientifiques, ingénieurs et responsables en matière de trafic doivent consacrer une partie de leurs efforts aux automobilistes et autres usagers de tout transport individuel, y compris les piétons, et s'atteler à relever les 3 défis essentiels qui se présentent :

1. Préserver la fluidité du trafic sur les grands axes routiers.
2. Décongestionner le trafic dans les villes.
3. Intégrer intelligemment le stationnement au trafic.

SOLUTIONS PROPOSEES ET LEURS INFLUENCES SUR L'ENVIRONNEMENT ET FACTEURS ASSOCIES:

Il est vrai que le fait de chercher des solutions à des problèmes d'un ordre nouveau est aussi un défit que s'emploient à relever les décideurs et acteurs en matière de trafic conscients des excellentes perspectives qu'offre ce marché d'avenir, surtout que l'être humain, l'économie et l'environnement sont les enjeux réels au cœur du problème.

Bien qu'il n'y a pas de solutions miracles pour résoudre, d'une façon radicale, les problèmes posés par la circulation, certaines mesures pratiques, s'appuyant naturellement sur des modèles mathématiques, peuvent être prises en vue d'atteindre les objectifs d'une gestion moderne de la circulation basée sur l'utilisation d'excellentes opportunités offertes par l'évolution considérable et continue de l'informatique et la révolution de cette fin du siècle en matière du numérique et des nouvelles technologies des télécommunications.

L'objectif essentiel de cette gestion moderne de la circulation est de rendre le trafic plus supportable, plus fluide et plus compatible avec l'environnement.

Ainsi les solutions-clé suivantes peuvent contribuer à relever les défis cités plus haut :

1. ***Bien informer les usagers de la route***, et à temps, par le biais de la télématique appliquée au trafic qui est née du mariage de la télécommunication et de l'informatique et qui désigne le matériel et le logiciel nécessaire à la collecte, au traitement et à la transmission des informations relatives au trafic.

Ces informations, nécessaires, s'adressant aux usagers de la routes se divisent en deux catégories :

- Les informations "Pretrip" qui permettent à l'usager, avant de se lancer à l'assaut des routes, de se renseigner sur la situation du trafic par la radio, par Internet, par téléphone etc....
- Les informations "Ontrip" utiles à l'usager, alors qu'il est en route, pour prendre connaissance de l'évolution du trafic grâce à des signaux ou des messages routiers variables, à des terminaux d'informations ou encore grâce à la radio etc....

Le recensement des informations (à l'exemple du volume du trafic) peut s'effectuer au moyen de systèmes fixes (équipements vidéo ou à infrarouge, boucles électromagnétiques, systèmes à ultrasons, barrières photoélectriques, etc....) ou mobiles (observation aérienne, véhicules de mesures "floating car", etc..)

D'autres informations, comme l'émission de substances polluantes, la consommation d'énergie et le niveau sonore, peuvent également être obtenues à l'intérieur du réseau de contrôle et peuvent alors être prises en compte pour les décisions stratégiques.

Toutes ces informations peuvent être traitées par un ordinateur central qui se charge de fournir aux usagers des résultats très utiles (itinéraires de délestage, parkings libres, vitesses conseillées dans les différentes zones de trafic, solutions alternatives, notamment l'utilisation des transports en commun etc.. .).

L'utilisation optimale de la télématique (y compris l'usage d'Internet) constitue ainsi un instrument pour décongestionner le trafic au profit d'une mobilité accrue et d'une meilleure protection de l'environnement.

Des études ont montré que, là où de tels systèmes existaient, 80% environ des usagers connaissent ces informations et 40% les utilisent.

2. Intervenir dans le trafic pour le réguler en augmentant surtout l'efficacité de guidage des usagers de la route.

L'usage des technologies de pointe peut permettre une signalisation claire et efficace qui prévient en permanence l'usager de la route de tous les dangers et éventualités qu'il peut rencontrer : accidents, travaux, bouchons, brouillard etc. ...

Le jalonnement dynamique permet d'anticiper et d'avertir l'usager sur les conditions précises qu'il rencontrera dans les kilomètres à venir. Informé, il peut ajuster sa conduite aux circonstances. Et les responsables de la circulation disposent avec ce système de jalonnement d'un outil de signalisation et d'information dynamique performant, interactif, pour une meilleure gestion du trafic, au service d'une plus grande sécurité et d'une meilleure prestation pour les usagers.

Ainsi, grâce à un affichage adapté des limitations de vitesse et des informations routiers, aux signaux de direction variables, indiquant même des itinéraires de remplacement, aux données relatives au trafic ou à la situation météo enregistrées à l'aide de capteurs divers et au traitement instantané et la visualisation de toutes les données, l'usager se trouve informé de la situation sur les routes et rues avec précision et en permanence et aura un panel de choix pour réagir en connaissance de cause et rectifier sa vitesse ou son itinéraire afin d'éviter les bouchons, voire en prévenir la formation, et par conséquent participer à combattre le stress, à économiser le temps et l'énergie et à réduire la pollution sonore et les émissions polluantes.

Au niveau des tunnels, qui nécessitent des exigences spécifiques en matière de sécurité, un ordinateur superviseur de zone, autonome, assurant l'enregistrement et la commande de toutes les données peut permettre la simulation et l'essai de déroulement réel d'un programme de régulation et l'activer en fonction de toutes les éventualités : accident, incendie, bouchon et travaux d'entretien. D'une manière efficace et à coût moindre, il garantît une régulation du trafic adaptée à ces événements prévus ou inopinés. Dès qu'un danger se manifeste, un système automatique intervient et le système permet même de spécifier l'affectation de certaines voies.

3. Gérer d'une manière judicieuse le stationnement et opter en particulier pour des systèmes de parking modernes.

Se déplacer en ville n'est qu'une facette du problème... il faut aussi pouvoir s'arrêter ! . Stationner facile, cela permet également d'éviter la paralysie de la circulation, l'asphyxie des centres urbains et surtout la réduction de la pollution et de la consommation d'énergie.

Un parking, ce n'est pas seulement un espace où le conducteur peut garer son véhicule. Derrière le problème de l'accès, qui concerne tout d'abord l'automobiliste, se cachent les problèmes auxquels les responsables du trafic et les exploitants de parking sont confrontés en permanence. Et surtout, les problèmes de gestion des infrastructures. Une tâche qui est loin d'être simple, puisqu'il s'agit de coordonner les détecteurs d'occupation, les barrières photoélectriques, les caisses automatiques, les distributeurs de billets, les ordinateurs ainsi que les logiciels et l'ensemble du matériel électronique.

Des techniques totalement compatibles et des technologies efficaces et économiques sont en mesure d'intégrer et de coordonner tous ces éléments et notamment l'enregistrement de l'espace de stationnement disponible, le guidage de l'automobiliste vers un parking précis, par le biais de jalonnement dynamique, le décompte du prix, le transfert de données, la gestion des erreurs, et d'autres fonctions...

La création du programme et l'établissement du concept technique, des itinéraires et du réseau d'information peuvent être sur mesure, en fonction des spécifités de la ville, puisque chaque ville est différente et possède ses propres structures, sa propre topographie et ses propres possibilités financières d'autant plus que chaque réseau urbain se définit selon ses caractéristiques propres.

Sur le terrain, dès la périphérie de la ville, des indicateurs dynamiques orientent l'usager en quête d'un emplacement de stationnement libre.

Dans le parking, chaque place est équipée de capteurs à ultrasons. Toutes les informations arrivent continuellement à l'ordinateur qui se charge de la recherche de places de stationnement ce qui garantit un remplissage optimal des parkings.

Plusieurs avantages apparaissent à travers cette recherche informatisée: d'une part, cette technique renforce la demande grâce à une plus grande satisfaction des clients, d'autre part, elle permet de réduire la pollution en diminuant le nombre de véhicules à la recherche d'une place de stationnement. D'autant plus que l'interconnexion via le réseau téléphonique mobile permet aussi d'utiliser des modes de paiement par cartes comme Parkcard ou EC etc. .. permettant la réduction des coûts liés à l'encaissement d'argent liquide.

4. Réagir rapidement aux imprévus et mettre en œuvre des moyens techniques, intelligents, capable de régler la circulation pour tous les usagers (y compris les transports publics).

Les conditions de circulation routière évoluent en fonction des paramètres variables. La densité du trafic diffère selon les saisons, les jours et les heures. L'environnement change : brouillard, pluie, vent, travaux, accidents, saturation, ralentissements etc. ..

Peut-on imaginer ainsi un pilote d'avion sans prévisions, sans tours de contrôle ?
Le système idéal serait un concept global intégré qui permet de régler l'ensemble de la circulation de manière cohérente et d'harmoniser en conséquence les flux de circulation urbains.
L'aspect essentiel de ce système intégré est la coordination totale entre transports individuels, transports en commun publics, piétons et cyclistes. Ainsi les mesures actuelles visent naturellement à privilégier l'utilisation des transports en commun urbains et le système intégré peut y s'adapter sans problème en limitant les temps d'attente aux feux de circulation pour les bus, les tramway ou les métros ou en leur donnant la priorité et sans arrêt aux feux et cela par une intervention dans la régulation.
L'utilisation intelligente des moyens informatiques, des techniques de détection et des nouvelles technologies des télécommunications permet la centralisation de toutes les informations souhaitées et le transfert des données relatives au trafic. Un ordinateur central analyse les données obtenues et livre ses résultats qui permettent de proposer les mesures de régulation du trafic nécessaires, en fonction de chaque situation. Cette technologie disponible et fiable est capable de détecter les problèmes au sein de la circulation et de les résoudre de manière rapide et aisée. Ainsi la possibilité de la libre programmation permet de résoudre tous les problèmes qui se posent aujourd'hui dans le cadre du fonctionnement adaptatif et de la régulation privilégiant les transports en commun urbains. Et ce-ci par le biais de l'évaluation des courants de circulation en analysant les différentes variables de mesures (intervalle véhiculaire, durée d'occupation, etc. ..) provenant des différents détecteurs ou des demandes de phase des transports en commun.
Le système intégré préconisé, grâce à sa conception modulaire, convient aux villes de toute envergure et peut s'installer et se développer progressivement en s'adaptant aux besoins de l'exploitant et en suivant l'évolution de la ville sans remise en cause des structures initialement mise en place (ouverture de nouveaux parkings et de nouvelles voies, amélioration de la capacité des infrastructures existantes, nouvelles implantations de panneaux et de feux etc. ..).
Une configuration réduite du système pourra, par exemple, servir à l'estimation des origines et des destinations sur la base des valeurs chiffrées disponibles, enregistrées en temps différé ou en temps réel. Il est envisageable aussi de transmettre des informations relatives aux engorgements du trafic et aux capacités de stationnement encore disponibles au cas par cas. Dans de tels cas le logiciel à concevoir ne nécessite pas forcement un ordinateur spécifique et pourra être intégré au poste de travail d'un sous-système déjà existant.
L'introduction progressive d'un système de gestion du trafic est ainsi possible sans aucune difficulté et sans entraîner de double investissements.
Cette manière de procéder présente même l'avantage de pouvoir accumuler progressivement une expérience dans le domaine de la technique de circulation, de l'informatique et de l'organisation, qui sera utile lors des extensions du système.
Ce système de gestion intégrée (SGI) dont les fonctions principales sont les suivantes:

- Visualisation des données du trafic et d'exploitation intégrées, généralement, au réseau routier numérisé.
- Modélisation de la situation momentanée du trafic et de l'environnement à l'échelle du réseau et son pronostic à moyen terme.
- Définition des consignes stratégiques et des plans d'action, sur la base de la situation qui se présente en temps réel, pour la régulation et la coordination des sous systèmes.
- Transmission en différé ou en temps réel d'informations routières pour différents services (radio, Minitel, Internet, télétexte, colonnes d'information, presse, prestataires de service etc. ..)
- Organisation de l'intégration et de l'interconnexion de tous les sous-systèmes de régulation et de contrôle du trafic (ordinateurs de régulation du trafic, de gestion des tunnels, de jalonnement dynamique des parkings etc. .., systèmes de contrôle des chemins de fer, de gestion de chantiers, d'information sur l'environnement, d'aide à l'exploitation des transports en commun etc. ..)

peut avoir différentes architectures et se présenter selon plusieurs structures dont les plus courantes sont:

- Une structure hiérarchique monocentrique (voir fig 1): convient pour la résolution de problèmes d'information et de gestion dans un réseau constitué de différents systèmes subordonnés ou la prise de décisions s'effectue selon une hiérarchie.
- Une structure hiérarchique polycentrique (voir fig 2): qui peut résoudre les problèmes dans une agglomération cohérente (ou un ensemble supra-régional d'informations et de tâches) par le biais des décisions prises selon une hiérarchie avec l'accord des postes voisins et d'un éventuel poste supérieur.
- Une structure coopérative décentralisée (voir fig 3): les décisions sont prises en coopération avec les systèmes intéressés, suivant un accord, par l'échange d'informations et des stratégies de coopération définies.

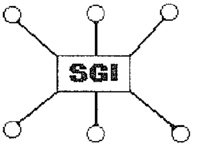

fig1

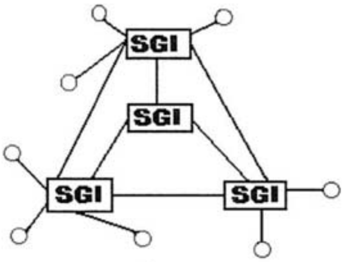

fig2

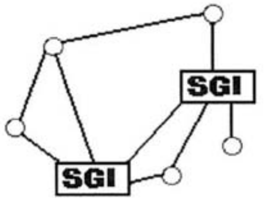

fig3

Cette flexibilité, au niveau des structures du système et des mécanismes de mise au point, offre de nombreuses possibilités de construction progressive de systèmes d'information et de gestion. Le système peut aussi, sans aucun problème, se développer parallèlement aux exigences de l'environnement et des exploitants du système.
Des structures plus complexes peuvent ainsi également être développées dans le cadre d'une stratégie d'évolution globale.

CONCLUSION :

La gestion intégrée du trafic utilisant les nouvelles techniques et technologies en matière d'information et des télécommunications présente des avantages considérables aux agglomérations urbaines tels que :

- La garantie de la sécurité du trafic et des usagers des routes et des espaces urbains.
- Une mobilité aisée et accrue.
- Une réduction substantielle des facteurs du stress.
- Une limitation des facteurs causant la dégradation de l'environnement tels que la pollution sonore et les émissions polluantes.
- Une économie significative des ressources naturelles et en particulier de l'énergie.
- Une amélioration du cadre de vie et de la santé des populations.

Des études du trafic ont montré qu'une utilisation bien meilleure de l'infrastructure routière était possible, grâce aux systèmes de gestion intégrée du trafic permettant l'échange d'informations entre les systèmes de régulation du trafic les plus variés et le recours à de nouvelles méthodes d'analyse et de prévisions qui, en permanence, constituent des aides nécessaires à la prise de décision aux usagers de la route et aux responsables de la régulation du trafic.
Il est ainsi primordial d'installer des systèmes de pointe, capables de réguler intelligemment la circulation, sous peine de mettre en péril la mobilité des usagers de la route et de paralyser le cœur des villes.
La longévité des grands centres urbains dépend surtout de leur capacité à rendre la circulation possible et aux moindres dégâts pour l'environnement. Et je cites à ce sujet le programme européen Auto-oil de réduction des émissions de véhicules qui est un nouveau plan de lutte contre l'effet de serre. D'ailleurs, 40% des efforts prévus au sommet de KYTO portent sur les transports d'autant plus que la future écotaxe sur l'énergie ainsi que les plans de déplacements urbains devront être approuvés prochainement (le 30 juin 2000).

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Transportation management issues for developing countries

Gestion de transport pour les pays en voie de développement

Gerencia del transporte en países en vías de desarrollo

S. Mitchell
Mitretek Systems, Washington, D.C., USA

R. Boenau
Federal Transit Administration, Washington, D.C., USA

ABSTRACT: As developing countries experience leaps in population growth, they are faced with the challenges placed on their transportation systems by that growth. These countries have access to the technologies, methods, successes, and failures of developed countries, especially in the area of Intelligent Transportation Systems (ITS). This paper discusses the problems and the experiences involving transportation management, technologies, and institutional-related issues in implementing various management strategies, and offers lessons learned to developing countries.

RÉSUMÉ: Comme les pays en voi de developpement subissent des sauts de croissances de population, ils rencontrent des difficultes dans leurs systemes de transports causees par cette augmentation. Ces pays ont acces aux technologies, methodes, succes, et echecs des pays developpes, surtout dans le domaine de STI. Cet article presente les difficultes et les essais d'implementer divers strategies concernant la gestion de transport, les technologies, et les sujets d'origine institutionelle qui permets aux pays en voi de developpement de profiter des experiences acquises.

RESUMEN: Mientras que la experiencia de los países en vías de desarrollo salta en el crecimiento de la poblacíon, se hacen frente con los desafíos puestos en sus sistemas del transporte por ese crecimiento. Estos países tienen acceso a las tecnologías, a los métodos, a los exitos, y a los incidentes de países desarrollados, especialmente en el área de los sistemas intelligentes del transporte (ITS). Este papel discute los problemas y las experiencias que implican la gerencia del transporte, tecnologías, y ediciones de institutional-related en poner varias estrategias de la gerencia en ejecución, y ofrece las lecciones aprendidas a los países en vías de desarrollo.

1 INTRODUCTION

Government and industry around the globe are currently faced with the challenge of meeting a rapidly growing demand for transportation services while minimizing the adverse energy and environmental impacts. Currently, developing countries are experiencing leaps in population growth, and they also have increased access to technological advances from industrial countries. This combination has both advantages and disadvantages. On one hand, it enables countries to get up to speed quickly, not having to develop products, systems, etc., from scratch. On the other hand, many of the available technologies, such as the automobile, have many supporting requirements that, if not in place, can cause more problems than they solve. Essentially, a transport system consists of two sides: the supply side and the demand side. For example, Mexico City has developed rapidly in the last 60 years, growing from 1 to 17 million inhabitants. During this same period, the metropolitan area has developed at a slower pace technologically; roadways, transit systems, etc., have not kept up with the availability of or demand for motorized transportation. During this same time period, the automobile has gone from a product available to only the very affluent, to one available to the masses. Mexico City, as have many cities in developing nations, has essentially leap-frogged the infrastructural development period; the transport system necessary to keep up with the easy availability of the automobile is not in place.

Transportation management is the process that attempts to manage or balance the needs of the users with the available transportation resources. This paper presents some background on why advanced countries, specifically the United States, have looked to various transportation management strategies to help address congestion problems, and presents some techniques and technologies available to successfully implement a management strategy that may also be appropriate to developing countries.

2 THE TRANSPORTATION SYSTEM

A transportation system is comprised of two components: available transportation resources, or the supply component; and the needs of the users, or the demand component. Each of these encompasses a number of elements as described below.

2.1 *Supply*

On the supply side, there are two primary sources, and a number of secondary sources. The first primary source is the road system, which is shared between automobiles, trucks and transit (buses). Often closely associated with these sources are bike paths and pedestrian walkways, which are the subject of a number of the management solutions. The second primary source are rail systems, which includes both transit and freight. Among the secondary sources are air space, waterways, etc., though these are not the topic of this paper.

Variations and modifications to these supply-side sources are such things as bus rapid transit (BRT), high occupancy vehicle (HOV) lanes, and mixed corridor operations (transit-rail and freight-rail sharing the same tracks). The goal of these techniques is to maximize utilization of infrastructure to improve traveler safety, service, and satisfaction.

2.2 *Demand*

On the demand side are the users. They need to travel from origin to destination using the available supply of transportation assets. These trips are made using various modes, including automobile, buses, trains, bicycles, walking, etc., and are needed at varying times of the day or night.

3 THE PROBLEM

Regions run into problems with congestion when the demand exceeds the supply. This sounds basic, and it is, though somehow it is often overlooked and so bears repeating. A region cannot have more demand than supply without having breakdowns somewhere in the system. The challenge is to accommodate all users' needs to travel with the available supply, while maintaining acceptable levels of service and customer satisfaction.

4 EXPERIENCE

Developing countries are in an excellent position to take advantage of the experiences of countries that have gone before them, and learn from the mistakes that have previously been made, so as not to make those same mistakes. Of prime example is the United States (US). Early in its history, the US transitioned from an agricultural (rural) to an industrial (urban) economy and country. Populations migrated to cities, leaving farms to find manufacturing jobs. Transport was still primitive; the car had not been developed yet, so people tended to live near their jobs. As the automobile became more generally available, and the post WWII economy began to boom, people began to migrate to the suburbs. Land was available for both residential and transportation uses, and the populations had not yet reached levels where congestion was considered a problem. The suburbanization of the country was on, with little acknowledgement of the need for organized planning, or transit systems in place (though some cities, like New York and Chicago early on had transit rail systems, and expanded them as they could). The philosophy was "you can build your way out of congestion", and this became the predominant method for trying to alleviate congestion. More and more roads were built, though the problems with congestion continued. Slowly this continued roadway expansion is being recognized as only a short term solution. In the late 1960's the United States began to realize the need for transportation management. Some of the developing countries are now just beginning to recognize that more roads are not the answer, and that other ways need to be explored to handle transport demand.

As transportation problems receive more and more attention in advanced countries, so do the attempts to solve them. Many advances, techniques, methods, etc., have become available, or been modified and improved, and are being looked upon to mitigate congestion problems. The challenge is to determine which ones will work, whether or not they are applicable, in what situations, and in what combinations. The remainder of this paper discusses some strategies that may be promising possibilities for developing countries in dealing with transportation issues.

5 TRANSPORTATION MANAGEMENT ISSUES

A number of techniques and technologies are available that can be included in an overall transportation management strategy. Some of these are traditional travel demand management (TDM) techniques implemented using supporting technologies, while others take advantage of advances in technology to increase supply. Not all may applicable in a given region.

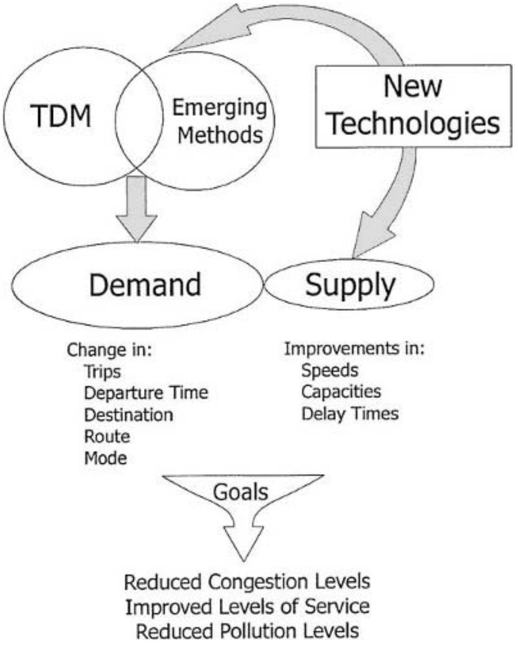

Figure 1 - Transportation Diagram

The figure above shows how TDM, other measures, and new technologies relate to each other and to the transportation system, and lists some of the goals and objectives of transportation management.

5.1 *Traditional TDM*

Travel demand management programs are designed to maximize the people-moving capability of the transportation system by increasing the number of persons in a vehicle, or by influencing the time of, or need to, travel. To accomplish these types of changes, TDM programs rely on incentives or disincentives to make these shifts in behavior attractive. In general there are a number of TDM measures, falling into three basic categories, that are designed to promote this shift in travel behavior. Below are described the different strategies available as part of TDM.

5.1.1 *Improved Alternatives*

If we desire to reduce the demand for single-occupant vehicle travel, then we must maximize the availability and quality of the basic alternatives offered to the traveler. Such measures include transit service improvements (e.g. new services and transfer centers); carpool and vanpool programs (automobile owners each in turn driving his/her own car or company-provided van and carrying other passengers); and bicycle/pedestrian facilities and site improvements.

5.1.2 *Incentives and Disincentives*

Despite our best efforts to develop alternatives to the single occupant vehicle (SOV), characteristics of the current land use and policy environment convey significant advantages to SOV users. In order to make the alternatives sufficiently attractive to encourage their use, it is necessary to consider various inducements that would cause the traveler to re-evaluate his/her choices. Such inducements include employer sponsored transit programs; HOV (high occupancy vehicle) lanes; fare bonus programs; rideshare, transit, and other subsidies (government grants); parking supply and pricing management; and tolls and congestion pricing.

5.1.3 *Alternative Work Arrangements*

A somewhat different type of alternative to shifting travelers to HOV travel modes is shifting the time of travel from congested peak periods, or reducing the actual frequency of travel by changing the underlying need to travel to a worksite on a daily basis. Such measures might include flexible work schedules; compressed work weeks; and telecommuting.

5.2 *Emerging Methods*

A number of methods are coming on the scene that do not fall completely beneath the TDM umbrella, or are extensions and combinations of different strategies, both TDM and non-TDM.

5.2.1 *Transit Oriented Development*

"People do not plan to fail, they just fail to plan." This is true regardless to what one applies it. Finances, football games, transportation. The common theme is without planning, it will fail. Transit oriented development (TOD) is one such philosophy of transportation planning. Today as communities look for ways to regain what was lost when they went suburban, they find TOD.

Part of this is an effort that the FTA initiated in 1994 called the Livable Communities Initiative, which encourages communities to build transit facilities and services that are customer-friendly, community-oriented, and well-designed. The facilities and services should reflect community needs and community-based partnerships. Federal money is made available for redevelopment and revitalization efforts.

Recently the San Diego, CA Metropolitan Transit Development Board adopted a policy to more easily coordinate transit and land use planning in an effort to make areas more pedestrian friendly.

5.2.2 *Station Cars*

The station car concept is a new form of mobility. Station cars environmentally sensitive (electric or efficient internal combustion vehicles) driven to and from mass transit stations by transit riders. They are an extension of mass transit, providing the same instant – yet more convenient – mobility as conventional vehicles. While away from the station, they can be used for any type of short trip. A station car system will be designed to support the specific transportation needs of each community.

Station cars might be particularly effective with a populace that is not yet dependent on, or infatuated with, the personal automobile.

5.2.3 *Transit Management Centers*

Transit management centers enable regions to coordinate all of their transit operations from a single, integrated location. Scheduling, routing, vehicle tracking, and demand tracking can be monitored and controlled in real-time. A natural extension of this is a transportation management center, which would bring all transportation operations, both transit and highway, under a single roof. With this all systems could be coordinated and optimized as a single operation.

5.3 *Enabling Technologies*

Until recently, many of the measures described above were impractical or impossible to implement, simply because the supporting technologies were not available, or were too expensive, to permit implementation. This forced many regions to search for and accept alternatives that were not optimal, but could be implemented relatively easily and inexpensively. For example, the availability of inexpensive toll tags enables easy implementation and monitoring of strategies such as congestion pricing and hot lanes, whereas before these methods were expensive or untenable. Advances in technology, and reduction in prices, is now enabling regions to consider all measures when striving to reduce congestion and improve transportation.

5.3.1 *Intelligent Transportation System (ITS) Technologies*

Intelligent transportation system technologies is an umbrella term that includes existing communications and information-based technologies as applied to transportation systems, and new technologies developed specifically for transportation applications. Such systems automatic vehicle location (AVL) systems, which are enabled by the global positioning system (GPS); collision avoidance and pollution monitoring systems, which are enabled by various detection methods (microwave, acoustic, laser); and toll tags, signal priority/preemption, and remote monitoring of vehicles, which are enabled by dedicated short range communications (DSRC). These systems facilitate effective implementation of many of the transportation management methods described earlier.

5.3.2 *Communications Based Train Control (CBTC)*

CBTC systems have existed since the early 1970's, and are an alternative to the traditional fixed-block track signal operations. CBTC is a train control system that uses continuous bi-directional communications between trains and wayside computers, and does not require track circuits for its operation. Key goals and objectives of CBTC systems include increased capacity through reductions in headway; streamlining of operations; improved safety; significant capital cost savings for new or expanded systems; operations and maintenance (O&M) cost savings through more easily maintained equipment and reduced labor requirements; and operational flexibility. CBTC enable transit agencies to manage their systems and demand much more efficiently, and coordinate operations between rail and other modes more effectively.

A number of CBTC systems have been installed in Europe, and are beginning to be implemented in the United States.

5.3.3 *Alternative Propulsion*

A number of alternative fuels that burn cleaner than diesel have been around for a number of years, though because of their typical higher costs have received little attention. Today, however, with enhanced sensitivity to environmental issues such as air and water pollution, they are receiving more attention. Alternative fuel buses - led by compressed natural gas (CNG) – are becoming more common in transit fleets all around the nation. Today's generation of CNG buses are working well - providing safe, efficient and reliable transit service, as well as significant emission reductions. In many cases, there operating costs are comparable or less than the diesel buses they are replacing.

Within the last decade, fuel cells have emerged as one of the most promising technologies to meet the clean transportation challenge (by potentially replacing the internal combustion engine in all areas of ground transportation). Fuel cells, with their characteristic high efficiency, very low or zero emissions, and fuel flexibility, offer the best prospects for a vehicle that will produce very low levels of polluting emissions, utilize energy from secure/renewable sources, and be economical, enjoyable, and safe to drive. This especially true when applied to fleet vehicles, with corresponding economies of scale.

6 INSTITUTIONAL ISSUES

Because of the manner in which transportation systems developed here in the United States, government agencies at all levels, from planning to traffic to transit, as well as other public and private sector interests have seen little need for cooperation amongst themselves. But as attention focuses more and more on transportation problems, these institutional relationships come under greater and more intense scrutiny. Public sentiment calls for coordination and cooperation where in many cases previously none existed. This is reflected in the emergence of transit oriented development, which requires both public and private sector agencies to work together to implement successful TDM strategies. It is also reflected in the growth of transportation management associations (TMA). A TMA is a proactive organization formed so that employers, developers, building owners, local government representatives, and others can work together and collectively establish policies, programs and services to address local transportation problems. The need for TMAs stems from a realization that the business community has a great influence on transportation demand management solutions. TMAs attempt to solve transportation problems by providing services directly to members or by providing a vehicle for organized private sector involvement into public sector planning, decision-making, and projects. To avoid confusion, TMAs are not a TDM strategy in and of themselves; they are institutional mechanisms to implement TDM strategies.

Recently the US Department of Transportation (DOT) recognized that transportation issues encompass all modes together. Within DOT are agencies that individually manage highway, rail, and transit related issues. The One DOT concept was introduced in the DOT Strategic Plan, and stated simply, encourages the Operating Administrations to "work better together." It builds on the strengths and technical expertise of each Modal Administration and encourages collaboration and integration, when necessary and applicable. Other institutional issues include cooperation with and accountability of private industry. For example, in Atlanta a major employer recognized that transit accessiblity was an important issue for many of its employees. They have since coordinated with MARTA to locate a major operations center at an existing, under-developed MARTA station. This effort required action, cooperation and compromise on all institutional levels, both public and private. However, the end result will save much more overall than the initial costs.

7 SUMMARY/CONCLUSION

Developing countries can learn from the mistakes of others who have faced the transportation problems like congestion, urban sprawl, etc. Successful transportation management is not a one-sided affair; a region cannot simply look to one side of the transportation equation for a solution. Management requires a holistic approach, one that begins with cooperation at all jurisdictional and community levels, and does not favor a single solution, or set of solutions, simply because they are the more politically expedient or provide the best short term benefit.

Availability of state of the art technologies makes implementation of successful transportation management methods easier and more effective than when these techniques were first developed. In addition, these strategies can be a more cost effective means, and a more environmentally sensitive method of utilizing existing transportation resources, as opposed to the traditional "build more roads" approach. This means that developing countries can avoid the learning curves and mistakes associated with various methods and strategies, and select those that apply to their situations.

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Morning vehicle occupancy rate entering the city center

Pichai Pamanikabud
Department of Civil Engineering, King Mongkut University of Technology-Thonburi, Bangkok, Thailand

ABSTRACT: This research aimed at the study of morning peak's vehicle occupancy rate of passenger cars entering into Bangkok's city center through the city's at-grade road network. Occupancy rate of pick-up vehicle was included into its investigation due to its popularity for passenger usage especially during the peak hours period. Analysis data was collected on 24 entrances into the city center along Ratchadapisek ring road which was used as Cordon line surround the city center. Vehicle occupancy rates were analyzed for different types of these passenger vehicles, which were classified into private passenger car, private pick-up, and public taxi. The difference between occupancy rate of private and public passenger vehicles were analyzed together with the overall vehicle occupancy rate for all of the vehicle types. Time series analysis of occupancy rate of each type of vehicle was also presented in this paper.

1 INTRODUCTION

The long queues of vehicles created by congesting traffic on almost every road leading to the city center are the common view that can be seen in every morning in Bangkok. This problem comes from too many cars on the roads, and the most importance of all is that there are very few passengers in each car. This research, therefore, was aimed at the study of occupancy rate of passenger in the private vehicles that included private passenger car, and private pick-up that is popularly used for passenger purpose during peak hours period in Bangkok. Taxi, which is the public passenger car, was also under the investigation.

2 STUDY SITES AND TYPES OF STUDY VEHICLE

Ratchadapisek Ring Road was used as Cordon line surrounding Bangkok city center. There were 24 at-grade intersections along this ring road that could be used to enter into the city center. Therefore, data for this study was collected on each of these at-grade intersections for the period of one hour during the morning peak hours period between 6.00 am. to 9.00 am.

Two types of private vehicle were investigated, namely, the private passenger car, and private pick-up. In Thailand, this pick-up is not only used to delivering goods but also for passenger purpose especially during the peak hours period in the cities. Another type of passenger car that used for public service or taxi was also included into this study due to its similar characteristics of passenger usage.

Data collection was done for the number of persons (passengers and driver) in each type of vehicles. This data was collected at each intersection of the 24 entrances to the city center, and then was enter into the processes of occupancy rates analysis.

3 ANALYSIS OF OCCUPANCY RATES

Occupancy rates of vehicles were analyzed in term of average number of passengers including driver or numbers of persons occupy each particular type of vehicles. This study investigated into three types of vehicular occupancy rates, namely, occupancy rate of each vehicle type, occupancy rates of private and public vehicles, and finally, the overall occupancy rate of all vehicles.

3.1 *Occupancy rate of each vehicle type*

The analysis of each type of vehicle's morning occupancy rate entering the city center can be mathematically described as the followings.

$$OR_{(i)} = \frac{P_{(i)}}{N_{(i)}} \tag{1}$$

where $OR_{(i)}$ = occupancy rate of vehicle type i (persons/vehicle); $P_{(i)}$ = total number of persons in vehicle type i (persons); $N_{(i)}$ = total number of vehicles in vehicle type i (vehicles); i = vehicle type i; i = 1 (private passenger car)(PC), i = 2 (private pick-up)(PU), and i = 3 (public taxi)(TX)

and

$$P_i = \sum_{\text{all } j} p_{(i)j} \tag{2}$$

where $p_{(i)j}$ = number of persons in each vehicle j of vehicle type i; j = the j vehicle

Results of this occupancy rate analysis for each type of vehicle together with the summarized results of distribution analyses of number of vehicles in each group of occupied persons per vehicle for passenger car, pick-up, and taxi are shown in Table 1. Figure 1 shows the plot of occupancy rates of passenger car , pick-up, and taxi respectively. From this morning peak period analysis, The lowest occupancy rate of 1.574 persons/veh appeared in passenger car. Pick-up's occupancy rate was in the middle of all three types of vehicles under the study with the value of 1.721 persons/veh. Taxi gave the highest occupancy rate of 2.009 persons/veh, which was due to its public service characteristics and also the high demand of ridership during this peak hours period.

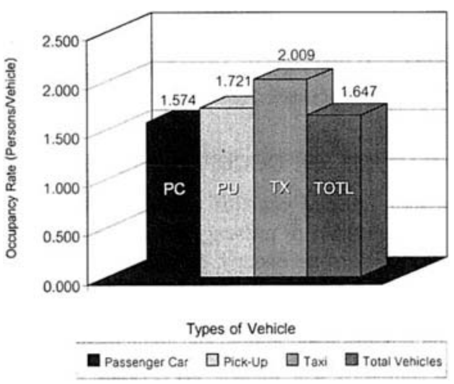

Figure 1. Occupancy rates of passenger car, pick-up, and taxi

3.2 *Occupancy rate of private and public vehicles*

This research also extended into the study for the difference between occupancy rates of private and public vehicles. The mathematical description of this analysis can be defined as the followings.

$$OR_{(m)} = \frac{P_{(m)}}{N_{(m)}} \tag{3}$$

and

$$P_{(m)} = \sum_{\text{all } n} p_{(m)n} \tag{4}$$

where $OR_{(m)}$ = occupancy rate of vehicle class m (persons/vehicle); $P_{(m)}$ = total number of persons in vehicle class m (persons); $N_{(m)}$ = total number of vehicles in vehicle class m (vehicles); $p_{(m)n}$ = number of persons in any vehicle n of vehicle class m (persons); m = vehicle class m, m = 1 (private vehicle (passenger car and pick-up), and m = 2 (public vehicle or taxi); n = any vehicle n in vehicle class m.

The analysis results of these private and public vehicles' occupancy rates are shown in Table 1. The comparative plot of occupancy rates of private vehicle, public vehicle, and the overall vehicle types are shown in Figure 2. From the results of this analysis, the private vehicle group gave the lowest occupancy rate of 1.599 persons/veh. This private vehicle occupancy rate was much lower than that of the public vehicle group (taxi), which gave the occupancy rate value of 2.009. This very low value of private vehicle occupancy rate implied that only one person occupied many of these private vehicles, which included passenger car and pick-up, during the morning peak hours period, and the average value of 1.599 persons occupied all of these private vehicles in entering into Bangkok city center during this period of time.

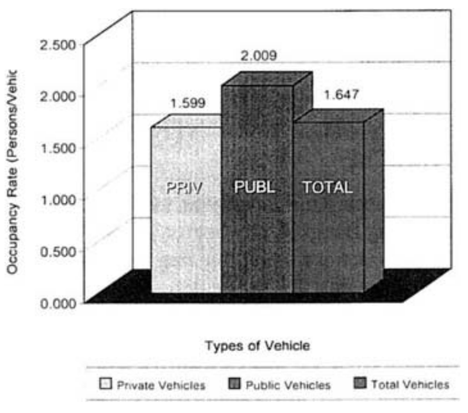

Figure 2. Occupancy rates for private, public, and all vehicle groups

Table 1. Occupancy rate of each type of vehicle, group of vehicles, and all vehicles during the morning peak period

MORNING PEAK HOURS PERIOD (6.00 A.M. - 9.00 A.M.)

Vehicle Types	No. of Veh. in Each Group of Occupied Persons in A Veh.							Sum Vehicles		Sum Persons		Occupancy Rate (Persons/Veh.)	
	1	2	3	4	5	6	7						
Private Passenger Car	43,486	28,449	5,514	1,547	303	31	16	79,346	95,631	124,927	152,952	1.574	1.599
Private Pick-Up	7,174	7,149	1,481	333	113	32	3	16,285		28,025		1.721	
Public Taxi	4,515	4,761	2,217	657	274	57	10	12,491	12,491	25,098	25,098	2.009	2.009
Total Vehicles	55,175	40,359	9,212	2,537	690	120	29	108,122		178,050		1.647	

3.3 *Overall occupancy rate of all vehicles*

The final analysis of overall occupancy rate for all combined types of vehicle during this study period were then analyzed with the following analytical formulas.

$$OR_{(overall)} = \frac{P_{(overall)}}{N_{(overall)}} \quad (5)$$

and

$$P\ (overall) = P\ (PC) + P\ (PU) + P\ (TX) \quad (6)$$

$$N\ (overall) = N\ (PC) + N\ (PU) + N\ (TX) \quad (7)$$

where OR (overall) = overall occupancy rate of all vehicles (persons/vehicle); P (overall) = total number of persons in all vehicles (persons); N (overall) = total number of all vehicles (vehicles); P (PC), P (PU), P (TX) = total number of persons in passenger car, pick-up, and taxi respectively; N(PC), N(PU), N(TX) = total number of vehicles for passenger car, pick-up, and taxi respectively.

This overall occupancy rate result and the distribution of number of vehicles in each group of occupied persons per vehicle for all types of vehicles are also shown in Table 1 and Figure 2 respectively. The low overall occupancy rate value of 1.647 persons/veh, as shown in this analysis, meant that there were only an average of 1.647 persons occupied in every four wheel motor vehicle to the total amount of about 108,122 vehicles entering Bangkok city center through the 24 entrances during the morning peak hours period. This is one of the main reasons behind the heavy traffic congestion in the city of Bangkok especially during the peak hours period.

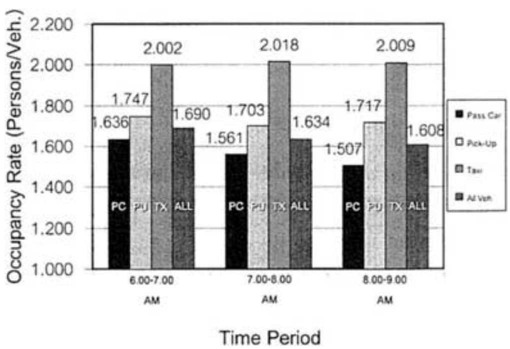

Figure 3. Distribution of occupancy rates of passenger car, pick-up, and taxi over time during peak hours period

3.4 *Distribution of occupancy rates over time*

The time series of passenger car, pick-up, and taxi occupancy rates together with the occupancy rates of the groups of private, public, and all vehicles were analyzed. This analysis was done in order to investigate the distribution characteristics of each particular type of vehicle's occupancy rate in relation to the hourly interval in the morning peak hours period. Results of time series analysis for occupancy rates of passenger car, pick-up, and taxi are shown in Figure 3, and the time series analysis for the groups of private vehicles, public vehicles, and all vehicles are shown in Figure 4. These results show that occupancy rate of passenger car decrease with the increasing of time period in the three time periods of 6.00-7.00, 7.00-8.00, and 8.00-9.00 during the peak hours period. For pick-up and taxi, occupancy rates over time do not show any significant variation during this morning peak period. However, the occupancy rates of all vehicle types decrease with the increasing of hours during this peak period. This distribution characteristic of all vehicle types over time are highly influence by that of passenger car, since amount of passenger car accounts for about 83% of the total vehicles during this morning peak period.

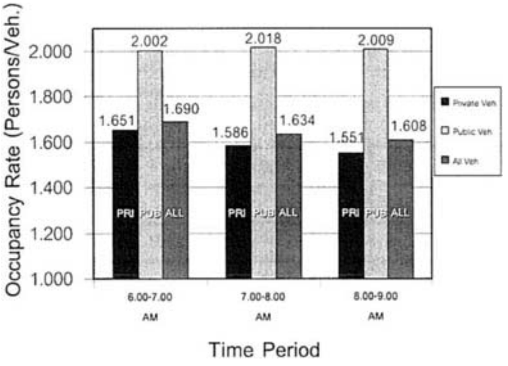

Figure 4. Distribution of occupancy ratees of private vehicles, public vehicles, and all vehicles over time during peak hours period

3.5 *Distribution of number of vehicles in each group of occupied persons in a vehicle*

Investigation was also given to the analysis of how many vehicles were in each group of occupied persons. The occupied persons in a vehicle were classified into 7 groups from 1 person/vehicle to 7 persons/vehicle respectively. The distribution results of this analysis are shown in Table 1 and Figure 5 respectively.

From these analysis results, the highest vehicle numbers appears in the group of one persons/vehicle for both private passenger car and private pick-up. Only one person or the driver himself occupies more than halves of total passenger cars, which are 43,486 out of 79,346 cars. This highest number is about 1.5 times and 7.9 times of the second and third ranked of two and three persons/vehicle respectively. For pick-up, the group of one person/vehicle is slightly more than the two persons/vehicle group with the results of 7,174 and 7,149 pick-ups respectively.

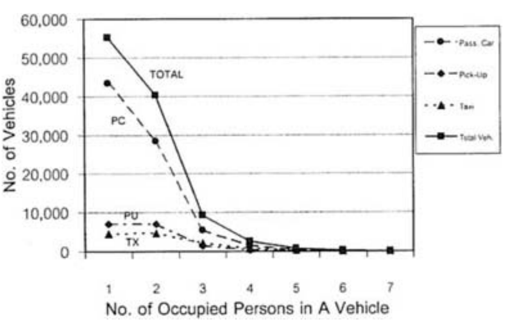

Figure 5. Distribution of number of vehicles in each group of occupied persons/vehicle

However, these values are about 5 times of the third ranked of three persons/vehicle group. Results from public taxi analysis show the interesting out come with the highest frequency occurs at the group of two persons/vehicle. This number of 4,761 taxis is more than the second ranked of one person/vehicle for about 5.4 %, and it is about two times of the value from the third ranked of three persons/vehicle group. For total vehicle analysis, the group of one person/vehicle gave the highest frequency of 55,175 vehicles which is about 51% of the overall four wheel vehicles of 108,122 in this study. This number is about 1.3 and 5.9 times more than the values of the groups of two and three persons/vehicle respectively.

4 CONCLUSION

Several conclusion points can be drawn from this study of morning peak occupancy rate for vehicle entering Bangkok's city center. In the individual vehicle type analysis, the lowest occupancy rate of 1.574 person/vehicle occurs in passenger car. Pick-up is in the middle with occupancy rate value of 1.721 persons/vehicle. The highest occupancy rate of 2.009 persons/vehicle appears in taxi, which represents the highly demand of ridership for this public service mode during this peak period. For the analysis of private and public vehicles' occupancy rates, the private vehicle class, which consists of passenger car and pick-up, gives the lowest occupancy rate of 1.599 persons/vehicle in comparison to that of 2.009 persons/vehicle from the public taxi. The final result of overall occupancy rate from all combined type of vehicles also show the low value of 1.647 persons/vehicle for all of the four wheel vehicles entering Bangkok city center during the morning peak hours period. The majority of vehicles are occupied by only one person/vehicle, and this is account for 51% of the total number of vehicles entering the city center at 24 at-grade entrances. There are also the influence of time for occupancy rates of passenger car and the group of all vehicle types. Occupancy rates of these two groups of vehicles decrease with the increasing of hourly periods during the morning peak.

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Road safety in urban Santa Fé de Bogotá D.C.

Seguridad vial en la Ciudad de Santa Fé de Bogotá D.C.

Yngve H.Granne & Brian L.Hills
Ross Silcock Limited and Transport Research Laboratory, London, UK

Elber Peréz Walteros & Santiago Henao Peréz
Ingeniero de la Secretaría de Tránsito y Transporte, Alcaldía Mayor and Escuela Colombiana de Ingeniería, Santa Fé de Bogotá, Colombia

ABSTRACT: The City authorities in Santa Fé de Bogotá have recognised that the city has a serious road traffic accident problem. This concern prompted the City authorities to decide to start the project for development of an accident data system for Bogota. The systems which were available, were of little use for accident investigation in relation to engineering remedial measures. A road safety project was therefore initiated by the Secretaría de Tránsito y Transporte, the transport authority in the city. The project consisted of two main parts, the establishment of an accident data system, and the establishment of an accident investigation unit.

RÉSUMÉ: Les responsables locaux de Santa Fé de Bogotá ont reconnu que la ville avait un sérieux problème de sécurité routièr. De ce fait; ils ont décidé de lancer un projet de base de données "Accident" pour Bogotá. Les systèmes existants n'offrent pas les spécifications requises en matière d'enqête accidents en relation avec les mesures correctrices. En conséquence, la Secretaría de Tránsito y Transporte, autorité compétente pour la ville, a initié un projet de Sécurité Routiére. Le projet est composé de deux parties principales, la costitution d'une base de données Accident et l'établissements d'une unité Enquête après accident.

RESUMEN: Las autoridades de Santa Fé de Bogotá han identificado que la ciudad tiene un serio problema de accidentalidad vial. Esta preocupación, motivó a las autoridades del Distrito Capital, adelantar un proyecto para el desarrollo de un sistema de manejo de la información sobre accidentalidad en Bogotá. El sistema existente no tenia mucha aplicación desde el punto de vista de la investigación en seguridad vial, y en relación con el análisis de medidas remediales de Ingeniería. En consecuencia, se inició un proyecto de seguridad vial, para la Alcaldía Mayor de Santa Fé de Bogotá, liderado por autoridad local correspondiente, la Secretaría de Tránsito y Transporte - STT. El proyecto estuvo constó de dos partes principales, el establecimiento de un sistema de manejo de datos de accidentalidad, y la conformación de una Unidad de Investigación sobre accidentalidad.

1 INTRODUCTION

1.1 *Concern*

The City authorities in Santa Fé de Bogotá recognised that the city has a serious road traffic accident problem. This concern prompted the City authorities to decide to initiate a project for the development of an accident data system for Bogota. The systems which were available, were of little use for accident investigation in relation to engineering remedial measures.

1.2 *Project Design*

The project consisted of two main parts, the establishment of an accident data system, and the establishment of an accident investigation unit. There were five elements in the project plan:

1. Accident attendance.
2. Location of accident data and data entry.
3. Data analysis.
4. Accident investigation unit.
5. Road Safety Action Plan for Bogotá.

1.3 *Project Period*

The project started officially on 13th January 1998 The first visit of the consultants took place in January, February and March 1998. The second and third visits were in May/June and September/October with the final visit in January 1999.

1.4 *Bogotá's problem*

Concern over road deaths was being expressed by local politicians and by the local and national press. The Bogotá problem relates particularly to pedestrian accidents.

1.5 *Remedial Action*

Remedial action taken prior to the project, includes an education programme designed to raise respect for red lights at traffic signals and drink drive enforcement campaigns aimed specifically at week-end and holiday travel. Legislation requiring wearing of seat belts and crash helmets was introduced at the same time. A publicity program to encourage cyclists and motor cyclists to wear helmets is ongoing at present. These measures have had some effect.

1.6 *This Paper*

This paper describes the road safety problem and the work undertaken during the project period.

2 SCALE AND NATURE OF THE PROBLEM

2.1 *Present Position*

The road safety situation in Bogotá is by any standard serious. Table 1 below shows the number of deaths and injuries caused by road accidents in Bogotá from 1991 tó 1996. In 1996 there were 1073 deaths on the road in Bogotá with 71 % of the deaths being pedestrians. Compared with similar size cities in the industrialised world, this figure is very high. The number of deaths in the whole of Colombia in 1996 was 7445. At 32 deaths per 10,000 registered vehicles, this is nearly 26 times the rate of deaths in countries like the UK, Sweden, Denmark and Norway.

Table 1: Road Accident Deaths and Injuries in Bogotá

	1991	1992	1993	1994
Deaths	1089	1284	1260	1341
Injuries	5086	5086	11505	13392
Total	6175	6370	12765	14733

	1995	1996	Total
Deaths	1139	1073	7186
Injuries	15906	10454	61429
Total	17045	11527	68615

2.2 *Causal Links*

In Bogotá the high number of pedestrian fatalities is undoubtedly linked to the use of alcohol. The number of deaths and injuries are greater toward the end of the week, particularly Saturday and Sunday mornings, after the traditional nights for the enjoyment of alcoholic drink. There is also no doubt that the major reason is the total lack of facilities for pedestrians to cross the road or even to walk along roads.

2.3 *Pedestrian facilities*

On some major roads, pedestrians are expected to cross 4 or more lanes of traffic without any form of crossing facility or with badly designed facilities. Research has shown that pedestrian safety is seriously compromised if pedestrians are expected to cross more than 2 lanes. It is very difficult for pedestrians to walk along the land between the kerb and the building line, (Figure 1) as he has to walk around parked cars, climb walls and other obstacles. The surface is varied, in a bad state of repair and with the obstacles in the way, it is impossible to use a wheelchair.

2.4 *Road Infrastructure*

The road infrastructure in Bogotá has been designed primarily with the motorised traffic in mind with little consideration given to pedestrian requirements. The major routes in the city are of variable design, some of very poor design from a road safety point of view, with dual carriageways with between 2 to 6 lanes in each direction. The major problem in terms of road safety in Bogotá is therefore the provision of pedestrian facilities which pedestrians are either likely to, or forced to use by restricting their other options.

2.5 *Road User Behaviour*

Road user behaviour in Bogota is very bad. Red light violation is extremely common. Pedestrians are not regarded, by the drivers, as legitimate road users.

Figure 1: Indiscriminate parking on the footpath and surface making it difficult for pedestrians

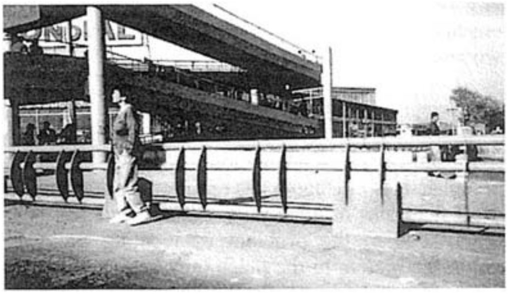

Figure 2: Poorly designed pedestrian guardrail

Outside peak hours, speeds tend to be very high on main routes, which adds to the potential hazard by both pedestrians and vehicle occupants.

2.6 *Pedestrian Guardrail*

Where pedestrian guardrail has been used, it is often of a dangerous design. This can be seen in Figure 2. The vertical curved plates on the roadside are particularly dangerous as car which hits the guardrail would sustain serious damage, and likely cause serious injury to its driver and passengers.

3 ACCIDENT ATTENDANCE

3.1 *The Traffic Police (La Policía de Tránsito)and the Judicial Police (La Fiscalía)*

Bogota has a dedicated traffic police force. The Policía de Tránsito in Bogotá are part of the National Police and are responsible for the detection and enforcement of traffic offences and the recording of details following accidents. The Traffic Police complete the accident report forms as part of their accident attendance. This form is the basis for the accident data base, and is completed reasonably well by the Police.

3.2 *Accident Management*

If involved in an accident, causing injury to a person or damage, drivers are obliged to stop and remain at the scene, with their vehicles in situ, until the arrival of the Traffic Police. The Traffic Police are not prompt at attending the accident location. These often serious delays can cause both danger to other road users and, more commonly in Bogotá, serious congestion. It is suspected that there is an under-reporting problem, particularly with minor injury and damage only accidents, as a result of the long waiting time. On arrival at the location of the accident the police action is determined by the degree of severity of the accident. There are three degrees of severity, fatal, injury or damage only. Fatal and injury accidents are investigated further by the Fiscalía. Damage only accidents are simply recorded and any infringements noted and appropriate tickets issued. In injury accidents, the Traffic Police transport drivers to the office of the Fiscalía where any further investigations are carried out. Following road death the Fiscalía attend the scene and the vehicles are left in place until they have completed the initial investigation.

3.3 *Training of the Police*

Only very limited training of police officers were possible under the Terms of Reference for the Project. Much more training is desirable, but had not been allowed for in the Project. However, in the January 1998 a training day was held for selected officers from the Traffic Police. The training was held to address the minor problems discovered on the accident report forms. Further training of selected police officers was carried out in January 1999 in aspects of forensic accident investigation. This training should be built upon, and advice was given with regards to courses available in the UK.

3.4 *Technical Notes*

Detail technical notes were prepared as advice for the police on the subjects covered in the all too brief seminars.

4 LOCATION OF ACCIDENT DATA AND DATA ENTRY

4.1 *The Accident Data System*

The Terms of Reference for the project specified that a major part of this project should consist of the installation a new microcomputer based road accident data system. The Transport Research Laboratory has developed a system named MAAP (Microcomputer Accident Analysis Package), which was originally developed for use in developing countries. The system, which was DOS based, has been installed as the main analysis tool for road accident in many countries in South America, Africa, Asia and the Pacific. The system has developed over a number of years as needs were identified, and many additional analysis tools have been added. Similarly, as computers have improved, the system has been refined, been converted to operate in Windows, and become more user friendly at the same time as graphics have replaced character based facilities.

4.2 *A City-wide Database*

Over 45,000 road accidents are recorded in Bogotá every year. The full data from the police accident reports was entered into the database system of Fondo de Prevencion Vial Nacional, a national road safety organisation funded by the insurance industry. It is generally agreed that this has been an excellent system as it has provided a city-wide database. However, the la Secretaría de Tránsito y Transporte (STT) needed to take over this to obtain a comprehensive database which was also useful to the engineer.

4.3 *Location of accidents*

The location of an accident is one of the most essential pieces of information to be recorded. The Colombian accident report form requires the reporting officer to give the street address of the accident location. Whilst the street address for many accidents can give quite an accurate location for the accident, for many accidents, it is of little use to the accident investigator. However, the reporting officer also normally draws a sketch of the accident that, if done well, can give an almost precise location for the accident. A number of countries require the police reporting officer to give the geographical co-ordinates ('Eastings' and 'Northings'). However, these locations are not always accurate. Therefore, the police co-ordinates are checked by someone specially trained in coding locations. As a result, the TRL always recommends that in all implementations of the MAAP computer system, a specialist member of the office unit should be trained to do the location coding, thus avoiding the need for a massive training programme for all police recording accidents.

4.4 *Checking and Data Entry*

The checking of the data, and the data entry is now carried out by two members of staff in the new Accident Investigation Unit. The data is entered straight into the newly established MAAP for Windows accident data system.

5. DATA ANALYSIS

5.1 *MAAP for Windows*

MAAP for Windows is relatively new, and has been developed to run in the up-to-date Windows 98 operating system. It is the latest system which has been installed for use in Bogotá.

5.2 *Hardware*

As part of the requirements for this project, one computer was purchased for the use of the project staff mainly as a word processing tool. A further two computers have been purchased for the use of the STT Accident Investigation Unit. The MAAP system has been installed on these computers, and the two have been networked.

5.3 *Installation of Software*

The installation and adaptation of MAAP to suit the circumstances in Bogotá has required a much greater effort than was originally envisaged. This has been largely due to the problem of locating accidents within the system to the place they happened on the ground. One major reason for these problems is the very complicated street name/number system which is used in Bogotá. A GIS based map locating system is now operating.

6 TRAFFIC ENGINEERING IN BOGOTÁ

6.1 *Priority to Motorised Traffic*

Traffic management has been carried out in Bogotá over the years, mainly aimed at keeping traffic moving as fast as possible. Bogotá employs traffic signals extensively, and most signal sets are relatively new, but using reasonably old technology.

6.2 *One-way Streets*

One-way streets have been employed extensively throughout the city, even down to the streets in mainly residential areas. The one way system is very badly signed and marked. This indicates that the only priority has been to keep traffic moving. Many wide one way streets speed the traffic up, which is hazardous to pedestrians, and is making it difficult for pedestrians to cross 4 lanes of traffic without any assistance in the form of pedestrian refuges or pedestrian crossings. However, some recent work in one of the main north-south routes in northern Bogotá, has the purpose of narrowing down the road space used by vehicles, and to widen the area used by pedestrians. This has substantial safety benefits for pedestrians.

6.3 *Traffic Safety Engineering Improvements*

Investigation of the existing databases in Bogotá during the first visit revealed that by far the major accident problem in the city was pedestrians being hit, often on the major roads, and frequently killed by the impact. The pedestrian problem also applies to most of the major road network with concentrations along certain lengths. When examining the network, it was quite obvious to a road safety professional that the total lack of pedestrian facilities, apart from pedestrian bridges, must be the major cause of this problem. The number of potential sites which could be used for more thorough investigation, and which subsequently could be used as a demonstration site for the purpose of training STT staff, were so many that a decision had to be taken on a pragmatic basis. Two sites were therefore chosen:

1. Carrera 30 from Calle 6 to Calle 13; and
2. Autosur from Avenida 68 to Avenida Boyacá.

Accident data from these sites was collected from the database at STT and analysed, and analysis was carried out by Medicina Legal y Ciencias Forences (a legal forensic bureau) on their database. The data was plotted, and detailed analysis was obtained about where within the sites the problem is particularly serious. The Accident Investigation Unit made several site visits with and without the consultants and the findings were discussed at length with the consultants and Medicina Legal staff.

6.4 *Surveys and physical Data Collection*

A team of sociologists were consulted, and their proposed approach was discussed. The Accident Investigation Unit asked the sociologists to carry out a number of surveys of the sites. This included:

a) Still photographs to be taken;
b) Video recording taken of the sites;
c) Surveys of traffic volumes to be carried out; and;
d) Surveys of pedestrians crossing the roads to be carried out in 100 metre sections along each site.

The collection of additional information was agreed which was more in the sociological field of work. This included:

e) Interview surveys attempting to establish where people were coming from and going to when they cross the road at the site; and
f) Attempting to establish whether or not the persons crossing the road in these locations are aware of the danger of crossing in these locations, and in fact feel it is dangerous when crossing.

This information subsequently led to a suggestion of several potential solutions to the problem.

6.5 *Physical Accident Site Improvements*

At the start of the project, it was hoped that physical accident site improvements would have been done by the end of the project period. However, for a number of reasons, this has not been possible. The STT Accident Investigation Unit therefore have follow up this work, determined final design, arranged for the design work to be completed, established where funding was available from, and will in due course supervise the final works.

7 ACCIDENT INVESTIGATION UNIT IN THE STT

7.1 *Establishment of Accident Investigation Unit*

The establishment of the Accident Investigation Unit has been a major problem during this project, due to very late appointment of staff for the Unit. For that reason, the staff were not available to work with the consultants for the first half of the contract period. The Unit has now been established, and consists of one senior engineer, one systems technician, and two staff to enter data. This level of staffing is below that which was recommended by the consultants. However, the Unit head is committed to the task of improving road safety, and hopefully further staff will be appointed in due course.

7.2 *Training of Staff*

The intention of the consultant was to bring selected staff to the Royal Society for Prevention of Accidents' (RoSPA) Accident Investigation and Prevention course in Birmingham, United Kingdom. This is a very highly regarded course, which is of great valuable for those attending. For various reasons, this has not been possible. The consultants have attempted to give the staff as much training locally as has been possible. A local course has been arranged by the consultant's local representative in Bogotá to attempt to replace some of the content of the RoSPA course.

8 ROAD SAFETY ACTION PLAN

8.1 *A costed Road Safety Action Plan*

A costed Road Safety Action Plan for Bogotá has been prepared for a five year period after the present project. The first page of that plan is shown in Figure 3, and the whole plan will be shown in the conference presentation. The primary objectives of this Project and therefore of this plan is road safety engineering and the collection and analysis of accident data. However, road safety is a multi-disciplinary subject. Therefore the plan also includes some important aspects related to public education and traffic policing. The plan, which is in a tabular form, schedules 58 activities over the five year period, and is costed to US$ 2,052,000. This is a relatively small investment over such a time period, and should be easily achieved provided the city authories are committed to improve safety on the roads of Bogotá.

Figure 3: Example of the Road Safety Action Plan for Bogotá (Page 1 of the Action Plan)

Road Safety Action Plan for the City of Santafé de Bogotá	Time Schedule					Expenditure Profile (US dollars, thousand)									
												Potential Sources of Funding			
Description	1999	2000	2001	2002	2003	1999	2000	2001	2002	2003	Total	Bogota	World Bank	Private Funding	Other
A. Accident Data Collection															
— A1- Data Collected by Colgrabar						50					50	✔			
— A2- 1 person appointed to enter data at STT						5					5	✔			
— A3- STT enters all data from the Police into the MAAP System							10	10	10	10	40	✔			
— A4- Cooperation established so all fatal accidents are entered on MAAP System						0.5	2	2	2	2	8.5	✔			
— A5- Very serious casualties followed up for 30 days after accident							1	2	2	2	7	✔			
— A6 STT data checked routinely against Medicina Lagal data for fatalities							0.5	1	1	1	3.5	✔			
B. Accident Investigation Unit in STT															
— BI- Staffing increased to 4 staff						2	2				4	✔			
— B2- Two staff trained overseas											0	✔			
— B3- Staffing increased to 6 staff							1	3			4	✔			
— B4- Further staff training overseas							6	6			12	✔			
— B5- Six permanent staff fully employed by Accident Investigation Unit							47	46	47	46	186	✔			
— B6- Unit fully functioning in close cooperation with Unit at IDU											0				
C. Accident Remedial Unit in IDU															
— C1- Unit formally established						3					3	✔			
— C2- 2 Staff trained overseas						17					17	✔			
— C3- Unit adequately staffed (6 members of staff)							47	46	47	46	186	✔			
— C4- Staffing increases as necessary as work increases									10	10	20	✔			
— C5- Unit fully functioning in close cooperation with Unit at STT											0	✔			

9 CONCLUSION

9.1 A project such as the one undertaken in the City of Santa Fé de Bogotá is only a beginning of the solution to a serious road accident problem. In the more industrialised countries of Western Europe, the improvement in road safety to the level of the present day has taken some 60 years. Providing the authorities in Bogotá has the commitment to tackle this serious problem with both effort and investment, there is no reason why a position such as in those conutries cannot be attained in a much shorter period through transfer of experience, maybe in between 10 and 20 years. This clearly also involves a commitment from the national government of Colombia, as the capital city is not isolated for the rest of the country. The authors have seen some good signs from the authorities. These signs will hopefully be transformed into action and success in the years to come.

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Education and training for road traffic safety in Nigeria

Samual Iyiola Oni
University of Lagos, Nigeria

ABSTRACT : The neglect of transport operator's training, environmental education and local/indigenous knowledge have constituted serious bottleneck in the implementation of Nigeria's national transport development programme. The deficiency in and poverty of the basic traffic safety education has also been responsible for the greatest part of Nigeria's road traffic accidents, manifesting mainly as human-related-psychological, psycho-graphical, attitudinal and behavioral tendencies. These problems include poor local knowledge of road safety education and enforcement of road traffic laws and highway code, indiscipline, non-compliance, incomprehension of road signs and traffic signals, absence of well-structured (socio-culturally oriented traffic bye-laws and regulations).
This paper therefore emphasizes traffic education and espouses the significance of training and retraining scheme. A thorough appreciation of this becomes essential tool in effective planning and performance of road safety management. This paper further shows education, training and publicity guaranteeing a sustainable road safety in Nigeria.
The paper sets appropriate framework and guidelines for training of transport operators through joint/integrated teaching, transport institutes and information mode. Appropriate geographic/traffic information system techniques/strategies, efficient use of road signs, signals, mass media, constant publicity, symposia, lectures and demonstrations need be adopted to educate, appeal and diffuse knowledge on the efficient and optimal use of roads and accident prevention and reduction.

First Paragraph

1.0 INTRODUCTION

With the growing demands on the road as a major mode of transport, the highway management and administration could not function efficiently due to the stress and neglect of traffic education and training programs for the operators/drivers and the managers. The attended neglect and gaps in Nigeria's road traffic safety administration are great. They are responsible for the high rate of traffic accidents.
A chaotic situation has arisen from

this development. The major stumbling block has been identified as human factors, Oni (1995). These problems include motorist/driving culture, poor attitude and incompetence of many professional drivers and wide extensive indiscipline, corruption, enforcement, disobedience for law, institutional gridlocks characterizing the motoring behaviour. A well founded and integrated road safety and behavioral education will serve as succor for this.

No matter the sophistication level of engineering ingenuity could resolve the problem, except an integrated traffic education, attitudinal change, persuasion, reorientation and modification of drivers and road users minds and character. This development should be backed-up by efficient traffic information system, effective citizens participation, institutional radicalization, local knowledge development, prioritization and rationalization as well as strong political will. The new education will influence the long-term attitude and behaviour changes, while the enforcement process will ensure laws being enforced fairly and justly by the agencies.

A review of the road transport system in Nigeria and road safety management in particular indicate a serious lack of focus on research and future transport technology. Whereas, relevant research is a useful instrument of change in the transport system of a country. Through research, relevant data and information for road safety planning, new strategies for solving road safety problems are evolved. The current non-compliance by the regulations and laws guiding and controlling the road system operations by the users is as a result of poor educational training, publicity and funding. As such, an increased investment on road usage education and traffic safety management are strongly advocated for.

2.0 OBJECTIVES

This paper opines to achieve the following objectives:

1) To espouse the significance of road safety knowledge, skills and attitudes leading to a new system of order, values and a conservation ethic; which will enable motorists/transport operators contribute to the wiser management of road traffic safety.

2) To work towards persuading decision makers of the need for a new type of in-service training for transport operators and transport-related officials; and the appreciation of local environmental education's role in traffic management.

3) To find the best formulae for the appreciation of environmental education and training at every level, and encourage traffic safety operators to think both vertically and horizontally, as there is need for cooperation at all levels - trainees and trainers.

4) To show that the gap in Nigeria's road traffic problem could only be solved by local environmental and traffic safety education, which considers the entire community and public as well as the old society.

5) To enable individual, groups and

the entire society acquire awareness and knowledge, develop attitudes, skills and abilities, and participation in solving the Nigeria road traffic safety problems, through an holistic, integrated and inter-disciplinary approach; as the stakeholding is diverse and multidimensional.

3.0 CONCEPTUAL ISSUES

In response to the highlighted problems embedded in Nigeria's road traffic safety management, 'environmental engineering education and training' has been identified as a problem. This requires an inter-disciplinary, multi-eclectic and multi-dimensional approach, an integration of education into the community and neighborhoods, and a life-long, forward-looking education. The approach is both top-downward (from planners/decision makers) and bottom-upward, providing a new approach to the traffic safety through sound environmental education.

Traffic Education

Traffic education here means the conscious training of all road users, most especially drivers of motor vehicles and motorcycles in proper and lawful behaviour on public highways. This should involve:

a) Knowledge of Road Traffic laws and highway code
b) Comprehension of road signs and traffic signals
c) Knowledge of one's responsibilities while driving
d) Respect for other road users
e) Respect for traffic control officers and their directives
f) Concern for the safety of all road users
g) Proficiency in driving.

The educational objectives could therefore be defined in terms of awareness, knowledge, skills, attitudes and commitment, all of which are necessary to deal effectively with environmental issues. This paper shows the selection, training, retraining processes and adopting environmental education for drivers and transport operators and strategies at integrating behavioral education into environmental education delivery. The objective is to suggest selection, training and retraining schemes that would lead to high standards of safety, cost effectiveness and performance in Nigeria's road traffic operations and environment. Other areas of attention include: Competent Vehicle Operator, Driver Retraining Schemes, and, Data Base For Education/Training

4.0 "SPATIAL SCHEMATA"

-The 'spatial schemata' is here viewed as the framework within which people organize their knowledge of the road traffic environment, containing the residue of past environmental experience and accommodating current sensory information. Once established, such schema may be modified by extension. The notion of the schema was derived from the work of cognitive psychologists on object perception (Bartlett), 1932) being first applied to environmental contexts by Lee (1954). The schema may be defined as the cognitive structure of coding system that allows the individual to respond appropriately to a shifting pattern of environmental stimuli. They are dynamic and thus changing to incorporate new ideas.

The underlying challenge is to create the educational changes needed to solve survival problems. The mechanism for creating the needed re-orientation and consequent change is behavioral, attitudinal and psychological integration into the educational and training process.

The main purpose of this paper therefore is to devise a token reinforcement system (low cost, workable in an "open field" setting, yet attractive enough to induce drivers and other road users).

4.1 Functional Training Models

One likely source of paradigm change is the development of new training models and programs (psychologically - based) for the Nigeria's road users ("person-centered" innovations) by behaviour modifiers. Seidman Rappaport (1974) at the University of Illinois developed an educational pyramid which uses professional experienced psychologists as consultants and teachers of larger number of graduate students, who in turn train and supervise a lager number of undergraduates and other non-professionals as direct interventionists in various social systems such as the elementary schools. The educational pyramid which could be adaptable to Nigerian roads situation shall be directed at four crucial needs of community psychology.

First, it includes a conceptual - methodology schema for understanding and evaluating the impact of community interventions at multiple levels of society. Second, it offers a model for training future professionals and non professional in their specific career goals. Third, the paradigm calls for rigorous and systematic evaluation of human service programs. Fourth, and most obviously, the paradigm allows for efficient deployment of psychologically polished manpower (Seidman and Rappaport, 1974). In addition, formalisation of the two programs makes the model to respond to the requirements of activism and empiricism. Professionals are trained as intervention planners and coordinators with the expectation that they will assume career roles as directors and supervisors of social change programs. They equally receive predominantly research-oriented training in anticipation of their role as evaluators of program effectiveness and conceptualizers of world programs. A recurring theme is the necessity of interdisciplinary and integrated preparation which is the pivot of this paper. The behavioral modification espoused here, serves as a source of environmental educational innovations which portends its ability to conceptualize and promote institutional change as opposed to the "psycho adaptation" of target populations (Renner, 1974).

Behavioral approaches to road traffic

environment have been long underplayed and under-estimated. This paper has therefore shown the resourcefulness and vitality of the behavioral paradigm to respond to the need for the applied and conception innovations that have been identified. This energetic innovation will fill the gap and insure that the initial achievements of behavioral consideration are continued.

4.2 An Operational Paradigm

This paradigm serves as an integrating framework providing related answers to questions on:
How spatial cognition develop?
How can perceptions be changed through proper training and education appealing to psychological tendencies.
The earlier paradigm depicts images and spatial schemata, as the basic cognitive elements that mediate behaviour. The individual road traffic operator is simultaneously part of the objective and behavioral environments; receiving locational and attributive information from the behavioral environment, but affecting both environment by his actions.
In the traffic situation, the trainer must monitor the effectiveness of his actions, assign value to the experience and thus correct future behavioral strategies. These in turn may modify road traffic cognition and stimulize further behaviour for a thorough traffic-calming and sustaining environment.

5.0 SUGGESTIONS

The relevant agencies in charge of road safety management include:
Federal Road Safety Commission
The Police - Traffic Unit
The Ministry of works - Highway Division should engage the public media - radio, television, newspapers and magazines in propagating the road safety and environmental education.
These agencies must give demonstrations to the public on the following:
(i) the proper and correct use of the roads and highways;
(ii) the meaning and significance of traffic signs;
(iii) demonstrations of correct and incorrect use of the road through films and posters.
The highway division should put up more road signs and advocate for and put up speed limits which should be enforced on the roads and highways by regular highway patrol. The entrenchment of effective enforcement network is highly necessary.
Private individuals should also contribute to public education through demonstrations, writing to the press, talks on televisions, radios and at clubs. Children's road safety clubs should be encouraged. The police department, through cooperation with the ministry of education can organize film shows and demonstrations on the correct use of the roads at least once a month. Each demonstration should be mobilized to advertise these and posters being put up.

Driving schools should be established. Better equipped and better paid police should be made to patrol our roads and highways.

This paper is of the opinion that instead of spending so much money on the new roads building and expansion, more funds should be invested in educating road users; and training and retraining of the young and inexperienced drivers and in giving general traffic/environmental education to the road users more especially the children.

6.0 SUMMARY AND CONCLUSION

This paper has espoused the role of a behaviorally integrated traffic education in road transport planning and development of a framework/guidelines for training transport operators, as well as the need for a form of participatory scheme that entails reward and penalties, supervision, management and training therefore forms the basis of this paper. The driver's perception measures must search for efficiency and safety, through initiating packages of courses, seminars and workshops. Basic suggestions such as the need to entrench socio-cultural factors into the transport education and training, as well as to increasingly fund behavioral-related transport training programme should be vigorously pursued.

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Author index
Index des auteurs
Índice