Tommy Gärling · Dick Ettema
Margareta Friman *Editors*

Handbook of Sustainable Travel

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Editors
Tommy Gärling
Department of Psychology
University of Gothenburg
Göteborg, Sweden

Dick Ettema
Faculty of Geosciences
Utrecht University
Utrecht, The Netherlands

Margareta Friman
SAMOT/CTF
Karlstad University
Karlstad, Sweden

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Preface

It has been a pleasure to work on this *Handbook of Sustainable Travel* even though its topic is not a pleasant one. It seems as we belong to a minority of people who are not optimistically biased about the future of the human habitat on the planet. Consensus among scientists is that by the end of the century, without effective changes in policy, the world will be much warmer than today with serious or catastrophic weather consequences. Emissions caused by the transport of people and goods continue to increase steadily, making the transport sector an important cause of global warming. This knowledge as well as knowledge of other long-term societal costs of current transportation systems motivated us to initiate this work. We believe it is urgent to disseminate what can be accomplished to increase sustainability of travel by households and individuals without seriously reducing their well-being and restricting their freedom of movement.

Travel is a form of unsustainable consumption resulting from the Western lifestyle societies allow, encourage or occasionally seem to force citizens to adopt. In the *Handbook of Sustainable Travel* we disseminate current research findings of both the positive and negative sides of travel. We primarily target readers who are not active researchers of travel behaviour (many of whom are chapter authors) – but other specialists including researchers in environmental science as well as politicians and journalists who have a professional need for reviews, analyses, and syntheses of research findings.

We thank all chapter authors and their co-authors for their contributions. They have fulfilled or exceeded our expectations leading to, as we think, an excellent coverage of most of the relevant research findings on travel behaviour. We also thank Margaret Deignan at Springer for her useful editorial assistance.

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Göteborg, Sweden — Tommy Gärling
Utrecht, The Netherlands — Dick Ettema
Karlstad, Sweden — Margareta Friman
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Contents

Contributors

Maya Abou-Zeid Department of Civil and Environmental Engineering, American University of Beirut, Beirut, Lebanon

Anne Aguiléra Department of Planning, Mobility and Environment at Ifsttar, LVMT, University of Paris East, Marne la Vallée, Cedex 2, France

Sebastian Bamberg Department of Psychology, University of Applied Science Bielefeld, Bielefeld, Germany

David Banister Transport Studies Unit, University of Oxford, Oxford, UK

Moshe Ben-Akiva Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge, MA, USA

Christina Bernardo Department of Civil, Architectural, and Environmental Engineering, University of Texas at Austin, Austin, TX, USA

Chandra Bhat Department of Civil, Architectural, and Environmental Engineering, University of Texas at Austin, Austin, TX, USA

Peter Bonsall The Institute for Transport Studies, University of Leeds, Leeds, UK

Dick Ettema Faculty of Geosciences, Utrecht University, Utrecht, The Netherlands

Lotta Frändberg Department of Human and Economic Geography, University of Gothenburg, Göteborg, Sweden

Margareta Friman SAMOT/CTF, Karlstad University, Karlstad, Sweden

Satoshi Fujii Department of Urban Management, Graduate School of Engineering, Kyoto University, Kyoto, Japan

Tommy Gärling Department of Psychology, University of Gothenburg, Göteborg, Sweden

Birgitta Gatersleben Department of Psychology, University of Surrey, Guildford, Surrey, UK

Susan Handy Institute of Transportation Studies, University of California, Davis, Davies, CA, USA

David A. Hensher Institute of Transport and Logistics Studies, The University of Sydney Business School, The University of Sydney, Sydney, NSW, Australia

Robin Hickman Bartlett School of Planning, University College London, London, UK

Zheng Li Institute of Transport and Logistics Studies, The University of Sydney Business School, The University of Sydney, Sydney, NSW, Australia

Jian Liu Transport Studies Unit, University of Oxford, Oxford, UK

Corinne Mulley Institute of Transport and Logistics Studies, The University of Sydney Business School, The University of Sydney, Sydney, NSW, Australia

Jeroen Nawijn Academy for Tourism, Centre for Sustainable Tourism and Transport, NHTV Breda University of Applied Sciences, Breda, The Netherlands

Paul Peeters Academy for Tourism, Centre for Sustainable Tourism and Transport, NHTV Breda University of Applied Sciences, Breda, The Netherlands

Soora Rasouli Urban Planning Group, Eindhoven University of Technology, Eindhoven, The Netherlands

Orit Rotem-Mindali Department of Geography and Environment, Bar Ilan University, Ramat Gan, Israel

Janet Stanley Monash Sustainability Institute, Monash University, Melbourne, VIC, Australia

John Stanley Faculty of Economics and Business, Institute of Transport and Logistics Studies, University of Sydney, Sydney, NSW, Australia

Ayako Taniguchi Department of Risk Engineering, University of Tsukuba, Tsukuba, Ibaraki, Japan

John Thøgersen Department of Business Administration, School of Business and Social Sciences, Aarhus University, Aarhus C, Denmark

Harry J.P. Timmermans Urban Planning Group, Eindhoven University of Technology, Eindhoven, The Netherlands

Bertil Vilhelmson Department of Human and Economic Geography, University of Gothenburg, Göteborg, Sweden

Bert van Wee Faculty of Technology, Policy and Management, Delft University of Technology, Delft, The Netherlands

Luis Willumsen Department of Civil, Environmental and Geomatic Engineering, University College of London, London, UK

Jimin Zhao Division of Social Science, Hong Kong University of Science and Technology, Hong Kong, Hong Kong

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Part I
Introduction

Overview of Handbook of Sustainable Travel

Dick Ettema, Margareta Friman, and Tommy Gärling

Introduction

Sustainability is at the top of policy and research agendas throughout the world. A search of the Internet reveals that the term "sustainable" is related to (among others) food, clothes, offices, agriculture, and architecture. It does not come as a surprise then that also travel, which is a significant part of people's daily consumption, is likewise viewed from a sustainability perspective. A transportation journal (*International Journal of Sustainable Transportation*) is dedicated to the topic. The relationship between travel and sustainability is also discussed in many papers published in the regular transportation literature.

In many cases sustainability in the context of travel is regarded in a narrow sense as to minimize the amount of car travel and the amount of greenhouse gas (GHG) emissions. However, exclusively focusing on these aspects denies the fact that transport policies should not only be valued for their environmental outcomes but also for their social and economic outcomes, and that these outcomes occur at different temporal and spatial scales.

The aim of the *Handbook of Sustainable Travel* is to discuss the sustainability of transportation systems from an environmental, social, and economic perspective, to provide insights into the underlying mechanisms, and to discuss potential strategies towards more sustainable travel. In this introductory chapter we give a brief

D. Ettema (✉)
Faculty of Geosciences, Utrecht University, Heidelberglaan 2,
P.O. Box 80115, 3508TC Utrecht, The Netherlands
e-mail: d.f.ettema@uu.nl

M. Friman
SAMOT/CTF, Karlstad University, 65188 Karlstad, Sweden
e-mail: Margareta.Friman@kau.se

T. Gärling
Department of Psychology, University of Gothenburg,
P.O. Box 500, 40530, Göteborg, Sweden
e-mail: Tommy.Garling@psy.gu.se

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background to the *Handbook of Sustainable Travel*, define its aim, and provide an overview of the chapters organized in four different parts, Introduction (Part I), Car Use (Part II), Travel and Social Sustainability (Part III), and Future Sustainable Travel (Part IV).

Background

Some scholars have proposed elaborate schemes for defining sustainability of travel. For instance, Donegan, Adamson, and Donegan (2007) recognize that sustainability has not only an environmental component, but also a social and an economic. Miller, Witlox, and Tribby (2013) propose a framework in which sustainability and liveability effects of transportation are classified into a variety of outcomes, such as productivity, development, energy efficiency, affordability, operational efficiency, equity/fairness, safety, security and health, community development, heritage protection, climate stability, air pollution prevention, noise prevention, water pollution prevention, open space preservation, good planning, and efficient pricing. Thus, apart from environmental aspects of sustainability, social and health outcomes constitute an important pillar of the definition of sustainable travel. This has led other scholars (e.g. Amekudzi, Jotin Khisty, & Khayesi, 2009) to propose measurement frameworks to trade off environmental and well-being effects against each other.

Irrespective of the exact definition of sustainability, it cannot be ignored that some developments have had a major impact on the environmentally unsustainability of travel. First, current travel is heavily dominated by private car use. The private car's penetration has in fact had an impact comparable to few other human inventions. Although cars were available at the beginning of the twentieth century, it was only in the years after World War II with the subsequent spread of affluence and the acceleration of car mass production that ownership was brought within the reach of most households in the industrialized world. Similar or even more extreme trends are observed for countries that started the industrialization process more recently (e.g., Brazil, South Korea, Taiwan) or which are to some extent industrialized such that they are beginning to experience income growth and a spread of affluence (e.g., China, India). In contrast, in many industrialized countries car travel appears to have peaked (Litman, 2012).

In many cases (e.g. Curtis, 2006; Kahn & Morris, 2009; Sun, Waygood, Fukui, & Kitamura, 2009) unsustainability of travel tends to be equated to car use without further specification, thus implicitly recognizing that car use contributes to greenhouse gas (GHG) emissions, health hazards due to pollution in the air of volatile organic compounds, nitrogen oxides, sulphur oxides, particulate matter, and carbon monoxide, unsafety caused by accident risks, and stress due to congestion and noise. Many studies provide support for these claims. Brand and Boardman (2008) indicate that air and car travel are responsible for the majority of GHG emissions. Brunekreef et al. (2009) report significant impacts of exposure to traffic-related air pollution on respiratory and cardiovascular mortality. Chi, Porter, Cosby, and Levinson (2013) report that traffic unsafety, expressed as the number of car accidents, increases with the amount of car traffic. The relationship between travel and stress is documented by Novaco and Gonzalez (2009) in a review of several US studies.

A second development that has greatly influenced travel patterns and their environmental social and economic effects is the increase in air travel. According to Gössling and Peeters (2007), air traffic has increased by 400 % between 1970 and 2000 and is predicted to grow at a steady rate. This trend applies to both tourism and business travel, and is facilitated by the extension of air traffic networks and fare reductions achieved by new business models in the air industry. Gössling and Peeters note that air travel has serious environmental impacts and causes disproportionate amounts of GHG emissions as compared to other travel modes.

Despite the unsustainability of car and air travel, a shift towards alternative travel modes is not always the solution. For instance, a shift towards electric vehicles may not be effective if the electricity is generated by polluting coal power plants. In a similar vein, public transport may not be sustainable if occupancy rates are low, or if public transport attracts travellers that would otherwise walk or bicycle.

Looking at travel from a broader sustainability perspective, measures to reduce car or air travel may lead to lower accessibility of jobs, services, and social opportunities, thereby causing negative social and economic effects. Such effects will depend on the locations of housing, schools, stores, and recreational sites, implying that land-use planning may provide important conditions for moving towards sustainable travel.

In addition, implications of transport policies curtailing private car use may have different impacts on different groups. For instance, reduced access to a car may have a larger negative impact for people without alternative travel opportunities or for people in poor health. Thus, how transport policies affect the well-being of different groups of citizens in a society needs to be taken into account.

Aim of the Handbook of Sustainable Travel

The *Handbook of Sustainable Travel* will provide a broad overview useful to academics as well as practitioners. To this end, we have brought together distinguished researchers of travel behaviour from a variety of academic backgrounds to provide state-of-art reviews of what today is known to have relevance for sustainable travel. Research on sustainable travel integrates several areas including environmental, traffic and transport psychology; transport planning and engineering; transport geography; transport economics; consumer services research; environmental sociology; and well-being research. We hope that the *Handbook of Sustainable Travel* will give a comprehensive understanding of ways to reduce unsustainable travel, promote alternatives for developing more sustainable transportation systems, and inform about measures to assess the implications of various future development paths in terms of their societal impacts.

Chapter Overview

The *Handbook of Sustainable Travel* has four parts. In this part (Part I: Introduction) the chapters review historical and future trends in travel (chapter "Spatial, Generational and Gendered Trends and Trend-Breaks in Mobility"), the role of travel for a good society (chapter "Benefits of Travel: Needs Versus Constraints in Uncertain Environments"), and travellers' satisfaction with various features of travel related to their choices (chapter "Satisfaction and Travel Choice"). Taken together, these chapters provide an introduction to the societal role of travel, its current environmental unsustainability, and its impact on people's well-being.

In **Part I**, chapter "Spatial, Generational and Gendered Trends and Trend-Breaks in Mobility", Lotta Frändberg and Bertil Vilhelmson report trends and trend-breaks in travel from the 1970s until today. Surprisingly, national data from many different countries show a levelling off and decline in daily car travel referred to as "peak travel". How can this be explained? Recent research highlights several explanations: Higher fuel prices, road congestion, substitutes such as Information and Communication Technology (ICT), increasing population density, saturation in demand, and growth in international air travel. Frändberg and Vilhelmson use data from Sweden for a detailed analysis of the trends in travel. Swedish data have the advantage of being longitudinal including both international and national travel. Similarly to other researchers, Frändberg and Vilhelmson come to the conclusion that daily travel has slowed down and even declined. However, they warn against jumping to conclusions about "peak travel". The Swedish data show, for instance, that international air travel has grown and replaced national travel in certain groups. Additionally, women now travel to a larger extent in the same way as men do. Reduced daily travel in Sweden is in fact mainly due to younger men who are travelling less and with other travel modes than the private car. The Swedish data warn that when describing the development of car use and "peak travel", one must be sure taking different groups and national versus international travel into account.

In chapter "Benefits of Travel: Needs Versus Constraints in Uncertain Environments", Soora Rasouli and Harry Timmermans discuss the benefits of travel from an individual and societal perspective. They describe how the need for motorized travel developed in moving from the agricultural to the modern industrialized societies. Rasouli and Timmermans also discuss the current role of ICT, which contrary to what has been anticipated does not appear to be to suppress travel. Another main point made in the chapter is that travel is not always only a negative episode between two positive stationary activity episodes. In fact, travel may be a positive break from routines or an opportunity to release frustration, chill down, and recharge for things to come. It is also an opportunity to have a moment for oneself, enjoying the passing of the landscape and the brief non-obligatory, superficial encounters with others. Based on these notions, in a formal way the conditions under which travel in itself becomes positive are identified.

Chapter "Satisfaction and Travel Choice" by Maya Abou-Zeid and Moshe Ben-Akiva addresses how travel (e.g. the work commute) affects subjective well-being (SWB), defined as the life satisfaction, happiness or emotional well-being that people themselves report that they experience. Abou-Zeid and Ben-Akiva note that current research has found that SWB is related to satisfaction with different life domains such as work, family life, and leisure. Travel is likely to be related to life satisfaction since travel is necessary for many of the daily activities contributing to satisfaction with the different life domains. Several empirical studies are reviewed that support that travel influences SWB. Travel may also in itself have benefits that increase SWB. A contribution of the chapter is to demonstrate theoretically and empirically how the efficiency of the standard random utility model of travel mode choice is improved when augmented with SWB indicators.

Part II (Car Use) departs from the fact that the car is the backbone of the current transportation system, and that a break away from it is likely to be necessary in the future. It describes the development of private car use, explains why the car generally is the primary mode of transport, and discusses how it can be changed in the future.

In chapter "The Unsustainability of Car Use", Bert van Wee gives an overview of the negative effects of car use including environmental impacts, urban problems such as local air pollution, noise, and acidification on buildings, and global problems such as climate change and acidification on nature, agriculture, and landscape. It is clear that the share of transportation in environmental problems cannot be ignored. A theoretical framework is presented identifying important factors accounting for transport volumes, which in the long run negatively affect the environment, accessibility, health, and safety. Van Wee underlines that person characteristics such as lifestyle and age are important in determining how society eventually may manage to cope with the negative effects. The overall conclusion is that current car use is unsustainable. The chapter also discusses a broad range of policy measures that can be implemented to influence the environmental impacts of urban transport. Such policy measures may have a wider impact than on the environment alone. A recommendation is therefore to use several different indicators when evaluating such measures.

In chapter "Psychological Motives for Car Use", Birgitta Gatersleben analyses psychological motives for car use. Understanding the instrumental, symbolic, and affective motives that influence car use is important in order to understand when and why people do or do not drive. With this knowledge, the possibility to pursue people to adopt a sustainable travel behaviour increases. Instrumental advantages of the car relate to perceptions of comfort, speed, and convenience. The car outperforms alternatives in terms of these attributes. Symbolic advantages relate to the car as a tool for communicating status, achievements in life, and impression management. Gatersleben reasons that the importance of these values is hard to determine but is still important to take into account. Affective advantages of the car relate to freedom and control. Perceived instrumental, symbolic, and affective values of cars form important barriers for an altered travel behaviour. They may also play an important role in promoting a sustainable travel behaviour. Another problem covered in the chapter is that travel is habitual which often counteracts conscious information processing about the pros and cons of the car.

In chapter "Pricing Methods to Influence Car Use", Peter Bonsall and Luis Willumsen give an overview of pricing methods to influence car use. Pricing methods included in the overview are car ownership taxes, fuel taxes, parking charges, tolls, congestion charges, and pay-as-you-go insurances. Several problems that apply to pricing methods in general are identified. One problem is that road users do not perceive the total costs of their travel, only the direct costs and charges. In order to optimize travel behaviour it is therefore important to expose users to the total costs. A related problem is that the costs are not always understood or even perceived by the users. They conclude that pricing is in itself is not sufficient to influence travel behaviour. An extended knowledge of human behaviour to be included in the implementation is called for.

In chapter "Social Marketing in Travel Demand Management", John Thøgersen describes three different cases of using social marketing techniques to influence how people choose to travel. It is clear that these techniques are effective to promote sustainable travel if correctly applied. Thøgersen notes that the collection of information about actual and potential customers' needs and wants is crucial for designing a successful social-marketing campaign which unfortunately current campaign makers often fail to do. Thøgersen also points to the fact that travel mode choice is frequently habitual dependent on contextual factors. Therefore, changes of context (e.g., moving to a new house or changing workplace) create windows of opportunities for social marketing to effectively influence travel choice. But social marketing has limitations. When the car has a strong symbolic value for individuals or when there are many barriers preventing the individuals to use alternative travel modes, social marketing is not likely to work.

In chapter "Psychological Contributions to the Development of Car Use Reduction Interventions", Sebastian Bamberg presents a conceptual framework assisting a broader understanding of changes in travel behaviour. The conceptual framework is grounded in self-regulation theories developed in psychology. Bamberg argues that interventions aiming at changing travel behaviour are most effective if they simultaneously alter people's attitudes, beliefs, and control standards, create situational and dispositional circumstances that are conductive for self-regulation, and suppress impulsive influences. Two types of interventions supporting voluntary modification of travel behaviour are discussed. Downstream interventions (e.g., education, changing attitudes) are targeting people´s different needs in the change process, and upstream interventions (e.g., economic incentives, transport planning) are targeting conditions in the environment to sustain a changed behaviour. It is concluded that effective and innovative intervention programmes can be developed, but that further evaluations and meta-analyses techniques are needed to establish reliable and precise estimates of the behavioural effects.

In chapter "Theoretical Underpinnings of Practical Strategies for Changing Travel Behavior", Satoshi Fujii and Ayako Taniguchi show how different mobility management strategies, including provision of information through travel campaigns and travel education, succeed by targeting important psychological processes. An integrated process model of travel behaviour modification is applied to explain the linkages between different strategies and behavioural change. Key factors for success are balanced information in combination with pull measures (increasing the attractiveness of other travel alternatives than the car) or push measures (decreasing the attractiveness of the car). These actions directly influence people's attitudes to change and intentions to implement changes. Timing of information is also crucial. An infrastructure investment should for instance always be followed by information of other travel alternatives since people are then more likely to pay attention to change alternatives. On the basis of the integrated model of travel behaviour modification, Fujii and Taniguchi discuss the influence of moral obligation on intentions to reduce car use. Research has shown that some people feel an obligation to use other travel modes than the car despite that the car is preferable. Based on this knowledge it is important for policy makers to make people aware of the consequences of car use and also make them feel responsible for making changes.

Part III (Travel and Social Sustainability) addresses issues related to the social sustainability of travel. An important mission is to provide insights in the social costs and benefits of travel. If transport policies are implemented that aim primarily at meeting environmental objectives (e.g. reducing GCG emissions), it is important that the social costs or benefits of such measures are taken into account. The chapters provide the necessary background to judge whether transport policies are also sustainable from a social point of view.

In chapter "Social Exclusion and Travel", John Stanley and Janet Stanley focus on the social dimension of sustainability in the context of travel. This dimension has received much less attention than environmental and economic dimensions. They start with an overview of social policy goals. A tenet is that people's well-being depends on satisfying basic needs, and that social exclusion is defined as a state in which barriers exist that prevent access to facilities and opportunities for social interaction. Lack of appropriate transportation (referred to as transport disadvantage) may be one such barrier. Stanley and Stanley state that transport disadvantage is associated with institutional barriers or facilitators (e.g. absence of public transport), individual barriers or facilitators (e.g. age or health), and external impacts (e.g. economic development or political environment). In an Australian case study, they illustrate how transport disadvantage impacts on social exclusion and well-being. They propose an analytical framework in which social exclusion is influenced by access to social capital, mobility characteristics, and the personality trait of extraversion. Social exclusion in turn influences personal well-being, which is also affected by sense of community and subjective wellbeing. Stanley and Stanley conclude that avoiding social exclusion in the context of governmental funding constraints requires creative use of existing travel options, which involve removing organizational barriers. Building on existing social networks and striving for social empowerment are also considered important instruments.

In chapter "Rose Tinted Memories as a Cause of Unsustainable Leisure Travel", Jeroen Nawijn and Paul Peeters elaborate on leisure travel decision making and its implications for affect, subjective well-being, and environmental sustainability. They note that leisure travel has serious negative impacts on different geographical scales, such as GHG emissions, local air pollution, landscape degradation, and impacts on biodiversity. Principal solutions include making shorter trips (and avoiding air travel), using public transport instead of car, and travelling less frequently. The authors claim that insight in the mechanism of leisure decision making is necessary to achieve such changes. Memory of positive experiences during a holiday is a driver for the desire to go on holiday more often, in order to generate more pleasurable feelings. However, individuals tend to remember their holiday as more pleasurable than it actually was. In addition, influence from others raises the standards of what a pleasurable holiday should be like, leading to longer travel to exotic destinations and higher leisure travel frequency. A shift in behaviour may accordingly lead to decreases in well-being initially, but this decrease may be counteracted by a change in the social norm, more interest in the closer environment, and providing attractive "slow" tourism options that increase the intensity of experience. Such a shift would require changes in the availability and marketing of leisure products, supported by pricing and infrastructural policies.

Chapter "Health and Travel" by Susan Handy is an overview of the multifaceted relationship between travel and health. A main argument is that negative health impacts are the outcome of travel decisions (mode, route, trip frequency) and that behaviour change therefore is an important way to diminish these impacts. A significant health impact is related to traffic safety. Behavioural issues that influence traffic safety include travel mode used and if driving type of road, frequency, and being intoxicated. However, traffic safety clearly also depends on others' choices. For instance, driving becomes less safe if others increasingly use heavier vehicles. A second influence of travel on health is through air pollution caused by combustion engines. Mode choice has a direct impact on the exposure to air pollutants, with walking and cycling leading to the highest exposures. In addition, decisions about speed and driving style have significant impact on the amount of pollution, to which also others are exposed. A third major impact is via physical activity implied by travel. Choosing physically active travel modes adds to meeting guidelines for the required physical activity. Handy notes that apart from walking and cycling, use of public transport, rollerblading or skateboarding can be considered active travel modes. However, also decisions made for others, such as to drive children to school, have a health effect on others. Handy argues that strategies to diminish negative impacts and increase positive health impacts should combine technological and behavioural policies. To influence behaviour, a wide range of options can be employed, ranging from pricing and making unhealthy travel less attractive (e.g. slower) to provide attractive alternatives (including land use and infrastructure planning), information campaigns, and legislation.

In chapter "Business Travel and Sustainability", Anne Aguiléra addresses environmental, economic, and social consequences of business travel as well as strategies to reduce its negative impact in these respects. Aguiléra notes that business travel has increased significantly over the past decades owing to globalization, an increasing share of multi-site firms, and an increase in outsourcing. However, sustainability effects have been under-researched. Aguiléra shows that business travel accounts for a significant share of total travel, with an emphasis on car and air traffic, thereby contributing to GHG emissions and air pollution. With respect to economic sustainability, it is noted that business travel creates economic activity by travel agencies, transport companies, hotels, and restaurants. On the other hand, business travel is a considerable financial cost for companies. With respect to social sustainability, Aguiléra notes negative social and health impacts. Multiday, long-distance business travel may cause stress and conflicts in families and lead to travel-related diseases as well as exposure to air pollutants and noise. Aguiléra argues for strategies to find compromises between the environmental, economic, and social impacts of business travel. This requires travelling less often, travel to closer destinations, and travel by more environmental friendly modes. Positive effects of such a change would be a reduction in travel stress and fatigue, making it easier for women to take up responsible functions. Yet, one must also consider the economic costs of such changes. Achieving these changes requires deliberate actions by companies and governments. Within companies, business travel can be treated more selectively, identifying what type of business trips can be made in a more environmental friendly way or be replaced by ICT interactions. Awareness campaigns that introduce best practices may be helpful in this respect. Governments could facilitate the shift by providing information and by dedicated subsidies.

In Part IV (Future Sustainable Travel) the aim is to highlight future alternatives to physical travel as well as ecologically sustainable travel modes (public transport, non-motorized modes), respectively.

One strategy to promote sustainable travel is to implement various land-use policies. In chapter "Do Future Land-Use Policies Increase Sustainable Travel?", Bert van Wee and Susan Handy discuss the significant effect of land-use policies on travel behaviour. Their chapter provides several useful insights that are well founded in research. A first proposition discussed is that land-use has an impact on travel. On the basis of reviewed research, they conclude that the built environment indeed has an effect, but it is hard to foresee its size since other factors come into play such as preferences, cultural norms, and self-selection. Next they discuss how effective land use policies are in changing land use. They conclude that the impact is minor in the short run and that aggressiveness in implementation as well as founding will determine the impact in the long run. However, land-use policies can have additional benefits. From a hypothetical example they infer that a policy seemingly unsuccessful in reducing vehicle travel may in fact be successful if one takes accessibility into account. They conclude that a broader evaluation of land-use policies should be implemented including not only travel-behaviour indicators but environmental impacts, accessibility, option values, safety, health impacts, preferences, financial aspects, and robustness.

In order to shape the alternatives and prospects for future sustainable travel, one needs to explore a number of possibilities entailing future uncertainties. In chapter "Integrated Transportation Solutions: Images of the Future", Robin Hickman, David Banister, Jimin Zhao, and Jian Liu present a scenario analysis approach which creates alternative images of the future. Scenario analysis is a tool to understand policy trajectories and to assess the uncertainty in a specific policy position. Knowledge about future consequences is obviously valuable information in strategic decision making. The authors provide an illustrative example by analyzing the future sustainability of transportation in London (UK) and Jinan (China). Hickman, Banister, Zhao, and Liu explain the scenario development process divided into four key stages: (1) Defining the study focus, (2) context review, (3) scenario development, and (4) quantification of scenarios. An advantage of the method is the involvement of different stakeholders. Involvement increases the likelihood of commitment to necessary action.

Another way to reduce the impact of car use is to make more people use public transport more often. In chapter "High Quality Public Transport: Gaining Acceptance of Bus Rapid Transit Systems", David Hensher, Corinne Mulley, and Zheng Li present convincing evidence that high-quality systems such as Bus Rapid Transit (BRT) can provide the level of service that is needed to attract car users to public transport. They explain the BRT standard approach 2012 to design, which is used as a proxy for quality of customer service around the world. Higher speed, better comfort, and higher capacity get higher points. Hensher, Mulley, and Li use data from 46 systems in 15 countries to determine which BRT system factors systematically affect BRT patronage. One of their conclusions is that BRT has great potential as a sustainable travel alternative. Another conclusion is that some system factors are important to support high service quality. Based on the empirical data it is shown that high levels of frequency, regularity, connectivity, and visibility may make a successful BRT system. The authors also discuss the complexities facing decision makers in developing and implementing BRT. Political commitment here plays a key role. Operational issues, integration, marketing, contracts, and collaboration in transport networks are all challenges that need to be overcome.

Public transport and non-motorized travel are environmentally sustainable travel modes. Separately or in combination, they contribute significantly to reduction in energy consumption and GHG emissions, to more efficient use of urban space, improved air quality, and public health. In chapter "Non-motorized Travel as a Sustainable Travel Option", Christina Bernardo and Chandra Bhat provide an overview of determinants (facilitators and deterrents) of non-motorized travel. They summarize statistics and some recent studies showing that the trend of increasing trip length, sprawling cities, and safety are deterrents of non-motorized travel in most developed as well as in developing countries. Motorized travel modes are preferred to non-motorized travel modes all over the world. Bernardo and Bhat also discuss how to encourage non-motorized travel. They conclude that information campaigns, travel behaviour modification strategies, built environment planning policies, and an increased integration of non-motorized travel and public transport are important.

Does shopping via the Internet (e-commerce) provide an important prospect for future sustainability of travel? In chapter "E-Commerce: Implications for Travel and the Environment", Orit Rotem-Mindali elaborates on this question. She presents data showing that e-commerce increases, but that the total share is still relatively small. She argues that the relationship between personal travel and e-commerce is generally viewed as multifaceted. Using the Internet for online shopping may substitute for shopping trips, modify trips, as well as have a complementary effect to increase the number or length of the trips. What factors would promote a continued positive development? Competitive prices, time savings, more information on goods and services, and more options are some possible factors. Lack of trust is an important barrier for a continued positive development since e-commerce is still associated with some risks, for instance due to not being able to examine the goods before purchase and the need to share personal data on the Internet. The technical development in the form of Smartphones, however, has to some extent replaced the value of the physical product. Today, the best deal is valued higher than the product in itself. Rotem-Mindali states that decision makers and researchers need to take three processes into account when evaluating the impact of e-commerce on travel: the information gathering process, the purchasing process, and the delivery process. All these processes have the potential to affect personal travel in different ways since they involve different actors, different travel modes, and are performed at different time frames.

In the final chapter "The Need to Change How People Think About the Consequences of Travel", we argue that the needed changes towards sustainable travel will more likely materialize if people (the public as well as politicians) change how they think about the consequences of travel, shifting from placing the highest weight on the short-term individual benefits to the long-term societal costs. Increasing knowledge of societal costs is one key factor to accomplish this. A second key factor is to make people in general more concerned about the well-being of unknown others in the society (including future generations). Information about research findings documenting long-term societal costs of travel, such as those presented in this book, must more effectively reach the general public through messages from (1) governments, (2) mass media, (3) producers and providers of travel services, and (4) other people (word-of-mouth). As discussed in the chapter, this would require significant changes in the messages and how they are conveyed by the different sources.

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Spatial, Generational and Gendered Trends and Trend-Breaks in Mobility

Lotta Frändberg and Bertil Vilhelmson

Introduction

The quest for sustainable development challenges the ever increasing demand for physical transportation and personal travel – on the ground and in the air, locally and globally. In this chapter we therefore look for possible trend-breaks in mobility that contrast historical development so far and business-as-usual futures. We do so by briefly reviewing recent studies of so called "peak travel" and then dig into the specific case of the changing travel patterns of the Swedish population. Using a unique series of national travel surveys conducted intermittently over more than 30 years, we investigate important long- and medium-term changes in both the daily and long-distance mobility of various population groups. We concentrate on changes in mobility related to generational shifts and changing gender relations, as these are two features of ongoing social transformation critical for future levels of mobility. All in all, our Swedish case and data let us address several crucial mobility change questions: whether the continued spatial extension of mobility is occurring at the expense of local interaction or whether it adds to existing travel patterns; whether historic shifts in modal choice towards faster means of transport are ongoing or are hampered in certain groups of the population; whether gendered gaps in travel are widening or narrowing; and whether new generations of young people are bearers of new preferences in travel behaviour.

L. Frändberg • B. Vilhelmson (✉)
Department of Human and Economic Geography, University of Gothenburg,
P.O. Box 630, 405 30 Göteborg, Sweden
e-mail: Lotta.Frandberg@geography.gu.se; Bertil.Vilhelmson@geography.gu.se

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Post War Trends and Recent Trend Shifts – State of the Art

Breaks in Growth

The general trends in mobility development during the post war period – those of continuous growth in motorization, in travel speeds and trip distances – are well documented from several sources (e.g., Knowles, 2006; Schäfer, 2006). In recent years, more detailed knowledge about these trends has become available through analyses of national travel survey data, for various Western countries from the 1970s and onwards. From these studies, several common, long-term mobility trends can be discerned: more or less constant per capita trip frequency, constant time use for travel, and increased average travel speeds and trip lengths (Metz, 2010; Pooley, Turnbull, & Adams, 2005; Scheiner, 2010). These developments are directly related to continued modal shifts from non-motorized transport and public transportation to car and air (Kwon & Preston, 2005; Scheiner, 2010). The overall implication of faster transportation modes and the constant use of time for travel is a substantial expansion in people's activity space: "The daily life-worlds of many individuals have shifted from the local to the regional level" (Scheiner, p. 76).

The expansion of motorized mobility has been present for such a long time now that it has almost become taken for granted. In the last few years however, another pattern has quite unexpectedly come into view. Time series of mobility development from several different countries now show a levelling off and even decline in daily mobility and/or car travel since around the year 2000 (Frändberg & Vilhelmson, 2011; Metz, 2010; Millard-Ball & Schipper, 2011; Newman & Kenworthy, 2011; Puentes & Tomer, 2008; Zumkeller, Chlond, & Manz, 2004). Germany was one of the first countries where peak travel was first documented (Kuhnimhof, Buehler, Wirtz, & Kalinowska, 2012) with overall per capita travel demand stagnating already since the mid 1990s (Zumkeller et al., 2004). In Britain growth rates in car travel slowed down considerably during the 1990s (Kwon & Preston, 2005) and stopped around 2002 (Lucas & Jones, 2009). Puentes and Tomer observe that vehicle-miles per capita in the US ceased to grow after 2000 and started falling in 2005. Recently, Millard-Ball and Schipper presented a cross-national analysis showing that from the early 2000s, travel activity reached a plateau and private vehicle use declined in all eight countries included in the study (USA, Canada, Australia, France, UK, Sweden, Germany, and Japan). Likewise, Newman and Kenworthy presented data from major cities in Australia, North America, and Europe showing that growth in car use had slowed considerably in all cities and that it had started to decline in some.

Several authors use terms such as "peak travel" (Millard-Ball & Schipper, 2011) or "peak car use" (Newman & Kenworthy, 2011) signalling an interpretation of the change as a long-term trend shift rather than a temporary setback. Newman and Kenworthy argues that: "Peak car use appears to be happening. It is a major historical discontinuity that was largely unpredicted by most urban professionals and academics" (p. 33). Since the shift is recent, knowledge about its causes is so far largely speculative. Among suggested contributing factors are: (a) rising fuel prices (although it has also been noted that the levelling out of travel preceded the rise in fuel prices since 2002; see Millard-Ball & Schipper, 2011; Puentes & Tomer, 2008); (b) increased road congestion (Metz, 2010); (c) travel substitution by Information and Communication Technology (ICT) (Kuhnimhof et al., 2012; Metz, 2010); (d) growth of a culture of urbanism (Newman & Kenworthy); (e) saturation of demand as a consequence of diminishing marginal utility of further increasing speed and reach (Metz, 2010; Schipper, 2009); (f) policy reorientation (Kuhnimhof et al., 2012; Millard-Ball & Schipper, 2011; Newman & Kenworthy, 2011), and (g) growth in international air travel (Kuhnimhof et al., 2012; Le Vine, Jones, & Polak, 2009; Metz, 2010; Millard-Ball & Schipper, 2011). Of these factors, policy reorientation stands out, in the sense that it represents conscious efforts to reduce car dependence through a variety of measures: taxation of fossil fuels, traffic calming (e.g. congestion charging), parking policies, promotion of walking and cycling, and improved public transport.

The references to growth in international air travel as part of the explanation for stagnating or diminishing daily travel deserve somewhat more attention from a sustainability perspective. British researchers acknowledge increased overseas travel as potentially influencing levels of domestic mobility, since UK residents spend an increasing amount of time (on average 12 days each year) abroad, where their travel is not captured by the national travel surveys (Le Vine et al., 2009; Metz, 2010). More important is the recognition that a greater proportion of overall mobility is being accounted for by aviation (Frändberg & Vilhelmson, 2011; Kuhnimhof, Buehler, & Dargay, 2011; Metz, 2010; Millard-Ball & Schipper, 2011). As international aviation is in most cases not included in the national travel surveys, the levelling out in overall mobility might in reality be a matter of a shift from domestic to transnational mobility.

Because of the threat to the environment, mobility has become an increasingly ambivalent phenomenon for the individual and society (Kesselring, 2008). The recent stagnation in mobility growth observed in many western countries is therefore often seen as positive from a sustainability perspective (Metz, 2010; Millard-Ball & Schipper, 2011), signalling emerging adaptations to environmentally sound levels as regards resource use and pollution. However, from what is known so far, the decline is concentrated to certain demographic groups and thereby associated with wider processes of social and economic change. New generations and changing gender relations are examples of important sources of change. In the following we therefore develop the discussion of mobility change and sustainability in relation to these two generic dimensions of differentiation.

Generational Shifts

The notion of "peak travel" refers to mobility development at an aggregate level, for the entire population in a certain country or city. However, in several of the countries concerned it has been shown that travel trends in different demographic groups diverge considerably. In the longer-term perspective, several countries have seen a shift in the differentiation of mobility by age group and gender. For example, whereas it was young people approximately 20 years old who travelled most in 1960s Britain, it is now the middle aged who travel most (Pooley et al., 2005). Hjorthol, Levin, and Sirén (2010) used cohort analysis of national travel surveys from Denmark, Norway, and Sweden and showed a significant period effect in car ownership and use by older people, especially for women, with a clear increase over the past 20 years. Both men and women are maintaining their car-use habits into old age, and older people today travel more than did comparable age groups 20–25 years ago. While commuting and work-related trips decline after retirement, shopping and leisure trips do not start to decline before extreme old age. Pooley et al. also note a sharp decline, since the early 1990s, in the proportion of young adults holding a driving licence. A similar pattern of decline in young adults' access to cars has been observed in Norway (Hjorthol, 2008), in Sweden (Frändberg & Vilhelmson, 2011) and in Germany (Kuhnimhof et al., 2012). This is also clearly reflected in substantial decreases in overall mobility and in car use among young adults, particularly among young men.

The recent decline in daily mobility among young adults provokes the question whether this is a temporary phenomenon or if we are indeed witnessing a generational break with respect to car dependence and mobility behaviour. Evidently, there are several structural factors that may contribute to explain the decline. First, an increasing share of young adults attends universities and colleges. This means that more have a low income and are living in cities, where it is fairly easy to manage partially or completely without a car. The lengthening of the study period also means a postponement of the start of a professional career and is likely to contribute to the increasing age for starting a family. All in all, many young adults are in a life situation where both the need for and the access to car-based mobility is limited (Kuhnimhof et al., 2012). The observed decline in mobility among young adults may therefore be a matter of postponement of adulthood, rather than a break with previous generations.

However, it is also important to recognize that those who are young today have been more than earlier generations confronted with spatial mobility as an ambivalent phenomenon. Potentially, increasing environmental awareness may therefore contribute to explain the decline in car use among young adults. If this is the case, more are likely to strive towards low levels of car dependence also in later life stages. Clearly, mobility has so far been a high cost area in terms of changing to environmental behaviour (Diekmann & Priesendörfer, 2003), and numerous studies have found only a weak link, if any, between environmental attitudes and car use (e.g. Gärling & Friman, 2012). To the extent that high mobility is in fact built into physical, social, and cultural structures, people who wish to change environmentally harmful travel habits may find this difficult to achieve over time. Perhaps a more realistic hope for a "generational break" in mobility trends lies in changing attitudes towards high mobility levels in combination with other social change processes. One important aspect here is increased "virtualization", which is very marked among young people, and there are some indications that increasing Internet use among young adults is associated with less travel (Vilhelmson & Thulin, 2008).

Gender-Related Shifts

Gender intersects all other determinants of travel change, often in complex ways. The notion of "gendered mobilities" refers to the fact that differences between men's and women's resource access, social positions, and activity patterns are reflected and reproduced by systematic differences in how much, by what modes, and for what purposes they travel (Polk, 1998; Uteng & Cresswell, 2008). General patterns observed in most contexts are that men on average travel farther and use cars more often than women do, despite women's travel patterns being characterized by greater complexity in terms of combining various activities (e.g., Hjorthol, 2008; Polk, 2004). Particularly large differences are often found in long-distance work-related travel, a form of mobility in which the conflict between work and family obligations is particularly pronounced (Bergström, 2010; Gustafson, 2006). As shown in the preceding section, the extent of the difference varies with age and between generations. On the whole, it seems to decrease over time, although studies of long term-change in actual travel behaviour are remarkably scant. Crane and Takahashi (2009) analyzed changes in the entire US metropolitan population over the 1985–2005 period as regards commuting and gender. They found sources of both convergence and divergence in travel behaviour. The gender gap in commute length for older workers was growing, while that of younger workers was steadily narrowing. Gil Solá (2009) found when comparing Swedish national travel survey data from 1994 and 2006 that the gender gap in daily commuting distance slightly increased over the period. However, at the regional level examples of convergence were also found. As regards access to mobility resources, in Britain, Norway, Sweden, and Germany the previously large gender differences in the proportion of people with driving licences declined considerably in the 1990s (Frändberg & Vilhelmson, 2011; Hjorthol, 2008; Kuhnimhof et al., 2012; Pooley et al., 2005). In Germany, the gender differences in licensing, car access and car use disappeared completely among young adults (Kuhnimhof et al.). This closing of the gender gap in car use among young adults happened in spite of stagnating mobility among young women. It was completely due to significant mobility reductions among young men.

Because of the close connection between social position and access to resources, on the one hand, and patterns of mobility, on the other, Hjorthol (2008) states that the study of men's and women's travel patterns can be seen as an indication of the degree of equality between the two groups. A trend towards increased gender equality in society would thus result in the convergence of women's and men's travel patterns. Convergence could occur in two main ways: women's mobility levels approaching those of men, in which case increased gender equality would drive the growth in overall mobility in the population; or men's travel behaviour approaching that of women, in which case both sustainability and gender equality would benefit. This is how gender differences in mobility have been considered to be an opportunity for a sustainable future: ". . . the travel habits and attitudes which dominate among women should also be seen as a norm within the transport sector, and integrated more fully into planning and policy" (Polk, 2009, p. 78). In more concrete terms, if men come to live their daily lives in ways that are now more typical of women, this could lead to reduced mobility levels and/or more environmentally benign travel patterns among men or particular groups of men. As discussed above, recent changes imply processes of both convergence and divergence, depending on what age groups and what type of mobility is considered. The fact that the gender gap seems to be closing among young, and that it does so through a decline in the mobility of men rather than mobility increase among women, is nevertheless promising both from a sustainability and gender equality perspective.

The Swedish Case

Data

The mobility trends in the Swedish population that are analyzed below are based on data retrieved from national travel surveys conducted intermittently since 1978 by Swedish governmental agencies.[1] In each survey, questions about all trips conducted during the course of 1 day were complemented by questions about long-distance trips (at least 100 km one way) taken over a longer reference period preceding the day of survey. The first two surveys (1978 and 1985) were carried out by means of personal interviews, whereas telephone interviews were used subsequently. The same general design and definitions have been used throughout, although some changes have been made between the surveys, some of which directly affect our analyses. Daily mobility is covered for the entire period 1978–2011, long-distance domestic travel for 1978–2006 and long-distance international for 1994–2006.

The Swedish case is of general interest for several reasons. The data cover more than 30 years, a period when daily mobility (measured in terms of distance travelled per capita) began to grow at a slower pace and recently showed signs to decline. The data also permit a more detailed analysis, rarely conducted in current research on "peak travel", as regards cohort and gender that informs about variability and stability in groups. Since long-distance mobility, particularly by air, plays an increasingly important role in overall mobility development and in discussions of climate change, there is also a need to integrate descriptions of mobility change over several time-spatial scales – ranging from repetitive daily local trips to intermittent international travel. The inclusion of international trips in the Swedish national travel surveys over the last decade provides a unique opportunity for such integrated description compared with surveys conducted in other countries (see e.g. Metz, 2010).

[1] Statistics Sweden (SCB), the Swedish Institute for Transport and Communications Analysis (SIKA) and Transport Analysis Sweden (TRA).

In the following, we present findings relating to the dynamics of mobility growth in general, and to gender gaps and generational shifts in travel patterns. For practical reasons, we present the results concerning daily trips and long-distance travel separately, although a main conclusion is that this distinction tends to disappear.

Daily Travel

Overall

In Sweden, as in other modern societies, the most persistent trend in daily mobility is that of increased distance and extended everyday activity spaces. This has been a more or less continuous process since the nineteenth century (see Fig. 1). It has fuelled urban sprawl and fostered a general distanciation of daily life. However, a weakening in such growth seems to have occurred in recent decades. Between 2006 and 2011 even a decrease in daily domestic travel is observed. This discontinuity is significant from a sustainability perspective, indicating a break in habits or perhaps an emerging decoupling of the stable relationship between income and mobility growth. Later in this section, we will demonstrate that this levelling off is associated with certain mobility counter-trends in segments of the population. Notably however, as indicated in Fig. 1 we also find that the long-lasting shift from local to regional activity spaces has been complemented by a new shift from regional to transnational travel.

In general, increases in the daily travelled distance are largely connected to the shift in the use of travel modes, from slower to faster, from shared to private, from inflexible to flexible. Over the observed past three decades, car driving was thus reinforced as the dominant travel mode (see Table 1) and increased its share of all trips from 41 to 47 %. Trips made as car passengers decreased, now making up 12 % of all trips, while the more environmental friendly modes of walking (21 %), biking (7 %), and trips by local or regional public transport (7 %) remained at stable levels. Largely, this leaves an impression of modest changes, somewhat contrasting the fact that the number of cars in Sweden increased by 36 %, from 2.8 to 4.4 million between 1978 and 2011.

The process of increased motorization, flexibility, and individualization is strongly gendered. Historically, men were forerunners in taking control of the car while reducing their use of public transport and walking. Men still hold that position, while women are gradually catching up by increasing their car use at the expense of other modes (Table 1). Still, women drive far less than men do, and make much more differentiated use of other modes.

The long-term trend towards increased distance travelled is firmly integrated with changes in people's daily use of time and space for key everyday activities – working, family life, and leisure. Over the three decades studied, the average trip length increased by 50 % overall. Compulsory trips for work, school, and shopping

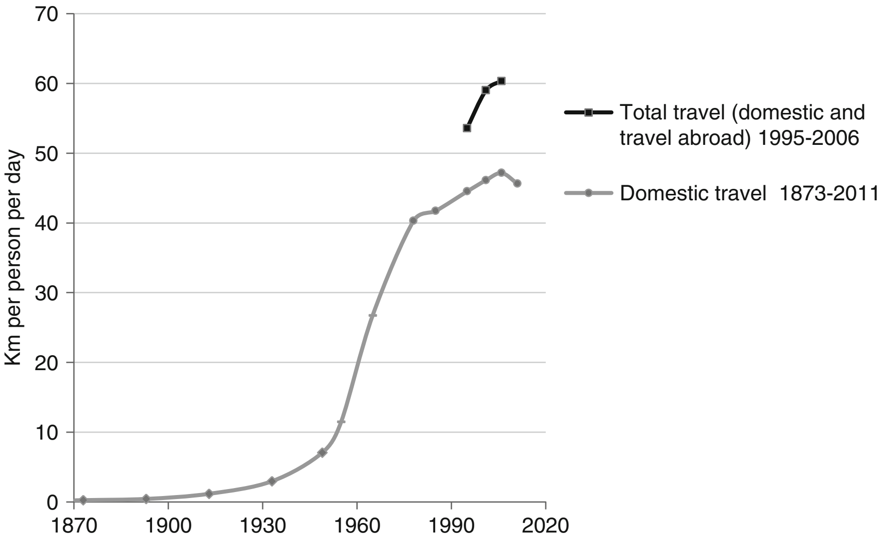

Fig. 1 Mobility growth in the Swedish population, 1873–2011. Sources: Data for period 1873–1963 compiled from Thorburn (1958) and Godlund (1958, 1966); data for 1978–2011 from the Swedish National Travel Surveys. Note: Estimates from Thorburn and Godlund do not include movement on foot

increased the most (more than 50 %), while discretionary and (on average) longer trips for leisure activities and visiting increased at somewhat lower rates (30–50 %). Trips for childcare and health services increased more moderately (approximately 10–20 %) perhaps as a result of being more fixed as regards location and access. This has led to a situation in which comparatively flexible trips related to free-time activities (e.g. visiting friends/relatives, leisure activities, sports, entertainment, and hobbies) on the one hand, and more fixed trips for work on the other, are associated with the longest trips, extending an average of around or more than 20 km from home. Trips for most other everyday activities – such as school, regular services, and shopping average between 5 and 10 km. Childcare obtained at daycare centres involves more local trips (less than 4 km from home). Apparently, few activities are today performed near home (i.e. within walking distance) or in what is traditionally perceived as a neighbourhood.

Age and Gender

The picture of long-term trends in mobility increase, followed by recent tendencies of calming, may be differentiated in important respects. Gender and age are of special interest, not the least as the rate of change occurs differently in different

Table 1 Modes of transport, 1978 and 2011. Swedish population 15–84 years old. Share of all daily trips

	Women			Men			All		
	1978 (%)	2011 (%)	Diff 1978–2011 (% unit)	1978 (%)	2011 (%)	Diff 1978–2011 (% unit)	1978 (%)	2011 (%)	Diff 1978–2011 (% unit)
Foot	30.4	24.1	−6.3	17.6	18.1	0.5	23.2	21.1	−2.1
Bicycle	8.9	7.7	−1.2	7	7.1	0.1	7.8	7.4	−0.4
Car, driver	24.1	37.5	13.4	55.2	57.1	1.9	41.6	47.3	+5.7
Car, passenger	23.3	16.6	−6.7	8.6	6.3	−2.3	15.0	11.5	−3.5
Public transportation	10.4	9.2	−1.2	5.7	6.6	0.9	7.8	7.3	−0.5
Other	2.8	4.9	+2.1	5.8	4.8	−1.0	4.5	4.8	+0.3
Total	100	100	0	100	100	0	100	100	0

Source: Data from the Swedish National Travel Surveys

Table 2 Daily travelled distance by age and gender 1978 and 2011. Swedish population 15–84 years old. Domestic trips (airline excluded). Km per person per day (mean value)

	1978			2011			Relative change, 1978–2011		
Age (years)	Women (km)	Men (km)	All (km)	Women (km)	Men (km)	All (km)	Women (%)	Men (%)	All (%)
15–24	34	53	44	35.2	31.6	33.4	2.3	−40.4	−24.1
25–34	35	63	49	37.7	48.6	43.4	7.8	−23.4	−11.4
35–44	34	61	48	34.7	59.5	46.9	1.9	−2.0	−2.1
45–54	32	55	44	38.8	65.3	52.0	21.1	18.4	17.7
55–64	28	43	35	34.5	48.5	41.7	25.0	12.7	18.5
65–74	11	26	18	27.3	42.3	34.7	139.6	62.3	90.5
75–84	9	8	8	14.4	16.2	15.2	68.7	97.1	80.9
All	28	50	39	33.3	47.6	40.5	18.0	−4.4	4.0

Source: Data from the Swedish National Travel Surveys

cohorts of women and men (see Table 2). Three main tendencies are observable over the period 1978–2011 in Sweden. As expected, comparing middle-aged and elderly groups of men and women in 1978 and 2011 revealed a general increase in distance travelled. This is the direct consequence of car access becoming more common among new generations of elderly. Furthermore, for women of all age groups, the overall distance travelled increased, the increase being much smaller among younger (<35 years old) than middle-aged and older women. More surprising is the decrease in daily distance travelled by groups of men under 45 years old. Notably, among young men average daily travelled distance decreased by more than 40 % over the period. This is indeed a radical shift – or a counter-trend – in the everyday mobility of Swedes. Presumably, a complex set of factors explains this generational shift in activity space and trip distance among young people. Youth has been transformed in recent decades: today young people study longer; they enter working life, establish families, and have children at a later age than before; they earn less money than previous generations, increasingly tend to move to larger cities, and spend a lot of time on the Internet (being "virtually mobile"). All these factors have various effects on physical mobility and patterns of out-of-home activity in daily life.

Although women have generally increased their mobility and men (especially young and middle-aged men) have somewhat reduced theirs, the substantial and persistent gender gap in mobility is notable. Men systematically travel longer distances daily than women do, though the gap is narrowing, especially among the young groups and those aged 65–84 years. Between 2005 and 2011 also a notable switch emerged: young women in the age bracket 15–24 years now on average travel longer distances per day than young men do.

This general tendency towards mobility convergence between the sexes does not apply to all trip purposes. For many households, organizing daily life, distance to work is of strategic importance. Men generally travel longer distances to work and thus have access to wider labour markets than do women. In Sweden

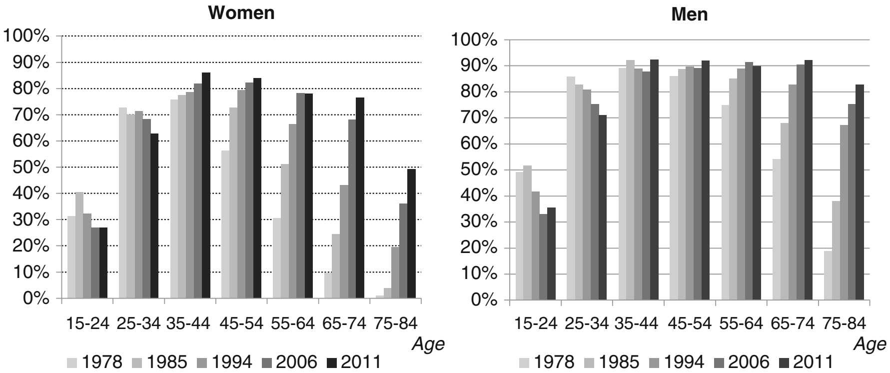

Fig. 2 Car access among women and men in Sweden 1978–2011. Car access = a person holding a driving licence and belonging to a household owning a car. Source: Data from the Swedish National Travel Surveys

this gap have in fact slightly, yet consistently, increased in recent decades (Frändberg & Vilhelmson, 2011), an observation that contradicts expectations of an evolution towards more similar commuting patterns in a society advancing towards greater equality between the sexes as regards education, working life, sharing of housework, and childcare.

Changes in people's access to cars may offer a first explanation as to why daily distance travelled changes over time. Over the studied period, certain shifts occurred in car access, defined as holding a driving licence and having at least one car in the household (see Fig. 2). First, car access declined notably among young women and men in the 18–24 year age bracket; systematic reductions, but not as large, also occurred among women and men aged 25–34. Second, what could be perceived as a saturation level (around 90 %) was reached among middle-aged men. Third, new cohorts of elderly people aged 55+ increased their car access rapidly, men at systematically higher levels than women.

In recent decades, therefore, automobility has been challenged by a counter-trend toward diminished car access in newer generations of young adults. This is further emphasized when cohort-wise changes in driving licence holding are taken into account (see Fig. 3). Since the 1980s, there has been an ongoing reduction in the share of young people holding a driving licence, although a slight increase has been observed in recent years. Also, cohort-wise evaluation reveals a catching-up tendency over time, in that recent cohorts of young people approach the previous cohort's high levels of licence holding when they are approximately 30–35 years old. Still, each new cohort takes somewhat longer to reach the level of the previous cohort. This indicates some lasting shifts in mobility levels between generations.

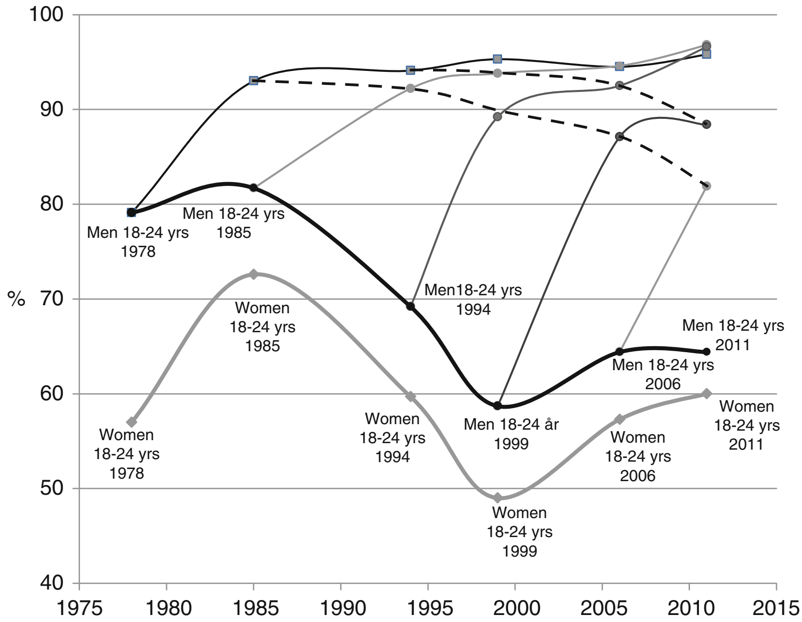

Fig. 3 Driving licence holding in cohorts aged 18–24 years, in Sweden 1978–2011. Source: Data from the Swedish National Travel Surveys

Long-Distance Domestic and Transnational Travel

Overall

From a sustainability perspective, any thorough changes in everyday (local and regional) travel must be viewed considering parallel changes in long-distance and transnational travel. Reductions in daily car use, for example, could be superseded by increased intermittent long-distance car trips or by transnational travel by air in accordance with the logic of the "rebound effect" reasoning (Binswanger, 2001; Frändberg & Vilhelmson, 2010). Such potential change in the spatial scale of travel is normally hard to monitor, as travel surveys generally do not record trips outside the country. However, in the Swedish case, we are able to benefit from the national travel survey data that for some years also comprises long-distance travel including travel abroad.

When it comes to long-distance mobility within Sweden, the 30-year period considered is characterized by stability rather than growth. Both in 1978 and in 2006, each Swede made an average of about eight long domestic trips, together amounting to approximately 3,500 km. The national travel surveys thus do not support the idea of overall growth (i.e., exceeding the growth of the population) in long-distance mobility within Sweden over the period, nor do they provide evidence of a continued modal shift from car to air in domestic travel. However, the

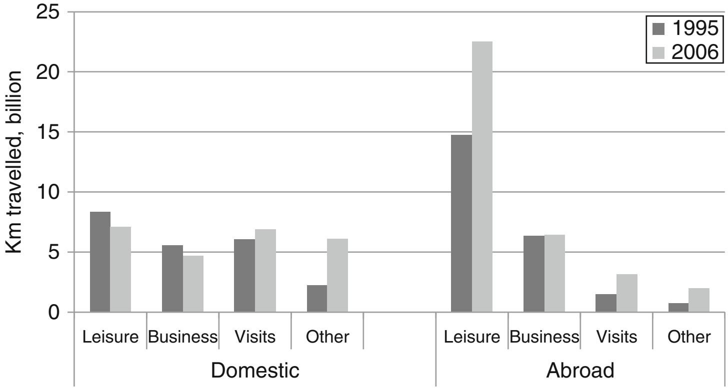

Fig. 4 Long-distance travel in 1995 and 2006 for various purposes by distance travelled; Swedish population 15–84 years old. Source: Data from Swedish NTS

mix of travel purposes has changed significantly. The most important domestic travel purposes, visits and other leisure travel, decreased in frequency over the period. Instead, trips for work and other purposes exceeding 100 km increased, particularly over the last decade.

Importantly, taking account of travel abroad changes the picture and renders the expected increase in long-distance leisure travel apparent. Over the relatively short period (that could be covered by the national travel survey data) between 1995 and 2006, the distance travelled abroad grew by over 50 % (see Fig. 1). General growth in the long-distance mobility of Swedes is thus mainly an issue of transnationalization (see also Frändberg & Vilhelmson, 2003). Leisure travel accounts for more than half of all trips abroad and also the largest growth in absolute number of trips (see Fig. 4). The observed long-term reduction in domestic long-distance leisure mobility discussed above, has thus been paralleled, at least since the 1990s, by a rapid increase in leisure travel to other countries. Furthermore, taking travel abroad into account also reveals the expected modal shift from car to air. In 2006, air travel accounted for more than half of the distance of long-distance trips within and outside the country whereas the car accounted for one third.

Age and Gender

Although the overall volume of long-distance domestic travel has remained fairly stable over the studied 30-year period, there have been substantial changes in certain age groups. The shift from young to older age groups that we noted above for daily mobility is clearly paralleled in long-distance travel within Sweden. In the 1970s, youth and young adults on average made about ten long-distance trips within Sweden – almost three times as many as did retirees. In 2006 the two groups were not that far apart, that is seven versus five trips per year. The largest change is found among young men. Men aged 15–24 on average travelled 1,500 km less on long trips within the country in 2006 than in 1978. We thus find a systematic counter-trend towards reduced mobility among the young, in particular young men, in both daily and long-distance domestic travel.

It is also apparent that men generally travel somewhat less and women somewhat more on long trips today than in 1978. The gender difference has thus been reduced over the period but is still substantial. The largest gap is found in long-distance work-related travel. Looking at the development of domestic long-distance travel for business and to work, respectively, we observe growth in women's travel over the period. In both cases, women's share of all trips increased from 5–10 % in 1978 to 25–30 % in 2006. The difference in travel frequency is thus still very large. In the case of long work trips, the absolute difference in travel frequency is as large today as it was in 1978. This corresponds closely to the persistence of the gender gap in work travel distances noted above.

When it comes to transnational mobility, the situation is different since growth has been pervasive, being found in travel in both sexes and in all age groups. Notably, the most rapid growth rates between 1995 and 2006 were found among youth and women under 44 years old. These observations are also valid for changes in overall air travel. Here, a near convergence between women and men has occurred – at least when considered in terms of distance travelled.

However, there are very large differences in air travel between different age groups and, more importantly, the direction of change seems to contradict that observed for daily and domestic long-distance travel. Whereas middle-aged people are the most mobile, people over 65 years old have by far the lowest mobility level as well as the lowest growth rate in both absolute and relative terms (40 %). For youth 15–24 years old, growth has been substantial (100 %), although absolute levels are still below those of middle-aged people. In this respect, trends in transnational mobility and air travel stand in contrast to those observed for daily and long-distance travel within Sweden. Although the data cover only one decade of the 30-year period considered here (1995–2006), the overall growth in distance travelled abroad among the young exceeds the overall decline in long-distance mobility within the country observed over the entire 30-year period.

Concluding Discussion

The present chapter explored long-term trends and potential trend conversions in the development of spatial mobility with special focus on the Swedish population. This was done towards the background of a growing international literature concerning mobility change in other Western countries. From this exploration, conclusions can be drawn in relation to a number of questions that are significant in relation to social and environmental sustainability.

One major question concerns overall mobility growth – is it still happening or not? For the Swedish population, we find that the long-term growth in everyday mobility as well as more intermittent long-distance domestic travel has slowed and recently even stagnated and declined. This indicates a break of a trend concerning domestic travel that is consistent with observations reported also from several other countries. The shift has recently been discussed in terms of "peak car use" and "peak travel" – a terminology implying a significant historical discontinuity rather than a temporary setback. Car use indeed seems to have peaked in Sweden and in several other countries during the past decade, but conclusions about "peak travel" seem premature or even misleading if international travel is not taken into account. In contrast to domestic stagnation and decline, we find that long-distance transnational travel has increased rapidly among Swedes. This may be interpreted in terms of a substitution of international travel for national. When discussing possible explanations of the recent stagnation in domestic mobility, Millard-Ball and Schipper (2011) recognize this possibility, but argue that including international flights would "close the gap somewhat but not completely" (p. 366). However, the time series from the Swedish national travel surveys analyzed here indicate that owing to the rapid increase in international travel, overall mobility growth continues unabated in spite of stagnating domestic travel (see Fig. 1).

Another significant question concerns the gender gap in mobility and how it develops. Have recent decades meant a substantial convergence and if so, is that a matter of women approaching the mobility levels of men, or is it the other way around? At a general level, we have observed a tendency towards upward mobility convergence between women and men in Sweden: distances travelled both daily within the country and abroad have increased more rapidly among women than among men in recent decades, and women as a group have also increased their car driving and air travel more rapidly than men have. The observation of an upward convergence must however not be over-generalized: in all age groups except the youngest, men still travel longer daily than women do. Perhaps most importantly, for regular daily trips to work, a slight upward divergence is noted, that is the difference is increasing rather than decreasing.

Trends with respect to gender still differ quite dramatically between age groups. This relates to the third main question of this chapter: whether new generations of young people have different preferences for travel? The general pattern among Swedes over the past three decades is a successive shift in travel volumes from young to old age groups. The general decline in domestic mobility discussed above is in fact entirely accounted for by young age groups, and particularly young men. Whereas the daily mobility of young women has been rather constant, men under 45 years old have reduced their daily travelled distances, and in the youngest age group this reduction is substantial. The gender mobility gap thus seems to be closing among young, and it does so through a decline in the mobility of men rather than a mobility increase among women. This is indeed a radical shift in the modern history of mobility.

The change is closely related to a consistently diminished car access and use in upcoming generations of young adults – primarily among both women and men in the 18–24 year age bracket. Reductions, but not so large, have also occurred in the group aged 25–34 years. Compared with earlier generations, fewer young people in new generations are acquiring driving licences, and this change has been ongoing for decades. The fact that each new age cohort takes somewhat longer time to reach the level of the previous cohort suggests some lasting shifts in mobility levels between generations.

Reduced everyday travel, fewer long-distance domestic trips, consistent reductions in dependence on and use of the car, the postponed acquirement of driving licences, use of slower modes of travel – should these observed tendencies towards mobility decline among youth be interpreted in terms of a serious challenge to or break from the car-dependent way of life? The available evidence does not warrant such far-reaching conclusions. A more appropriate conclusion appears to be that the observed counter-trend towards mobility decline among the young (especially young men) can be seen as evidence of the existence of substantial flexibility, in the sense that car-intensive lifestyles are not strongly structurally determined. The results may no doubt be seen as good news from a sustainability perspective that stresses the ecological limits to growth and the need not only to increase the efficiency of transportation systems and technologies, but also to adapt behaviour to find tolerable and sustainable levels of travel consumption. However, the pattern of mobility reduction among the young does not apply to intermittent, long-distance travel. Rather, reduced everyday travel has to some extent been replaced (and may be explained) by more globalized lifestyles. This clearly complicates the interpretation of the observed changes among the young in relation to future sustainable mobility regimes. It does reinforce the need to consider mobility at several time–spatial scales in these discussions.

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Benefits of Travel: Needs Versus Constraints in Uncertain Environments

Soora Rasouli and Harry J.P. Timmermans

Introduction

Why do we travel? Because we want to – or because we have no other choice? This pertinent question about the drivers, motives, and determinants of human choice behaviour has fuelled academic discussions and preoccupations in transportation research and related disciplines for many decades. Dominant theories and models postulate that individuals prefer to minimize their travel. For example, central place theory (e.g., Beavon, 1977; Berry & Pred, 1961) and related location theories are based on the premise that consumers minimize travel distance by choosing the closest qualifying destination to conduct a particular activity. Gravity and spatial interaction models (e.g., Batty, 1976; Wilson, 1967, 1970) are based on the concept of distance decay, which states that individuals' probability of choosing a particular destination is some nonlinear, decreasing function of travel distance or travel time. Random utility models (e.g., Ben-Akiva & Lerman, 1985; Hensher & Johnson, 1981) commonly assume that travel time and travel distance have a negative utility. Wardop's equilibrium principle (Wardrop, 1952), which underlies most traffic assignment models, is based on the notion that travellers will choose the shortest route between their origin and destination. What brings land use and transportation together in integrated land use and transportation models (e.g., Hunt et al., 2001; Waddell, 2002; Wegener, 2004) is the concept of accessibility (e.g., Halden, Jones, & Wixey, 2005), which in turn is a monotone transformation of travel time or travel distance. Other concepts and principles could be mentioned. Together, these theories, models and principles constitute a dominant body of knowledge in

S. Rasouli (✉) • H.J.P. Timmermans
Urban Planning Group, Eindhoven University of Technology, P.O. Box 513, 5600 MB Eindhoven, The Netherlands
e-mail: s.rasouli@tue.nl; h.j.p.timmermans@tue.nl

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transportation research against which new empirical findings are evaluated. Estimated negative coefficients for travel time and travel distance are generally considered as evidence of the formulated choice model.

Vice versa, positive estimates or non-monotonically decreasing utilities as a function of increasing travel time or travel distance are typically viewed as signals of model misspecification or unreliable data. Nevertheless, such positive estimates may be obtained in some types of research. Shopping behaviour research in some European countries is a good example. It is not a surprise that consumers in these countries often face the choice of visiting the city centre at a farther distance but also with many more opportunities than visiting closer but substantially smaller neighbourhood shopping centres. Because a high percentage of consumers choose the city centre, under some circumstances a positive distance parameter may be obtained. The question is whether this reflects consumer's preference or the spatial configuration of shopping opportunities. In this particular example, the answer seems clear. If there would have been more, competing larger shopping centres within shorter distance, the shopping choice data would have been quite different. Hence, spatial constraints strongly affect, and in this case even dictate, revealed choice data. Consumers have limited options and cannot truly entertain any other choice but to travel to the city centre whether they like it or not.

It is just one example of a more general discussion on the issue of preference versus constraints (e.g., Hägerstrand, 1970; Rushton, 1969). Although this issue is still open for further debate, the example convincingly shows that one cannot uncritically take revealed choice data to reflect underlying preferences. In that sense, much research in transportation on travel choices has a weak methodological basis. It is easy to show that the same behavioural principle applied to different urban systems that vary in terms of the configuration of facilities will result in quite distinct and different revealed choice data. Using such data then to infer underlying behavioural processes (utility or preference structure) is doomed to lead to invalid and biased results (Timmermans & Veldhuisen, 1981). The challenge is how to unfold and disentangle observed activity travel patterns into preferences and effects of the spatial configuration of opportunities, which at the same time defines a set of spatial and spatio-temporal constraints.

Thus, many normative theories in transportation science and related disciplines have been based on the "homo economicus" principle of distance-minimizing behaviour. As these theories have assumed isotropic conditions, this postulate seems logical within the theoretical perspective of these economic theories. In reality, however, destinations are not identical, but vary in terms of their attributes and therefore the utility derived from visiting such locations. Most operational models of spatial choice behaviour have therefore assumed some trade-off between the attractiveness of the destinations and distance decay (e.g., Golledge & Gärling, 2001; Golledge & Timmermans, 1988). Individuals are assumed to be willing to travel further distance to visit more attractive destinations, but the utility of travel itself is assumed to be a monotonically decreasing function of travel time or travel distance. Is there reason to critically question these commonly made assumptions and replace them by a wider set of more encompassing assumptions?

Needs, Desires and Aspirations

Ever since its inception, mankind has manifested a tendency to travel, explore and conquer. In part, travel was triggered by the necessity of finding new land, in part to satisfy feelings of curiosity. Travel is just an integral part of daily life as it were. To survive and grant meaning to their lives, people have always nurtured a set of needs and desires and corresponding aspiration levels (e.g., Maslow, 1943, 1970; Maslow & Lowery, 1998; McClelland, 1975; Miller, 2005; Petri, 1991). They have developed strategies to satisfy their needs, realize their desires and cope with the many challenges and uncertainties that characterize the context within which their aspirations need to be achieved. Their needs, desires and aspirations (materialistic and non-materialistic) are partly congruent with, partially antagonistic to, the norms entertained by their larger socio-economic-cultural-political environment. Some needs are shared by whole mankind. Others are shared within particular socio-cultural groups. As individuals mature, needs, desires and aspirations evolve as a function of upbringing and education, attitude formation within social networks, bounded by the formal regulations of society and social norms of the social networks of the individual (e.g., Terry & Hogg, 2000). Formal and informal norms set the context within which needs, desires and aspirations can be (publicly) expressed and behaviour can be manifested. The socio-economic-cultural-political environment provides opportunities and creates order but at the same time may inflict frustration to the extent it suppresses strong desires and intended behaviours, leading individuals either to ignore the official norms, act on their desires informally in split worlds or attempt to change the norms and regulations and the corresponding institutions. In attaining their needs and desires, individuals may not only be triggered by the principle of minimizing travel time in organizing daily activity-travel patterns in time and space. For example, in countries with less democratic regimes, many people tend to avoid public places for their leisure and social activities because privacy in these countries has a different meaning as government tends to interfere in many aspects of their citizen's life. Consequently, people tend to prefer travelling to a friend's house even though it is at a further distance and gather there to socialize or have a meal rather than choosing a public place close by. This example reflects the contention that citizen's behaviour is not primarily enforced by their inherent preferences but may also reflect suppression of preferences and shows the possible effect of the political environment on travel behaviour.

Communities and societies at large have historically shown a tendency of self-organization. Behaviour as expressions of cultural and other activities, within the context of what is deemed permissible, and processes to achieve aspirations moderated by governments and business organizations have been institutionalized. Schools for education, work places to make an income, religious buildings for religious activities, shopping centres and markets to buy goods, and more, have been created. The crystallization of activities into artificial environments invites individuals to shape their daily behaviour in particular ways and has been instrumental to the evolution of daily rhythms, scripts, routines and activity-travel repertoires (e.g., Axhausen, 2002). At the same time, however, the spatial distribution of land use, jointly with the institutional context also control and limit individual's choices in the sense that they represent spatial, temporal, and spatio-temporal constraints on behaviour. Businesses, firms, and organizations are spatially organized in that their business model, in conjunction with rules and regulations formulated and maintained by governments, lead them to prefer particular locations in the urban system and avoid others. The combined location decisions then give rise to the spatial configuration of land use.

To achieve their aspirations, individuals and households will gradually develop across their life trajectories an agenda of commitments (start a family, find a job, get education, etcetera). These commitments involve a set of recurring activities according to certain rhythms and regularities within phases of their life trajectory (e.g., Verhoeven, Arentze, Timmermans, & van der Waerden, 2005). Most activities are conducted at arranged locations and buildings in the urban system, which are reached by using the transportation network. Hence, a person's daily schedule will consist of a sequence of activity episodes, intertwined by travel episodes. Travel is an act of going to the next activity location. Thus, the transportation system and travel are essential in connecting activity locations and assure a well-functioning urban system. At the same time, inequality in accessibility and connectedness is unavoidable, leading to welfare loss and perhaps in extreme cases to social exclusion. Thus, the urban and transportation systems offer possibilities that are beneficial in that they provide the décor to become engaged in activities and travel, but at the same time constrain people's options to organize their activities in time and space.

Re-iterating the hallmark of activity-based analysis, travel represents induced demand in that the spatial configuration of land use and facilities requires individuals and households to travel in order to participate in their daily activities, which in turn are instrumental to achieving a set of needs, desires and aspirations (Timmermans, Arentze, & Joh, 2002). The most basic needs are *physiological*. People cannot survive without food, water clothes and shelter. Unless they grow and produce these themselves, they depend on buying such merchandise at markets or stores. In order to do so, they need income, reflecting *economic* needs. As we have institutionalized most paid work in formal jobs, work schedules and work arrangements, such economic needs trigger work commutes, concentrating on particular time slots of the day, reflecting the temporal organization of work arrangements. People also have *social* needs. They have parents, they may have parents-in-law, siblings, and children. They have co-workers, friends and acquaintances. They may be part of religious, political or social organizations and clubs. Maintenance of such social networks and their activation for mental support, exchange of information and expression of commitment, inclusion, belonging and cohesion, requires communication, which often is manifested in travel, perhaps in addition to modern information and communication media use. Finally, people also have *psychological* needs. Fundamental are the needs of arousal, self-realization, self-esteem, and activation (e.g., Berlyne, 1967; Duffy, 1962; Hewstone, 1989, Johnson-Laird, 1983). These needs impact happiness and quality of life and; may trigger people to reconsider their routines, scripts, commitments, rituals, and habitual behaviour patterns. Diminishing arousal levels with increasing duration and length of activities, commitments and repetitious choices may lead to boredom, stress and frustration, and stimulate novelty and variety-seeking. In turn, this may lead to breaking with commitments as mechanisms to cope with built-up stress and frustration and escape from current reality, when simply laughing away sorrow no longer helps. Travel in that context may be an act of a temporary escape from everyday life. It may involve short distance travel, but it also includes long distance travel for a short break or longer vacation.

If this reasoning is accepted, it follows that only a certain share of travel should be considered solely as an intermezzo between activity episodes, which only requires effort without any other benefits and therefore can be best represented as a disutility. Travel may however be more than only an episode of negative utility (e.g., Ory & Mokhtarian, 2005; Redmond & Mokhtarian, 2001; Salomon & Mokhtarian, 1998) in that it may represent a positive act of a temporary break from routines or an opportunity to release frustration, chill down and recharge for things to come. Moreover, travel may not only be perceived as physical replacement, but also as an opportunity for multi-tasking (e.g., Kenyon & Lyons, 2007; Lyons & Urry, 2005; Mokhtarian & Salomon, 2001; Timmermans & Van der Waerden, 2008; Van der Waerden, Kemperman, Timmermans, & van Hulle, 2009; Van der Waerden, Timmermans, & van Neerven, 2009; Zhang & Timmermans, 2010, Timmermans and Zhang, 2009, Lyons et al., 2006), having a moment for one-self and enjoying the passing of the landscape and the brief non-obligatory, superficial encounters with others.

Shifting Contexts

People remember the days of their grandparents, who were farmers occupying rural land. Literally everything was self-made and self-produced at the farm in these autarkic communities. People grew their vegetables and potatoes, ate their chicken, veal, pork and steaks, milked the cows, grew fruits and even made the clothes themselves. As there was no radio and no television, entertainment to the extent it existed involved playing cards or other family games. The only outing, on foot, was going to church on Sundays, with the men meeting after the church ceremony in the local bar to have drinks and socialize.

In part due to succession rights, farm land was split into increasingly smaller pieces that did not allow sons to run a successful business. In response to this as well as an increasing international competition, the contribution of agriculture to the national economy was reduced in these regions and especially sons had to move elsewhere or stay and find a job in a different sector of the economy. The fading out of agriculture and the autarkic society caused the shift to an exchange economy, division of labour, exchange of people, capital, commodities and services, first regionally, then nationally and more lately globally.

Rapidly increasing productivity and exports quickly led to the emergence of a middle class with rapidly increasing wages. As an expression of the newly acquired wealth, cars started to appear in middle class neighbourhoods: a first one, a second one, then they had to design and develop parking places in the streets and soon these newly created places were insufficient. Yet, these were the times of the delivery of goods. Very few women had a driver licence or car. Moreover, they had to take care of their large families and could not go grocery shopping. A representative of the grocery store would drop by twice per week to collect the grocery list and deliver the items on next call. Mom was waiting at home to welcome her children when they returned from school. In those years, children played after school in the streets and neighbourhood, in its parks and small green spaces, or annoyed next door neighbours. After school time was spontaneous, cheap, yet fulfilling as ever.

One family in the street was first to go on summer holiday, rather than visiting grandparents over the summer school vacation. The travel industry was still insignificant. People bought a tent and travelled by their newly acquired car into the unknown and scary world of different cultures, foods, customs and languages, but not too far to be able to return home within a few hours if the worst imaginations would become reality. Soon, in these vacation villages, enclaves with people of the same language, country of origin and interest appeared, allowing them to do the same routine activities they used to do at home, eating the same food, brought from home along the trip, drinking the same beer, playing the same games, often with the same friends, the only difference being the location (e.g., Bargeman & van der Poel, 2006; Giddens, 1994).

The introduction and affordability of new technology meant that women's housekeeping tasks required less time, which could be released for other activities, including work. The women's liberation movement led to more and better education for women, triggering more women participation in the workforce. It did not only make women financially independent, but also substantially increased the spending power of double-earner households, that should be turned into more clothes, increasingly larger television sets, a (larger) house, a bathroom, new furniture and ultimately a second car and more vacations to increasingly more distant exorbitant destinations, which could be reached only by air or sea. For some social groups, the enclaves remained, only now the entourage changed to scenery that people only watched on television before, which by now had entered into all dining rooms and many sleeping rooms.

Although women's liberation and the general process of democratization increased women's participation in the workforce, it did not substantially change women's time use (e.g., Dowling, 2000; Hanson & Pratt, 1990; Kwan, 1999, 2000). Women by and large did the child care and housekeeping. In part, this reflected male's attitudes, in part women's feelings of higher responsibility in conducting these tasks, and in part their upbringing in which mothers did not teach their daughters how to change gender roles. Thus, in the end, many women became masters of multi-tasking and multi-stop, multi-purpose trips (e.g., Aitken, 2000; Hanson & Hanson, 1980, 1981; Hanson & Johnston, 1985; Kwan, 1999, 2000; Strathman, Dueker, & Davis, 1994) using whatever travel mode was available, after the man took the family car to work where it sat idle for 8 h. To cope with the resulting time pressure, enabled by increased family income, it led to the rapid appearance of a second car in families allowing women to run even more errands and take the larger share in the household task allocation process (e.g., Ettema, Schwanen, & Timmermans, 2004, 2007).

One of these added tasks was escorting children to whatever they wanted to go. Children were not only insisting on designer clothes and the possession of the latest gadgets and technologies; any (self-)respected child was assumed to master several languages, play music instruments, be a ballerina and be active in different kinds of sports. The spontaneity, non-pressured, self-organized system of leisure activities was replaced by an institutionalized system of including or excluding small networks surrounding a whole range of leisure activities. These activities became the self-imposed constants in the organization of daily life. From the perspective of travel, escorting became a fair share of daily traffic flows, especially on Saturdays and in the early evenings.

At the same time, the introduction of modern Information and Communication Technology (ICT) allowed people to use Internet to pay their bills, transfer money, arrange their vacation travel and more (e.g., Dijst, 2004; Handy & Yantis, 1997; Salomon, 1986). Consequently, these activities could be deleted from their out-of-home activity schedules, resulting in less travel. Other activities such as shopping for technical equipment soon followed, especially by men. At the same time, however, use of the Internet also led to exposure to new merchandise and to comparative shopping and may thus have triggered additional travel. Slowly, modern technology has also entered business communities, such as for example the rapidly increasing popularity of Skype and similar technology, and webinars. Social media have entered the arena, on the one hand stimulating travel, on the other hand avoiding travel as people do not necessarily have to meet face-to-face except for business that benefits from non-verbal communication. Thus, the use of modern technology and travel are mutually related and may demonstrate both substitution and synergetic effects (e.g., Mokhtarian, Salomon, & Handy, 2006).

Modern ICT has also further supported the prevalence of some kinds of multi-tasking. Nowadays, people can work on the train, check and process their email, call, Skype, etcetera. Boundaries between work and non-work activities, and between travel and activity episodes have become increasingly blurred. The synchronicity of activities has led to fragmentation of time (e.g. Dijst, 2004). It implies that the value or utility of travel time episodes can no longer be refined to pure travel but should incorporate the benefits of possible activities conducted whilst travelling (e.g., Connolly, Caulfield, & O'Mahony, 2009; Kirby, Smith, & Carreno, 2007).

Needs and Constraints Re-addressed

These anecdotes and research findings provide evidence of the perpetual and unsaturated drive for arousal. Repeated exposure to the same experience ultimately turns into boredom (relationships, jobs, activities), triggering individuals to reconsider their current behaviour and possibly explore and experience different choice alternatives, awaking arousal. Moreover, the anecdotes illustrate that this urge for arousal has co-evolved with a social and economic system that has been very forthcoming in catering to these needs, and that in fact lends its bare existence to the dynamics of consumer needs. Leaving open the discussion whether the evolving needs and desires are truly needed or have been artificially created by intelligent marketing campaigns, history has shown that across the world individuals are eager to set higher aspiration levels and satisfy their needs and desires at increasing rates (e.g., Bourdieu, 1984). If they cannot afford to pay, they use credit to enjoy immediate consumption, amplified by the expectation that postponed consumption would be detrimental to their self-interest in light of rapidly increasing prices and inflation. In parallel, individuals have been given the opportunity to act on their preferences. In light of an uncertain future and inflation, a tendency to instantaneous consumption of happiness can be observed in the new generation: no past-no future!

Moreover, the anecdotes suggest that in the interplay between the demand and the supply side, constraints have become less stringent and therefore less critical, due to processes such as accumulated wealth, longer life trajectories, higher travel speed, increased awareness of opportunities by simply Googling to find the best or closest location for engaging in some specific activity, and increased opportunities and accessibility provided by 24 h supermarkets, restaurants, clinics, and extended store hours of large shopping centres. Due to rapidly increasing divorce rates and the consequent larger share of single households, further amplified by extended opening hours of facilities, people are willing and enabled to conduct social and leisure activities until late at night even on weekdays. This desire, which can be observed to increase, has led to a diffusion of a shift in opening hours of bars, restaurants and other facilities from major cities to smaller cities which subsequently reduces the impact of temporal constraints on implementing these type of activities.

Travel and Uncertain Environments

The argument that individuals and households try to achieve their needs and desires by organizing their daily activities according to particular scripts and routines, subject to the constraints defined by the supply of facilities in conjunction with the properties of the transportation network does not do ful justice to the complexity of the problem. Not only the relationship between the urban and transportation environment but also the needs and desires of individuals and households is dynamic. In addition, the dynamics in the introduction and diffusion of new products in the urban and transportation systems cause that at best individuals can only have partial and imperfect information about their environment. Moreover, because traffic conditions emerge as a result of the accumulated decisions of many individuals, the transportation system will exhibit inherent variability and the same can be said about many aspects of the urban environment. Consequently, activity-travel decisions are made in uncertain environments. Individuals will build up their beliefs about the states of the transportation system and the urban system and act on the basis of these beliefs. Individuals will try to make sense of the observed variability in the states of the system by identifying conditions that account for such variability. For example, they may realize that congestion levels depend on the day of the week or the time of day. Consequently, beliefs and associated routines may be context-dependent. When assessing any constraints affecting their choices, they should also incorporate uncertainty in the effect of such constraints, whenever the constraint is not inherently deterministic.

Uncertain environments also imply that when executing an activity-travel programme, people cannot be sure that their decision necessarily represents an optimum choice, considering the opportunities in their environments and various types of constraints. They may not know all options, their beliefs about the states of the system may be imperfect or the actual state of the system may differ from the believed state. To reduce such uncertainty, individuals can adopt different strategies. In addition to searching for information using modern technology or consulting members of their social network, travel itself represents another way of exploring new alternatives, updating beliefs and developing context-dependent choice heuristics to organize activities and travel in time and space such as to meet one's aspiration levels (Arentze & Timmermans, 2005).

Benefits of Travel for the Individual

So what do these observations imply for the individual benefits of travel? Our arguments suggest that individuals are not necessarily reluctant to travel and that the utility of travel time and travel distance does not necessarily monotonically decrease as a function of increasing time and distance. Vacation travel provides an opportunity to meet new people, experience new regions and cultures, not only giving a chance to interact with new cultures, but also teaching one to better recognize and revalue oneself. Consider a person who was born and raised in an affluent country. He might see pictures or reports in the media of poor people in a third world nation. Such pictures may not make a profound impact. However, if this person travels to those countries and gets first-hand experience of the living conditions there, not only his perspective on life would change but he would also return home with more appreciation of the comfort and lifestyle he enjoys in his own country. Likewise, people in underdeveloped nations need to be exposed to the advancements in developed countries, so that their minds are not limited by the restrictions imposed by their poverty, which in turn may be a good motivation to plan and try to develop their country as much as possible. In that sense, international travel and personal experiences contribute to personal development and international awareness. As Marcel Proust (1923) said "The real voyage of discovery consists not in seeking new landscapes, but in having new eyes". Such new exposures and experiences and self-reflection are critical to recharge and re-calibrate for the daily routines.

In the context of such daily routines, individuals benefit from travel not only because it is strictly necessary and instrumental to become engaged in mandatory and discretionary activities, but also because travel itself may trigger arousal when during travel individuals may enjoy the scenery, be exposed to new or re-lived memorized experiences or simply avoid satiation by engaging in novelty or variety-seeking behaviour. Travel also in a daily context may be a break from routines, and an episode for oneself to relax, refresh and recharge before taking up responsibilities and fulfilling the commitments of everyday life.

Travel and activity episodes have, however, become increasingly blurred due to the omnipresence of ICT. Travel in the sense of being away, out-of-touch, implying a-synchronic communication, has become less of a reality in that people can share their travel and experiences with their friends and loved-ones, real time and visually. The importance of well-thought activity-travel plans has become reduced as modern technology allows easy and constant re-planning if necessary and letting others know that no re-planning is necessary: "Hi honey, as usual, I just boarded the train and should be at home as planned at 6:12 pm – will call u again when I arrive – Love you ☺". Modern technology has allowed individuals to capture the benefits of travel by multi-tasking to enjoy and capitalize the uninterrupted nature of travel (as long as the smart phone is off).

Finally, in a daily context, travelling in the sense of trying new places, different times and other routes is a way of personally experiencing the urban and transportation environments, thereby learning and updating beliefs to reduce uncertainties and reinforce activity-travel patterns that allow one to cope best with the uncertainty inherently embedded in dynamic urban systems. Travel is a way of exploring the environment and developing context-dependent activity-travel patterns that are instrumental in achieving certain aspirations related to travel times and quality of daily travel. Travel is beneficial in developing mental representation of urban systems, which in turn are instrumental, if not necessary, to successfully cope with the challenges of organizing daily activities (e.g. Gärling & Golledge, 2000).

Benefits of Travel for the Society

Travel does not only have benefits for individuals but also for society at large. Given the way production processes have evolved over time, travel has become critical in keeping the socio-economic systems operational. The benefits of travel for society can be argued at different spatial scales.

Internationalization and globalization characterize the latest stage of economic development. The quest for increased or at least continued profits, jointly with fierce competition, has shifted complete branches of particular industries to locate in other countries and operate internationally. The resulting transportation of products is only feasible due the very existence of transportation systems and the low costs of transportation relative to other factors affecting costs and profits.

At the daily level, traffic is the “blood” of urban systems. People and goods need to be moved between places to keep the economy going and allowing people to become engaged in mandatory and discretionary activities. Travel contributes to the smooth functioning of the urban system and remedies inherent discrepancies in the spatial allocation of land uses in the urban system.

In addition to these economic benefits, travel also contributes to the maintenance of social networks and cultural exchange. Traditional local communities have been dissipated and large streams of voluntary and non-voluntary international migration can be observed. Consequently for some segments of the society international social networks have emerged. Admitting that modern communication technology allows people to stay in touch easily, nevertheless face-to-face contacts and the travel implied have resulted from such expanded social networks and at the same time are critical in sustaining such networks. In other words, travel is a necessary albeit not sufficient condition for quality of life from an economic, social and health perspective. Lack of accessibility may reduce participation in various types of activities and in extreme cases induce social exclusion (e.g. Cass, Shove, & Urry, 2003; Kenyon, Lyons, & Rafferty, 2002).

Travelling in terms of short and long distance is instrumental to exchange culture and information. Although globalization, enabled by travel, has the risk of melting identities, at the same time people and governments may also become increasingly aware of their cultural heritage which they may then wish to maintain. In the long run, the effect of long distance travel for society concerns developing arterials, highways, railways and airways systems to facilitate connections between areas with high travel demand which in turn would result in improved culture, vision and experience, which ultimately will bring the world some steps closer to what is called the universal village.

A Utility Formalization

In most current research, the utility of a travel episode i, $U_{ni}^{t'}$ for individual n, is assumed to vary as a function of start time, duration, travel mode and a selected set of attributes of these choice facets. For each mode and start time s, utility is commonly defined as a disutility, sometimes conditional on start time and travel mode. It is further assumed that disutility increases monotonically with increasing distance or travel time.

Thus far in this chapter, we have argued that the utility of a travel episode is not only influenced by the efforts individuals invest to travel between different places, but that the utility of the travel episode is also influenced by non-travel experiences, including multi-tasking, critical incidents and the larger context in which the travel episode takes place, including the purpose of the trip and its embedding in the larger context of the activity-travel schedule. An important question to ask is therefore when the benefits of travel become positive. The problem can be expressed as follows: if we specify disutility of travel as commonly done, can we find the parameter conditions under which the utility of a travel episode is positive. Ignoring the other subscripts, let U^t_{nir} be the utility of non-travel related to activities and context. Then, the utility of a travel episode will be positive if

$$U^t_{nir} > U^{t'}_{ni} \tag{1}$$

We will now show that whether this occurs depends on the specification of the utility functions. To allow for the notion of variety-seeking behaviour, it has been commonly assumed that the utility of an activity is a logarithmic function of time (duration). Because the duration of an activity during travel (and of other experiences) may be less than the length of the travel episode itself, let $t(t \le t')$ denote the duration of the activity. Then,

$$U^t_{nir} = \beta_r \ln(t+1), \beta_r > 0 \tag{2}$$

As for the disutility of travel time, most discrete choice models (e.g., Ben Akiva & Lerman, 1985) have assumed that the utility of travel time is linearly decreasing with time. Hence, $U^{t'}_{ni} = \beta_{t'} t'$, where $\beta_{t'} < 0$. Alternatively, a negative power function, $U^{t'}_{ni} = t'^{\beta_{t'}}$, $\beta_{t'} < 0$, or exponential function, $U^{t'}_{ni} = \exp(\beta_{t'} t')$, $\beta_{t'} < 0$, have been assumed (e.g. Batty, 1976). This means that different answers to the question when the benefits of travel will become positive will be found for different sets of assumptions regarding the disutility of travel time and the utility of activity duration.

In case of the logarithmic function for activity duration and the linear function for travel time disutility, the duration t at which the utility of non-travel related activities and context becomes higher than the disutility of travel can be found by solving

$$\beta_r \ln(t+1) > \beta_{t'} t' \tag{3}$$

By exponentiation and re-arranging, we obtain

$$\exp(\ln(t+1)) > \exp\left(\frac{\beta_{t'} t'}{\beta_r}\right) \tag{4}$$

Consequently,

$$t + 1 > (\exp(t'))^{\frac{\beta_{t'}}{\beta_r}} \tag{5}$$

Re-arranging gives

$$t > (\exp(t'))^{\frac{\beta_{t'}}{\beta_r}} - 1 \tag{6}$$

A similar expression can be derived for the case when the disutility of travel time is a power function,

$$\beta_r \ln(t+1) > t'^{\beta_{t'}} \tag{7}$$

And by exponentiating

$$\exp(\ln(t+1)) > \exp\left(\frac{t'^{\beta_{t'}}}{\beta_r}\right) \tag{8}$$

Consequently,

$$(t+1) > \left(\exp\,(t')^{\beta_{t'}}\right)^{\frac{1}{\beta_r}} \tag{9}$$

The duration t at which the utility of the non-travel component of the utility function becomes higher than the disutility of travel is equal to

$$t > \left(\exp\,(t')^{\beta_{t'}}\right)^{\frac{1}{\beta_r}} - 1 \tag{10}$$

If an exponential function for the disutility of travel time is assumed, the inequality is expressed as

$$\beta_r \ln(t+1) > \exp(\beta_{t'} t') \tag{11}$$

Again by exponentiating

$$\exp(\ln(t+1)) > \exp\left(\frac{\exp(\beta_{t'} t')}{\beta_r}\right)$$

Thus,

$$(t+1) > \exp\left(\frac{(\exp(t'))^{\beta_{t'}}}{\beta_r}\right) \tag{12}$$

which can be re-written as

$$t > \left(\exp\,(\exp(t'))^{\beta_{t'}}\right)^{\frac{1}{\beta_r}} - 1 \tag{13}$$

The above equations identify the duration of activities at which the instantaneous utility of the activity is higher than the disutility of travel. Perhaps more relevant in the context of this chapter is to calculate the utility of the complete travel episode. The accumulated utility as a function of duration of non-travel related utilities and context, denoted here as d, during a travel episode is equal to

$$\int_0^{d_r} U_{nir}^{t} dt \tag{14}$$

and the corresponding value for only travel time

$$\int_0^{T'} U_{ni}^{t'} dt' \tag{15}$$

where T' is the total time of the travel episode. Thus, the utility of a travel episode accounting for both these factors is positive if

$$\int_0^{d_r} U_{nir}^{t} dt > \int_0^{T'} U_{ni}^{t'} dt' \tag{16}$$

By solving for t, the minimum duration to reach a positive utility for the travel episode can be found. Assuming that the utility function for the duration of activities is logarithmic and the disutility of travel is linear, the following equation holds. Noting that the integral of a logarithmic function $\ln x$ is equal to $x \ln x - x$ and the integral of a linear function x is equal to $\frac{x^2}{2}$, $\int_0^{d_r} \beta_r \ln(t+1) dt > \int_0^{T'} \beta_{t'} t' dt'$ can be rewritten as

$$\beta_r[(t+1)\ln(t+1) - (t+1)] > \frac{\beta_{t'} t'^2}{2} \tag{17}$$

and by applying the limits of the integral, correcting for scale and re-arranging

$$[(d_r+1)\ln(d_r+1) - (d_r+1)] + 1 > \frac{\beta_{t'} T'^2}{2\beta_r} \tag{18}$$

or

$$[(d_r+1)(\ln(d_r+1) - 1)] + 1 > \frac{\beta_{t'} T'^2}{2\beta_r} \tag{19}$$

By exponentiating and expanding

$$(\exp(\ln(d_r + 1) - 1)^{d_r+1} > \exp\left(\frac{\beta_{t'}}{2\beta_r} T'^2 - 1\right) \tag{20}$$

or

$$\left(\frac{\exp(\ln(d_r + 1))}{\exp(1)}\right)^{d_r+1} > \left(\frac{(\exp(T'^2))^{\frac{\beta_{t'}}{2\beta_r}}}{\exp(1)}\right) \tag{21}$$

$$\left(\frac{d_r + 1}{2.718}\right)^{d_r+1} > \left(\frac{\left(\exp(T'^2)\right)^{\frac{\beta_{t'}}{2\beta_r}}}{2.718}\right) \tag{22}$$

If it is assumed that the disutility of travel time is a power function, then

$$\int_0^{d_r} \beta_r \ln(t + 1) dt > \int_0^{T'} t'^{\beta_{t'}} dt' \tag{23}$$

Noting that the integral of x^n equals $\frac{x^{n+1}}{n+1}$,

$$\beta_r[(t + 1)\ln(t + 1) - (t + 1)] > \frac{t'^{\beta_{t'}+1}}{\beta_{t'} + 1} \tag{24}$$

and by applying the limits of the integral and re-arranging

$$(d_r + 1)(\ln(d_r + 1) - 1) > \frac{T'^{\beta_{t'}+1}}{\beta_r(\beta_{t'} + 1)} - 1 \tag{25}$$

Exponentiation of both sides of the equation gives

$$\exp[(d_r + 1)(\ln(d_r + 1) - 1)] > \exp\left(\frac{T'^{\beta_{t'}+1}}{\beta_r(\beta_{t'} + 1)} - 1\right) \tag{26}$$

and

$$(\exp(\ln(d_r + 1) - 1))^{d_r+1} > \frac{\left(\exp\left(T'^{\beta_{t'}+1}\right)\right)^{\frac{1}{\beta_r\left(\beta_{t'}+1\right)}}}{\exp(1)} \tag{27}$$

$$\left(\frac{(\exp(\ln(d_r+1)))}{\exp(1)}\right)^{d_r+1} > \frac{\left(\exp\left(T'^{\beta_{t'}+1}\right)\right)^{\frac{1}{\beta_r\left(\beta_{t'}+1\right)}}}{\exp(1)} \tag{28}$$

$$\left(\frac{(d_r+1)}{2.1718}\right)^{d_r+1} > \left(\frac{\exp\left(T'^{(\beta_{t'}+1)}\right)^{\frac{1}{\beta_r\left(\beta_{t'}+1\right)}}}{2.718}\right) \tag{29}$$

If the function for travel time is assumed to be exponential, the accumulated utility is given by the integral

$$\int_0^{d_r} \beta_r \ln(t+1)dt > \int_0^{T'} \exp(\beta_{t'}t')dt' \tag{30}$$

Since integral of exp(x) equals exp(x)

$$(t+1)\ln(t+1) - (t+1) > \frac{\exp(\beta_{t'}t')}{\beta_{t'}\beta_r} \tag{31}$$

and after applying limits for the integral and re-arranging

$$[(d_r+1)(\ln(d_r+1)-1))+1] > \frac{\exp(\beta_{t'}T')-1}{\beta_{t'}\beta_r} \tag{32}$$

Exponentiation gives

$$\exp((d_r+1)(\ln(d_r+1)-1)) \geq \exp(\frac{\exp(\beta_{t'}\cdot T')-1}{\beta_{t'}\beta_r}-1) \tag{33}$$

which is equal to

$$(\exp(\ln(d_r+1)-1))^{d_r+1} > \exp\left[\left(\frac{\exp(\beta_{t'}T')-1}{\beta_{t'}\beta_r}\right)-1\right] \tag{34}$$

or

$$\left(\frac{\exp(\ln(d_r+1))}{\exp(1)}\right)^{d+1} > \frac{\exp\left(\frac{(\exp\beta_{t'}T')-1}{\beta_{t'}\beta_r}\right)}{\exp(1)} \tag{35}$$

which is equal to

$$\left(\frac{\exp(\ln(d_r+1))}{\exp(1)}\right)^{d+1} > \frac{(\exp((\exp \beta_{t'} T') - 1))^{\frac{1}{\beta_{t'}\beta_r}}}{\exp(1)} \tag{36}$$

Thus,

$$\left(\frac{d_r+1}{2.718}\right)^{d_r+1} \geq \frac{\left(\frac{\exp(\exp(\beta_{t'} \cdot T'))}{2.718}\right)^{\frac{1}{\beta_r\beta_{t'}}}}{2.718} \tag{37}$$

Equations (22), (29) and (37) define the relationship between activity duration and travel time at which the overall utility for the travel episodes becomes positive. It is meant to be a starting point to formulate and develop operational models that represents enhanced specification of the utility of travel. It goes without saying that these equations represent minimum cases in the sense that the various factors contributing to the utility such as multi-tasking, context, and other need to be specified separately. More realistic models will differentiate between these different factors and will also include the purpose of the trip as well as the effects of previous and future activity episodes.

Concluding Remarks

The main point of this chapter is that travel can be largely understood as a balancing act between dynamic needs and various types of constraints acting on people's possibilities to realize their preferences. An important determinant of travel is people's drive for novelty or variety-seeking behaviour. People have always demonstrated the tendency to explore new things – locations, countries, shopping centres and products – only limited by constraints. As this is a universal drive, and an increasingly larger share of the world population experiences more resources and less restrictions, the need to travel internationally, nationally and locally must be expected to increase.

We have focused on the benefits of travel for both the individual and society at large. From the perspective of sustainable development, however, the tendency of increased travel, unlikely to be changed in current "exponential times", has also many negative aspects, including rapidly increasing emissions and energy consumption. One can only hope that new technology will arrive timely as otherwise the depletion of scarce resources is a real threat. It will be impossible to deny the new countries the benefits of travel that others have enjoyed for decades.

For policy makers in urban planning and transportation, the challenge is to design or stimulate the development of urban systems that meet the social requirements of their inhabitants. Resilient urban systems based a distributed land use system which results in the same level of satisfaction but with a less amount of travel distance are the ideal for the future.

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Satisfaction and Travel Choices

Maya Abou-Zeid and Moshe Ben-Akiva

Introduction

Subjective well-being (SWB) or what is also commonly labelled as happiness refers to people's own evaluation of the quality of their life along both cognitive and affective dimensions (Andrews & Withey, 1976; Diener, Scollon, & Lucas, 2003). Research on SWB has resulted in the emergence of new fields such as hedonic psychology (Kahneman, Diener, & Schwarz, 1999), positive psychology (Seligman, 2002), and happiness economics (Bruni & Porta, 2007; Frey & Stutzer, 2002). A great number of surveys have been conducted to measure SWB, and governments in several countries (e.g. Bhutan, France, United Kingdom) have included or are including well-being as an important indicator of social progress and as a measure for guiding public policy.

Generally, satisfaction with different life domains, such as work, health, marriage, and leisure, contributes to overall SWB. On a daily level, the ability to participate in activities is crucial for SWB (Cantor & Sanderson, 1999) because it helps people satisfy their needs (Chapin, 1974; Maslow, 1970; Oishi, Diener, Lucas, & Suh, 1999). Participation in activities requires travel. The extent to which the transportation system facilitates access to activities should therefore be an important factor affecting SWB.

In recent years, the general interest in SWB research and its connection with travel, activities, and needs have motivated interest in measuring satisfaction with

M. Abou-Zeid (✉)
Department of Civil and Environmental Engineering, American University of Beirut,
P.O. Box 11-0236/FEA-CEE, Bechtel Room 2M3, Riad El-Solh, Beirut 1107 2020, Lebanon
e-mail: ma202@aub.edu.lb

M. Ben-Akiva
Department of Civil and Environmental Engineering, Massachusetts Institute of Technology,
77 Massachusetts Avenue, Cambridge, MA 02139, USA
e-mail: mba@mit.edu

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travel. Most of the work in this area has focused on understanding the causes and correlates of travel satisfaction or well-being (especially for commutes) and on estimating the effects on overall SWB. A smaller number of studies have modelled the relationship between well-being and travel behaviour or addressed the implications of the well-being approach for transport policy.

The purpose of this chapter is to review the application of SWB to transportation. In particular, we focus on relating SWB to travel attributes and behaviour for transportation planning and forecasting purposes. The chapter is not meant to be a comprehensive review of the SWB literature in transportation (see, for example, the reviews by Abou-Zeid, 2009; Ettema, Gärling, Olsson, & Friman, 2010). The next section covers measurement of SWB in transportation and major empirical findings relating travel to overall SWB and the dynamics of travel well-being. The following section discusses SWB in relation to travel choice models, first providing a review of studies linking SWB to activity/travel choice and attributes, and then presenting an extended random utility modelling framework that incorporates well-being measures as indicators of utility. The last section concludes.

Measurement of Subjective Well-Being Related to Travel

Empirical evidence from the measurement of SWB related to activities and travel has supported some of the findings of the general SWB research. In this section we discuss two of the main insights and the evidence supporting them. The first insight is that overall well-being or life satisfaction is influenced by satisfaction in various life domains, and travel seems to play a significant role for overall well-being. The second is that the dynamic nature of well-being is also evident in travel and has implications for the measurement of activity and travel well-being.

Transportation and Overall Subjective Well-Being

Travel affects people's overall SWB primarily by facilitating access to activities in various life domains (work, leisure, family life) and satisfying the corresponding needs. The activities and travel are shaped by the activity and transportation systems (spatial configuration, opportunities) available to people. There may also be direct effects of travel on overall SWB if it generates psychological benefits (e.g. creating a sense of freedom in movement or providing private time) or is associated with health impacts (e.g. benefits of active travel, stress due to commuting). For further discussion of the relationship between travel and well-being, see Delbosc (2012) and Ettema et al. (2010).

SWB researchers have measured activity and travel well-being using instruments such as the Day Reconstruction method (Kahneman & Krueger, 2006; Kahneman, Krueger, Schkade, Schwarz, & Stone, 2004) and found significant variation of

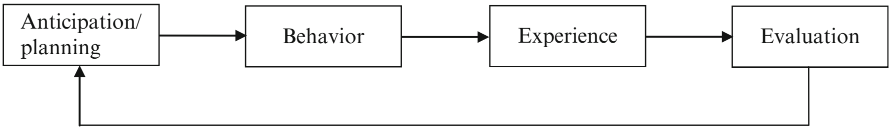

Fig. 1 The dynamic nature of the relation of SWB to behaviour (After Dolan & White, 2006)

happiness by activity type including activities such as commuting. Furthermore, a number of studies have found evidence for the role of transportation in overall well-being. Jakobsson Bergstad et al. (2012) measured several dimensions of affect associated with activities finding a significant influence of affect experienced while performing routine out-of-home activities (which require travel) on overall weekly mood and life satisfaction, with a larger influence on mood. Similarly, using a Canadian time-use survey, Spinney, Scott, and Newbold (2009) found significant correlation between the daily exposure to different types of out-of-home activities and quality of life for elderly non-working Canadians. Duarte et al. (2010) assessed the direct influence of travel happiness on overall happiness. They found that happiness related to work trips and leisure trips positively influence overall happiness, albeit to a smaller extent than the influence of life domains such as family, social, and financial.

The main conclusion from these studies is that travel plays a vital role for overall SWB. It would be useful to gain further evidence on the separate influences of access and travel as this would have direct implications for the design of transport policies aimed at increasing overall SWB. For example, one important question is to what extent transport policies should focus on travel time savings versus improving access to closer and attractive destinations.

Dynamics of Activity/Travel Well-Being

Dolan and White (2006) argue that SWB is a temporal and iterative process involving several stages such as anticipation/planning of a behaviour, actual behaviour, the experience itself, and evaluation of the experience or behaviour, as shown schematically in Fig. 1. This process can be tapped at different points in time, resulting in different measures.

Two studies lend further support to the dynamic nature of SWB measures in transportation. Abou-Zeid, Witter, Bierlaire, Kaufmann, and Ben-Akiva (2012) found that satisfaction with the commute by car of a sample of habitual car drivers was different when measured close to the moment of decision making about mode choice than when measured under routine conditions of daily commuting involving no updating of choices. This difference was attributed to stronger cognitive awareness at the moment of decision making and to possible shifts in the frame of reference when evaluating satisfaction. Pedersen, Friman, and Kristensen (2011) measured predicted, experienced, and remembered satisfaction with public transport for a sample of habitual car drivers and found that experienced satisfaction was significantly different from predicted and remembered satisfaction, similar to other results in the general SWB literature (Kahneman, Fredrickson, Schreiber, & Redelmeier, 1993; Wirtz, Kruger, Scollon, & Diener, 2003).

The main conclusion from these studies is that the time at which SWB is measured matters, and that different indicators can be used for different purposes. We will return to this point when we present a modelling framework that incorporates different types of well-being indicators.

Subjective Well-Being and Travel Choice Models

In this section, we specifically focus on transportation research that includes modelling SWB as a function of activity/travel attributes or linking it to activity/travel behaviour. The section first reviews the main findings of several studies in this area and then presents a general modelling framework for including SWB indicators in random utility models with an application to transportation.

Review of Studies Linking Subjective Well-Being to Activity/Travel Attributes and Choices

With respect to activity participation and SWB, a number of studies have found that activity happiness varies significantly by activity type and socio-economic group and is correlated with behaviour. For example, using structural equation modelling, Abou-Zeid and Ben-Akiva (2012) found significant correlations between activity happiness/travel satisfaction and the propensity to participate in activities as measured by weekly activity frequency for different types of activities: the greater the happiness derived from an activity and the satisfaction with travel to the activity, the greater the propensity to participate in the activity. Using multivariate ordinal probit models, Archer, Paleti, Konduri, Pendyala, and Bhat (2013) found that affective feelings (happiness, stress, meaningfulness, pain, tiredness, sadness) associated with different activity type-location combinations (in-home vs. out-of-home) are significantly influenced by activity attributes such as activity duration, start time, and child accompaniment.

Studies focused purely on travel well-being have also identified links between travel happiness and behaviour. For example, Duarte, Garcia, Limão, and Polydoropoulou (2009) found that experienced happiness and expected happiness (represented through cartoons depicting the travel environment) were significant attributes in models of travel mode choice. Moreover, travel well-being studies, especially those focusing on commute stress and commute satisfaction, have identified a number of modal attributes affecting these components of well-being, including travel time, cost, distance, congestion, variability/predictability of travel time, crowding, frequency of negative critical incidents, perceived control and effort, degree of arousal/boredom, symbolic and affective factors such as the perception of the car as providing independence and control, and activities conducted during travel as a coping mechanism to reduce stress (see, e.g., Koslowsky, Kluger, & Reich, 1995, for the commuting stress literature, and Abou-Zeid & Ben-Akiva, 2011; Ettema et al., 2011; Friman, Edvardsson, & Gärling, 2001; Friman & Gärling, 2001; Olsson, Gärling, Ettema, Friman, & Fujii, 2012, for commute/travel satisfaction related findings, and Ory & Mokhtarian, 2005, for a travel liking study).

Modelling Framework

Given the connection between well-being and behaviour established in both the general SWB literature and the transportation literature, our aim in this section is to provide a framework for systematically including SWB indicators in travel behaviour models and particularly as part of the widely used random utility model. The key concept is the relationship between happiness or well-being and utility. It is shown that the standard random utility modelling framework can be extended with SWB indicators in both cross-sectional and dynamic contexts. This is followed by an application of the extended framework to travel mode choice.

Happiness and Utility[1]

McFadden (2005) summarizes the history of the study and measurement of well-being and its relationship to utility in classical and neoclassical economics and in the modern behavioural re-evaluation of the consumer. In the classical era, Bentham (1789/1948) defined utility as the experiences of pleasure and pain. Utility was related to the process, experience or sensation attached to actions rather than to their consequences. In the neoclassical era, economists viewed utility as a "black box whose inner workings were not their concern" arguing that preferences can only be inferred from choices.

In the modern behavioural re-evaluation of consumer theory, in particular Kahneman (2000) and Kahneman, Wakker, and Sarin (1997) have made significant contributions to the revival of discussions about the relationship between happiness and utility. They distinguished between experienced utility (as in Bentham's conceptualization) and decision utility (as used by neoclassical economists). Furthermore, experienced utility can refer to remembered utility (retrospective judgement

[1] The discussion in this section is based on Abou-Zeid and Ben-Akiva (2010, 2012).

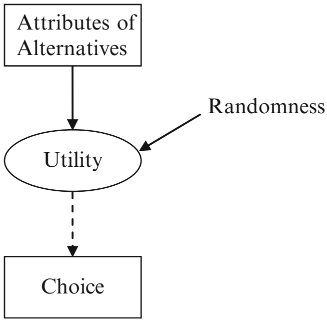

Fig. 2 Standard discrete choice framework based on the random utility model

of an experience), moment utility (real-time affective experience), and predicted utility (anticipated experience). A number of studies have found that remembered utility affects decision utility in the sense that people tend to repeat experiences that are remembered more favourably.

From this conceptualization of utility and happiness, it may be concluded that happiness or SWB and utility are the same concept, but a distinction needs to be made among the different notions of utility. Consequently, one can use SWB measures as indicators of utility in random utility models, but different measures of well-being collected at different points in time may reflect different notions of utility. In the following sections, after reviewing the standard random utility model framework, we present a framework and its application that show the enrichment of random utility models with happiness data.

The Standard Random Utility Model

The discrete choice model based on random utility theory has been widely used to model travel-related decisions such as car ownership, activity participation, destination, and travel mode choice. The standard random utility modelling framework is shown in Fig. 2 (Ben-Akiva & Lerman, 1985; McFadden, 1984). In this figure and subsequent figures, solid arrows represent structural relationships while dashed arrows represent measurement relationships. Variables in rectangles are observed, while those in ellipses are latent or unobserved.

The utility of every alternative is a function of measurable attributes of the alternative and random factors that are not observed. Equation (1) expresses this relationship, where U_{in} denotes the utility of alternative i for individual n, X_{in} is a vector of attributes of alternative i for individual n (including interactions with characteristics of individual n), β is a vector of parameters, ε_{in} is a disturbance associated with alternative i and individual n, and $U(.)$ is a function

$$U_{in} = U(X_{in}; \beta, \varepsilon_{in}), \quad \forall i \tag{1}$$

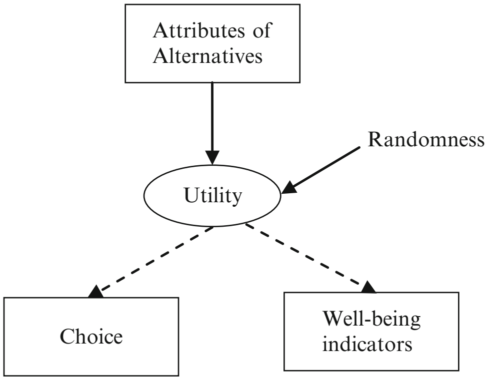

Fig. 3 Discrete choice framework with well-being indicators in a static context (After Abou-Zeid & Ben-Akiva, 2012)

Utility is inferred from observed choices and is used to explain these choices. That is, decision protocols based on utility maximization assume that the alternative that is chosen has the maximum utility among the alternatives in the choice set. This is reflected in Eq. (2), where y_{in} is a choice indicator equal to 1 if alternative i is chosen by individual n and is 0 otherwise, and C_n is the choice set of individual n

$$y_{in} = \begin{cases} 1 & \text{if } U_{in} \geq U_{jn} \quad \forall j \in C_n \\ 0 & \text{otherwise} \end{cases}, \quad \forall i \tag{2}$$

Choice models based on random utility theory have been criticized for their inadequate representation of the process and context of decision making (see, for example, Ben-Akiva et al., 2012). A number of developments have taken place to address these limitations, including the incorporation of attitudes and perceptions in choice models through the Hybrid Choice model (Ben-Akiva, McFadden et al., 2002a; Ben-Akiva, Walker et al., 2002b; Walker & Ben-Akiva, 2002), the use of non-expected utility theories such as prospect theory (Kahneman & Tversky, 1979), and models of social interactions in choice processes (e.g. Brock & Durlauf, 2001; de Palma, Picard, & Ziegelmeyer, 2011).

Another direction for enhancing random utility models is through the use of well-being data. In particular, the choice indicator may be an inadequate measure of the utility on its own. Well-being indicators may also capture information about the utility and can be used as additional indicators of the utility to enhance its measurement (Abou-Zeid & Ben-Akiva, 2010).

Random Utility Model with Subjective Well-Being Indicators: Cross-Sectional Framework

In a static or cross-sectional context, the framework of the standard random utility model shown in Fig. 2 can be extended as shown in Fig. 3, where both the choice and the well-being measures are indicators of the utility. Mathematically, the use of well-being measures adds equations of the following form to the standard choice model

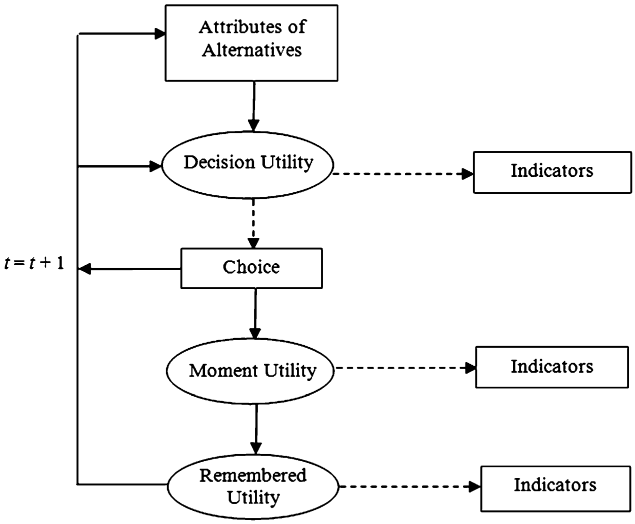

Fig. 4 Discrete choice framework with well-being indicators in a dynamic context (After Abou-Zeid & Ben-Akiva, 2010)

$$h_{in} = h(U_{in}; \upsilon_{in}), \text{ for } i \text{ such that } y_{in} = 1 \tag{3}$$

where h_{in} is an indicator of happiness or satisfaction with alternative i for individual n, υ_{in} is a measurement error, and $h(.)$ is a function. Since happiness indicators would generally be collected for the chosen alternative only, the above equation applies to this alternative.

When measuring well-being in a cross-sectional context, one issue that arises is that a happiness judgement by a respondent after the choice had been made is an indicator of remembered utility while the choice is an indicator of decision utility. The happiness measure is thus an imperfect indicator of decision utility in a cross-sectional context. In Abou-Zeid and Ben-Akiva (2012), a method is suggested for addressing this issue by collecting indicators of how different the experience is from expectations or plans and using the well-being indicators only if the experience is as expected or as planned.

Random Utility Model with Subjective Well-Being Indicators: Dynamic Framework

In a dynamic context, one can represent the different notions of utility, their interactions, and the use of well-being measures as indicators of these utilities. Such a dynamic modelling framework is shown in Fig. 4 for a given time period and is analogous to the dynamic SWB process depicted in Fig. 1. Each of the three types of utility may have its own well-being indicators which would be expressed as a

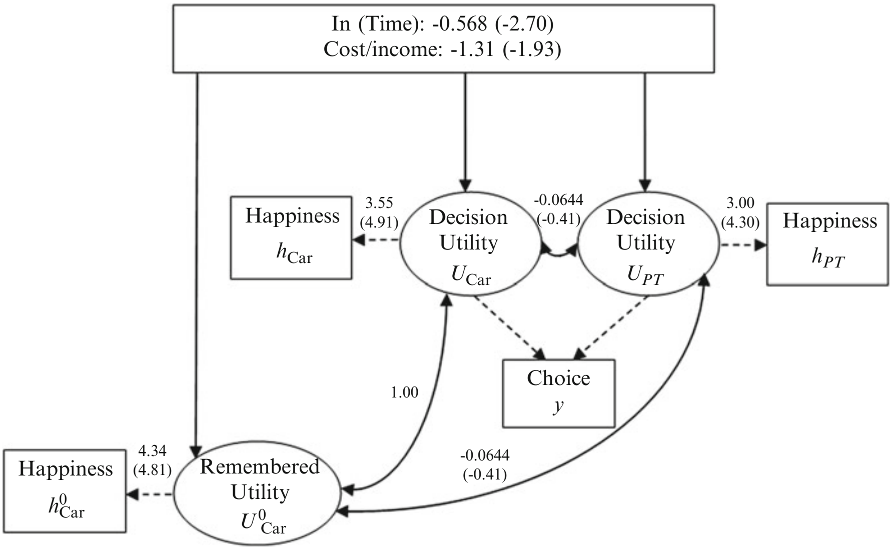

Fig. 5 Modelling framework and parameter estimates from a public transport experiment (*t*-statistics are shown in parentheses) (After from Abou-Zeid, 2009)

function of the corresponding type of utility in a manner similar to Eq. (3). The well-being indicator of decision utility may be obtained at the time of decision making; the well-being indicator of moment utility may be obtained during the experience of the outcome of the decision; the well-being indicator of remembered utility may be obtained retrospectively. Remembered utility in one time period affects decision utility in the following time period.

An Application of the Extended Model

A simplified version of the dynamic framework shown in Fig. 4 was applied to data from an experiment (Abou-Zeid, 2009). A sample of habitual car drivers commuted with public transport (PT) for a few days and then had to make a choice of whether to continue using their car or to switch to PT. The following self-reported indicators were collected: pre-treatment satisfaction or happiness with the commute by car, post-treatment satisfaction with the car commute, post-treatment satisfaction with the PT commute, and the post-treatment car versus PT choice. Out of 67 participants, 20 participants cancelled their full-time parking permits post-treatment and switched to PT.

The travel mode choice model framework and estimation results are shown in Fig. 5, where curved arrows represent correlations. The framework distinguishes between decision utility (of car and PT) and remembered utility (of car) and uses different indicators of commute satisfaction to capture these notions of utility. In the

Table 1 Efficiency of extended and standard random utility model; $\hat{\beta}$ denotes the parameter estimates and $\hat{V}$ denotes the fitted systematic utility component

	Extended model (Choice + Happiness)	Standard model (Choice only)
$\mathrm{Var}(\hat{\beta}_{\mathrm{Standard}}) - \mathrm{Var}(\hat{\beta}_{\mathrm{Extended}})$	Positive definite	
$\overline{\mathrm{Var}}(\hat{V}_{\mathrm{Car}})$	3.69	56.8
$\overline{\mathrm{Var}}(\hat{V}_{\mathrm{PT}})$	3.61	55.9

After Abou-Zeid (2009)

pre-treatment period, the car is the habitual choice so its utility represents a remembered utility. In the post-treatment period, participants have to make a choice of whether to continue commuting by car or to switch to PT. The car and PT utilities at the moment of decision making are then decision utilities. The utilities are affected by explanatory variables including travel time and travel cost divided by income, and they are correlated with each other. With regard to the indicators, the choice of car or PT is an indicator of post-treatment or decision utility. The pre-treatment car satisfaction measure is an indicator of pre-treatment (or remembered) car utility. The post-treatment car and PT satisfaction measures are indicators of post-treatment (or decision) car and PT utilities, respectively. The detailed model formulation is available in Abou-Zeid (2009).

Among the main findings, the effect of the different utilities on the happiness indicators was positive and statistically significant, implying that the satisfaction or happiness measures are valid indicators of utility. Moreover, commuting cost was found to affect only the mode choice decision but not the satisfaction ratings. This can also be interpreted to mean that satisfaction ratings reflect the actual affective experience (time, comfort, convenience) that does not include monetary aspects.

The performance of the model with happiness indicators (extended model) was compared to that of a model of travel mode choice without happiness indicators (standard model) using several criteria. While the standard model had better goodness-of-fit, the extended model was more efficient, that is it resulted in more accurate parameter estimates. As shown in Table 1, the difference of the variance-covariance matrices of the parameter estimates (standard minus extended) is positive-definite; the variance of the systematic utility of car and PT, computed as the average variance across the sample, is substantially smaller in the extended model than in the standard model. Thus, a main benefit in using well-being measures as indicators of utility seems to be a substantial gain in efficiency.

Conclusions

This chapter provided an overview of subjective well-being (SWB) research in the transportation field focusing on measurement and modelling efforts as they relate activity/travel well-being to travel attributes and behaviour and to SWB. It is concluded that SWB is highly relevant to activity and travel behaviour and provides a useful indicator of this behaviour. This chapter also presented the extension of random utility choice models with SWB indicators added as utility indicators with an application to travel mode choice. This extension of the standard random utility model to include SWB is part of a broader agenda for the extension of this model to better represent the process and context of decision making that would result in richer behavioural models (Ben-Akiva et al., 2012).

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Part II
Car Use

The Unsustainability of Car Use

Bert van Wee

Introduction

Cars and car use has many advantages for individuals, households and the wider society. Cars provide access to many locations of opportunities (jobs, shops, family and friends, schools, universities, and recreational locations) that without a car would not be possible or at least more difficult. In addition the car is often a convenient mode of travel, offering door-to-door access. In Western countries, due to income increases in the past century, most households have at least one car. In most these countries the number of cars per 1,000 people is above 450 (Schäfer, Heywood, Jacoby, & Waitz, 2009).

Increasing car-use levels come at a cost, both at the individual level, as well as for society. At the individual level risk levels (road safety) are a major drawback, as well as the related lack of exercise. At the level of society a wide range of negative environmental impacts of car use exist, ranging from climate change at the global level to local air pollution and noise nuisance at the local level. This chapter aims to give an overview of these downsides of car use. The overview does not imply that car use should be reduced. From a broad welfare perspective the pros and cons of (additional) car use should be compared – for a reduction the pros should exceed the cons, and the cons should include the drawbacks addressed in this chapter.

It is not the aim of this chapter to give a full overview of all the environmental and other impacts of transport, their causes and cures in the form of policy options. For further reading, Hensher and Button (2003) and the journal *Transportation Research Part D: Environment* are recommended.

The next section gives an overview of the environmental impacts of traffic. The following section describes the contribution of travel to environmental impacts.

B. van Wee (✉)
Faculty of Technology, Policy and Management, Delft University of Technology,
P.O. Box 5015, 2600 GA Delft, The Netherlands
e-mail: g.p.vanwee@tudelft.nl

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The fourth section proposes a conceptual model of the impact of transport on the environment. The health impacts of transport are conceptualized in the fifth section. The sixth section elaborates the positive impacts of walking and cycling. The seventh section gives an overview of policy measures to reduce the environmental impacts. The eighth section discusses the sustainability of car use. In the final section the most important conclusions of this chapter are summarized.

Overview of the Environmental Impact of Traffic

Urban/Local Environmental Problems

Local air pollution is one of the most important environmental effects. The emissions of motorized road vehicles contribute heavily to especially peak levels of concentrations of pollutants, causing health effects and odour nuisance, but also dirt on windows and other parts of buildings, garden furniture and laundry. The emissions of PM (Particulate Matter – small particulates), NO_2, VOC and CO are relatively important for health. Note however that traffic is not the only emitter of these pollutants. The overall concentration at a certain location near a road consists of a regional or national background concentration, a local background concentration that is higher at a greater distance from the urban fringe (i.e. in the central parts of a city), and the contribution of a nearby road. The regional/national background concentration is the result of the emissions of many sources. Traffic also contributes to these background concentrations. Concentrations often exceed the standards for air quality that are a compromise between what is desirable from a health perspective and what is realistic practically or financially acceptable. In case of PM there is not a "no effect" threshold – the current standards are definitely a compromise.

Another dominant effect is noise, especially from road vehicles, rail vehicles, and aircraft. Unfortunately, due to methodological inconsistencies, it is hardly or not at all possible to give quantitative numbers on noise nuisance at an international level, such as the EU (EEA, 2000). A little less problematic, though still uncertain, are the figures for noise exposure. Berglund, Lindvall, and Schwela (1999) gives numbers for a selection of Western (mainly European) countries. The percentage of the population exposed to noise levels over 65 dB(A) due to road transport varies from 3 to 30 %. These numbers are also very uncertain. Whereas in Sweden the percentage is only 3 %, in the also sparsely populated neighbour country Norway the figure is 12 %, the numbers for the neighbours Germany and the Netherlands are also 12 and 3 %, respectively. Although differences in policy measures or in the land-use and transport system may contribute, it is very likely that the differences between these neighbouring countries are in practice smaller than the numbers suggest. In almost all countries the share of the population exposed to high levels of noise from aircraft and rail are lower than from road.

A third local environmental problem is the impact of acidification on buildings in part from emissions of NO_x, SO_2 and NH_3. Traffic does not contribute to NH_3 (which is mainly emitted by agriculture), but it does contribute to SO_2 and especially NO_x. Due to acidifying emissions, statues and some parts of buildings are affected, the results of which include a reduction in the quality or even loss of cultural heritage.

The health effects of air pollution, effects on buildings and noise are mainly urban problems, not only because in Western countries most people live in urban areas, but also because emission levels (expressed as per square kilometre emissions) are higher in such areas.

The environmental problems described so far are generally recognized in overviews of environmental problems as well as in policy documents. Since the mid-1990s there has been a growing awareness, both in research and policy making, that even if vehicles were completely quiet, did not emit pollutants, and only used renewable clean energy, some problems would still remain – problems that are often included in what is called "livability".

Non-urban Environmental Problems

Three other environmental problems related to transport are important. The first is climate change, mainly as a result of the combustion of fossil fuels causing CO_2 emissions. CO_2 is not the only substance causing climate change, but as far as the share of transport is concerned, it is by far the most important substance. The second problem is the effects of acidification on nature, agriculture, and the landscape. The third problem is large-scale air pollution, not only resulting from the emissions but also from complex chemical reactions taking place in the atmosphere, resulting in ozone formation.

How large is the impact of transport on the environment? Economists have developed methods to calculate these impacts. There is still discussion about whether they can be expressed in monetary terms at all, and if so how this should be done. It is beyond the scope of the chapter to elaborate on this discussion, but the outcomes of quantifications are relevant. As an example, in the Netherlands environmental costs for 2008 are estimated to be 2.1–8.5 billion euro (Kennisinstituut voor Mobiliteitsbeleid [KiM], 2010), for the year 2007 the cost of road accidents is as high as 12 billion euro (SWOV, 2009 based on AVV, 2006), for 2010 the costs of congestion (not only including travel time losses but also costs of the unreliability of travel times, and the costs of changes in behaviour, such as departure time and mode choice) are 2.8–3.7 billion euros (KiM, 2011). The examples show that, whereas in policy discussions and the media the attention paid to congestion is much larger than the attention paid to the environment, the costs of the environmental impacts of transport exceed those of congestion.

The Share of Transport in Environmental Problems

Transport is a major contributor to many environmental problems. Table 1 presents the share of transport in total emissions of SO_2, NO_x, CO, VOC, PM and CO_2 in the US 2008. As may be seen, the transport sector emits over half of NO_x and CO emissions, and about one-third of HC and CO_2 emissions. The share of SO_2 seems to be small but emissions of ships at sea are excluded, because these do not occur within a country's boundaries and are therefore not included in national statistics.

The table does furthermore not fully express transport's share in the health impacts of these pollutants since, on average, the distance between road traffic and the people exposed is much shorter than for other sources of pollution, such as power plants. Traffic emissions therefore have a greater health impact per kilogram than average emissions (Dorland & Jansen, 1997; Eyre, Ozdemiroglu, Pearce, & Steele, 1997; Newton, 1997). This is especially the case for road transport, more than for non-road transport. Figure 1 visualises the contribution of road-traffic-related emissions PM10 and PM2.5 in microgram/m^3 as a function of the distance

Table 1 Shares of transport in emissions in the USA, 2008

Component	Share
SO_2	4.5
NO_x	57.9
CO	73.2
VOC	37.7
PM-2.5	0.2
PM-10	3.2
CO_2	33.2

After Davis, Diegel, and Boundy (2010)

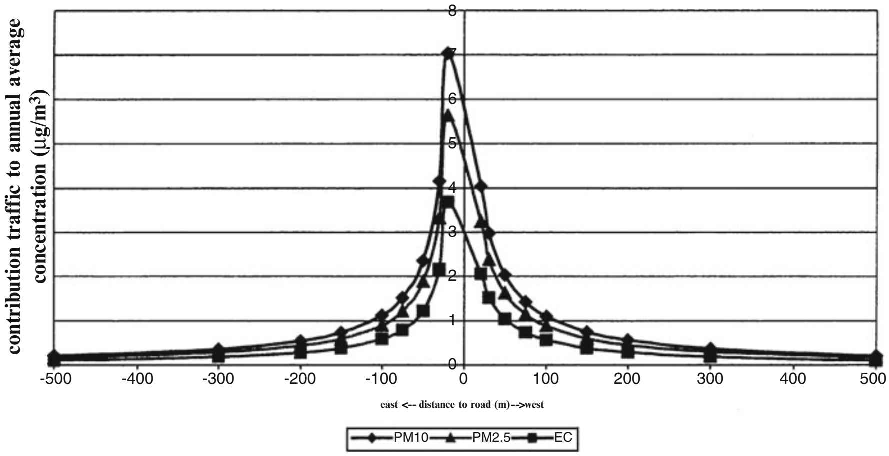

Fig. 1 Contribution of road-traffic-related emissions as a function of the distance to the road (From Janssen, Brunekreef, Hoek, & Keuken, 2002)

from the road, using a motorway location in the Netherlands. Bennett et al. (2002) have introduced the concept of the intake factor. Evans et al. (2002) give an overview of studies on this factor. A study by Smith (1993a, 1993b) is cited to conclude that the intake of emissions of particulates of vehicles is ten times higher than those of a power plant. For further examples see Marshall, Riley, McKone, and Nazaroff (2003) and Marshall, Mc Kone, Deaking, and Nazaroff (2005). To conclude, the share in emissions of different sectors is only a rough indicator of the share of effects. The impact of distance on effects should be included to give insights into the environmental effects of emissions, resulting in a relatively high share of road transport emissions.

A Conceptual Framework for the Impact of Transport on the Environment

Figure 2 illustrates a conceptual framework identifying factors affecting the environmental impacts of transport. These environmental effects highly depend on transport volumes resulting from the desires, needs, obligations and choice options of people and firms, the locations of activities such as living, working and shopping, and transport

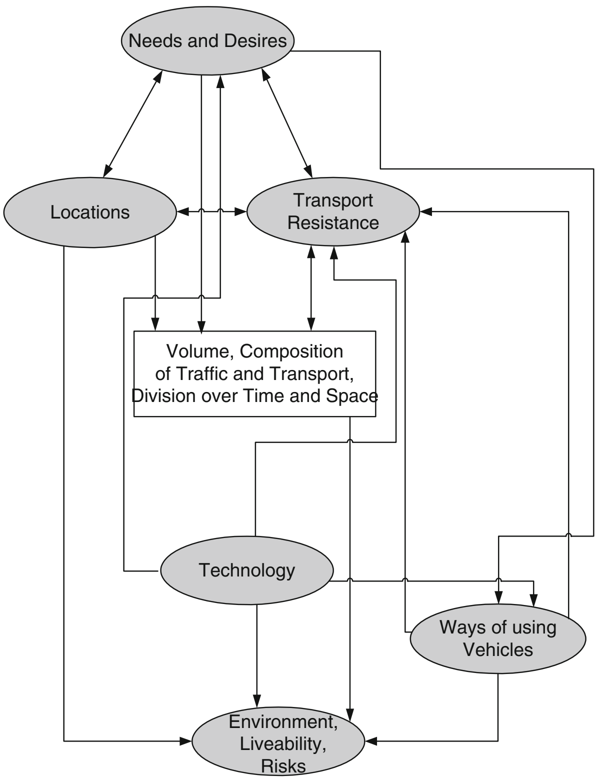

Fig. 2 A conceptual framework identifying factors having an impact on transport volumes, and the impact of transport volumes on the environment, accessibility, and safety (Source: Van Wee 2007)

impediments, often expressed in time, money costs and other factors. These factors vary according to socio-economic factors such as age and household type.

Technology and people's driving speed and style also have impacts on the environment. Driving fast does not only reduce travel times but people also like it. The distribution of traffic over space and over time has an impact on the environment, including the breakdown of traffic within and outside the build-up area and by road class. For example, traffic on a road along which hardly any houses are sited causes less noise nuisance compared to a traffic on a road along which many houses are located at close distances. Concentrations of pollutants on the pavements are higher if the pavement is located near a busy road. In terms of the impact of traffic on noise nuisance over time, a breakdown into hours of the day is important since night traffic causes more nuisance than daytime traffic does. On the other hand, night traffic seldom causes congestion.

Health Impacts of Road Transport

The health impacts of concentrations of pollutants are often considered to be the most important environmental impact category at the urban scale. Figure 3 illustrates a conceptual model of the relationship between emissions, concentrations, exposure, and health effects. The model is derived from research on transport emissions, dispersion of pollutants, and public health (see, e.g., Van Pul, Van Zandvoort, De Leeuw, & Sluyter, 1996; Whitelegg, Gatrell, & Naumann, 1993, for the relations between emissions and concentrations, and Van Wee, 2007, for an overview of health impacts of exposure to concentrations). The health effects on people result from exposure to concentrations of pollutants. Apart from the exposure, people's characteristics are also relevant. For example, people at an old age are more vulnerable to high concentrations of pollutants than young people are. The peak in mortality in periods of high concentrations of pollutants in Western cities mainly applies to older people. Life-style is also important. For example, the additional negative impacts of exposure to high concentrations of pollutants differ between smokers and non-smokers. The exposure of people depends on the concentrations of pollutants at locations where they carry out their activities, the characteristics of these activities, and the time they spend at these locations. For example, being physically active in a high-concentration location causes more health impacts than doing office work. Note that it is not only people that stay near roads that are exposed to emissions of road traffic, but also people in the role of travellers using cars or buses, trams, cycling, and walking.

The concentrations of pollutants at locations depend on the emissions of road vehicles and the dispersion of these pollutants. The distance between the locations of emissions and the locations of activities is particularly important, but also the average wind speed and direction matter as well as the objects between the locations of emissions and activities. The emissions from motorized vehicles depend on transport and traffic volumes (the number of vehicle kilometres), the

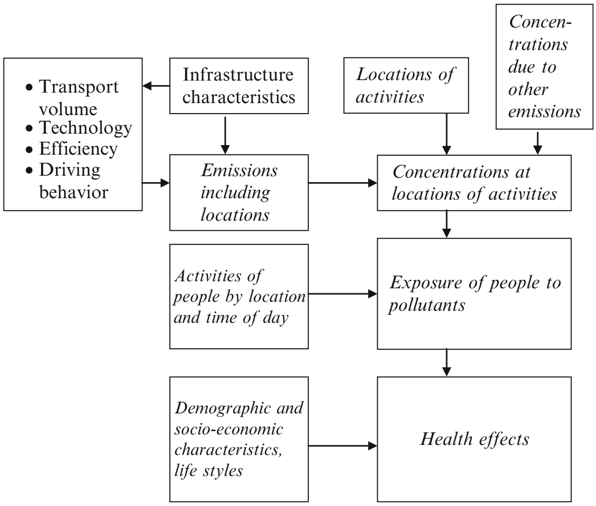

Fig. 3 A conceptual model of the health impacts of transport emissions (Source: Van Wee 2007)

technology of the vehicles and fuels used. Driving style also matters. For example, driving at high speeds and aggressively causes higher overall emission levels (El-Shawarby, Ahn, & Rakha, 2005).

Health Impacts of Walking and Cycling

Analyses of transport's environmental effects often only focus on the negative impacts of driving and less of the impacts of parked vehicles. In Western countries many people are much less active than is healthy for them. This often starts at school age, especially if parents bring their children to and from school by car, not allowing them to walk or cycle. Many adults commute by car and use their car for most of their other trips as well. If they do not exercise (sports, jogging, cycling), these adults are rarely physically active, and certainly not active enough from a health perspective. Although there is still much debate, several studies find that some urban forms result in a larger share of slow transport modes (see, for example, Frank, Saelens, Powell, & Chapman, 2007). Generally these studies show that an urban form with a high density of buildings with mixed use, an attractive infrastructure for cycling and walking, and a nice environment for walking and cycling results in a higher share of slow modes and a positive impact on health. A growing body of research has explicitly linked this impact of travel behaviour to an impact on health (Andersen et al., 2011; Badland & Schofield, 2005; Bassett, Pucher, Buehler, Thompson, & Crouter, 2011; Buehler, Pucher, Merom, & Bauman, 2011; Dora, 2004; Fraser & Lock, 2011; Lumsdon & Mitchel, 1999; Morisson et al., 2003; see Handy, 2005, for an overview of theory and empirical evidence). The importance of the possible health impacts of transport policy measures is illustrated by a Norwegian study showing that cycling infrastructure had much higher benefits for society than costs. The health benefits vary between cities and towns, ranging from 55 to 75 % of all benefits (Saelensminde, 2004).

Policy Measures

What can policy makers do to reduce the environmental impacts of transport? This section gives an overview of possible policy measures. The environmental impacts of transport depend on a number of determinants. The first is the overall volume of transport, expressed as passenger kilometres (persons) or tonne kilometres (goods). The second category is the modal split (for passenger transport car driver, car passenger, train, bus/tram/metro, walking, cycling, aircraft, ship). The third is the technology used. A fourth category is the efficiency of using vehicles (for lorries the load factor, and for cars, trains and buses the occupancy rate). The fifth is the manner in which vehicles are used (driving speed and style).

Governments have several types of policy instruments to influence these determinants, including regulations, prices, infrastructure planning, land-use planning, specific public transport policies (influencing services offered), marketing, and the provision of information and communication. Table 2 shows the relationship between the type of policy instruments and the determinants. As may be seen, restrictions and prices potentially have the widest range of impacts, followed by land use and infrastructure measures.

Restrictions can reduce overall volume, for instance due to limiting access to certain areas. If access is limited to certain vehicles (e.g. motorized transport, which is often the case in central urban areas) it may affect the modal split. Most technological changes in vehicles that reduce emissions result from restrictions. Restrictions on lorries in certain areas may affect the load factors (and therefore the efficiency of using freight vehicles) The CAFÉ regulations in the US have reduced

Table 2 Dominant relationships between determinants for environmental impact of transport (rows) and policy instruments (columns)

	Volume	Modal split	Technology	Efficiency of using vehicles	Use of vehicles/ driving behaviour
Restrictions	*	*	*	*	*
Prices	*	*	*	*	*
Infrastructure planning	*	*			*
Land-use planning	*	*			*
Public transport policies	*	*			
Marketing		*			
Information and communication	*	*		*	*

After Blok and Van Wee (1994)
*Dominant relationships

the energy use of cars (Perl & Dunn, 2007). Speed limits also reduce energy use and some emissions.

Higher fuel prices may reduce overall transport volume, and may lead to a shift to other modes. Higher taxes for vehicles without a three-way catalytic converter in the years before 1993 (the introducing of the Euro 1 standards) increased the sales of “clean” cars in The Netherlands in those years and therefore led to technological changes in the car fleet (Van Wee, 1995). Higher fuel prices may decrease the share of car use (efficiency) and lead to lower speeds on motorways to save fuel.

Providing more and faster infrastructure increases transport volumes and driving speeds (Goodwin, 1996). More compact land use and mixed use may reduce overall transport volume, and increase the share of slow modes. It may also change the distribution of car kilometres over road classes and therefore affect driving behaviour.

Subsidizing public transport may increase the quality and quantity of public transport services and its share. Marketing public transport may also increase its share.

The provision of Information and Communication Technology (ICT) may change people’s travel behaviour. For example, route information may reduce trip distance, public transport information may increase its share. Information provided through ICT may increase the efficiency of freight transport by making it possible to pick up a load on a return trip. Information provided by on-board units may change people’s driving behaviour.

Our main message is firstly that a broad range of policy measures exist to influence the environmental impact of urban transport and secondly that policy measures may have a much wider impact than on the environment alone. These complex relationships have an important impact on decision making for policies: It is seldom possible to draw policy recommendations based on research into mobility and environmental effects alone. Policy options should be evaluated using a much wider evaluation framework and a set of indicators. Indicators must include the impact on emissions, the impact on concentrations or the environmental, the impact on health, including those related to the positive effects of cycling and walking, accessibility impacts (including congestion), safety impacts, in terms of land-use measures also the residential preferences of people, and location preferences of firms. It must also address robustness: Can the land-use and transport system be maintained for many decades under changes in energy supply, people’s preferences, and demography.

The policy discussion of the environmental impacts of transport is broad. Here it is limited to a few major issues that often lead to wrong conclusions. The first issue is the cost-effectiveness of transport measures. In the case of policy-related studies that should give insights into how to meet certain environmental standards, particularly the maximum levels of emissions of certain pollutants, it is common to pay attention to the cost-effectiveness of possible future policy options. Such studies look, for example, at the costs of the reduction of NO_x or PM emission by 1 t. However, on average the distance between urban road traffic and people exposed is much shorter than for other sources such as power plants (see third section). Therefore, per kilogram, road traffic emissions have a greater health impact.

The cost-effectiveness of measures to reduce emissions is a poor indicator of the cost-effectiveness of health impacts. Distance needs to be taken into account.

The second issue to address is modal shift policy. Many countries, as well as the EU, have proposed a shift to public transport and slow modes based on average figures of emissions per km. Though certainly not suggesting that modal shift policies can never be fruitful and never be recommended, some warnings are in order. Firstly, average figures may not be applicable for specific situations. If one wants to compare long-distance goods transport by rail and road, urban and short distance road trips should be excluded, making the average performance of road for long distances better than for all road goods transport. Secondly, due to the limited overlap in markets between cars and public transport, making public transport cheaper or faster primarily results in an increase in its use, but only a minority of the extra use originates from previous car users. Depending on the specific situation, making public transport cheaper or faster may result in an increase in emissions. See Van Wee, Janse, and Van den Brink (2005) for an extensive elaboration of this discussion.

The third issue is self-selection. In both travel behaviour research as well as research into the impacts of transport (e.g. on health) it is currently common to include important determinants such as income, age, sex, and household structure. The phenomenon of self-selection refers to differences within homogeneous population strata. In a certain population strata differences exist because some people, for example, prefer to travel by car whereas others with seemingly the same characteristics prefer to travel by public transport and slow modes (Bagley & Mokhtarian, 2002; Kitamura, Mokhtarian, & Laidet, 1997). Self-selection is mainly studied in the context of residential self-selection (RSS). In a broad definition, RSS relates to the tendency of people to choose locations based on their travel abilities, needs and preferences (Litman, 2012). This broad definition would also include the phenomenon that high-income people are inclined to live in more expensive houses and neighbourhoods. Such self-selection processes are addressed in current research that includes socio-economic and demographic variables. A problem occurs if people self-select based on unobserved variables, such as attitudes or lifestyles. Research shows that including RSS related to attitudes or lifestyle generally reduces the independent impact of land use on travel behaviour (Cao, Mokhtarian, & Handy, 2009). Van Wee (2009) argues that self-selection may not only occur with respect to the residential location, but also in several other respects, such as related to destination choice (e.g. work place), and environment quality. For example, people who are extremely annoyed by traffic noise are probably less often living near roads, railway lines or airports (but Nijland, Hartemink, van Kamp, & van Wee, 2007, did not find such an effect). The same may be true of people with asthma or other breathing problems. If so, this self-selection results in an underestimation of the negative impacts of transport on noise nuisance or health. If a new infrastructure is built in or near a quiet area, the share of sensitive people may be higher than at current locations near infrastructure.

How Unsustainable Is Car Use?

In the third section it was shown that the transport sector has a large share in harmful emissions. Can one therefore conclude that car use is unsustainable? The answer to this question is not easy to give. Firstly, cars are not equivalent to the whole transport sector. Secondly, it is possible that the share of cars or transport in the emission of a particular substance is high, but that the overall volume of the emissions of that substance is not a problem. Thirdly, the share in emissions may be high, but that car use also heavily generates benefits to society.

To further complicate the issue, the answer may depend on the definition of sustainability. Two categories of definitions exist. One category focuses on intergenerational aspects of production and consumption: The current generation should not fulfil its needs in such a way that it jeopardizes the needs of future generations (e.g. World Commission on Environment and Development [WCED], 1987). The other category of definitions focuses on the balance between the economy, environmental, and social impacts (often labelled as people, planet, and profit): Sustainable development should warrant a sound balance between the dimensions (e.g. Serageldin & Steer, 1994). Reflecting on the first category of definitions it is clear that several environmental problems exist that do not necessarily have an intergenerational aspect. Take local air pollution and noise as examples. There is simply not an element of less noise or air pollution for the current generation at the costs of future generations. Probably the most important elements of intergenerational trade-offs exist in the areas of climate change, the use of fossil fuels, and the use of other non-renewables (raw materials). Car use of the current generation very likely contributes to climate change that future generations will face. It uses non-renewables like fossil fuels (mainly oil) and raw materials are used for the produce cars. In addition one could argue that the land for infrastructure and the deterioration of ecosystems as a result of habitat fragmentation causes effects difficult to reverse. On the positive side, future generations benefit from infrastructure that is useful to them. Considering the ambitious targets for climate change as set by, for example, the EU and the trend of increases of CO_2 emissions of the transport sector, and the depletion of fossil fuels, it is very likely that the current generations' car use is not sustainable.

If we adapt the second definition of sustainability (balance between people, planet, and profit) the answer to the question about the sustainability of car use is more difficult to answer. Car use definitely contributes to "profit". In Western countries people on average spend 10–15 % of their income on transport, mainly car use (e.g. Schäfer et al., 2009), and many people have jobs in the car industry. So the car is an important economic factor in society. And it definitely contributes to the "people" dimension: Many people benefit from the access the car and roads provide to them. But the "people" dimension has more aspects: Those without a car, or without a car available (e.g. because their partner uses the car to commute) face decreasing levels of accessibility due to the reduction in local shops and services that is partly caused by scale increases in retail and services that would at least have occurred to a lesser extent without growing car ownership. And growing car use decreases the viability of some public transport services, and consequently the accessibility of destinations by public transport. In addition, some negative externalities of car use, such as those related to safety and noise, also negatively affect the "people" dimension. Most clearly the "planet" dimension suffers from current car use levels, due to climate change and other effects. The problem is to define which imbalances between "profit" and the positive effects for people on the one hand, and the negative effects for people and planet on the other hand, would lead to the conclusion that the current level of car use is unsustainable. And it is probably even more difficult to say which *changes* in the current car use system that would restore the balance. If, for example, in four decades the current car fleets would be replaced by electric cars and electricity would mainly be produced sustainably (using solar and wind energy and other sustainable sources), would the car system then be sustainable? Or how much should CO_2 emissions of cars be reduced to make car use sustainable? Probably an equal share in reductions needed to meet the targets is too much, because CO_2 emissions in other sectors are cheaper.

We conclude that at least from an intergenerational perspective car use very likely is not sustainable, and from a "people, planet, and profit" perspective this probably also applies. At least it seems that if developing countries would face increases in car ownership up to those of Western countries (450–650 cars per 1,000 inhabitants) and cars would remain dependent on oil and not become much more fuel efficient, car use cannot sustain because of a lack of oil and is unsustainable because of the impact on climate change and probably also the use of non-renewable materials.

Conclusions

During the past four decades the environmental impacts of transport have become important in both policy and assessment methods. Traffic contributes to both local environmental problems, such as local air pollution and noise, as well as to environmental problems at a higher spatial scale, such as acidification and climate change. In the US the share of transport in the emissions of CO, CH, NO_x and CO_2 lies roughly between 30 and 75 %, making transport the most important sector causing negative environmental impacts. The share in emissions even underestimates the share in health effects, since in general the distance between road transport and the locations where people stay is shorter than on average, resulting in a relatively high health impact per unit of emissions. The environmental impacts of transport depend on transport volume (e.g. vehicle kilometres), technology, the way vehicles are used (speed, acceleration), the distribution of the use of vehicles over space and time, and the locations of exposed people, nature, and buildings. For health impacts the socio-demographic characteristics of the population are relevant, as are activity patterns over time. Walking and cycling has a positive health effect. Some land-use concepts contribute to a higher share of slow modes in travel behaviour, mixed use, high densities, attractive infrastructure for cycling and walking, and a pleasant environment for walking and cycling being the most important land-use characteristics.

Policy measures to reduce the environmental impact of transport include restrictions, pricing measures, infrastructure planning, land-use planning, public transport policies, marketing, communication, and information provision. These measures may have an impact on transport volume, modal split, technology, the efficiency of the use of vehicles (load factors, occupancy rates) as well as the way vehicles are used (speed, aggressive driving). Because several policy measures have a greater impact than on the environment alone, decisions should be based on a framework that not only includes the environmental impacts, but also other relevant impacts (such as safety impacts and the preferences of people with respect to their residential location). In the policy debate of impacts of transport on the environment, the relatively short distance between road traffic and exposed people should be taken into consideration in cross-sectorial cost-effectiveness comparisons of measures to reduce emissions. Modal shift measures may certainly contribute to a decrease in the environmental effects of transport, but the effect is often overestimated. Self-selection may be an important factor to take into consideration in assessing the impact of transport on the environment, but it is generally ignored in both research and policy making.

The answer to the question if current car use levels are unsustainable, is not easy to give, and depends on the selected definition and criteria for sustainability. But it is plausible to assume that if developing countries would face increases in car ownership levels up to those of Western countries and cars would remain dependent on oil and not become much more fuel-efficient, the system cannot sustain because of a lack of oil and is unsustainable because of the impact on climate change and probably also the use of several non-renewables.

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Psychological Motives for Car Use

Birgitta Gatersleben

Introduction

People buy and use cars for a range of different reasons and there are many reasons why they may not want to reduce or change their car use even though this may result in better health, environmental sustainability or financial savings. This chapter gives an overview of psychological motives of car use in order to explore opportunities and barriers for more sustainable travel. Like many other material objects, cars have instrumental, affective and symbolic value (Dittmar, 1992, 2004). They enable people to get from A to B quickly, cheaply and comfortably (instrumental value). But cars are also useful objects for non-verbal communication of achievements and identities to others (symbolic value) and buying and driving cars can elicit feelings of thrill, excitement, and stress (affective value; see Gatersleben, 2007; Gatersleben & Steg, 2012). This chapter discusses each of these three different types of outcomes and gives and overview of relevant research. The chapter ends with some theoretical considerations of the relationship between the three different aspects of car use and travel behaviours and discusses practical considerations.

The Instrumental Value of Cars

Most lifestyles in today's society involve a range of activities in geographically dispersed locations. In order to support such lifestyles fast, convenient, and affordable transportation is important (Jakobsson, 2007). For many people and in the majority of situations the car can provide this service better and cheaper than other

B. Gatersleben (✉)
Department of Psychology, University of Surrey, Guildford,
Surrey GU2 7XH, UK
e-mail: b.gatersleben@surrey.ac.uk

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modes of travel such as bus, train or bicycle. It is therefore not surprising that when asked why they drive, most people refer to instrumental advantages of the car in terms of comfort, speed and convenience (e.g., Bamberg, Ajzen, & Schmidt, 2003). Instrumental aspects, therefore, play an important role in understanding why people do or do not use cars. But the effect of objective instrumental costs and benefits on travel behaviours is shaped by perceptions of these costs and benefits. Travel motivations and behaviours are primarily affected by perceptions of costs and benefits which do not necessarily reflect actual costs and benefits.

According to one of the most influential theories in psychology, the Theory of Planned Behaviour (TPB, Ajzen & Fishbein, 1977), planned behaviour is influenced by intentions to perform this behaviour which is in turn influenced by attitudes towards the behaviour (is it a good or bad thing to do), perceived social norms (what do others think and do), and perceived behavioural control (how easy or difficult is it to do). For instance, people are more likely (to be willing) to reduce their car use if they feel this is a good thing to do, if they believe that they can and that others will approve of this (e.g., Bamberg et al., 2003). Attitudes towards a behaviour are a function of the expected outcomes of that behaviour and the value attached to those outcomes. Perceived outcomes are affected by objective instrumental costs and benefits but they are not necessarily the same. Individuals may not know about or take into account all costs and benefits and they will weigh different costs and benefits in different ways. Asking people why they drive may therefore unravel perceived outcomes but may not necessarily reflect actual advantages and disadvantages of different modes.

Jakobsson (2007) indicated that reported instrumental costs and benefits may reflect justifications. People may not always be aware of why they have decided to do something and they may give answers they believe to be socially desirable or morally acceptable. Asking people why they do something can then result in post-rationalisation or justification rather than reflect actual motivations or objective costs and benefits of different travel modes. As a result, providing better infrastructure or support in order to make more sustainable travel options more convenient or cheaper may not necessarily result in desirable behaviour changes, even if people have expressed positive views towards such interventions (Gatersleben & Appleton, 2007; Van Vugt, Van Lange, Meertens, & Joireman, 1996). In fact, potential users of improved facilities for sustainable travel alternatives may well change their attitudes and perceptions rather than their behaviour in response to implementation of such improvements. This is what Van Vugt et al. (1996) found when studying attitudes and behaviours of solo drivers before and after opening of one of the first car pool lanes in Europe. Cognitive dissonance theory may help explain this finding (Festinger, 1957). When people are faced with a discrepancy between what they say (carpooling is good) and what they do (solo driving), they can either change their behaviour or their attitudes and they will generally choose the easiest option: Changing attitudes rather than behaviours.

Studying perceived costs and benefits of travel options in order to examine travel motivations assumes that people are aware of such costs and benefits and make planned and informed decisions. But people are generally not able to take all possible outcomes into account and they weigh costs and benefits by subjective importance. Moreover, many travel behaviours are not planned but habitual. With repetition and a stable context habitual behaviour tends to develop and there is significant evidence that much car use is habitual (Aarts, Verplanken, & Van Knippenberg, 1998; Bamberg et al., 2003; Verplanken, Walker, Davis, & Jurasek, 2008). Habitual car use takes place without thinking. For instance, when we leave our home in the morning we rarely think about which mode of travel to use to get to work. We simply pick up our keys and our bag, walk out of the house, get in the car and drive away. It is not until we cannot find our keys that we may (have to) consider alternatives. Such habits can form a significant barrier towards change. Providing new facilities or introducing information campaigns which aim to change the (perceived) costs and benefits of cars and alternative travel options are unlikely to be effective if people do not think about their behaviour to begin with. In these cases information or new infrastructure may not even be noticed. It has been argued, therefore, that interventions may be more effective when people go through a major transition in their life when routines and habits are disrupted (e.g., moving house, starting a new job, starting a family) during which time they need to reconsider many aspects in their life including their travel behaviours (Verplanken et al., 2008).

But even when people make informed decisions the perceived instrumental costs and benefits of cars can form a significant barrier to change to more sustainable alternatives (Van Vugt et al., 1996). From a sustainability perspective this problem is aggravated by the fact that the (perceived) negative (environmental) consequences of driving are generally not immediately experienced by the driver but tend to affect others, far away and in the future whereas, personal benefits are experienced immediately (Vlek, Hendrickx, & Steg, 1993). Moreover, the collective costs of car use are not caused by one single driver and cannot be solved by individual drivers. How car use is related to environmental problems can therefore be described as a social dilemma (Eek, Loukopoulos, Fujii, & Gärling, 2002) where it is more beneficial for the individuals to act in their self-interest (comfort, speed) by driving a car than that of the collective (the environment) by using more sustainable travel modes. However, if everybody make cooperative choices all would benefit (from sufficient energy resources, safe roads, and clean air). Because the benefits of driving (and the costs of using sustainable alternatives) for people, here and now, outweigh the costs of this behaviour (or the benefits of sustainable behaviour) for the collective, it has been argued that sustainable travel choices should be treated as pro-social or altruistic choices – choices we make for the benefits of others (the collective; e.g., Wall, Devine-Wright, & Mill, 2007). For instance, Nordlund and Garvill (2003) found that people are more inclined to (try to) reduce their car use when they hold stronger pro-environmental and pro-social or altruistic values (as opposed to egoistic), feel more morally obliged to act pro-environmentally, and perceive more travel-related environmental problems.

To summarise, if people are asked why they drive they often refer to instrumental aspects such as speed, comfort, costs, and convenience. Answers to these questions may reflect perceptions or even justifications of behaviour which are influenced by a range of factors including external factors such as actual costs and benefits and social norms as well as internal factors such as limited rationality and personal values. These perceived advantages can form significant barriers for changes to more sustainable forms of travel. If people strongly believe that the car is faster, more comfortable and cheaper to use than alternative modes of travel, the alternatives may be difficult to promote.

The Symbolic Value of Cars

For many the private car has strong symbolic appeal. It is an ideal visual material object which people can use to (non-verbally) communicate their achievements, status, and values (impression management) and which can be very useful to form impressions of others (impression formation). For instance, given a choice not everybody will want to drive a Nissan Micra, a black Hummer or a pink VW Beatle. Moreover, most of us will not find it difficult (and perhaps even fun) to imagine what kind of person drives a vintage Rolls Royce, a Mini Cooper, a Lamborghini or a Suzuki Swift. Cars have strong symbolic appeal and the type of car people drive affects social perceptions. A recent study showed that women find men more attractive when these men are shown with a high status car as compared to an average status car (Dunn & Searle, 2010).

The relative importance of symbolic aspects of cars is rarely a topic of empirical research. However, years of media advertisement showing cars as symbols of status, confidence, power, and competence would suggest it is an important issue to take into account when developing sustainable transport policies (Hiscock, Macintyre, Kearns, & Ellaway, 2002; Marsh & Collett, 1986; Stokes & Hallett, 1992; Stradling, Meadows, & Beatty, 1999).

When asked why they drive, people do not tend to refer spontaneously or directly to the symbolic value of cars. Moreover, when they are asked to judge the importance of instrumental, affective, and symbolic costs and benefits of cars on rating scales symbolic aspects tend to receive lower ratings than instrumental aspects (Gatersleben, 2007; Steg, Vlek, & Slotegraaf, 2001). However, such responses may be strongly influenced by perceived social norms. When Steg et al. (2001) asked participants to evaluate the attractiveness of scenarios, describing a range of everyday experiences with cars, symbolic and affective aspects influenced attractiveness ratings more than instrumental aspects. The highest rated scenario described a situation where someone feels proud of his or her new "dream car" which is admired by a neighbour.

Status concerns are usually associated with barriers to promote more sustainable transport options. However, they can also be levied to promote sustainable transport. A US study found that when status concerns were made salient, study participants were more likely to choose a (more expensive) hybrid car over a (cheaper but instrumentally superior) luxury car (Griskevicius, Tybur, & Van den Bergh, 2010). But this was only true when choices were made in public rather than anonymously (e.g., in a regular versus a virtual store). Other research has shown that bicyclists are often proud to be cyclists and being a “cyclist” can be an important part of who they are (Gatersleben & Haddad, 2010; Gatersleben & Appleton, 2007).

Identity is a theoretical concept which may help provide further insight into the symbolic aspects of cars. Identity can play a role in travel behaviours in different ways. First, travel choices can help develop and maintain different social role identities such as “a mother”. This can work in different ways. For instance, a good mother may be perceived to drive her children to school to keep them safe and dry. But “a good mother” may also be perceived to walk her children to school to give them exercise. A recent study showed that car use is significantly related to social identities such as driver, parent, and worker (Murtagh, Gatersleben, & Uzzell, 2012a). People hold multiple identities (Stryker, 1980) and can identify with more than one role at the same time. But different identities become salient at different points in time depending on the social and physical context. For instance, being a student or a professor is likely to be more salient at work whereas being a parent is more salient at a parents’ evening. In theory these social processes could be levered to promote more sustainable travel options. For instance, if “a good mother” is perceived to walk her children to school someone who sees herself as such but drives may be motivated to take up walking. However, this does require sufficient freedom and opportunity to change. Otherwise such threats to identity can also result into significant resistance to change (Murtagh, Gatersleben, & Uzzell, 2012b).

Identity can also be related to travel behaviours through attachment to the car itself. For some people a car can become an extension of the self. They may identify with their car and spend a lot of time caring for and personalising their car. Their car may be an important place to be; a place to feel safe and comfortable; a space to protect and care for. In this case a car can be perceived as a primary territory, like a home (Fraine, Smith, Zinkiewicz, Chapman, & Sheehan, 2007). Territoriality research has demonstrated that people tend to feel more in control, confident and comfortable in their primary than in other territories. Such advantages are often mentioned by people when they are interviewed about their car ownership and use (Gatersleben, 2007). Identification with one’s car is likely to form a significant barrier to the acceptability of changes to car use. However, this is rarely studied. There is some evidence that car drivers tend to be less willing to reduce their car use when they derive a sense of personal identity from driving (Stradling et al., 1999) and that identification with “being a driver” explains resistance to car reduction scenarios (Murtagh et al., 2012b) but the evidence is scarce.

Finally, different consumer identities may relate to travel in different ways. For instance, if you see yourself as a healthy consumer you may be more likely to walk or cycle, and a green consumer may be more likely to use more sustainable travel modes (Gatersleben & Steg, 2012). A green identity has been positively related to sustainable behaviour (Whitmarsh & O’Neill, 2010). But research in this area is relatively new and deserves further attention.

Individual differences exist in the relative importance of the symbolic value of cars. For instance, men may value symbolic outcomes more than women do

(Steg et al., 2001). Moreover, people with a stronger materialistic value orientation (who believe that acquiring wealth and material possessions will improve their wellbeing and status) are more likely to believe that they can impress others if they drive the right kind of car. In an empirical study it was found that those with a stronger materialistic value orientation expressed a greater desire to drive an expensive car for a day and less willingness to reduce their car use (Gatersleben, 2011).

To summarise, the symbolic value of cars can play an important role in motivating sustainable as well as unsustainable travel behaviours. However, the relative importance of these aspects may not be easy to determine as people do not spontaneously refer to them in surveys or interview studies.

The Affective Value of Cars

Driving can be stressful. Some research suggests that car users have a more stressful commute than train users (Wener & Evans, 2010). But, there is also evidence that the car commute can provide an important opportunity for people to relax and unwind (Gatersleben & Uzzell, 2007; Kluger, 1998; Mann & Abraham, 2006). On average, car use tends to be evaluated much more positively than public transport on affective aspects even by infrequent drivers (Jensen, 1999; Steg, 2005). But when affective appraisals of the commute of different mode users are compared, it appears that walkers and cyclists have more positive experiences than public transport users and drivers. Walking has been found to be particularly relaxing and cycling particularly exciting, whereas driving was mostly stressful and public transport use was mostly boring (Gatersleben & Uzzell, 2007).

Positive affective experiences are more significant for leisure than for commuter journeys. Anable and Gatersleben (2005) showed that instrumental aspects such as speed, convenience, predictability, and cost are most important for commuter journeys. For leisure journeys, affective aspects such as excitement, freedom, and relaxation are equally important, whereas predictability, for instance, appears much less important for leisure than for commuter journeys. Driving can even be a leisure activity in its own right. Many people take their car out for a spin or for a drive through the countryside without needing to travel to a specific destination. Mokhtarian and Salomon (2001) suggest it is important to further examine this positive utility of the driving activity on its own.

Feeling free and in control are some of the most often referred to positive emotions when people are interviewed about their car use (Hiscock et al., 2002; Lupton, 2002; Mann & Abraham, 2006; Steg, 2005; Stradling et al., 1999). For instance, Hiscock et al. suggest that "convenience provided respondents with feelings of control over their lives" and "unreliability [of public transport] meant people felt less in control of their lives" (Hiscock et al., p. 126). A sense of control is perceived as an important mediator of commuting stress (e.g., Evans, Wener, & Phillips, 2002).

Control is not only relevant for the car journey. Private cars also give their users control over the indoor environment. In qualitative studies car users often refer to being able to control undesirable social contacts, which is an important advantage of the car as compared to public transport (Hiscock et al., 2002; Lupton, 2002; Mann & Abraham, 2006). As mentioned earlier, Fraine et al. (2007) found that many participants talked about their car as a primary territory where they feel in control and safe.

Positive affective driving experiences are negatively related to willingness to adopt more sustainable travel behaviours and accept policy measures aimed at reducing car use (Nilsson & Küller, 2000; Stradling et al., 1999). On the other hand, some research suggests that anticipated affective outcomes can be positively related to sustainable travel choices. Feeling proud when adopting sustainable travel options, or feeling guilty when not adopting such behaviours, can be strongly related to intentions and behaviours (Wall et al., 2007). Affective attitudes can even be better predictors of behaviours and behavioural intentions than instrumental attitudes. For example, Carrus, Passafaro, and Bonnes (2008) showed that positive and negative affect explained a desire to use public transport over and above other factors such as subjective norms and perceived behavioural control. And one of the strongest correlates of cycling behaviour is the enjoyment of cycling (Gatersleben & Appleton, 2007).

In summary, car use is often perceived to be stressful but it also appears to elicit positive emotions in many car users and in many situations, particularly leisure journeys. These positive experiences may form important barriers for promoting changes to more sustainable travel behaviours, especially if people anticipate or have less positive affective experiences in more sustainable modes.

Conclusions

Driving a car can be stressful but it can also be thrilling, exiting, and provide a sense of control. Driving a beautiful car, a latest model or an eco-friendly car can make someone feel proud, whereas driving a clapped out old banger may make one feel embarrassed. Understanding the instrumental, symbolic, and affective aspects that influence car use motives is important in order to develop a better insight into when and why people do or do not drive and how they may be persuaded to adopt more sustainable travel behaviours.

Individual car use contributes to a range of social and environmental problems in today's societies. Promoting more sustainable travel is important to prevent escalation of travel-generated health, safety, energy, and pollution problems. However, this is not easy as many variables play a role in travel choices. When trying to reduce car use, it is important to consider the role of cars in modern societies, which for many may extend far beyond the simple utility function of a travel mode. For some, cars have strong symbolic value and most people tend to feel safe and secure in their car. Cars are private spaces where people feel at home. Such functions cannot be provided by any collective mode of travel.

The relative importance of instrumental, symbolic and affective aspects varies between situations and individuals. Having a pleasant journey may be more important for leisure journeys, whereas getting there quickly may be more important for commuter journeys. And driving the right type of car may be more important for some people in some social situations than for others. The perceived instrumental, symbolic, and affective value of cars can form important barriers for promoting more sustainable travel behaviours but can also help promote such behaviours. Bicyclists, for instance, often feel a strong sense of pride and ownership over their bicycles, and as bicycles are individual forms of travel, they share many of the advantages with cars such as flexibility and control (Gatersleben & Appleton, 2007). Moreover, if status concerns play an important role in choosing the right kind of car, under the right circumstances this can be a sustainable car (Griskevicius et al., 2010).

The instrumental, affective, and symbolic value of cars and driving are strongly related and are not easy to pull apart. A big car with a large engine size, for instance, is more likely to be comfortable and fast (instrumental) and is also more likely to be used as a symbol of status and success (symbolic) and elicit feelings of pride and thrill (affect) when it is being driven. Mann and Abraham (2006) suggest that individuals do not make clear distinctions between affective and instrumental aspects of the car. It is therefore not possible, at this moment, to draw clear causal conclusions about the relationship between the different aspects. Arguably, however, instrumental functions of the car are likely to form a basis for perceived symbolic functions and experienced affect. This clearly deserves further investigation.

Motivations are functions of both external factors and internal factors (Jakobsson, 2007). External factors (features of the car, infrastructure, availability of transportation, social norms) can influence the instrumental, affective and symbolic value of cars. But the relative importance of these factors for travel motives is also affected by internal factors such as individual preferences, identities, personal norms, and values. Exactly how each of the aspects influence motives and how they are formed needs further investigation.

Understanding the relative importance people attach to different aspects of car ownership and use is important to develop an in-depth understanding of car use motives. Although the value of cars, compared to other (more sustainable) modes of travel, is usually described in instrumental terms, this chapter showed that symbolic and affective aspects also play a significant role. If the final goal of transport policies is to promote more sustainable travel behaviours, it is important to take these aspects into account. This chapter suggests that instrumental, symbolic, and affective aspects can form significant barriers for change. However, such aspects can also be levered to promote more sustainable travel behaviours. More research into the relative importance of the three different types of aspects, the relationships between them, and the effectiveness of interventions targeting the different aspects is needed in order to help develop more effective sustainable transport policies.

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Pricing Methods to Influence Car Use

Peter Bonsall and Luis Willumsen

Introduction

The use of taxes, charges, and subsidies to influence car use has obvious attractions. The idea that people are influenced by prices chimes with common sense and has a clear theoretical basis in economics. Furthermore, the use of taxes and charges to influence behaviour has the additional advantage that it can be self-funding or even yield a useful revenue stream to governments. However, we will argue that the use of prices to influence car use can also be surprisingly difficult.

Governments of countries with free market economies do not have total control over prices and may find that their attempts to increase the price of car use relative to that of competing modes are frustrated by market forces. For example, recent decades have seen the price of owning and running a car decline due to falling costs of production and increasing engine efficiency while the costs of public transport provision have been increasing due, among other things, to increased costs of labour and the "vicious spiral" of falling demand.

It is sometimes argued that the prices which emerge from the operation of market forces are, almost by definition, economically efficient and therefore to be welcomed. The current authors suggest that this argument is flawed because it fails to recognise that the market for transport is not structured to reflect the true costs of car use, including all social and environmental externalities.

P. Bonsall (✉)
The Institute for Transport Studies, University of Leeds,
Leeds LS2 9JT, UK
e-mail: p.w.bonsall@its.leeds.ac.uk

L. Willumsen
Department of Civil, Environmental and Geomatic Engineering,
University College of London, London, UK
e-mail: luis@luiswillumsen.com

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Mobility provides many benefits, but it also incurs significant costs that are not perceived by the traveller; examples include the pollution, accidents, and congestion forced on other drivers. These externalities distort the market and result in overconsumption of the under-priced resources. The problem is compounded because transport is co-produced by consumers (who buy vehicles and fuel, shoes, make travel decisions, and select locations for their activities), businesses (that provide parking, operate transportation services, and develop land) and governments (that supply and regulate roads, parking facilities, walkways, and land use development). Fragmentation of production, with each contributor having different pricing structures and objectives, significantly complicates the evolution of prices. Almost inevitably, the provision and use of transportation systems become distorted in ways that result in economically inefficient mobility and wasted resources.

Free market economists tend to think that social welfare (human satisfaction and happiness) can be maximised through market operations provided that all goods are correctly priced, consumers are fully-informed and unconstrained in their choices, and public policies refrain from interfering with the workings of the market (Gómez-Ibáñez, Tye, & Winston, 1999; Litman, 2011). The efficient pricing of all goods requires knowledge of the cost of externalities and a mechanism to pass them on to end users. The creation of a fully-informed unconstrained consumer requires investment in information dissemination and the removal of barriers to the provision of goods and services (such as sustainable travel modes including walking and cycling). The requirement that public policy should refrain from distorting the market is more contentious because, taken literally, it would prevent governments from intervening to favour a particular travel mode (e.g. by subsidising its infrastructure or by giving priority to cars over pedestrians or vice versa) even if the intervention was actually designed to correct a market failure (as when a tax is imposed in order to reflect some otherwise un-priced externality).

Efficient pricing may result in significantly increased costs to the user of some travel modes and demand for them may fall. This is a natural consequence of the need to ensure that society avoids devoting $X worth of resources to produce services users value at less than $X. If roads and parking facilities are not rationed by price, they will be rationed by congestion. Travellers dislike both pricing and congestion but pricing is more efficient because it allows higher-value travel to outbid lower-value travel, and provides revenue that has alternative uses whereas time wasted in congestion has little value.

Optimal pricing requires consideration of equity as well as of efficiency and must not ignore transaction costs (the costs of designing, implementing, enforcing, and responding to a pricing regime). Transaction costs may be a significant component of any kind of pricing; *theoretical* optimal pricing tends to ignore transaction costs while *functional* optimal pricing includes them.

There is an issue as to whether prices should reflect the marginal costs imposed by the marginal user – so called Short-Run Marginal Cost Pricing (SRMC) or whether users as a group should bear all costs, which requires pricing based on Long-Run Average Costs (LRAC). Interested readers can pursue this issue in the literature (see, e.g., Roth, 1996).

Efficient Pricing Is Difficult to Achieve

Externalities of Car Use

An externality occurs when the production of a good or service causes costs or benefits to a third party. For example, air travel services generate noise and air pollution which impacts on people living near airports and under flight paths, not to mention the emissions of greenhouse gases (GHG) in the upper atmosphere. Similarly, each additional vehicle on a crowded road imposes a quantum of delay on all the following vehicles and also adds to the sum of noise and pollution being produced.

Transport networks and services generate both positive and negative externalities on users and non-users. The ability to provide emergency services, increases in land value and agglomeration benefits are often mentioned as positive externalities of transport. The negative externalities are wide-ranging and include environmental impacts like local air pollution, GHG emissions, noise and light pollution, safety hazards, community severance, and congestion.

The basic issue is that road users do not perceive the true costs of their journeys; they only perceive direct costs and charges (fuel, tolls, parking) and the decisions they make are therefore sub-optimal. Poor travel choices are fostered when the marginal private costs perceived by drivers are significantly less than the marginal social costs incurred to society. In order to optimise traveller's behaviour, it is necessary to expose them to the true (social) marginal costs of every section of their journeys – but calculating these costs, informing the potential travellers of the resulting price in a timely manner, and imposing the charge in a cost-effective manner all represent a considerable challenge.

The calculation of long-run marginal or even average costs requires knowledge about future use of transport facilities (e.g. how many vehicles of what type will be used on which roads particular times of day) and of relevant costs (e.g. future price of fuel, materials, maintenance). Moreover, an accurate allocation and charging of these prices implies significant transaction costs that limit optimality.

History and Politics – The Right of Free Access

Despite its many attractions efficient pricing is difficult to achieve and governments have seldom sought to do so in the transport field. Part of the difficulty, as discussed above, is technical but the main one is political.

Although the principle of charging for the use of roads to finance their construction and maintenance is long established, people tend to assume that free access to roads is part of their fundamental rights of movement and so object to any attempt to introduce charges for their use. The Turnpike Trusts, originally set up in 1706 in the UK, led to serious outbreaks of rioting in which toll-gates were destroyed – largely because the population objected to paying tolls for travel on roads which had previously been free. Nevertheless, the Turnpike Trusts were a success, and the money raised was used to finance the building of new and better roads such that, between 1,750 and 1,800, the average journey from London to Edinburgh was reduced from 12 to 4 days.

The introduction and enforcement of charges for parking in urban areas has also often led to protests from motorists. It is now well established that the successful introduction of such charges requires extensive consultation and fair enforcement. Only a few brave politicians have risked tolling existing roads in urban areas.

The fear of pricing has led some politicians to favour a road-space rationing strategy to manage congestion. We refer to schemes which restrict access to central areas to vehicles whose number plate ends on particular digits selected on rotation during the working week. In cities where air pollution is a significant risk (e.g. Mexico City, Santiago, Bogotá), the number of digits banned on any one day may depend on forecasted air quality. With good enforcement this approach is initially successful in reducing traffic congestion. However, there is evidence that some high-income residents buy additional vehicles with the appropriate number plates to overcome this restriction. The scheme could be seen as a pricing scheme by proxy – or alternatively a rather iniquitous and inefficient one from which no funds are collected for public use.

The Perception of Costs and Prices

The successful use of prices to support a more sustainable set of travel choices requires not just that prices should be at an appropriate level but that they are perceived and understood by travellers when making their choices. It is not enough that a price is established to cover the relevant costs; it is also essential that this price signal is known and perceived directly by the user at the time when the decision to use a facility is being made.

Car users are already subject to several pricing signals relating to the costs of running their cars and meeting the legal requirements to keep a car on the road. Some of these costs are very difficult to estimate and keep in mind when car users make decisions. This is partly because very few people have a complete and accurate idea of the marginal cost of running their vehicles. Even in the case of the most direct running cost, fuel, most people have little idea of the cost per unit distance or how this varies with traffic conditions. Some on-board information systems can provide drivers with a continuous readout on fuel consumption expressed in terms of the amount of fuel used or even in terms of the cost of that fuel, but research suggests that few drivers bother to monitor this. Car usage also affects maintenance costs but these are generally seen simply as occasional charges required to keep the vehicle roadworthy and their conversion into costs per unit distance is rarely attempted. Depreciation, annual road tax, and insurance are also only vaguely associated with distance travelled. The task of computing these costs and associating them correctly to different segments of a car journey is complex and most drivers see little reason to make the effort.

We must conclude that car-running costs are seldom fully perceived at the time of deciding whether to take the car or an alternative. Out-of-pocket costs like tolls or parking charges are more directly perceived but even they are often unknown at the time that the decision to use a particular mode or route is being made. The increasing use of electronic means of payment tends to further separate the act of consumption from that of payment and is likely to erode the perception of the charges.

Information technology offers the possibility of delivering the required information at the appropriate time but, unless it can deliver the information with minimum effort on the part of the traveller, it is by no means certain that people would make use of it.

The full cost of making a car journey includes several items which are generally covered by taxation collected independently of car use. Thus the cost of provision and maintenance of infrastructure, signage, traffic control, lighting, and policing as well as of the medical services required following accidents or as a result of pollution are rarely linked to car use in the mind of drivers.

The time taken to complete a journey is an important part of its overall cost. The value of time expended is perceived differently depending on the activity (or absence of it) undertaken during travel. Driving under stressful conditions (stop-go because of traffic lights, overtaking on two-way roads, queuing, and simply congestion) is perceived as more onerous than driving on uncongested, grade separated, and uncongested dual carriageways. In the same vein, walking and waiting time are perceived as more "costly" than in-vehicle time.

Turning finally to the perception of externalities it is clear that, without a very clear signal as to their value, travellers will have little idea of their magnitude and no means of taking them into account in a "rational" manner. Even if they are vaguely aware that they are contributing to costs that will be borne by society, they have no way of judging the extent to which they ought to change their behaviour.

But even if the cost of externalities were passed on to those who cause them and even if travellers had access to all the relevant information about the full cost of all the relevant alternatives, it would be naïve to assume that they would seek to take them fully into account and so select the most cost effective course of behaviour. The notion of a rational *Homo Economicus* who carefully weighs the characteristics of all alternatives and chooses that which maximises their personal utility is only a useful assumption to make the mathematics and models tractable. Real people have limited willingness and ability to consider the full range of costs and alternatives. They consider only a manageable sub-set of options and use simple heuristics to compare and choose among them. In fact this kind of decision making is rational in another sense; the sheer effort that would be involved in an attempt to gather and process all the relevant information would be a significant burden which might well be greater than any likely benefit that could accrue from making the "right decision". A simpler decision process might not be perfect but it is likely to be much more fit for purpose.

It is well established that real decision makers do not process price information dispassionately. For example, they tend to be influenced by assumedly correct prices (even if they are not the same as the actual prices), to put more weight on perceived losses than on equivalent perceived gains, to be more averse to making a needlessly expensive choice than they are keen to make a cheapest one, to have an emotional reaction to perceived risks and uncertainties and to be heavily influenced by the way that choices and prices are presented. For all these reasons their responses to pricing information can be difficult to predict.

Interestingly enough, those intending to sell cars have been very effective in exploiting these aspects of human behaviour by attaching positive emotional traits to their products with images of freedom, individuality, adventure, and even sexual attraction. Very considerable resources have been spent spreading these ideas so that a car is not just a mobility product but a positive lifestyle choice that "defines" the modern urbanite.

Examples of Use of Pricing to Promote Sustainable Travel

We conclude that socially optimal pricing taking full account of all relevant externalities is often politically difficult to pursue, technically difficult to achieve, and expensive to implement. We have also noted that car users already face a set of prices that is only partially known and understood, often not perceived by people at the time of making decisions, and that their responses to complex prices are difficult to predict.

Nevertheless, the following policy tools have been developed which use pricing to influence car use and it is useful to review their effectiveness: (a) car ownership taxes, (b) fuel tax, (c) parking charges, (d) tolls (inter-urban and urban), (e) congestion or road user charges, and (f) pay-as-you-drive insurance. Not all of these are equally good at influencing behaviour but it is worth focussing on two aspects of each one. First, how effective is it at correcting distortions and omissions at the location and time when the decision to use the car on a particular route is taken. Second, how efficient it is as a means of collecting funds (i.e. the level of transaction costs), which is not a minor consideration because transaction costs introduce an additional element that can outweigh the benefits of deploying a particular pricing mechanism.

Car Ownership Taxes

General taxation can be collected efficiently but has a minimal impact on travel behaviour. Taxation of vehicle ownership through purchase taxes or an annual charge may have some impact on vehicle acquisition. Most countries impose some form of annual charge on car owners. There is usually a notion that the revenue generated will be used to provide and maintain road infrastructure but the link is often rather tenuous. Although some countries levy a fixed charge irrespective of the size of vehicle, many have a sliding scale with larger vehicles attracting a higher charge. Several countries base the charge on the engine size or on its emissions. For example, in 2012 the UK's highest rated vehicles attract a first year registration fee of £1,030 and an annual charge of £475 while the lowest (those with emissions below 100 CO_2 g/km) attract no charge at all. These scales were introduced with the expressed intention that they would influence people to purchase vehicles with lower emissions.

A number of countries have sought to use very high purchase taxes or annual charges to limit the number of cars owned. Singapore has three decades of experience with a transportation policy based on balanced development of road and transit infrastructure and restraint of traffic. In addition to its taxes on vehicle ownership, Singapore requires each vehicle to have a Certificate of Entitlement (COE) before it can be driven on the road. Instituted in 1990, the COE is designed to limit car ownership and hence the number of vehicles on the country's roads. The COE allows holders to own a car for a period of 10 years, after which they must scrap or export their car with financial incentives or bid for another COE at the prevailing rate. The price of the COE is fixed through a bidding process which is manipulated to ensure that the growth in the total car fleet in Singapore is restricted. During 2012 the COE for a car with an engine of less than 1,600 cc is around £24,000 – more expensive than the car itself! Singapore's use of vehicle ownership taxes and the COE have succeeded in restraining growth in its car fleet to a relatively modest 3 % per year (May, 2004) but this type of car ownership restraint clearly raises issues of equity and may only be feasible under special geographical conditions.

Purchase taxes, annual ownership taxes, and other annual charges can ensure that revenue from vehicle ownership and use covers the costs of providing (and maintaining) roads and their complementary services but, crucially, they are not related to car use and are simply perceived as part of the unavoidable cost of owning a car. Perversely, the introduction of high charges on vehicle ownership may actually encourage vehicle use because, given the large sunk costs of car ownership, the marginal cost of using it is perceived as low and the incentive to get maximum use out of the asset is increased.

In order to provide a simple and obvious incentive to reduce vehicle use it would be beneficial to replace fixed annual taxes and charges by charges which reflect the distance travelled by the vehicle during the year. This might be achieved by, for example, using an audited record of the odometer reading to calculate a refund on the charges paid in full at the start of the year. No such scheme yet exists but the current authors would recommend its serious consideration.

Fuel Taxes

Fuel tax is a very efficient way of collecting revenue for the state because the costs of collection are low and largely borne by fuel retailers rather than the government. It has an obvious potential influence on car use because it increases operating costs.

There is a wide international variation in respect of the level of taxation levied on vehicle fuel. In general terms in most European countries more than half of the final price of fuel reflects a tax component (including VAT); in contrast, in countries like Australia, the USA and Mexico the tax component is much smaller, see for example the website of the Australian Institute of Petroleum that keeps an up to date record of fuel taxation in OECD countries (http://www.aip.com.au/pricing/internationalprices.htm).

Given its potential impact on behaviour and low cost of collection, it has often been suggested that fuel taxes should be increased such that it replaces some or all of the annual taxes discussed above and perhaps also the costs of third party insurance. The argument being that, without adding to the net costs of the average motorist, the annual taxes could be more effectively targeted at vehicle use. The fact that fuel consumption is high in congested conditions and that high emitting vehicles tend to consume more fuel, adds further justification for this approach.

However, despite its attractions as a means of raising revenue while influencing behaviour, fuel tax is a very visible tax and governments have generally been reluctant to increase it as far as might be warranted. Attempts to raise fuel taxes have, in numerous countries, led to public protest and, not uncommonly, to a government climb down.

Fuel tax is a rather blunt instrument in that it cannot be used to target vehicle use at specific locations or times of day. A large increase in fuel tax would result in over-high costs for motoring on empty roads. Also, it may be that the potential benefits of fuel taxation are now being eroded by the introduction of electric-powered vehicles (it being impossible to tax the electricity used in cars at a level required to influence vehicle use without seriously distorting the pricing of domestic electricity).

Parking Charges

Cars spend most of their life stationary in parking spaces and car use is not possible without parking. Provision of parking facilities is a significant cost to society; not only do the spaces consume valuable urban land but on-street parking may cause delay to moving vehicles and accident risk to pedestrians. It is not surprising; therefore, that parking policy has sought to limit the availability of parking spaces in city centres and to price them accordingly.

Two approaches to pricing parking can be identified: Parking management and mobility management (Shoup, 2005). In the first case one seeks to price parking such that space is used most efficiently. For example, if prices at the most convenient spaces are increased, it is likely that they will become available to users whose trips are of the greatest value. The general strategy should be to price parking so that some 10–15 % of the spaces are always available for the high-value user requiring them. This reduces parking search time and the associated congestion.

Parking policy can contribute to a mobility management strategy by seeking to charge or tax private non-residential parking such that average parking charges are higher than the price of a return journey by public transport. Charging a premium for all-day parking can similarly help to influence the timing of trips. Its effectiveness in influencing behaviour is increased if payment is clearly associated with usage of the facility – implying that, although cheaper to administer, the use of weekly or monthly charges should be discouraged.

Transaction costs for parking pricing are relatively low, particularly if enforcement costs can be funded from fines, and generally leave a significant positive balance to the authorities. Drivers' response to parking charges varies depending upon the availability of alternatives. The price elasticity of demand for vehicle travel with respect to parking charge is generally thought to be in the range −0.1 to −0.4 (Feeney, 1989; Pratt, 1999).

Despite its attractions, parking pricing is not a very efficient way to price externalities because it only covers the static part of car use and is in a very limited way related to the movement part of the journey. Parking charges in an area may serve to manage car trips ending there but does nothing to charge through-traffic and therefore has limited impact on routing behaviour. It should also be noted that the introduction of parking charges in just one area may simply divert traffic to other areas (Hensher & King, 2001).

Tolled Facilities and Road User Charges

As noted earlier, there is widespread public objection to the introduction of tolls on existing roads. There is much less objection to the provision of new tolled facilities and so toll road concessions have become a very common mechanism by which to fund investment in new roads. A network of toll roads was introduced in the UK in the eighteenth century and, although the UK toll roads have long since been nationalised, extensive networks of toll roads have been developed in recent decades in the US, Canada, France, Spain, Italy, and Australia. Some emerging countries have also adopted the tolling of roads as means to provide much needed good quality infrastructure. Mexico, Brazil, Argentina, and Chile have developed extensive systems of toll roads, whilst South Africa, Indonesia, and China are developing their own.

One of the differences between a toll road and an un-tolled one is the need to provide facilities to collect money from users.[1] This incurs an additional cost to facilitate transactions and traditionally resulted in large, expensive congestion-generating toll plazas at intervals along the new road. In order to reduce delays

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[1] Although Britain and Portugal have made extensive use of shadow tolls, where the payment is made not by the user but by the government (on the basis of audited counts of traffic using the facility), this is contrary to the objectives of efficient pricing to influence behaviour as it makes no difference to the costs borne by the driver.

and toll-collection costs, automatic toll collection lanes were introduced, accepting coins, pre-paid tokens/cards, and normal credit/debit cards. The use of accounts linked to an electronic tag or a vehicle number plate read automatically from a video image has further speeded up tolling transactions and reduces their costs.

After the introduction of Open Road or Free-Flow Electronic Toll Collection (ETC) on Highway 407 in Toronto, a new range of payment methods became practical for tolling roads. Implementations followed in Melbourne, Santiago, and Israel as well as an alternative fast lane in other roads, for example in Puerto Rico. Open Road (OR) ETC offers important advantages to toll road operators but it is particularly attractive for implementation in urban areas where there is no space for toll plazas. Moreover, OR-ETC generates no delays and reduces emissions as it permits non-stop operations – a very attractive proposition in congested and polluted urban areas. However, the use of ETC creates a separation in time between use and payment, which weakens its effectiveness as an influencer of travel behaviour.

The availability of non-stop payment technologies has facilitated another variant of priced road-space: The managed lanes known as *HOT lanes*,[2] which are available free to high occupancy vehicles (usually cars with two or more passengers) and to any vehicle paying a toll. The lanes are segregated from the rest of the traffic on a motorway and a key feature of many of them is that their pricing is dynamic and usually set to ensure free-flowing conditions in the priced lanes; this type of pricing is usually referred to as "value pricing" (Small & Yan, 2001) because the drivers paying benefit from a guaranteed level of service. The availability of an adjacent free, but usually congested, set of lanes makes this approach more acceptable to drivers, but it means that congestion externalities are not charged to all the drivers who generate them.

Rome and Milan have introduced road-user charges within their central areas. The Rome scheme ("Zona Traffico Limitato") was introduced in 2001 and involved designating an area to which vehicles would only have access on payment of a daily fee or purchase of an annual licence. The charge for non-residents was set at 20 Euro per day (or 550 Euro per year) for a private car. Charges for residents were set much lower. The system involved a set of "gates" around the zone, some of which employed automatic number plate recognition technology while others were electronic or relied on police control. Different parts of the zone were active for different periods (some permanent, some through the working day, some during the morning peak only, some only at night). The scheme apparently resulted in a 20 % reduction in traffic levels during the hours of operation with a particular reduction in the use of private car and an increase in pedestrian traffic (CURACAO, 2009). The Milan scheme ("Ecopass") involved restricting access to the city centre to vehicles for which a pass had been purchased. The annual cost of the pass varied from zero to 250 Euros (or 10 Euros per day) depending on the emissions category of the vehicle. According to CURACAO, introduction of the scheme along with

[2] "HOT" refers to High Occupancy Toll.

other environmental measures in 2007 resulted in a 14 % reduction in traffic within the area and a 6 % increase in public transport patronage.

The Rome charging scheme may sound complex because of its use of a range of different technologies and the different charging periods in different parts of the charging zone. Some of the urban ETC roads also have complex pricing schemes. The urban toll roads in Santiago de Chile, for example, have three levels of charging per kilometre depending on time of day, direction of movement, and speed, as measured over a longer period. This is a semi-dynamic approach to value pricing and is similar to the criteria used in Singapore's congestion charge (see below). The prices are displayed on relevant websites (see for example http://www.costaneranorte.cl/tarifas.html) and on many of the gantries where the transactions are recorded. The use of a complex pricing structure is theoretically sound but, if it becomes too difficult for the driver to predict the charge in advance of their decision to use the road, its efficiency as a means of influencing travel behaviour is severely undermined. Research into responses to complex pricing structures (e.g. Bonsall, Shires, Matthews, Maule, & Beale, 2007) has suggested that, beyond a certain point, additional complexity causes the user to misperceive the price signal or to ignore it altogether.

A rather different approach to the collection of tolls has been to equip the vehicle with a device which records distance driven on certain types of road or at certain times of day and then issues an appropriate charge. This approach is most associated with heavy goods vehicles whose tachograph records, perhaps assisted by GPS records, provide a means of calculating the appropriate charge. Such a system has particular attractions when the "tolls" are to be charged over an extensive network (e.g. on all roads in a particular country) or the targeted vehicles are few in number (e.g. all heavy-goods vehicles or all foreign-registered vehicles) because it requires less tolling infrastructure. There is no reason in principle why this approach could not be used to charge for road use by private cars.

Congestion Charging

The economic theory underpinning congestion charging was first put forward by Pigou (the father of welfare economics) in 1920, with Walters (1961) relating it specifically to road traffic. The underlying notion is that, since each additional vehicle in the network causes delay to other traffic, some method should be devised to ensure that that additional vehicle pays a charge which reflects the costs that it imposes. If the charge dissuades them from travelling, then this is an indication that travel would have been of less value than the costs which it would have imposed. If the charge does not dissuade them from travelling than it is assumed that the benefit to the traveller exceeds the charge – and the revenue can be used to benefit those who suffer from the delay caused.

The specific case for congestion charging was first made over 40 years ago in the Smeed Report (1964) in the UK. The report observed that the then general structure of motoring taxation, dating from 1909, comprised a fixed element (the annual Road Tax) unrelated to road use and a variable element related to use through the Fuel Tax. The report pointed out that this structure did not reflect the real costs generated when someone undertakes a journey, and was particularly oblivious to costs imposed on others. Since then, transport economists have increasingly advocated the adoption of congestion charging provided it is targeted to the location and time when excessive delays take place.

Singapore was the first country to adopt congestion charging. Its Area Pricing Scheme, introduced in 1975, comprised a cordon which vehicles could cross during the morning peak only if they displayed a pre-purchased paper licence. The immediate impact was a significant reduction in peak period car traffic and congestion and an increase in public transport patronage – a review by Holland and Watson (1978) reported that 22 % of drivers retimed their journeys to avoid the charge, 17 % switched to car sharing, and 19 % switched to bus. In 1998 the paper-based system was replaced by a better targeted electronic one which uses a combination of cordon and hotspot charging. In addition to the cordon around the city centre, additional charging gantries were introduced at congestion points. The level of the charges at each gantry is reviewed every 3 months and is set so as to bring the speeds back to a target level; if speeds are below 45 km/h on expressways (20 km/h on other roads) the charges are raised but if speeds exceed 65 km/h on expressways (30 km/h on other roads) they are reduced. The charges are displayed prominently at each gantry and on a website. Menon (2000) reports that the introduction of electronic road pricing brought about a further 15 % reduction in traffic levels and that there is considerable sensitivity to the timing of the different charge levels.

In 1986 the city of Bergen in Norway introduced a flat rate to enter the central business district from 0600 to 2200 Monday to Friday. Oslo, Stavanger, Trondheim, and other cities introduced similar systems – although Trondheim's scheme differed from the others in that the charges were differentiated by time of day. These schemes had relatively little impact on traffic levels – although Trondheim's did reduce peak period traffic by 17 % (CURACAO, 2009); their justification was rather that they allowed the collection of revenue for further investment in the transportation system.

Despite these early examples, two main considerations delayed implementation of congestion charging elsewhere. The first is the concern about its possible regressive nature: The rich will pay and benefit from faster travel whilst the poor will have to use inferior modes of travel. The second objection, perhaps more politically worrisome, is that voters will find congestion charging an unacceptable form of taxation. Two experiences have demonstrated that in the right conditions these objections can be overcome: The implementation of the London and Stockholm congestion charging schemes in the first decade of this century.

The introduction of the London scheme in 2003 represented a major breakthrough both technically and politically, and has been hailed as a first successful implementation in a European city. The London scheme involves charging a daily fee to drivers who wish to drive in the defined area between 0700 and 1800 on weekdays. Payment of the charge entitles the user to drive as much as they wish within the area on that day and so provides no incentive to avoid the busiest locations or times of day. The charge was initially set at £5 with a 90 % discount for residents of the charged area but, even at this low level, it was very effective in changing behaviour: there was a 30 % reduction in congestion, most of which was attributed to a shift to public transport or to diversion around the charge area.[3] This degree of change was at the higher end of expectations – a fact which may be explained by two effects. First, the introduction of the congestion charge was a major change in conditions that made travellers re-consider their options more seriously than small incremental changes had done. Second, the lack of familiarity with the different methods of payment initially available created an additional transaction cost for users (the inconvenience of paying). Both effects lost their importance over time and it was necessary to increase the charge to retain the congestion reduction benefits.[4] Another notable feature of the London scheme is that it has coincided with improvements in public transport and the introduction of the Oystercard – a smartcard which offers an attractive alternative to cash fares.

The Stockholm implementation was technically more advanced than London's and followed an interesting pattern of public consultation. The scheme was first introduced "experimentally" for 7 months during 2006 and was then switched off to allow users to decide whether they wanted to keep it or not. Residents marginally voted to keep the system so it was re-introduced in August 2007 with minor improvements. Under the Stockholm scheme, users pay when crossing a cordon around the city centre. Pricing is variable with time of day; it is free from 1830 to 0630 the following day and the ranges from about 1.05 and 2.10 € depending on time of the day. The charge is significantly lower than London's and is more directly related to use (for further details, see Börjesson, Eliasson, Hugosson, & Brundell-Freij, 2012). The headline results of the Stockholm scheme are a 22 % reduction in traffic crossing the cordon during the charge period and a 6 % increase in use of public transport.

The success of congestion charging in London and Stockholm is well documented and includes significant changes in travel behaviour, routing, and travel mode choice which have resulted in reductions in traffic and in delays. Tables 1 and 2 summarise some of the key results.

It is interesting to note that the London scheme appears to require a higher charge to achieve its impacts than is required in Singapore or Stockholm. This may be related to the fact that the latter two cities have time-varying charges which are

[3] According to Transport for London (2004), the vehicle kilometres (vehicles being defined as having four or more wheels) in the charging zone during charging hours had fallen by 15 % during the first year while the number of vehicles entering the charging zone during charging hours fell by 18 %. It was calculated that most of this reduction could be attributed to a switch to public transport or to diversion around the cordon, with very little being attributed to trips having been cancelled or made to a different destination.

[4] The charge was increased to £8 in 2005, and the size of the charge zone was significantly increased in 2007. As of August 2012, the daily fee is between £12 and £9 depending on the form of payment.

Table 1 Changes in traffic entering central London charging zone (Transport for London, 2008)

	2003 vs 2002 (%)	2007 vs 2002 (%)
All vehicles	−14	−16
Four or more wheels	−18	−21
Cars	−33	−36
Vans	−11	−13
Lorries	−10	−5
Licensed taxis	17	7
Buses and coaches	23	31
Powered two wheelers	13	−3
Pedal cycles	20	66

Table 2 Changes in traffic flows in Stockholm between spring 2005 (pre-charging) and spring 2006 (shortly after introduction of charges) (Stockholmsförsöket, 2006)

Locale	Morning peak (0700–0900)	Evening peak (1600–1800)	Charge period (0630–1830)	Full 24 h
Congestion charging zone (Entering/exiting)	−16 %	−24 %	−22 %	−19 %
Major inner city streets	−7 %	−10 %	−10 %	−7 %
Minor inner city streets	−8 %	−13 %	−10 %	−8 %

displayed on prominent gantries, whereas London has a fixed charge and the only information provided on street is a sign stating that you are entering the charge area. Another difference between London and the other two cities is that the London schemes has much higher operational costs because there are many more collection points and a heavy reliance on video tolling rather than tags.

Other, more sophisticated forms of congestion charging have been proposed. For example, it would be possible to use the tracking data available from on-board navigation systems, and even from the latest generation of mobile phones, to introduce a dynamic charging regime which charges an individual motorist according to their location within the network at a given time or even to reflect whether they are currently within congested conditions.[5] A further degree of sophistication could ensure that the motorist is alerted to the potential charge before they reach a decision point in the network. But, despite their potential attractions, no such system has yet left the drawing board.

Many cities besides Singapore, London, and Stockholm have considered introducing congestion charging. Recent examples include New York and Edinburgh but, for a number of reasons, mostly political, implementation has been abandoned or at least postponed. Study of these failures has highlighted the importance of developing a sound and comprehensive consultation and communication strategy prior to implementation (Menaz, Matthews, & Nash, 2004).

[5] A system which used the fact that a vehicle was moving slowly as an indicator that it was in congested conditions excited interest some years ago until it became clear that it was likely to increase accident risks because drivers would try to avoid slowing down at intersections and pedestrian crossings in case they were charged for wilfully travelling in congested conditions.

Pay-As-You-Drive Insurance

Most governments require drivers to have some form of third party insurance before they are allowed to drive on the public road. The premiums are generally in the form of annual payments which reflect an assessment of the risk of the driver (or car) being involved in an accident or other claim. Knowledge that a claim may lead to higher premiums in subsequent years may have some effect on driver behaviour but the annual premium provides the driver with no incentive to drive less.

Under Pay-As-You-Drive (PAYD) insurance, which is being offered to motorists in an increasing number of OECD countries, the insurance premium is calculated dynamically and reflects the distance driven and, depending on the technology adopted, may also take account of the times at which the driving occurs, the type of roads used, and even the driving style adopted (the most sophisticated systems could allow the premiums to reflect the amount of speeding, excessive braking, driving for long periods without a break, and so on). Such systems obviously provide an incentive to the driver to drive safely and to reduce the overall distance driven.

The potential social benefits of this type of insurance may warrant government approval or assistance but it should be recognised that, although the interests of government and insurance companies may be similar in respect to safety, they will diverge in respect of other externalities. For example, insurance companies may wish to discourage night-time driving and so may charge higher premiums for driving at night, whereas network managers might wish to encourage drivers to use the excess capacity available at night time in preference to busy roads during peak periods.

Discussion and Conclusions

Although consumers are influenced by prices, and although pricing may appear to be a relatively simple tool with which to influence behaviour, there are limits to the extent that governments can influence car use through pricing alone. Because of its co-produced nature, with some of the most significant costs borne by the public sector, none of the conditions for efficient pricing is met and transport is characterised by extremely inefficient pricing markets. Many of the most important costs are fixed and therefore unaffected by potential changes in behaviour. Externalities, in particular congestion and emissions, are not priced and therefore generally ignored by the traveller.

A number of pricing mechanisms can be used to partially correct these distortions and omissions, but none of them is perfect and all suffer from the fact that the complexity of an “ideal” pricing regime is likely to result in confusion or apathy on the part of the road user. Although some methods, notably the congestion charging schemes in Singapore, London, and Stockholm have achieved significant behavioural change with consequential improvements in efficiency and equity, there are technical and political barriers to their wider implementation. It is not sufficient to devise the appropriate price correction; it is necessary to link it directly to use and to ensure the user perceives the new price in full and at the time when a change in behaviour is possible. Modern technology can assisting with the calculation of appropriate prices and their timely display to users but some new forms of payment create a separation in time between use and payment which dulls the effect of the price signal.

A deeper understanding of human behaviour must be part of the chosen pricing strategy. The way in which measures, alternatives and prices are framed have an influence on behavioural change that marketers have learnt to refine in their use. The ethical application of this understanding should help to define a more behaviourally effective pricing approach.

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Social Marketing in Travel Demand Management

John Thøgersen

Introduction

The growing car traffic worldwide is not sustainable, creating both global and local environmental problems. Countries, regions, and municipalities all over the world therefore search for and experiment with ways to reduce car traffic (European Environment Agency [EEA], 2012). The Travel Demand Management (TDM) toolbox contains both "hard" measures, such as economic penalties and infrastructure changes that favours non-motorized travel (Pucher, Dill, & Handy, 2010), and "soft" measures, such as the marketing techniques discussed in this chapter and various information-based measures (Richter, Friman, & Gärling, 2010, 2011). "Harder" measures are generally viewed as more effective, but they also tend to be met with widespread and persistent political and public resistance (Gärling & Loukopoulos, 2007; Schuitema, Steg, & Rothengatter, 2010). This is an important reason why TDM researchers and, particularly, practitioners are searching for effective techniques for inducing voluntary behaviour change (e.g., Brög, Erl, Ker, Ryle, & Wall, 2009; Gärling & Friman, 2012; Möser & Bamberg, 2008). In this chapter, examples of skillfully implemented marketing interventions are reviewed, some of which have shown quite impressive results in terms of reducing car use and shifting travellers to other travel modes, particularly when combined with "hard" measures (Brög et al., 2009; Pucher et al., 2010).

Attempts to reduce car use are usually motivated by social goals, such as reducing congestion and the emission of greenhouse gases (GHG), which means that marketing campaigns in this area can be classified as social marketing. Below the social marketing concept is defined and how social marketing techniques have

J. Thøgersen (✉)
Department of Business Administration, School of Business and Social Sciences,
Aarhus University, Bartholins Allé 10 – bld. 1327, 8000 Aarhus C, Denmark
e-mail: jbt@asb.dk

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been used in TDM is briefly summarized. Next, three specific applications of social marketing in this area are described. Finally, perspectives and limitations of this approach are discussed.

What Is Social Marketing?

Marketing techniques have been used to promote public transport services for a long time (Deka, 1996). Experiences from these commercial applications can be useful also in a TDM context, but here the perspective extends what is commercially profitable. When marketing is used to promote social objectives, rather than for private ends, it is called *social marketing* (e.g., Andreasen, 1994; Donovan & Henley, 2010; Kotler & Zaltman, 1971; McKenzie-Mohr, Schultz, Kotler, & Lee, 2012).

Kotler and Zaltman (1971) introduced the social marketing concept. Currently, the main application areas for social marketing are health, safety, the environment, and community involvement (Donovan & Henley, 2010; McKenzie-Mohr et al., 2012). Social marketing programmes have also been applied to travel mode choice (see below) and to a variety of other transportation-related behaviours, such as preventing drunken driving and speeding and promoting the use of seat belts (e.g., Hastings, Stead, & Webb, 2004). Social marketing belongs to the "soft" policy measures of intervention, together with, for example, communication and education (Bamberg, Fujii, Friman, & Gärling, 2011; Möser & Bamberg, 2008; Richter et al., 2010, 2011). However, social marketing differs from other "soft" measures as the ultimate goal is always to influence behaviour, not only people's knowledge or attitudes (Andreasen, 1991, 1994).

Social marketing principles and techniques have been tested in a large number of empirical studies, many of which have been published in widely circulated international journals, including *Journal of Marketing*, *European Journal of Marketing*, *Social Marketing Quarterly*, *Journal of Social Marketing*, and *Journal of Public Policy and Marketing*. In spite of this, and in spite of the publication of widely cited conceptual papers (e.g., Andreasen, 1993, 1994; Kotler & Zaltman, 1971) and book-length treatments of social marketing (e.g., Andreasen, 1995; Donovan & Henley, 2010; Kotler & Lee, 2008; McKenzie-Mohr et al., 2012), what constitutes a social marketing approach to social change is still in dispute (Andreasen, 2006; Lefebvre, 2011).

Andreasen (1994, p. 110) proposed the following widely cited definition of social marketing: "Social marketing is the adaptation of commercial marketing technologies to programmes designed to influence the voluntary behaviour of target audiences to improve their welfare and that of the society of which they are part." Like other influential definitions of social marketing (e.g., the one proposed by Kotler & Zaltman, 1971), this one emphasizes that social marketing is more than advertising or communication. Communication is needed in social marketing campaigns in order to create or increase awareness about a (new) social idea and perhaps even to persuade people to accept it, but the bottom line of marketing programmes is to change behaviour, and awareness or attitudes do not always transform into behaviour. The idea that people can be persuaded by communication alone to accept a behaviour that conflicts with their own felt needs and wants is rejected as futile by social marketers. Instead, social marketers are concerned with designing solutions to the targeted social problem (i.e., “products”) that are perceived as desirable and gratifying by their potential adopters. They are also concerned with providing convenient distribution channels and offering solutions that are generally characterized by a favourable balance between perceived costs and benefits. Market research is used to ascertain the needs, wants, and perceived barriers of those targeted by the programme and to monitor and evaluate their satisfaction and the needs for adjustments after implementing the programme.

Traditionally, social marketing has been limited to voluntary behaviour change, as expressed in Andreasen’s definition cited above. However, in recent years prominent social marketing researchers have begun extending social marketing beyond voluntary behaviour change (Andreasen, 2006; Donovan & Henley, 2010). Acknowledging that the context is often a stronger determinant of peoples’ choices than their own motivation, Andreasen and others have proposed that a traditional “downstream” approach, targeting individual actors, need to be supplemented by interventions “upstream,” targeting possible constraints and facilitators shaping people’s behaviour.

“Upstream” approaches are, of course, well known in transportation where they are often referred to as “hard” measures (Richter et al., 2011), including changes in infrastructure that are “forced upon” travellers, such as road closures, car-free zones, bike lanes, and usually less coercive pricing measures (Gärling & Loukopoulos, 2007). When social marketing moves upstream, it means developing and implementing campaigns targeting policy makers, community leaders, the media, or others with power to determine important contextual determinants of peoples’ behaviour (Andreasen, 2006). The development of upstream social marketing is still in its infancy and there is a lack of reported upstream social marketing campaigns related to TDM. Hence, the following discussion is limited to research on the use of social marketing for influencing voluntary changes in travel mode choice.

How a social marketing programme should be designed in order to maximize the chances of success in terms of voluntary behaviour change depends on the targeted behaviour. Andreasen (1991) suggests that three characteristics or dimensions are particularly important when assessing behaviour in this context: (1) The involvement of the actor (low-high), (2) whether it is an one-short or continuing behaviour, and (3) whether it is performed by individuals or groups. For instance, a social marketing campaign with the purpose of reducing harms produced by car traffic may focus on persuading people to buy a more energy efficient car (e.g., Gallagher & Muehlegger, 2008; Kurani & Turrentine, 2002). In this case it would target a high-involvement decision made infrequently by individuals (or individual families). Although most people would undoubtedly like their car to be energy efficient, buying one can be impeded by lack of knowledge and understanding of what makes a car energy efficient, which cars are energy efficient or the advantages of having an energy efficient car. Actually buying one may also be impeded by a higher price, lower capacity for carrying passengers and luggage, less comfort and safety, and a less powerful engine (e.g., Gärling & Thøgersen, 2001; Kurani & Turrentine, 2002). In order to change behaviour successfully, the social marketing campaign needs to target important impediments, be they misperceptions or real disadvantages of the promoted behaviour.

Other social marketing campaigns may aim to persuade car users to increase their use of alternative travel modes for commuting, such as walking, cycling, or public transport (Brög et al., 2009). Such campaigns would target a continuing behaviour performed by large groups of people every day, but usually on an individual basis, and normally with little involvement in the choice of travel mode (unless something interferes with their chosen mode). Changing continuing behaviour involves breaking old habits, learning new ones, and freezing the new pattern of behaviour, which is often more difficult than changing a one-shot action (e.g., Møller & Thøgersen, 2008; Verplanken, Aarts, & Van Knippenberg, 1997; Verplanken, Aarts, Van Knippenberg, & Van Knippenberg, 1994). Low involvement means that people are usually not interested in information about the issue, although it may help them to make better choices (Aarts, Verplanken, & Van Knippenberg, 1997; Verplanken et al., 1997). Particularly the disinterest in information reduces the effectiveness of mass communication. Hence, a special effort is needed to create sufficient situational involvement to make targeted commuters receptive to information about alternative travel modes and willing to try alternatives. Further, mechanisms that enable and make it convenient for people to translate their motivation into action are particularly important for changing this type of behaviour (e.g., Andreasen, 1991; Thøgersen, 1997).

As already indicated, social marketing campaigns purporting to reduce the harms from car traffic may target different behaviours. One suggested approach is de-marketing of the car, that is to attempt to reduce the car's attractiveness (Wright & Egan, 2000). Another approach would be to promote alternatives to travelling, for example, stay home and watch TV instead of going to the theatre or teleworking instead of commuting (e.g., Gärling, 2005; Møller-Jensen, Jensen-Butler, Madsen, Millard, & Schmidt, 2008). However, the most common approach – and probably also the most feasible in most cases – is to promote alternative modes of travel. Below, I focus especially on the latter approach.

Review of Social Marketing Applications

The last couple of decades have witnessed an increasing number and a wide variety of applications of social marketing principles in TDM. In some cases, a social marketing programme has been designed to promote a specific alternative to single occupancy car-driving, such as ridesharing or carpooling (e.g., Chan & Shaheen, 2011; Glazer, Koval, & Gerard, 1986; Kearney & De Young, 1996; Smith &

Beroldo, 2002), cycling (for a comprehensive review, see Pucher et al., 2010), or public transport (e.g., Bachman & Katzev, 1982; see also Deka, 1996; Enoch & Potter, 2002; Stradling, 2002). In other, more ambitious cases the goal has been to match available alternatives (individual travel modes or a combination) to the individual driver's needs (e.g., Brög et al., 2009; Lohmann-Hansen, Lahrmann, & Madsen, 2001). Often, special events are organized – or the campaign is linked to one – in order to create public interest and situational involvement (e.g., Rose, Marfurt, & Harbutt, 2003; Thayer, 1992). Events may be planned (e.g., a bike-to-work week) or unplanned but foreseen (e.g., smog alert days), and they may be one shot (e.g., marking the end of a period with sub-standard service, for instance due to the renovation of a railway line) or recurrent (e.g., a yearly car-free day). In order to create public interest, event-based social marketing may rely mostly on a single marketing parameter, usually a special offer (e.g., Tetraplan, 2004), or the campaigners may create a package of propositions for broader appeal, often including a strong social element (Rose et al., 2003).

Below, three cases are described in some detail. The cases are chosen to illustrate the breadth of social marketing campaigns in TDM. The effects of each campaign are reasonably well documented and publicly available.

Case 1: Individualized Marketing

The "individualized marketing" approach was developed by the German consultant company Socialdata GmbH (Brög et al., 2009). After preliminary tests in the early 1990s in Kassel and Nuremberg, Germany, followed by an international demonstration project consisting of 45 local projects in 13 European countries, the first large-scale application of this approach was carried out in South Perth, Australia, in 1997 (the 'TravelSmart' campaign).

The approach is marketing oriented as it is based on a thorough customer survey aiming at uncovering the reasons for an individual's travel mode choice for every trip, awareness of alternatives, and perceptions of barriers that prevent the individual from choosing alternative modes of travel. Another marketing-oriented characteristic is that the "customer base" is segmented, and different segments are targeted differently. Further, the approach utilizes a number of techniques from the marketing toolbox, notably personal communication and sales promotion (in the form of a free "sample"), in addition to information material. An important limitation of the approach is, however, that it focuses on promoting existing solutions only. It contains no element of "product development" where the marketer is open to the possible need for new solutions that are adapted to customer needs and wants. In this respect, it is sales, rather than marketing oriented (Andreasen, 1991; Donovan & Henley, 2010).

A unique feature of the "individualized marketing" approach is that it includes an attempt to reach *all* households in the targeted area with direct and personal communication. Contacted households, who are willing to participate, are segmented based on behaviour (use of various travel modes), interest (in the promoted travel modes), and knowledge. No further resources (except for a small gift to participants) are wasted on those not interested or those already using alternative travel modes to the car and having sufficient knowledge about such alternatives. Those already using alternative travel modes, but expressing a need for further information, receive the required information. Those *not* using alternative travel modes, but being interested in doing so, receive requested information and are offered a home visit by a specialized advisor regarding the use of public transport, bicycling or walking. If relevant, they also receive a free "test ticket" for a month so that they can familiarize themselves with public transport in the area.

In the South Perth case, 40 % of contacted households fell in the "not using, but interested" category.[1] About 10 % of these (i.e., 4 % of contacted households) received a home visit by Perth bus staff offering advise about public transport as well as free tickets, and 42 % (i.e., 17 % of contacted households) received home visits by an advisor regarding cycling or walking. Eight per cent of contacted households received personalized timetables to public transport and about 40 % received packages of more general information about alternative travel modes. Based on all residents in the area (not only the participants) the programme achieved a 14 % reduction of car-as-driver trips, with the total number of trips remaining constant. Car-as-passenger trips (i.e., car-sharing) increased by 9 %, public transport by 17 %, cycling by 61 %, and walking by 35 %. Moreover, these changes were still sustained more than 2 years after the programme ended. The programme has since been extended to over 400,000 residents in the Perth area, achieving a reduction of car trips by 11 % overall (Brög et al., 2009).

The "individualized marketing" approach is obviously not cheap. However, based on the South Perth pilot study, it was calculated that the individualized marketing approach had a cost-benefit ratio of 1:13 (James, 2002). Hence, there is reason to believe that it may be well worth the costs, also in other contexts.

By now, the "individualized marketing" approach has been applied in more than 100 pilot and nearly 150 large-scale projects, targeting a total of more than three million people on three continents (Brög et al., 2009). Reported short-term results of these other applications are similar to those reported from South Perth, although they vary substantively between countries and applications. Long-term results, 5 years after the campaign, have been reported for one other application, in the Swedish city of Dalvik, and also these are similar to what was achieved in South Perth (Socialdata Sverige, 2002, reported in Brög et al.).

[1] The presentation of the South Perth case is based on Brög et al. (2009), Brög, Erl and Mense (2005), James (2002), and the web site of Department of Transport, Western Australia, retrieved from http://www.transport.wa.gov.au/activetransport/24605.asp

Case 2: The Nottingham Cycle-Friendly Employers' Project [2]

The Nottingham Cycle-Friendly Employers' (NCFE) project was one of the major projects implemented in the late 1990s as part of the UK Department of Transport's Cycle Challenge project.[3] Although comparatively ambitious, the project shares elements and experiences with a large number of other projects aimed at promoting cycling, especially for commuting to work. Although it was not conceptualized as such, the NCFE project contains many of the defining characteristics of a social marketing campaign.

The NCFE project commenced in 1996 and was scheduled to run for 2 years (but both the implementation and the evaluation took longer than envisaged). Its objective was to increase cycling for commutes and official work trips. Eight large employers in the Greater Nottingham area were involved as project partners, four of which were institutions of higher education. Between them, they employed over 32,000 people, and if students were included the numbers using the sites increased to around 77,000. The project was partly financed by a grant from the UK Department of Transport.

The project was essentially a (social) marketing campaign as important "offers" provided as part of the project were based on consultations with potential "customers" – that is, employees of the project partners – about their needs, wants, and barriers, using a combination of travel surveys, e-mails, and discussion groups. However, not all project partners planned such consultations from the outset, which was pointed out in the campaign evaluation as a major source of delays (Cleary & McClintock, 2000). The campaign combined a number of means, including substantive changes in facilities for cyclists, publicity and information material, promotional events, and social interventions.

According to interviewed cyclists, the most important substantive changes were improved workplace showering and changing facilities for cyclists and secure cycle parking. The publicity and information material endorsed environmental and health benefits of cycling as well as the usefulness and appropriateness of this means of transport for local journeys. Among the promotional events were bike-to-work days and bikers' breakfasts. The promotional events functioned both as means for catching attention and as social events. Most of the participating employers also organized Bicycle User Groups, that is groups of enthusiastic cycling employees, which were viewed both as a means of social influence and a source of advice and feedback about the programme.

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[2] This summary of the Nottingham Cycle-Friendly Employers' (NCFE) project is based on Cleary and McClintock (2000) and Department for Transport, Local Government and the Regions (2001).

[3] Another, more recent Cycle Challenge case from Southampton, UK, is reported at www.toolsofchange.com/en/case-studies/detail/654

As concluded by Cleary and McClintock (2000, p. 122), it is "not altogether clear cut . . . [which] . . . precise number of new cycle commuters was generated directly as a result of the project." Cleary Hughes Associates was contracted to evaluate the project in 1999 by means of a questionnaire survey, which was sent to samples of cyclist and non-cyclist commuters at each of the partner employers. Below, the most important results from the survey are summarized (Department for Transport, Local Government and the Regions, 2001), with the reservation that behavioural self-reports, and especially retrospective ones, may not be reliable. Self-reports about awareness and opinions are much less error-prone.

- 42 % of cyclists reported that they cycled to work more frequently after the NCFE project than before. Forty-nine percent cycled the same amount and 9 % less. Amongst those who said they cycled to work more frequently, 30 % said this was as a result of the new facilities, 30 % as a result of moving house or job and 30 % for health reasons.
- 67 % of cyclists were aware of the improved facilities that resulted from the NCFE project.
- Newsletters and promotional events were by far the most successful ways of spreading information about the improvements.
- 16 % of bicycle owners said that they used their bicycles for journeys at work (short official journeys), with 7 % doing so on a weekly basis.
- For cyclists, provision of showers and lockers was seen as the most important worksite improvement to encourage cycling by 46 % of respondents, followed by cycle parking (36 %) and financial incentives (10 %). For non-cyclists, cycle parking is most important for 36 % of respondents, followed by showers/lockers (29 %) and financial incentives (25 %).
- 32 % of non-cyclists would consider commuting by bicycle in the future. Of these, 38 % said that they did not cycle to work because of a lack of facilities.

Case 3: Zero Fare Svendborg Line Project

Occasionally, users of public transport experience periods of substandard service due to renovation or maintenance work. Delays, cancellations, and substitution of the regular travel mode with an inferior one (e.g., bus instead of train) inevitably lead to customer dissatisfaction, and some dissatisfied customers may change to private car. This was the situation facing the Danish Railways Company (DSB) runnimg the Svendborg-Odense line (Svendborg line for short) in late 2003 (Høberg, 2003). For months, a major modernization project had led to irregularities in the service and to the use of buses instead of trains on the line. Hence, DSB made an extra effort to promote the new and modernized Svendborg line. They decided to offer their customers a zero fare in the whole month of January 2004.

DSB management hoped that the free month would make customers feel compensated for the substandard service they had had to put up with the year before, and that lost customers in this way would be won back (Ellesøe & Flensburg, 2004). They also hoped that the initiative would attract much public attention, create interest and curiosity, and convince new customers to try the Svendborg line. Furthermore, they hoped that some of these new customers would continue using the line after the promotion period (Ritzau, 2004). All these expectations were borne out, according to a thorough evaluation of the campaign issued by the Danish Ministry of Transport and Energy (Tetraplan, 2004).

In addition to DSB's regular passenger counts, a questionnaire survey was carried out covering a random sample of about 2,500 passengers on the Svendborg line in the second half of January 2005, and those who gave their permission and their e-mail addresses were contacted again 2 months later for a re-interview. According to the passenger counts, the number of passengers on the Svendborg line in January 2004 (the free month) more than doubled compared with the months of January the previous 2 years. It was estimated that the number of new (i.e., "trial") users amounted to 8 % of the population in the region where the line is located. In February 2004, when the fare was back to normal, the number of passengers was 25 % higher than in February the year before and 15 % higher than 2 years before. It was estimated that about a third of the increase could be attributed to the free month while two thirds were due to improved service on the new and modernized Svendborg line. Eighteen per cent of the passengers in the free month said they would have taken the car had the train not been free. Consistent with this, the Danish Road Directorate registered a (small) decrease in the traffic on the Odense-Svendborg highway on Fridays to Sundays in the free month. Eighty per cent of those passengers only trying the line in the free month reported that they travelled to destinations serviced by the Svendborg line less than once a week. Hence, they used the line for an occasional journey or only out of curiosity. Still, offering these passengers a free trial is not necessarily a waste. Due to the experience, they may be more inclined to use the line regularly, should their circumstances change in the future. Generally, trial users were more satisfied with the service on the modernized Svendborg line than the regular users, indicating a positive trial experience.

DSB's communication to their customers about the issue was multiplied by good press coverage, in local as well as national media, and this is part of the reason for the high interest and trial created by the zero fare month. Due to the novelty and conspicuousness of the approach, the free month was seemingly perceived as newsworthy by the news media, as expected by DSB management.

The most important results from the re-interviews 2 months after the campaign, in March, are the following. The passengers in January who did not travel with the Svendborg line in March were mainly people who rarely travelled to the destinations served by the line. They travelled in January either because of the free fare or because of incidental circumstances. Generally, the 10 % of the re-interviewed who were new customers, using the line in March as well as in January, on average used the line less frequently than the regular users. The reason was partly that they used the line for less regular travel purposes, partly that they used the line for commuting to work less often than the regular customers. Hence, the new customers tended to use the train as a supplementary travel option, or they were still in a trial phase 2 months after starting using the line. However, it is a promising observation that, except with regard to the number of departures, new customers in general expressed greater satisfaction with the service than the regular users.

Because of the success of the zero fare campaign, DSB decided to repeat it on the modernized Grenaa-Aarhus line in May 2005, with the same short-term effect as on the Svendborg line in terms of the number of passengers in the free month (Plougsgaard, 2005).

Based on these positive experiences, the use of sales promotion in the form of a zero fare for a limited time to promote a new or improved product seems to have become a standard tool in Danish public transport companies' marketing toolbox. For example, in August 2011, Danish public transport company Sydtrafik offered a free 10-trips ticket to its customers in five local areas where the bus system had been substantially improved.[4] In December 2012, the Danish public transport company Midttrafik celebrated the integration of two local train lines by offering travellers a zero fare in the last three weekends before Christmas (Midttrafik, 2012).

Discussion of Case Study Findings

As illustrated by the three cases, social marketing can be an effective approach to voluntary behaviour change, also in the area of travel mode choice. The core distinguishing characteristic of this approach is its foundation in the conviction that fulfilling the target "customer's" needs and wants is a prerequisite. Hence, the collection of information about actual and potential customers' needs and wants is crucial for designing a successful marketing campaign. Usually, information is collected by means of market research, but as illustrated by the third case feedback from customers to front personnel or the customer services department is an additional, important source of information.

Social marketing differs from commercial marketing in several important ways. For instance, there are often fewer opportunities to modify offerings (Andreasen, 1991). This means that the possibilities of designing offerings that are desirable to target adopters can be severely restricted. It has hence been suggested that an important reason why fewer and fewer people use public transport is its low status and that the solution therefore is to develop public transport offerings that appeal to status-conscious commuters (e.g., Everett & Watson, 1987). Although there is substantial evidence backing the first proposition (e.g., Steg, Vlek, & Slotegraaf, 2001), there are obvious limits to how far one can go to remedy this without compromising (some of) the social goals that motivate the promotion of alternatives to car use (e.g., the need to reduce the emission of GHG).

[4] Retrieved from http://www.sydtrafik.dk/Default.aspx?ID=33&M=News&PID=613&NewsID=2405

This is not to say that it is impossible to make alternative travel modes more appealing within the given constraints. As demonstrated by campaigns such as the NCFE project, it is often possible to improve the balance between perceived costs and barriers for alternative travel modes. Sometimes the most important improvements may concern peripherals of the travel (e.g., lockers and shower facilities and safe cycle parking in the NCFE case) rather than the travel mode itself (Pucher et al., 2010).

Still, considering the restrictions that exist when it comes to developing more appealing, but still sustainable, travel options, it is a valuable lesson from the "individualized marketing" campaigns that it is at least sometimes possible to obtain substantial changes in the modal split away from the car, although the campaign is limited to promoting already existing alternatives only.

Another important lesson from the "individualized marketing" campaigns is that impressive results in terms of travel mode changes can be produced by combining a number of specific measures, none of which have proven particularly successful when applied individually. For instance, the general results from studies which have systematically evaluated the use of sales promotion in the form of a free month test ticket for public transport (e.g., Fujii & Kitamura, 2003; Thøgersen, 2009; Thøgersen & Møller, 2008) is that the use of public transport by car users increases when the free ticket is in effect, but that most of the effect disappears when they have to pay the normal fare again. Another element included in the "individualized marketing" approach, providing personalized timetables, has proven to be ineffective even in the short run when given alone to randomly assigned drivers (Østergaard & Schougaard, 1997; Thøgersen & Møller, 2008), and so have general appeals (Hutton & Ahtola, 1991) and information about the societal benefits from using alternative options (Staats, Wit, & Midden, 1996).

Especially two things distinguish campaigns based on the "individualized marketing" approach from these latter case study campaigns and tests. Firstly, the "individualized marketing" approach combines various means of influencing behaviour rather than relying on a single one. It is well documented that the combined effect of influence means, such as information and an economic incentive, can be much larger than the additive effect of the individual means (e.g., Stern, 1999). Secondly, the "individualized marketing" approach tailors the offering to the situation and wants of individual "customers." A major advantage of tailoring the offering is that it is much more cost effective to allocate (costly) incentives and customized information to households that actually need and want them. In addition, by tailoring the offering one reduces the risk of overloading targeted people in superfluous information.

As mentioned in the introduction, producing situational involvement – and the use of attention-catching techniques for this purpose – is a necessary component of a social marketing campaign targeting a low-involvement continuing behaviour, such as everyday travel mode choice. It is an important common property of the three cases described here that they all involved the application of special (but different) techniques for catching the audiences' attention. The "individualized marketing" approach uses direct communication to catch attention (Seethaler &

Rose, 2004). DSB's zero fare campaign relied on a conspicuous special offer, and the NCFE campaign organized special events such as bike-to-work weeks and bicyclers' breakfasts, among other things. The fact that everyday travel mode choice is collective behaviour means that there are often opportunities for organizing social events, which may be instrumental in catching attention, and which may, in addition, initiate and build on social dynamics to spread word of mouth that support and reinforce individuals' decision to use alternative travel modes (Rose & Marfurt, 2007).

Everyday travel mode choices are often made habitually and like other habitual choices they are usually reinforced by contextual factors (e.g., Thøgersen & Møller, 2008; Verplanken et al., 1994). Verplanken and Wood (2006) argue that the context dependency of habitual choice is not only a limitation, but also a source of opportunities. Specifically they suggest that changes of context, due to contextual factors, such as road closures, or personal, such as when people change residence or job, create opportunities to effectively influence transport habits. For example, Fujii, Gärling, and Kitamura (2001) found that a temporary highway closure was instrumental in breaking car-commuting habits in Osaka, Japan. Furthermore, Thøgersen (2012) found that also the effects of an intervention designed to break travel habits – a temporary price promotion in the form of a free month's travel pass – depended on context change. On average, the free travel pass made car users double their commuting by public transport, but the effect was limited to those that had changed residence or workplace within the last 3 months. Based on evidence such as this, Verplanken, Walker, Davis, and Jurasek (2008) and Verplanken and Wood (2006) suggest that a context change opens a "window of opportunity" for effectively influencing habitual transport behaviour by means of voluntary measures. Probably based more on intuition than on research, municipalities around the world, including State College[5] in Pennsylvania, USA, and Munich in Germany (Bamberg, 2006), already take advantage of such "windows". They entice new residents to try out local public transportation by including a free ticket or pass for the city's public transport in their welcome package.

Conclusions and Discussion

There is an abundance of evidence documenting the effectiveness of social marketing techniques in TDM. Social marketing campaigns in this area vary much in scope and in level of ambition. Successful social marketing is based on a thorough understanding of "customers" needs, wants, and perceived barriers, it uses a combination of means to create an attractive offering tailored to these needs,

[5] Retrieved from http://www.catabus.com/ServiceSchedules/CATABUS/Fares/AptPass/index.html

wants, and perceived barriers of individual segments of consumers, and it applies proven techniques for catching attention to the offerings.

Yet, there are limits to what social marketing can accomplish. There may be individuals or communities for whom private car use has a strong symbolic value and therefore the norms dictate that a private car is "the only proper travel mode for a decent person." Social marketing is not particularly well suited to change values and norms (Andreasen, 1991). Here, persuasive massmedia messages aimed at de-marketing the car may be required (perhaps for a long time) before it is meaningful to implement a campaign promoting alternatives. Also, social marketing is limited to cases where only perceived barriers prevent people from using alternative travel modes. A study in Germany found this to be the case for about 25 % of car trips (VDV & Socialdata, 1993; cited in Brög et al., 2009). For another quarter of car trips, there were constraints to using alternative modes, such as using the car for business purposes or to carry a heavy load, and for about a third of the trips using public transport would have required system improvements, such as the provision of an adequate bus connection or improved service frequencies. On this backcloth, and according to previous experiences, it is unlikely that even best-practice social marketing campaigns alone should be able to reduce car driving by more than at most 10–15 %. If larger reductions are desired, more fundamental structural changes are needed, either in the form of improvements for alternative travel modes or restrictions on or penalties for car driving (e.g., EEA, 2012; Frederick & Kenyon, 1991; Pucher et al., 2010). On the other hand, even such "hard" measures have limited impact on travel mode choice. For example, a study of nine cases of transport (rail) system improvements in Germany found an impact on the number of public transport trips per person per year of the same magnitude as that obtained by means of the individualized marketing approach (Brög et al.). In eight cases where system improvements and individualized marketing were combined, the impact in terms of the number of public transport trips per person per year was approximately equal to the sum of the impacts of the two types of interventions when each of them was used separately. Hence, when bigger changes are desired, "hard" and "soft" types of interventions may be beneficial to combine (Bamberg et al., 2011; EEA, 2012; Maibach, Steg, & Anable, 2009; Pucher et al., 2010).

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Psychological Contributions to the Development of Car Use Reduction Interventions

Sebastian Bamberg

Introduction

The problems associated with car use are receiving increasing recognition. Although the main focus is currently on carbon dioxide (CO_2) emissions, there are also other issues such as noise pollution, congestion and time loss, traffic accidents, and encroachment on land. Despite the fact that car companies are working on electric and fuel-cell powered cars, these problems cannot be solved by cleaner vehicle technology alone but only by reducing the total level of car use. As a consequence, urban areas in particular have seen a multitude of "soft" transport policy measures in recent years designed to motivate citizens to voluntarily reduce their everyday car use. Several narrative reviews of empirical evaluations of the behavioural effects of these types of intervention (Cairns et al., 2008; Richter, Friman, & Gärling, 2010, 2011) have concluded that such interventions are effective. Two meta-analyses (Fujii, Bamberg, Friman, & Gärling, 2009; Möser & Bamberg, 2008) quantitatively summarizing the results of these evaluation results also indicate significant effects of soft car-use reduction interventions. Still, the effect sizes are small ($d = 0.15$–0.17). One possible reason for this may be that most of the measures have been developed by marketing practitioners who base their intervention concepts more on commonsense arguments than on systematic insights gained from empirically validated behaviour theories (Richter et al., 2011). This runs counter to the conclusion drawn by academic intervention researchers (e.g., Bartholomew, Parcel, Kok, & Gottlieb, 2006) that the development of effective behaviour change interventions depends on the adoption of those theory-based change techniques that have been found to be effective in methodologically rigorous field trials. Such research can also clarify whether particular approaches are ineffective and should be abandoned.

S. Bamberg (✉)
Department of Psychology, University of Applied Science Bielefeld,
Kurt-Schumacher Str. 6, 33615 Bielefeld, Germany
e-mail: Sebastian.bamberg@fh-bielefeld.de

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The present chapter is motivated by the conviction that the transfer of knowledge from psychological research to marketing practice is a basic requirement for the future development of more effective, evidence-based soft car-use reduction interventions. The first part of this chapter summarizes insights gained within the last decades from psychological research on the central mechanisms underlying both the continuation and modification of behaviour. The focus is on the intra-psychic processes determining behavioural decisions. This does not exclude an emphasis on that the person and environment interact to determine behaviour and behaviour change (Lewin, 1951). From this perspective, intra-psychic processes are always influenced or even controlled by the environment in which the person is embedded.

The second part of the chapter presents a more detailed exploration of what kind of intervention types can be derived from the identified behavioural mechanisms. Consistent with the emphasis on a Person × Environment interaction, this review focuses on a distinction between "downstream" and "upstream" approaches to behaviour change (McKinlay, 1993; Verplanken & Wood, 2006). Downstream interventions focus on changing people's existing behaviours, that is directly changing the intra-psychic behavioural determinants. In contrast, upstream interventions focus on changing the environment in which the behaviours occur and promoting alternatives. Thus, whereas downstream interventions aim to alleviate existing negative behaviours, upstream interventions aim to prevent such behaviours in the first place.

Review of Relevant Theory and Research

An Intergrative Theory of Current Car Use

In the last three decades, psychology has made considerable progress toward understanding the intra-psychic determinants of car use. Much of this research has been guided by two contrasting theories. Whereas the Theory of Planned Behaviour (TPB, Ajzen, 1991) views car use and car-use reduction as the consequence of a choice aiming at maximizing personal benefits, the Norm Activation Model (NAM, Schwartz & Howard, 1981) views car-use reduction as a pro-social behaviour guided by the activation of a moral norm based on the insight that one is morally obliged to reduce personal car use. Table 1 presents the results of a meta-analysis conducted by Gardner and Abraham (2008) reporting pooled correlations between central TPB and NAM constructs and self-reported car driving obtained from 28 studies. These results confirm a significant association between the TPB constructs car-use intention, attitude, perceived behavioural control (PBC), and self-reported car use. However, the pooled correlation between subjective norm and car use is not significant. The meta-analysis also showed significant negative associations between a negative attitude towards car use, PBC, subjective norm, and car use. The same holds for the NAM constructs personal moral norm, problem awareness, and perceived responsibility of negative car-use consequences.

Table 1 Pooled correlations (r) between the TPB and NAM constructs and self-reported car use

	Car driving			
Determinant	*n*	*k*	*r*	95 % CI
Intention to use car	2,517	4	.53	[.35, .72]
Attitude to car use	569	4	.27	[.15, .70]
Attitude to noncar use	1,270	3	−.41	[−.48, −.38]
PBC over car use	324	2	.31	[.03, .65]
PBC over noncar use	2,334	2	−.51	[−.63, −.38]
Subjective norm for car use	555	3	−.07	[−.14, .01]
Subjective norm for noncar use	1,069	2	−.36	[−.45, −.27]
Personal moral norm for noncar use	563	2	−.41	[−.70, −.11]
Problem awareness	799	2	−.24	[−.33, −.15]
Perceived responsibility for car use problems	403	2	−.18	[−.50, −.13]

Note: k = number of pooled studies; n = pooled sample size; CI = confidence interval

These results indicate that constructs from both the TPB and the NAM should be viewed as important determinants of car use.

Bamberg, Hunecke and Blöhbaum (2007; see also Bamberg & Möser, 2007) proposed augmenting the TPB with personal moral norms from the NAM as another determinant of intention. Furthermore, because of the inconsistent findings on the direct association between intention and subjective norm, their integrative joint theory ascribes another role to subjective norm than that in the TPB. In line with research on informational social influence (e.g., Moscovici, 1985), it is posited that people follow social norms because these norms inform about "normal" behaviour. Thus, whereas personal norms provide information about whether a behaviour is morally right or wrong, social norms provide information about how this behaviour is perceived by a majority of others. Figure 1 presents the integrative theory together with the results of an empirical test in the domain of public-transport use (for details, see Bamberg et al., 2007). As postulated by the TPB, intention entirely mediates the impact of all other variables on actual public-transport use. Intention explains about 50 % of the variance in self-reported public-transport use at a 6-month follow-up. Even after controlling the impact of the TPB constructs attitude and PBC, the NAM construct personal norm remains a statistically significant and substantive third determinant of intention. Taken together, the three variables explain about 90 % of the variance in intention. As predicted, social norm is not associated directly with intention, but indirectly via its strong association with PBC, attitude, and personal norm. The hypothesis is supported that in the case of travel-mode choice, people use perceived social norms as an easily accessible information base for what is the best behavioural option in a given context.

A Stage Model of Self-Regulated Behaviour Change

The integrative theory is a structural model, that is its focus is on identifying important psychological determinants of car use as well as their structural

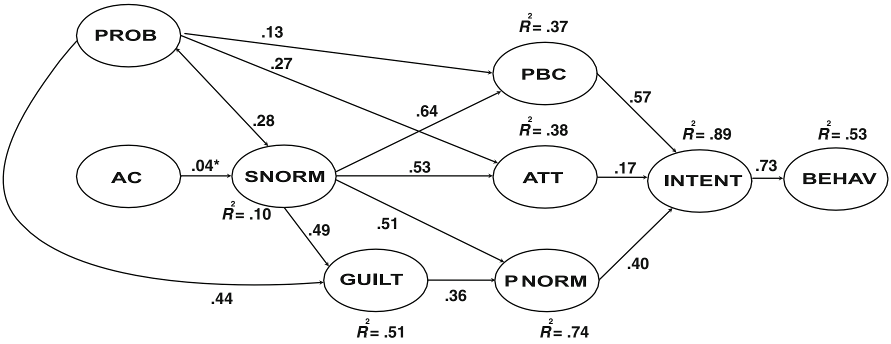

Fig. 1 Structural equation model (n = 517) with standardized path coefficients (all significant at $p < .05$ except one marked by *) and explained variance (R^2) supporting the integrative theory of car use (Bamberg et al., 2007) (Denotations are as follows: *Behav* actual public transportation use, *Intent* PT use intention, *Pnorm* personal norm, *Att* attitude, *PBC* perceived behavioural control, *Guilt* anticipated feelings of guilt, *Snorm* subjective norm, *Prob* General problem awareness, *AC* Awareness of negative consequences caused by own car use)

relationships. It does however not deal directly with the dynamic and temporal aspects of the behaviour change process. What motivates a person to critically re-evaluate her or his current car use? How does a car-use reduction goal develop? How is it transformed into a concrete behaviour change strategy? And how do individuals overcome the problems they encounter when trying to implement this new behavioural strategy?

In psychology the self-regulation approach is a theoretical perspective that deals explicitly with the dynamic, temporal aspects of behaviour change. Self-regulation research assumes that a person starts to think about change when information emerges indicating that important personal goals are not being met. Consequently, self-regulation is construed as a dynamic motivational system of setting goals, developing and enacting strategies to achieve these goals, appraising progress, and revising goals and strategies accordingly (Baumeister, 2005; De Ridder & De Wit, 2006). Stage models explicitly adopt the self-regulation perspective for studying behaviour change.

The Model of Action Phases (MAP) proposed by Heckhausen and Gollwitzer (1987; Gollwitzer, 1990) is a stage model. It stresses the deliberate, goal-directed nature of behaviour change. As a consequence, the MAP focuses on the course of action a person follows in order to successfully reach an intended goal. It assumes that this course of action can be broken down into four time-ordered, qualitatively different stages, each characterized by a specific task. In the first (pre-decisional) stage, a person's task is to deliberately reflect on competing wishes (e.g., the conflict between quick, comfortable and environmentally friendly travelling) and turn some of these into binding goals. The MAP assumes that this self-commitment results in a goal intention. A goal intention has the structure "I intend to reach goal *X*" where *X* relates to a certain personal goal to which a person feels committed (e.g. "I intend to reduce my car use for daily trips"). According to Heckhausen and

Gollwitzer, a person forms a goal intention by weighting the desirability and feasibility of competing goals. Simultaneously, the formation of a goal intention marks the transition into the second (pre-actional) stage. Because several actions could normally be used as a means to achieve the intended goal (e.g., public transport, cycling or walking instead of the car), the task in this second stage is to select the most suitable behavioural strategy to achieve the desired goal. The deliberate weighing of the pros and cons of alternative possible behavioural strategies should result in a behavioural intention reflecting a person's self-commitment to one of these behavioural strategies. A behavioural intention has the structure "I intend to perform behavioural option *Y*" (e.g., "I intend to use public transport instead of the car for daily trips") and marks the transition point from the pre-actional to the third (actional) stage. In the actional stage, a person's task is to enact the chosen behavioural strategy, that is to initiate and implement the necessary actions. If the performance of a new behaviour is intended, this requires deliberate preparation and planning. Gollwitzer (1999) assumes that the enactment of the intended new behaviour is facilitated by forming an implementation intention having the structure "If I encounter situation *S*, then I shall perform behaviour *Y*" (e.g., "Tomorrow morning at 7:30, I shall go to the bus stop Friedrichstrasse and take bus number 8 to Berliner Platz"). The formation of an implementation intention should create a strong mental link between a specific future situation and the initiation of the intended new behaviour. Once this critical situation is actually encountered, the actions specified in the implementation intention would be initiated automatically. The formation of an implementation intention marks the transition from the actional stage to the fourth (post-actional) stage. In this stage, a person's task is to evaluate what she or he has achieved and decide whether further action is necessary. This is done by comparing desired to actually achieved outcomes. A second important task in this stage consists in controlling temptation, that is preventing a relapse into the old behaviour.

Whereas the MAP provides strong claims for why and how to differentiate stages of the behaviour change process, it makes only general statements about social-cognitive and affective factors or processes promoting stage transition. For this reason, Bamberg (2012, 2013) proposed a further development of the MAP into the Stage Model of Self-Regulated Behaviour Change (SSBC). The SSBC integrates theoretical constructs derived from the NAM as predictors of the goal intention and constructs derived from the TPB as predictors of the behavioural intention. Currently, there is little empirically supported knowledge about social cognitive and affective factors/processes promoting the formation of an implementation intention. A few years ago, Schwarzer (2008) proposed viewing coping and action planning as factors promoting the formation of an implementation intention. Coping planning refers to the ability to imagine scenarios that may hinder the performance of an intended behaviour and to develop one or more plans to cope with such a challenging situation (e.g., "If I plan to use the bicycle on Sunday but the weather does not permit it, I shall use public transport instead"). Action planning refers to the specific situation parameters ("when," "where") and a sequence of action ("how"). Schwarzer assumes that a person's confidence in

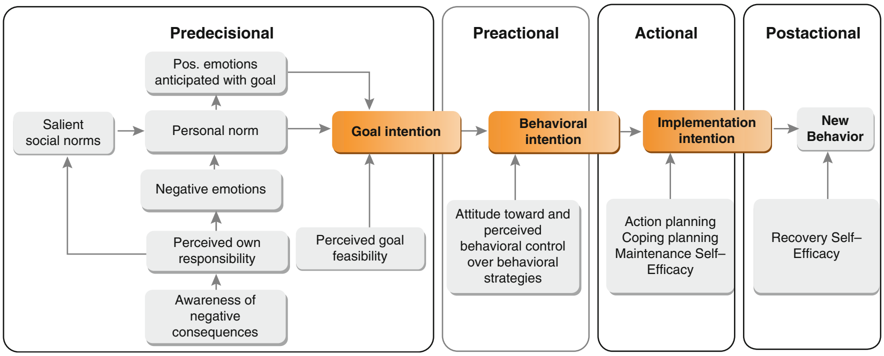

Fig. 2 The Stage Model of Self-Regulated Behavioural Change (SSBC, Bamberg, 2012, 2013)

being capable of maintaining a difficult behaviour (so-called coping self-efficacy) may also impact on the formation of an implementation intention. He further assumes that in the post-actional stage, a person's confidence in being capable of resuming a difficult behaviour after a relapse (so-called recovery self-efficacy) may increase the maintenance of the implemented new behaviour. Figure 2 presents the SSBC framework with the four stage-specific sets of social-cognitive constructs assumed to contribute to the formation of the following three critical transition points: goal intention, behavioural intention, and implementation intention.

The Role of Habits

Typical for all the above-mentioned models is the assumption that travel-mode choice is the result of a deliberate intention or decision. However, when people go shopping in a nearby supermarket, do they really consider several travel-mode options before deciding which one to use? It seems plausible to assume that travel-mode choice frequently is habitual, especially when the same travel mode has been made repeatedly to reach the same goal (e.g., Aarts, Verplanken, & Van Knippenberg, 1997; Verplanken & Moonen, 1998). Aarts and Dijksterhuis (2000a, 2000b) propose viewing habits as a strong mental link between goals (e.g., going to the supermarket) and actions (e.g., using a bike) that are instrumental in obtaining these goals. The goal–action associations develop as a result of frequent and consistent choices made to attain a certain goal (e.g., always use a bike to go to the supermarket). Because of these associations, the habitual choice or action is activated automatically when the relevant goal is activated. In concrete terms, activation of the goal to go to the supermarket leads automatically to activation of the associated action, that is to use the bicycle. From this point of view, habits could be conceived of as a type of goal-directed behaviour that is activated or primed automatically by environmental cues.

Aarts and Dijksterhuis (2000a) tested this idea in the realm of travel behaviour. In their experiment, they employed a response latency paradigm to demonstrate that habitual bicycle users respond faster to the cue "bicycle" after priming the goal of travelling to a certain destination. Thus, habitual and non-habitual bicycle users were primed unobtrusively with the goal of travelling to the university or not. A subsequent reaction time task measured the accessibility of the concept of bicycle. Results showed that the travel goal facilitated access to the concept of bicycle, but only for those persons who used a bicycle regularly for this trip, thus suggesting that in these persons cycling was activated automatically by the goal of travelling to the university.

Whereas the question of whether goal pursuit can be instigated automatically by external primes seems to be settled, the current challenge is to figure out how to get from an activated cognitive goal structure to motivated behaviour. According to Aarts, Custers, and Veltkamp (2008), the best candidate for a mechanism that would determine the value of a primed goal outside conscious awareness is one that relies on affective processes. It is known that affect plays a fundamental role in motivating human action and is evoked quite quickly without reaching conscious awareness. If the experiences with an object or behaviour are rewarding, the representation of that object or behaviour is associated mentally with positive affect, and this leads to the formation of an implicit attitude towards it (e.g., Olsen & Fazio, 2006). Implicit attitudes are the positive or negative thoughts or feelings towards objects that arise due to past experiences of which one is either unaware or unable to attribute to an identified previous experience. This representation of affect is activated as a consequence of priming a goal and leads to the motivational approach-avoidance orientation represented by the activation of a corresponding behavioural schema.

Habits Versus Conscious Intentions

The automaticity of habit prevents alternative actions. There are several reasons for this (Neal, Wood, & Quinn, 2006). First, given that habits are cued directly by the environment without conscious decision making, the practised response is likely to be available more immediately than thoughtfully generated alternatives. When multiple response options are available, the speed of automatically activated responses gives them precedence over responses generated through slower routes. Second, habits require minimal regulatory control. Habitual performance places few demands on people's limited capacities for self-control (Baumeister, Muraven, & Tice, 2000), whereas greater capacity is required to suppress habits and carry out alternative behaviours that require conscious guidance and deliberation. For these reasons, habits take precedence over more thoughtful actions. The availability and efficiency of habits is a challenge to any decisions to change established behaviour.

Illustrating the potency of travel habits, Verplanken and Van Knippenberg (1997) assessed the travel-mode choice of residents of a small Dutch village. Participants kept a diary for 1 week in which they recorded their choice of travel mode for all trips outside the village. The village was connected to two nearby towns by both a highway and efficient public transport systems (i.e., bus and train). Frequency of car use, calculated as the proportion of trips made by car during the week, was predicted from the strength of participants' car-use habits and their reported intentions to use the car. Findings showed that for residents with weak or moderate habits, more favourable intentions generated greater use of the car, whereas for those with strong habits, intentions were essentially unrelated to car use.

The interpretation of the findings that habits are performed without intention has important implications for behaviour change. Interventions that successfully promote the formation of a car-use reduction intention do not necessarily influence actual car use. Webb and Sheeran's (2006) meta-analysis provides striking evidence in support of this idea. They reviewed previous experiments that had given people persuasive messages or other information designed to change their intentions to perform various behaviours. If the interventions addressed actions that were not frequently performed, interventions that changed intentions also changed behaviour. However, if the interventions addressed behaviours that could be repeated sufficiently to form habits, interventions that changed intentions did not necessarily change behaviour. Thus, habits were not easily altered through interventions that altered intentions.

A Dual-System Perspective

The research discussed above provides strong evidence that environmental stimuli can subtly activate mental constructs that direct behaviour even when people are unaware of the source of activation. Thus, in the last decade researchers have struggled with the task of theoretically integrating this insight with the empirically also well supported models stressing the role of conscious intentions as behavioural determinants. Dual-system models (e.g., Smith & DeCoster, 2000) provide the currently most convincing solution to this problem. This section will sketch one prominent example of such a model, the Reflective-Impulsive Model (RIM, Strack & Deutsch, 2004), to illustrate central assumptions underlying dual-system models.

The RIM distinguishes between two separate but interacting systems that jointly guide behaviour: The impulsive system and the reflective system (Strack & Deutsch, 2004). The impulsive system consists of an associative store in which processes operate relatively quickly and impose few demands on resources such as cognitive capacity. Associations are believed to form as the outcome of learning experiences. In a specific situation, environmental and social cues activate affectively laden automatic associations that further guide attention and information processing. This leads to a largely automatic approach and avoidance tendencies toward the object that prepare the organism to execute related behavioural schemata. Thus, the impulsive system generates a quick and rough tendency for behaviour execution. In contrast, personal standards, attitudes or expectancies

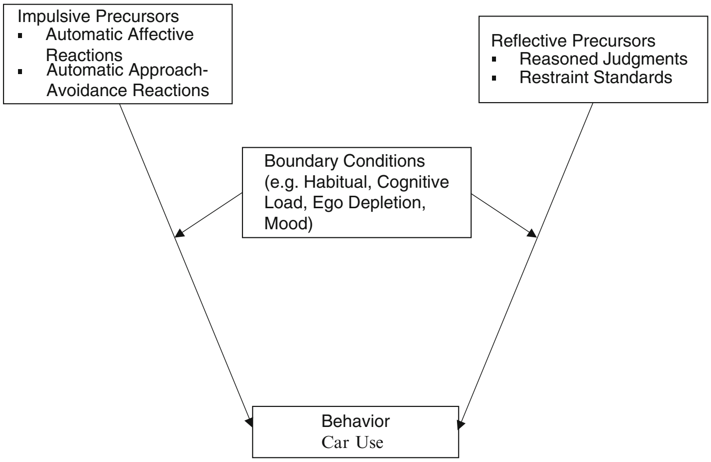

Fig. 3 A framework for the prediction of travel behaviour by impulsive versus reflective precursors and associated boundary conditions (moderators) (Adapted from Hofmann, Friese, & Wiers, 2008)

reside in the reflective system. This system weighs pros and cons to integrate information in order to arrive at short- or long-term plans for "reasoned action" and deliberate decision-making. These plans and decisions then activate proper behavioural schemata that compete with those provided by the impulsive system. Often, the behavioural schemata activated by the two systems will be compatible such that they facilitate behaviour execution. At times, however, the schemata will be incompatible. One important capacity of the reflective system is its ability to override the behavioural schemata activated by the impulsive system. This capacity is effortful and comes at a cost. To the extent that a person is unwilling or unable to invest the required effort, the behavioural schemata suggested by the impulsive system will be executed. Thus, the relative impact of the impulsive and the reflective systems on behaviour changes as a function of not only the strengths of the respective system's contents but also the motivation and ability to exert self-control. From this point of view, habits undermine a person's motivation to exert self-control. Consequently, impulses should better predict behaviour in participants whose behaviour has become strongly habitual over time (Conner, Perugini, O'Gorman, Ayres, & Prestwich, 2007). Alongside habit, situational factors such as cognitive overload, stress, or drinking alcohol that constrain motivation and ability to exert self-control should reduce the impact of the reflective system. As illustrated in Fig. 3, dual-system models posit that the predictive validity of behaviour models may be enhanced if such models include reflective and impulsive precursors, and if they specify situational and dispositional boundaries that may shift the weight toward one or the other type of precursor.

Summary

In the last decades, psychological research addressing the determinants of travel behaviour has been advanced through the application of theories such as TPB and NAM. One common element of these models is that behaviour is the result of cognitive processes of appraising the expectancy and value of different potential behavioural options. These appraisal processes should also form the basis for the decision to change current behaviour. Such decisions and the resulting goal-directed behaviour are typically seen as reasoned, conscious, and intentional acts that require volitional control or willpower in order to be effective. However, research on the habitual nature of travel behaviour provides strong evidence that alongside conscious intentions, travel behaviour is also influenced by automatic impulsive processes activated by situational cues without conscious awareness. Results further indicate that in the case of travel behaviours that are performed frequently in stable contexts, automatic processes may even override the impact of conscious intentions. By viewing behaviour as resulting from the interplay between impulsive and reflective processes and their boundary conditions, dual-system models such as the RIM provide a promising approach to integrate reflective and impulsive processes into an overarching model. This dual-system perspective has important implications for the development of interventions aiming to promote car-use reduction. Such interventions may be most effective if they simultaneously attempt to change attitudes, beliefs, and control standards; create situational and dispositional circumstances that are conducive for effective self-regulation of personal behaviour change goals; and, in addition, suppress impulsive influences on behaviour.

Implications for Car Use Reduction Intervention

In this section I shall present a more detailed discussion of the implications of the theories presented above for the systematic, theory-based development of effective car-use reduction interventions. This discussion is structured by the central insight summarized in the last section, that car-use reduction interventions are most effective if they simultaneously attempt to change contents of the reflective system, block the automatic activation of car-use habits, and create situational and dispositional circumstances that are conducive for effective self-regulation of behaviour change. As mentioned in the introduction, intervention types targeting changes to the content of the reflective system are summarized under the heading of "downstream interventions", and intervention types aiming to block the automatic activation of old habits under the heading of "upstream interventions." Combined intervention types are discussed under the heading of "downstream-plus-context-change."

Downstream Intervention Approaches for Changing Contents of the Reflective System

I shall use SSBC presented above to systematically present downstream intervention types. As a stage model, SSBC stresses the need to develop stage-tailored intervention modules matching the specific needs of persons who are in one of the four different stages of behaviour change. Many soft car-use reduction interventions developed by practitioners have intuitively adopted the idea to tailor interventions to the specific needs and barriers of different groups (Richter et al., 2010, 2011). However, the procedures used by these interventions for distinguishing different car user groups have been criticized as being based on ad hoc assumptions. In contrast, as will be described below, SSBC provides a systematic theory-based approach for identifying stage groups and for developing respective stage-tailored interventions.

Interventions Targeting the Pre-decisional Stage

In the first, pre-decisional stage, people are performing the behaviour to be targeted on a regular, habitual basis. They are not fully aware of the negative consequences associated with this behaviour, and thus they see no reason for behaviour change. Confronting people in this stage with a direct request to change their behaviour runs the risk of triggering reactance. People who are psychologically not ready for behaviour change may perceive such a request as an attempt to limit their freedom of choice by social pressure. Furthermore, people in this stage may be convinced that behaviour change is not feasible for them personally. As a consequence, the main intervention task in this stage is to give a person a push towards thinking about the negative consequences of her or his current behaviour, to raise the awareness of the discrepancy between this behaviour and important personal standards, and thus increase her or his insight that a change of current behaviour is necessary and possible (i.e. the formation of a goal intention).

On the promotion side, SSBC provides clear guidelines regarding the strategies on which interventions targeting people in the pre-decisional stage should focus: (a) Enhancing problem awareness; (b) Increasing acceptance of personal responsibility; (c) Making social norms salient; (d) Strengthening perceived ability to change current behaviour; and (e) Promoting the formation of a clear and challenging, but not excessive personal change goal. However, because of the aforementioned risk of eliciting reactance, interventions in this stage should include not only arguments promoting behaviour change but also elements trying to reduce reactance. Research (e.g., Knowles & Riner, 2007) has indicated that one of the most effective strategies to reduce reactance is merely to acknowledge the fact that the person may come to feel some resistance. A second strategy is to minimize the request. Instead of requesting complete behaviour change, one asks for only a small change ("even a penny will help"). A third technique to prevent reactance is the "power of yes", that is asking people whether they agree with an assumption or conclusion. Providing choice between multiple behavioural alternatives is another strategy to prevent reactance.

Interventions Targeting the Pre-actional Stage

People in the pre-actional stage of behaviour change already have committed themselves to the general goal of changing their current behaviour (high goal intention). However, because several actions (e.g., cycling, walking, public transport) could normally be used as a means to achieve this goal (e.g., car-use reduction), the task confronting them is to select the personally most suitable behavioural strategy. Consequently, the main intervention goal in this stage is first to provide more knowledge about the pros and cons as well as the personal feasibility of behavioural alternatives, then provide help in selecting the best alternative. TPB (Fishbein & Ajzen, 2010) has proven particularly useful in guiding the systematic development of intervention strategies aiming to promote a person's exploration of the pros and cons of behavioural alternatives. Besides promoting arguments, interventions for people in the pre-actional stage should also include arguments targeting potential sources of reactance or resistance. According to Knowles and Riner (2007), one effective strategy to deal with concerns about an offer consists in giving guarantees. In the mobility case, for example, participants could be offered a free 1-week travel pass to test whether public transport services fit their purposes.

Interventions Targeting the Actional Stage

In the actional stage people not only possess a strong goal intention but also have formed a strong behavioural intention, that is they have made a decision about which new behavioural strategy they want to choose instead of the old one. However, people often have difficulties in translating their "good" behavioural intentions into action. Thus, they often fail to do the things that they say they intend to do or fail to avoid doing things that they do not want to do (Orbell & Sheeran, 1998). Obviously, the successful implementation of behavioural intentions must deal effectively with two self-regulatory problems: the failure to initiate action (failing to get started) and the shielding of an ongoing goal pursuit from unwanted influences (getting derailed). Gollwitzer (1999; Gollwitzer & Sheeran, 2006) proposed that explicitly motivating people to form implementation intentions offers a simple and effective strategy for dealing with self-regulatory problems. As discussed above, implementation intentions are specific "if–then" plans of action that specify where, when, and how behaviour is to be executed in order to accomplish a particular goal. To form an implementation intention, the person must identify a response that promotes goal attainment (the *then* component of the plan) and anticipate an opportunity to initiate that response (the *if* component). Because forming implementation intentions means that people think about and choose a critical future situation for action, the mental representation of this situation becomes highly accessible (Gollwitzer). Heightened accessibility of the chosen opportunity implies that one is "perceptually ready" to encounter that situation; consequently, the ability to detect the specified opportunity is enhanced. Evidence indicates that opportunities to act that are specified in implementation intentions do not easily escape attention, even while being busy with other ongoing tasks (Gollwitzer & Sheeran). Forming an if–then plan involves not only choosing a good opportunity to act but also rehearsing the association between that opportunity and a chosen response. The consequence is the formation of a strong opportunity-response link such that the person can respond immediately and efficiently (automatically) at the critical moment. Evidence shows that people who form implementation intentions produce automatic responses as soon as they encounter their specified opportunity (Gollwitzer & Sheeran). Those who have formed implementation intentions are therefore in a very good position to achieve their goals compared to individuals who have merely formed a behavioural intention.

Interventions Targeting the Post-actional Stage

In the post-actional stage people have been engaging in the selected new behaviour strategy for some time. Thus, they are reflecting on the experiences they have made with the new behaviour and are comparing it to the old behaviour. As a result, the main intervention task in this stage is twofold: to provide feedback on how successfully people have achieved their personal change goal and to help them cope with the temptation to relapse into the old behaviour. As a consequence, besides repeating and strengthening the positive consequences associated with the new behaviour and helping people overcome still existing barriers, the focus of interventions should be on providing social support. This could be done by explicitly thanking and praising people for their good decision and offering them a small gift in recognition. Besides asking them whether they need additional information, another intervention element for this stage consists in motivating people to think about buying a permanent monthly or annual public transport pass. The idea behind this intervention element is to increase commitment to current behaviour and to strengthen its habitual nature.

Downstream Intervention Approaches for Changing Contents of the Impulsive System

Because of the important role of automatic processes in the activation of behaviour discussed above, it is vital that effective car-use reduction interventions try to influence these automatic processes and not only the content of the reflective system.

Implementation Intentions as a Strategy for Breaking Habits

The formation of implementation intentions is discussed not only as an effective self-regulatory strategy for promoting the enactment of new behavioural intentions but also as an effective strategy to break existing counter-intentional habits. Several authors have noted that habits and implementation intentions seem to instigate similar automatic responses that differ only in origin, that is whether they are the result of repeated action (i.e., habits) or reflect conscious planning (i.e., implementation intentions, see, e.g., Aarts & Dijksterhuis, 2000a, 2000b). Based on this similarity, it has been suggested that implementation intentions could be used not only to promote the initiation of new, wanted behaviours but also to break existing unwanted habits. Indeed, in addition to the large body of studies demonstrating the efficacy of implementation intentions in promoting the initiation of new behaviours, evidence underscoring the potential of these counter-habitual implementation intentions in breaking existing habits has started to accumulate in recent years. Counter-habitual implementation intentions have been found to be effective in changing several types of habits such as recycling habits (Holland, Aarts, & Langendam, 2006), reducing automatic stereotyped thoughts (Stewart & Payne, 2008), and decreasing unhealthy snack consumption (Adriaanse, De Ridder, & De Wit, 2009).

Changing Implicit Attitudes

Although research on changing implicit attitudes in order to change behaviour is still in its infancy (Gawronski & Sritharan, 2010), three implicit attitude change techniques have been tested successfully in laboratory studies: evaluative conditioning, association training, and approach/avoidance training (AAT). Evaluative conditioning involves exposing participants to repeated pairings of the relevant conditioned stimulus (e.g., car, bike) with negative or positive words or images (the unconditioned stimulus). Evaluative conditioning has been shown to change implicit attitudes (Olson & Fazio, 2006) and influence subsequent behaviour (Wiers et al., 2008). Evaluative conditioning promotes implicit attitude change primarily when participants have neutral attitudes to begin with, and it modifies behaviour largely when cognitive resources for reflective thought are compromised (Gibson, 2008). Association training involves a similar procedure as evaluative conditioning. It also appears to influence behaviour primarily when participants' reflective capacity is reduced, for example, through cognitive load (Kawakami, Dovidio, & van Kamp, 2005; Kawakami, Phills, Steele, & Dovidio, 2007). This technique involves multiple trials in which participants are taught to overcome automatic action tendencies by learning to approach one class of stimuli and avoid its counterpart. Findings have shown that also AAT is effective in changing both implicit attitudes and subsequent behaviour (e.g., Wiers et al.).

Upstream Intervention Approaches

Because automatic processes depend on environmental cues, a unique source of changing behaviour would be through changing the environmental features by which they are triggered. Alongside their impact on the conscious evaluation of the benefits and costs of behavioural options, this is probably a second important mechanism through which upstream interventions could change a person's behaviour. Upstream interventions elicit changes in the performance environments, so that the automatic performance of old undesired habits is blocked and desired habits flourish (Verplanken & Wood, 2006). In other words, upstream interventions attempt to shape the conditions that promote and sustain desired habits. Upstream interventions that involve large-scale, macro-level policy changes are especially suitable to address the societal and environmental structures that promote and sustain habits. Examples that are relevant to travel behaviour include economic incentives and policy-driven changes that alter the physical environment or the behavioural alternatives within that environment. Economic incentives are upstream policy interventions that encourage desired behaviour through the provision of tax relief, cash incentives, or other subsidies for desired services. Economic measures may also discourage undesired behaviours through the imposition of taxes (e.g., "sin" taxes). Another way upstream interventions change the environment is by modifying it directly. For example, coordinating city planning with road design and efficient transportation systems could reduce consumers' reliance on the private car. Changes in behavioural alternatives can also be accomplished through limiting possible responses (e.g., limiting car access to inner city districts).

Downstream-Plus-Context-Change Interventions

Alongside systematic changes in the performance environment caused by upstream interventions, such changes frequently occur as consequence of people's movement into another life phase, for example, when adolescents leave their parents' home, couples start a family, and older people enter retirement. Sometime environments change temporarily, for example, as a consequence of street construction works. In these situations, existing habits are broken or vulnerable, and downstream interventions may have a relatively high prospect of success. Verplanken and Wood (2006) used the term "downstream-plus-context-change" to label these interventions. The underlying assumption is that individuals are in a position that requires finding new ways to behave. Consequently, they are more open to new information that helps to guide their new behaviours. A number of studies have now provided empirical evidence that downstream-plus-context-change may be more effective than downstream interventions alone. For example, Cairns et al. (2008) quote studies from the Netherlands and the US reporting that downstream car-use reduction interventions such as work travel plans reduce car use by 20–25 % if they are accompanied by upstream measures such as parking management and bus subsidies. Without accompanying upstream measures, work travel plans result in lower car reductions of 5–15 %. Fujii and Kitamura (2003) found that during a temporary freeway closure, a 1-month bus ticket motivated habitual car commuters to switch to public transport. Bamberg, Rölle, and Weber (2003) evaluated the effects of a downstream intervention (combination of information and a free public transport ticket) in a changed context (moving to a new residence) on travel-mode choice by car users. In this study, former car users showed a strong behavioural change to this small, relatively inexpensive downstream intervention. This result was replicated by Thøgersen (2009) who found that a free 1-month travel card for public transportation increased public transport use only in the group of car drivers who recently relocated their place of residence or workplace.

The Role of Mass Media Campaigns

Available evidence indicates that one should not expect direct behaviour change effects from mass media campaigns focusing on increasing citizens' awareness of the problems associated with car use (e.g., Albarracin et al., 2005; Derzon & Lipsey, 2002; Lodish et al., 1995). Yet, mass media campaigns may increasing problem awareness and knowledge, which are prerequisites for introducing a new social-normative climate influencing the target behaviour. Such a social-normative climate is created by the beliefs widely shared within a society that doing something is inherently "right" or "wrong" without regard to the benefits or costs to self. Examples of the importance of changing the general social-normative climate towards targeted behaviours are the cases of drinking-and-driving, seat-belt use, and smoking, in which a combination of intensive mass media campaigns, legislation, and enforcement has changed social norms concerning these behaviours. There is now a prevalent belief that most people see these behaviours as wrong. If a person internalizes these new social norms as personal norms, this may have a significant impact on the formation of a behaviour change goal.

Conclusions

This chapter has reviewed some psychological research that helps to understand when, why, and how "soft" car-use reduction interventions may be successful. An encouraging finding is the considerable progress that has been made over the last decades in understanding the mechanisms underlying voluntary behaviour change. These insights have important implications for the development of more effective future interventions aiming to promote car-use reduction. Such interventions may be most effective if they simultaneously attempt to change people's attitudes, beliefs, and intentions; create situational and dispositional circumstances that are conducive for effective self-regulation of personal behaviour change goals; and, in addition, change impulsive influences on behaviour.

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Theoretical Underpinnings of Practical Strategies for Changing Travel Behaviour

Satoshi Fujii and Ayako Taniguchi

Introduction

Current transportation policies focus on reducing car use or other changes in travel behaviour by car users due to the social costs associated with car use, including traffic congestion, traffic accidents, air pollution, and global warming. In this context, transportation policymakers have proposed various measures to induce changes in the travel behaviour of car users. These measures include investments in infrastructure designed to increase the benefits of using non-auto travel modes and coercive measures to decrease the benefits of car use. In addition to these measures designed to change the travel environment, behavioural strategies such as mobility management have also been implemented to increase awareness and influence psychological factors to encourage voluntary change from car use to non-auto travel modes. Typical mobility management strategies include the provision of specific information about public transport as well as the development of travel campaigns and travel education.

A typical programme involves asking participants to report on their travel behaviour or to provide information related to changing their travel behaviour. Participants in such a programme might also receive pertinent data, including information on the CO_2 emissions of their cars, advice about how to reduce car use, and individualized information about public transport that could be used as an alternative to car travel. Examples of such programmes include Individualized

S. Fujii
Department of Urban Management, Graduate School of Engineering,
Kyoto University, C1, Nishikyo-ku, Kyoto 615-8540, Japan
e-mail: fujii@trans.kuciv.kyoto-u.ac.jp

A. Taniguchi (✉)
Department of Risk Engineering, University of Tsukuba, Ten-noh-dai 1-1-1,
Tsukuba, Ibaraki 305-8573, Japan
e-mail: taniguchi@risk.tsukuba.ac.jp

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Marketing (Brög, 1998), Travel Smart (Department of Transport, Western Australia, 2000), Travel Blending (Ampt & Rooney, 1999; Rose & Ampt, 2001), and the Wise Way to Use a Car Programme (Taniguchi, Hara, Takano, & Kagaya, 2002, Taniguchi, Hara, Takano, Kagaya, & Fujii, 2003). We refer to these behaviour modification programmes as "travel feedback programmes" (TFPs; Taniguchi et al., 2003).

TFPs have been widely implemented in EU countries, Australia, and Japan and have reduced car use by about 7–15 % among those participating in EU countries and in Australia (see Jones, 2003a, 2003b) and by 19 % (the average of ten TFP cases) among those participating in Japan (see Fujii & Taniguchi, 2006).

The success of these measures in changing travel behaviour can be explained using an integrated model to understand changes in travel behaviour (e.g., Taniguchi & Fujii, 2007). In this chapter we will first describe the integrated model of the behaviour change process. We will then use this model to analyze how various types of behavioural interventions are able to change travel behaviour. We will also discuss a specific model for behaviour change that emphasizes moral obligation in reference to social values.

A Process Model of Voluntary Travel Behaviour Modification

To understand the process by which travel behaviour is modified so that people use public transport instead of cars, we examined various theories about behaviour and attitudes, including Ajzen's (1985) Theory of Planned Behaviour (TPB), the Norm Activation Model (NAM; Schwarz, 1977), the theory of implementation intention (Gollwitzer, 1993, 1996), and theories of habit (Gärling, Fujii, & Boe, 2001; Ronis, Yates, & Kirscht, 1989; Verplanken & Aarts, 1999). On this basis we have developed an integrated process model of travel behaviour change, as shown in Fig. 1, which incorporate TPB, NAM, the theory of implementation intention, and theories of habit.

The model rests on the assumption that reductions in car use are influenced by behavioural intentions in this regard, and that behavioural intentions are, in turn, influenced by psychological factors, including attitudes and perceived behavioural control. These factors are considered in TPB, one of the most widely used behavioural theories (Conner & Armitage, 1998). Although TPB refers to non-altruistic behaviour, modification of travel behaviour from the use of car to the use of public transport may be encouraged by altruistic motivations, as is hypothesized by NAM. According to norm activation theory, travel behaviour would be influenced by an awareness of the negative consequences of car use. Awareness of three types of consequences (for society, the biosphere, and life in general) and environmental issues (Fransson & Gärling, 1999) can be presumed to act as determinants of behavioural intentions. According to NAM, the effects of

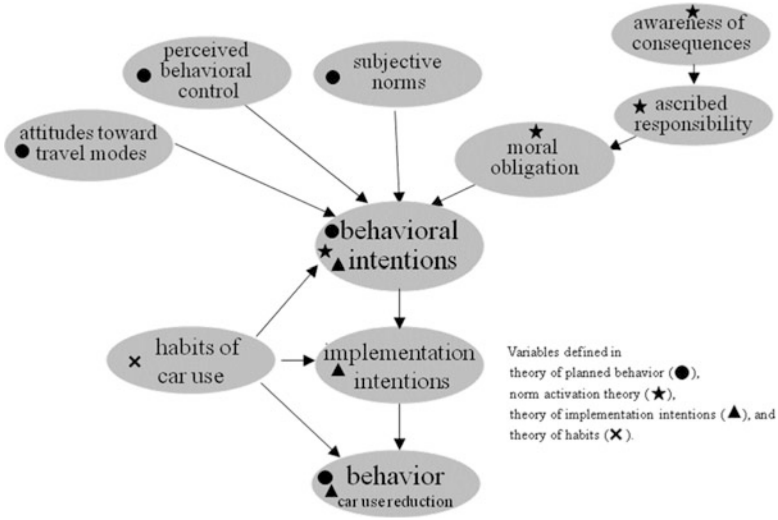

Fig. 1 Integrated model of travel behaviour modification proposed by Taniguchi and Fujii (2007). (Several variables (e.g. several types of awareness of consequences) assumed in Taniguchi & Fujii, 2007, are for simplification aggregated to one variable; two variables (ascribed responsibility and moral obligation) that were implicitly assumed in the model are explicitly described)

these determinants are mediated by ascribed responsibility and the sense of moral obligation related to modifying one's travel behaviour (Fujii, 2010).

Other determinants of behavioural intentions include subjective norms such as injunctive and descriptive subjective norms. These are related to social pressure (Snyder & Stukas, 1998). Injunctive subjective norms refer to beliefs that others, such as family members, have a moral obligation to reduce car use, whereas descriptive subjective norms refer to beliefs that others, such as family members, agree with the target individual's decreased car use.

Appropriate behavioural intentions are necessary but not sufficient for achieving sustained car-use reduction. In the real world, travel behaviour is not always modified despite intentions to do so. In an attempt to determine how intentions are implemented in behaviour, Heckhausen and Gollwitzer (1987) and Gollwitzer (1993, 1996) distinguished between "goal intention" and "implementation intention." Whereas goal intention can be regarded as a behavioural intention (Gärling & Fujii, 2002; Fujii, 2005), implementation intention entails a plan for when, where, and how to implement the target behaviour. Gärling and Fujii (2002) hypothesized that the effect of behavioural intention on behaviour is mediated by implementation intention. They used data on the causal relationships among behavioural intentions, implementation intentions or planning, and actual behaviour to support this assumption.

To understand travel behaviour modification, it is necessary to consider habits. Studies have suggested that the habit of using a car prevents changing from car use to alternative travel modes (Gärling et al., 2001; Ronis et al., 1989; Verplanken & Aarts, 1999). The proposed model hypothesizes that habitual car use will be associated with decreased behavioural intentions, implementation intentions, and likelihood that car-use behaviour will be modified.

Taniguchi and Fujii (2007) and Fujii (2010) tested the model in Fig. 1 finding that car-use reduction was influenced by implementation intentions, that implementation intentions were influenced by behavioural intentions, and that behavioural intentions were influenced by hypothesized determinants, including habitual car use, environmental awareness of car-use consequences, and a sense of moral obligation.

Theoretical Explanation of Changes in Behaviour

The integrated model can be used to show how transport policies may be effective in changing travel behaviour. The most traditional way to change travel behaviour involves investing in the infrastructure associated with non-auto travel modes including public transport, cycling, and walking. Such investments are expected to improve attitudes toward travel modes other than the car through changing beliefs about the attributes of these modes such as time, cost, and convenience, thus leading to behavioural changes that favour non-auto travel modes over auto travel modes. Infrastructure investment may greatly change people's travel behaviour if the investment is on a sufficiently large scale. Furthermore, if people become aware of large-scale behaviour changes, the descriptive norm for the behaviour may be activated, and this activation may lead to additional behaviour changes. Large-scale infrastructure investment may consequently induce a "snowball effect" (i.e., changes in the behaviour of some individuals induce changes in the behaviour of other individuals; see Klandermas, 1992).

However, such effects can never emerge unless enough people are aware of the investment. Therefore, it is essential for people to know about the infrastructure investment. It is known that habitual car use prevents acquisition of information about alternative travel modes (e.g., Fujii & Gärling, 2003, 2007). Therefore, strategies for providing easy-to-understand information about the infrastructure investment is necessary for changing habitual drivers' behaviour. Information-provision strategies that can induce sufficient motivation for information acquisition are also effective for changing the behaviour of habitual drivers. TFPs (e.g., Taniguchi & Fujii, 2007) are typical strategies that can provide easily understood information or induce motivation for information acquisition.

It should be noted that infrastructure investment, such as the construction of railroads, subways, or bicycle lanes, attract public attention in the areas affected. Therefore, the timing of infrastructure investment provides key information about non-auto travel modes. This implies that the effectiveness of TFPs will be enhanced by the investment. In other words, the combination of infrastructure investment and information-provision strategies related to TFPs is more effective than is each strategy alone.

Another typical approach to changing travel behaviour involves decreasing the benefits associated with car use. These types of approaches are called push measures, whereas those to increase the benefits of alternatives to car travel are called pull measures. Examples are economic policies related to road pricing and gasoline taxation, legal policies to regulate car use, and physical measures such as reducing the capacity of roads. These measures are also expected to promote negative attitudes toward cars by changing beliefs about the benefits of car use.

It should be noted that car users, even those with strong car-use habits, will be sensitive to decreasing benefits of car use which directly affect their behaviour (Gärling & Fujii, 2009). For this reason, push measures may be more effective than pull measures. However, the public attitude toward these measures is generally negative (Jakobsson, Fujii, & Gärling, 2000; Jones, 1991, 1995, 2003a, 2003b). Such a negative public attitude may prevent politicians from endorsing push measures (Gärling & Schuitema, 2007). Therefore, persuasive communication regarding such measures, including regulation and road pricing, are important for improving the acceptability of such measures (Schmocker, Pettersson, & Fujii, 2012).

Pull and push measures are expected to change the beliefs that determine attitudes toward travel modes in order to change travel behaviour. However, the beliefs assumed to determine attitudes constitute only some of the determinants of behavioural change, as implied by our integrated model (Fig. 1). Therefore, strategies to change other determinants, such as subjective norm or awareness of consequences, are also expected to be important in efforts to change travel behaviour. TFPs are examples of such measures. Taniguchi and Fujii (2007) found that persuasive messages provided in TFPs activate subjective norms related to the use of alternatives to cars. Awareness of consequences is also expected to be elicited by the provision of information regarding the negative consequences of car use. Additionally, we found that TFPs had a direct impact on behavioural intentions because such communications seem to short-cut the decision process regarding behavioural change without eliciting the involvement of the determinants of behavioural intentions. We also found that implementation intentions were also directly elicited by the TFP. This is because they help to develop a plan for behaviour change through the provision of information regarding alternative travel modes to car travel.

Thus, information-provision measures such as TFPs are expected to change travel behaviour in that they simultaneously affect a range of variables that are related to behavioural change. It has been repeatedly and empirically shown that such measures actually change travel behaviour (e.g., Gärling & Fujii, 2009; Taniguchi, Suzuki, & Fujii, 2007). However, combinations of these information-provision measures and other pull or push measures are more effective than are single measures, as previously indicated. This is because travel behaviour modification can be achieved via the involvement of several psychological variables that are assumed to cause travel behaviour change (Fig. 1), and different psychological variables can be recruited by different types of measures.

Typical combinations of psychological and pull/push measures include incorporating small incentives into a communication programme. Although such small incentives cannot continuously support a behavioural change, they may nevertheless induce car users to change their habits (Gärling & Fujii, 2009). Small incentives may consequently be expected to operate as temporary structural changes (Fujii & Gärling, 2005) and thus increase the effectiveness of TFPs (Brög, 1998; Taniguchi & Fujii, 2007).

TFPs are found to be more effective for new than for old residents (Fujii & Taniguchi, 2010). This is because new residents have not yet developed travel habits for their new residential area. Additionally, new residents tend to be more motivated to access various types of information concerning their new residential area.

Eliciting Feelings of Moral Obligation

The determinants hypothesized by the TPB (i.e., attitudes, perceived behavioural control, and subjective norms) are dependent on the situation or environment in which decisions about travel behaviour are made. However, although moral obligation is partially dependent on situations, it is also partially dependent on personality and personal attributes that are not necessarily dependent on situations. Therefore, if people feel a strong moral obligation to use non-auto travel modes, they will use non-auto travel modes regardless of the situation, even when car use is more personally beneficial than are other modes of travel. Therefore, educational measures to elicit feelings of moral obligation are powerful strategies for encouraging people not to use cars.

An experiment conducted by Fujii (2010) showed that the moral obligation to refrain from car use and to instead use public transportation was positively influenced by explanations about the negative consequences of car use. This is because such an explanation had a positive effect on awareness of the consequences of car use and because the awareness, in turn, had a positive effect on ascribed responsibility that influences feelings of moral obligation (sees Fig. 1). In addition to this, the data showed that the enactment of a law to regulate car use had a positive effect on the ascribed responsibility to refrain from car use and the inclination to instead use public transport as well as on the sense of moral obligation. This result implies that a feeling of being morally obliged can be elicited by activating ascribed responsibility by enacting a law to regulate car use. A structural equation model analysis that incorporated moral obligation, awareness of consequences, ascribed responsibility, and a dummy coded variable denoting introduction of the law showed that awareness of consequences has a positive effect on ascribed responsibility, and that ascribed responsibility, in turn, has a positive effect on moral obligation, as hypothesized by Schwartz (1977). Additionally, the dummy variable regarding the introduction of the law has a directly positive effect on ascribed responsibility but no direct effect on awareness of consequences. Thus, the ability to elicit feelings of moral obligation by enacting a law would be expected to be enhanced by the activation of ascribed responsibility.

This result implies that a change in people's travel behaviour associated with a perceived moral obligation to refrain from car use may be induced by two kinds of measures: Communication about the negative consequences of car use and enactment of a law to regulate car use. The latter approach to eliciting feelings of moral obligation has not been well articulated in the context of making transport policies.

The findings suggest that transport-policy makers can regard the enactment of a law to regulate car use as a strategy for inducing change in travel behaviour. Additionally, the combination of enacting such a law and communicating to the public the reason that such a law is important may be more effective in eliciting feelings of moral obligation than is any of the measure singly.

Previous research on the elicitation of feelings of moral obligation has also studied variables related to personality. Such deeper determinants of feelings of moral obligation are especially important to efforts to understand changes in travel behaviour because such variables contribute to behavioural intentions related to behavioural change via activating feelings of moral obligation. In this context, we will discuss such in-depth variables from theoretical and empirical perspectives in what follows.

The Value Belief Norm (VBN) theory of pro-social behaviour (Stern, Dietz, Kalof, & Guagnano, 1995; Stern, Dietz, Abel, Guagnano, & Kalof, 1999) hypothesizes that beliefs about or awareness of consequences are influenced by social values, as defined in the research by Schwartz (1992, 1994). According to the VBN theory, individuals who endorse basic social values such as the importance of environmental protection believe that valued objects are threatened and feel obligated to engage in appropriate action. Schwartz (1992, 1994) developed a comprehensive universal theory of human values based on extensive cross-country research. According to this theory, people's values can be generally categorized into the following four types: self-transcendence (altruism) versus self-enhancement (self-interest) and conservation (traditional values) versus openness to change. The VBN theory based on Schwartz' value theory has been used to explain pro-environmental behaviours in a large number of studies (e.g., Biel & Thøgersen, 2007; De Groot & Steg, 2008; Hansla, Gamble, Juliusson, & Gärling, 2008; Lindenberg & Steg, 2007; Schultz & Zelezny, 1999; Steg, Dreijerink, & Abrahamse, 2005; Stern et al., 1995, 1999; Thøgersen & Ölander, 2002).

Although attitudes towards car use were not explicitly included in the original VBN theory, these attitudes may be affected in the opposite direction by the same variables activating norms related to not using cars considered to be a pro-social behaviour. That is, attitudes towards car use (i.e., the egoistic consequences of car use) can as shown in Fig. 2 be expected to have negative effects on ascribed responsibility, because individuals with positive attitudes towards car use may be motivated to avoid feeling responsible and morally obligated to use non-auto modes, as implied by the theory of cognitive dissonance (Festinger, 1957). It can also be assumed that psychological variables disencouraging car use (and non-auto modes use) will be enhanced by increased awareness of the adverse egoistic consequences. On the other hand, psychological variables promoting the use of non-auto travel modes can be expected to be enhanced as a result of increased awareness of the positive collective consequences of non-auto travel modes. Thus, awareness of the collective consequences of car use and of the egoistic consequences (i.e., attitudinal beliefs) can be expected to have opposite influences on the same psychological variables (e.g., ascribed responsibility) involved in the process of norm activation.

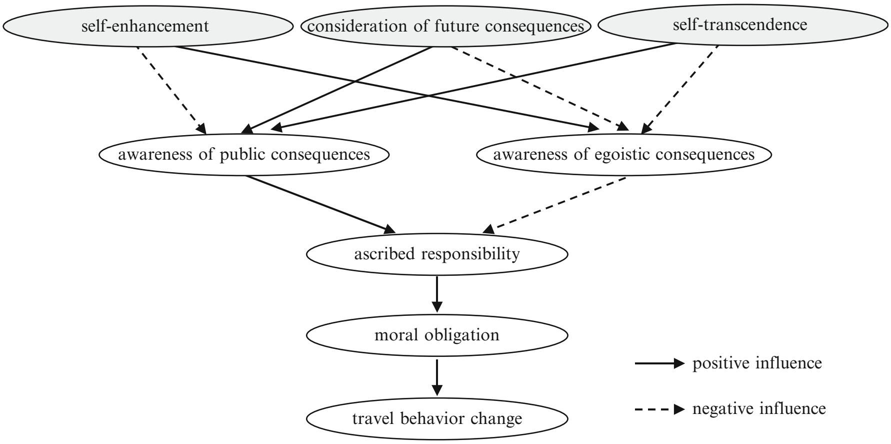

Fig. 2 Structural relationships among travel behaviour change, moral obligation, ascribed responsibility, awareness of public and egoistic consequences, self-transcendence and enhancement, and consideration of future outcomes proposed by Fujii (2010)

Consideration of future consequences constitutes another variable that was not explicitly included in the VBN theory (Strathman, Gleicher, Boninger, & Edwards, 1994). This factor refers to the extent to which individuals consider the distant potential consequences of their current behaviours and the extent to which they are influenced by these potential consequences. Because considering future consequences would identify the principles underpinning important choices in a wide variety of situations, it can also be regarded as a type of value that transcends specific situations. Strathman et al. (1994) implied that those who highly value the consideration of consequences are characterized by high levels of self-regulation, and such characteristics are regarded as important contributors to promoting cooperative behaviours, that is the use of non-auto travel modes (e.g., Joireman, Van Lange, & Van Vugt, 2004). However, the broader value clusters developed by Schwartz (1992, 1994) (i.e., self-transcendence, self-enhancement, conservation, and openness to change) may not completely account for the consideration of future consequences. Because both self-transcendence and self-enhancement do not directly relate to the time dimension, they frame change in terms that are primarily related to the present, and conservation relates primarily to considerations of the past. Therefore, it can be hypothesized that consideration of future consequences will have an effect that is independent of the effect of the values related to awareness of consequences that were originally included in the VBN theory.

Figure 2 shows the structural relationships among the variables described above. It is hypothesized that the intention to engage in pro-social behaviour would be positively influenced by a sense of moral obligation, which, in turn, would be positively influenced by ascribed responsibility, and that this, in turn, would be positively influenced by awareness of public consequences and negatively influenced by awareness of egoistic consequences (or attitudes toward adverse travel behaviour). It was also hypothesized that considerations of future consequences and valuing self-transcendence would have positive effects on awareness of public consequences and negative effects on awareness of egoistic consequences (attitudes, beliefs), and that self-enhancement, on the other hand, would have a negative effect on awareness of public consequences and a positive effect on awareness of egoistic consequences (attitudes, beliefs). Regarding the effects of valuing conservation versus being open to change, specific hypotheses could not be theoretically developed.

Fujii (2009) empirically tested the proposed model using data ($n = 1{,}200$) obtained in various cities in Japan and found that all the hypothesized paths were supported. This result implies that educational policies with potential influence on values may have substantial importance in promoting changes in travel behaviour because self-transcendence, self-enhancement, and consideration of future consequences were shown to affect the determinants of intentions to change travel behaviour in favour of non-auto travel modes. Educational efforts should include not only communication about mobility management designed to change attitudes and behaviours (e.g., Taniguchi et al., 2007), but also collaboration with elementary schools that may influence students' values (e.g., Taniguchi & Fujii, 2007) about the environment and related transportation issues.

Concluding Remarks

In this chapter we discussed how several types of practical strategies can change travel behaviour in a socially desirable direction. To this end, we applied the integrated process model of behaviour change proposed by Taniguchi and Fujii (2007). The model implies that several psychological variables, including intentions, attitudes, awareness, responsibility, morals, norms, and habits have important roles in behavioural change. Thus, it is important to identify and understand those psychological variables involved in behavioural change that are influenced by relevant policies and to comprehend how they operate, irrespectively of the specified types of policies involved. In this context, we argued that a combination of policy changes will be more effective in changing behaviour than will single measures.

A typical effective combination involves providing information that can directly influence implementation intentions and pull or push measures that can directly change attitudes toward travel modes. This is likely to be more effective partially because attitudinal changes do not necessarily lead to behavioural changes in the absence of implementation intentions, and partially because implementation intentions will be more strongly activated as attitudes change. Note that because communication strategies such as travel feedback programmes can directly induce behavioural and implementation intentions, they can, individually, change travel behaviour even though combining them with push or pull measures will be more effective.

We then discussed elicitation of feelings of moral obligation related to changing travel behaviour. Those with a strong sense of moral obligation are more likely to change their travel behaviour regardless of the egoistic benefits of using travel modes. It was found that those who place high value on self-transcendence and consideration of future consequences and low value on self-enhancement are likely to have a stronger sense of moral obligation, irrespective of egoistic beliefs related to car use and use of non-auto travel modes. Therefore, social education or the development of a social culture that promotes such socially desirable values and reduces the impact of egoistic values will be important in efforts promoting socially desirable travel behaviour changes. The combination of social education/culture and the implementation of specific transportation measures will likely be among the most effective multifaceted approaches to the development of a sustainable society.

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Part III
Travel and Social Sustainability

Social Exclusion and Travel

John Stanley and Janet Stanley

Introduction

Since the landmark Brundlandt Commission Report (1987), "triple bottom line" approaches to high level goal setting for transport systems have been common. Economic and some environmental drivers have long currency in terms of influencing transportation initiatives, with the economic dimension receiving an important stimulus in recent years from work on agglomeration economies and climate change becoming more important in relation to environmental goals. The social policy or welfare dimension is the least developed. This applies both with respect to impact assessment (ex ante and ex post) of specific transport policies, programmes or projects (Geurs, Boon, & Van Wee, 2009), and also in terms of the generation of such policies, programmes or projects to specifically target social policy goal achievement. Where they are considered, social policy drivers of transportaton initiatives tend to cluster around a few particular issues – public transport fare concessions to assist those on a low income, physical access to public transport for those with a disability, and recently, transport measures to assist access for those people at risk of social exclusion.

The above topics are certainly worthy issues to pursue but are only a small part of the story to fully understand the place of transportation in achieving broad social policy goals. After all, in most situations, transportation of itself is rarely an end point goal, but a means of obtaining an economic or social outcome. The authors argue that the transportation field is yet to fully understand and define the full set of

J. Stanley (✉)
Faculty of Economics and Business, Institute of Transport and Logistics Studies,
University of Sydney, Sydney, NSW 2006, Australia
e-mail: john.stanley@sydney.edu.au

J. Stanley
Monash Sustainability Institute, Monash University, Melbourne, VIC, Australia
e-mail: janet.stanley@monash.edu

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social policy goals where transport plays a role. Instead, interest in social policy goals has concentrated on some parts of the picture without a clear understanding of how these parts might make up the whole, as well as leaving important gaps. By way of example, social inclusion work was largely pioneered in the UK by the, then, Social Exclusion Unit (SEU). In the report on transport (Social Exclusion Unit [SEU], 2003) five groups of transport-related barriers to social inclusion were identified: (1) The availability and physical accessibility of transportation; (2) The cost of transportation; (3) Services located in inaccessible places; (4) Safety and security – fear of crime; (5) Travel horizons – people on low incomes were found to be less willing to travel to access work than those on higher incomes. These identified topics are important issues of themselves but do not represent a cohesive structure or framework leading to an improvement in wellbeing, nor indeed, social inclusion. Currently, the Norwegian *National Transport Plan 2010–19* states that it is about (inter alia) "making society more inclusive and universally accessible" (Norwegian Ministry of Transport and Communications, 2009, p. 3). The goals to realise social inclusion are not spelt out, except perhaps improved infrastructure for pedestrians and cyclists and universal design features. Similar goals which reflect part of the story and which provide tenuous connections between actions and goals, are reflected in many transport plans at a national level or at subsidiary levels (e.g. provinces/States or local authorities), depending on where jurisdictional transportation responsibilities lie.

This chapter gives an overview of social goals, identifies missing pieces of the jigsaw, and offers some work that has been done by the authors and colleagues on trying to understand the place of transportation in achieving social policy goals.

Social Policy Goals

The authors acknowledge that an important barrier to understanding the social policy role of transportation is social science itself, which consists of a number of different disciplines each holding different theories and ideological perspectives. While there is increasing agreement about what many of the strategic social policy goals might be, much is uncertain about issues such as the conditions which maximize the achievement of positive outcomes, how these conditions interact, how much is needed of each of these conditions and how these conditions should be measured.

Wellbeing is commonly seen as the target goal for social policy. Wellbeing is achieved when human needs are met. Human needs were defined by Maslow (1954) and while there are variations on these, they still stand strong. Maslow defined these needs as: Physiological – the ability to breathe, have food and water and sleep; Safety – health and freedom from violence; Love and belonging – friendship, family and sexual intimacy; Esteem – self-esteem, achievement, confidence and respect; and Self-actualisation – morality, creativity, acceptance and lack of prejudice.

To achieve these needs and maximize wellbeing, certain conditions are required. These conditions enable people to directly obtain needs, such as forming friendships, as well as facilitate the means to achieving needs. For example, a minimum level of income is required to purchase food and shelter, and therefore people need the capacity to generate income, which may require a job and the means to access the job. This is described in the idea of a person having capabilities to achieve goals (Sen, 1992). Capabilities denote opportunity and ability to generate wellbeing, taking into account relevant personal characteristics and skills and external factors, and societal resources, such as the provision of infrastructure.

Social exclusion can be described as the existence of barriers which make it difficult or impossible for people to participate fully in society (SEU, 2003). Often there are multiple, interacting barriers, some of which can be under personal control and others which are external to the person. Equality of opportunity across society makes it easier for all people to achieve wellbeing. Wilkinson and Pickett (2010) have drawn attention to the fact that high inequality not only adversely impacts on those who are experiencing disadvantage. Many outcome measures of quality of life for geographically based areas, such as in life expectancy, the extent of drug addiction, obesity, homicides, and mental illness, occur more frequently where the inequality between people is highest.

It can be seen by this brief overview of social policy goals that transportation can play a role in both the direct achievement of good outcomes for people (e.g. having the ability to travel to see a friend) and indirectly, to assist the achievement of intermediate goals, to enable the procurement of income such as to meet basic physiological needs. However, the ability to be mobile is just one component of the mix which facilitates wellbeing. The relative importance of transportation is yet to be fully defined and understood. This is not an easy task as those with low wellbeing or high levels of social exclusion commonly experience multiple disadvantages along with transport disadvantage, with many adversities having compounding or cumulative effects.

Transport Disadvantage

Whatever the social goals desired, a person may experience *transport disadvantage*. This may arise from a single reason, but it is more likely to be due to a number of linked issues and more likely to occur with people who are at risk of social exclusion. The causes of transport disadvantage can be classified into three broad categories (J.R. Stanley, 2011): (1) Institutional barriers or facilitators. This would include factors like the first issue identified by the SEU – the absence of transport or the absence of particular services, such as medical or educational services. These issues are commonly spatially based. (2) Individual barriers or facilitators. These include issues such as personal characteristics, including age, personality traits, health, language, and culture. (3) External impacts. This includes broad trends external to the personal and structural conditions, such as climate change and environmental conditions, population growth, the political environment, government ideology and policy, and international economic trends, such as recession.

Thus, it is possible for people to be able to move around freely (have a high level of mobility) but not have good access to shops and personal business outlets such as banks, because of the lack of such services near where they live or the lack of travel options to reach the services where they are available. Equally, people may live near a bank but not be able to access this facility because of a personal disability and uneven footpaths that prevent wheelchair travel. Transport disadvantage reduces mobility and hence access to goods, services, and relationships, and therefore inhibits achievement of wellbeing.

Research on transport disadvantage usually focuses on particular groups thought most likely to be at risk, such as older persons, youth, unemployed people (see, e.g., Mollenkopf, Marcellini, Ruoppila, Szeman, & Tacken, 2005; Spinney, Scott, & Newbold, 2009; J. K. Stanley & J. R. Stanley, 2007). Because the availability of travel opportunities is a fundamental ingredient in transport disadvantage and these opportunities are place-based, a spatial overlay is common. There is a large body of case study research identifying people who might be transport disadvantaged in a locational sense, much of which is summarised in Kamruzzaman and Hine (2012) and Lucas (2012). Delbosc and Currie (2011), for example, find that adults living on the fringe of Melbourne travel twice as far as those living in inner Melbourne on a given day, and report more transportation difficulties and activities they are unable to undertake than those living in the inner area.

Spatially-based research on transport disadvantage frequently uses distance-based, time based or generalised-cost-based measures of relative accessibility to particular services (such as jobs or health services) to suggest relative degrees of transport disadvantage. Separate measures are sometimes estimated for cars and public transport. The recent focus on agglomeration economies as possible wider economic benefits from major transport projects, and the role of effective density in driving agglomeration economies (Graham, 2007), may help to broaden work on transport disadvantage, because accessibility measures are embedded within the measure of effective density that is used to identify agglomeration effects.

Understanding the Role of Transport in Achieving Social Policy Goals

A large Australian research project was undertaken to explore the role of transportation in achieving social goals. This project targeted the goal of wellbeing to seek to understand the precursors to achievement of this goal and the role of transportation. An extensive interview with a sample of 1,019 people was undertaken in Victoria, Australia. The content of the interview comprehensively covered the definitional components of the condition being explored, as well as institutional and personal conditions. Thus, information was gathered on demographic characteristics, socio-economic conditions, living location, service provisions, and key social conditions said to be needed to achieve wellbeing, such as social inclusion, social capital, connection with community, and personality traits, as well as a range of issues related to transportation itself. The following defines how the key concepts were understood and measured.

Social Exclusion and Transport

The concept of social exclusion has grown from work which sought to better understand and represent poverty. While poverty and social exclusion are related, social exclusion recognises the possibility of multiple barriers in addition to low income and unemployment, such as poor health, limited education, ethnic minority status, age, and poor mobility.

Understanding barriers likely to cause exclusion supports a multi-dimensional approach to tackling the problem of exclusion. The way of including people with these disadvantages is not only, or even necessarily, to give them more money but also to develop social or other policies which specifically address their source(s) of disadvantage. To give a transportation example, people may be socially excluded due to their unemployment, which in turn may be because of a lack of transportation available to take them to and from available employment. Reducing transport disadvantage may increase the employment prospects and, if successfully realized, increase social inclusion and wellbeing.

Much of the work on social exclusion and transport follows the landmark work undertaken by the UK Social Exclusion Unit (SEU). It is perhaps no surprise that the UK was where this foundational work on transport and social exclusion took place. Deregulation of bus services outside London in 1986 reduced patronage of bus services by over 30 % and must have substantially accentuated problems of transport disadvantage. Such deregulation is not common. The SEU work was important in underpinning the subsequent UK legislative requirement for Local Transport Plans, with an accessibility planning focus. However, Lucas (2012) suggests that there has been a relatively poor take up of the transport and social exclusion agenda amongst UK local authorities and that the current UK national government's localism agenda may reinforce this lack of focus. There are now many published articles on social exclusion and transportation, most of which describe the disadvantages people experience in the absence of transport to reach services.

Measurement

Measurement of social exclusion is difficult. However, ideas about what social exclusion comprised appear to show consistent trends from about 2000, with work from a key group of researchers in the UK (see, e.g., Burchardt, LeGrand, & Piachaud, 2002; Gordon et al., 2000; Levitas, 2000). The London School of Economics approach (Burchardt et al., 2002) identified four dimensions likely to reflect a tendency towards social exclusion. The recent Australian research modified these four dimensions for application (J. K. Stanley, Hensher, Stanley, Currie, & Greene, 2011a; J. K. Stanley, Hensher, Stanley, & Vella-Brodrick, 2011b). A "participation" dimension was re-defined as social support to better reflect what was being measured, a measure of participation in activities was added, in line with other definitions of social exclusion in use, and the political engagement measure was broadened, to encompass more general political activity (election voting, the measure used by Burchardt et al. (2002), not being compulsory in Australia). The indicators for a person's risk of social exclusion used in the Australian study included the following:

- household income – less than a threshold of $500 gross per week
- employment status – not employed, in education or training, not looking after family nor undertaking voluntary activities
- political activity – did not contribute to/participate in a government political party, campaign or action group to improve social/environmental conditions, or to a local community committee/group in the past 12 months
- social support – not able to get help if you need it from close or extended family, friends or neighbours
- participation – did not attend a library, sport (participant or spectator), hobby or arts event in the past month.

Each dimension was given equal weight in the Australian study to provide an indicator of a person's risk of being socially excluded. The London School of Economics approach treats each dimension separately, not seeking to combine them, noting that different cohorts may emerge on each dimension (Burchardt et al., 2002). The Australian research recognised this position but argued that the more dimensions a person has present, the greater their risk of social exclusion.

Wellbeing and Transport

The concept of wellbeing comes from two distinct theoretical bases. Firstly, it arises from concepts around social justice which lead to social policy to assist in achieving a more equitable outcome. As Manderson (2005, p. 2) notes "...we have a self-interest in meeting the needs of people to function fully and independently, according to their capacity, thereby to contribute to the public good. We also have an interest in reducing distress, want and disease." This notion of wellbeing also includes ideas around values. The emphasis (and perhaps even inclusion) of various components of wellbeing will vary according to beliefs about notions such as equality of opportunity, positive discrimination, and rights and responsibilities. Secondly, ideas about wellbeing arise from psychology (e.g. Diener, Suh, Lucas, & Smith, 1999), which has a strong interest in measurement of personal attributes in contrast to the more theoretical and philosophical perspective taken in the first approach.

The connection of mobility to wellbeing is a more recent area of study than that of links between transport and social exclusion. This is somewhat surprising given the high value people generally ascribe to wellbeing (Hamilton & Rush, 2006), its association with a range of other highly valued outcomes such as positive relationships, low health care use and productivity (Keyes & Grzywacz, 2005; Lyubomirsky, King, & Diener, 2005) and the growing interest in going beyond Gross Domestic Product as an indicator of national welfare, such as the report commissioned by Sarkozy (Stiglitz, Sen, & Fitoussi, undated).

Government policies and initiatives, such as improving transportation systems, might then be seen as having the ultimate goal of enhancing the wellbeing of individuals and groups, communities and society generally. This is achieved by enabling them to be satisfied with life, standard of living, health, achievements in life, personal relationships, feeling part of their community, and safety and future security. This line of reasoning has recently been taken up by Ettema, Gärling, Olsson, and Friman (2010), who propose the direct application of subjective wellbeing in transportation contexts. Given links between wellbeing and utility, and the role of the latter (in monetised format) in cost-benefit analysis, this is an emerging direction in transport analysis and evaluation. Van Praag and Ferrer-i-Carbonell (2004) have used such an approach in evaluating aircraft noise nuisance.

In recognition of a likely connection between mobility and wellbeing, some recent studies have focused on understanding and measuring this association. The European MOBILATE project (Mollenkopf et al., 2005) studied relationships between mobility and subjectively assessed wellbeing among older Europeans. Structural equation modelling undertaken as part of this research found a significant relationship between outdoor mobility and quality of life (as measured by affect and life satisfaction measures as defined below).

Spinney et al. (2009) examined links between mobility and wellbeing for older Canadians, using time budgets to highlight activities that are expected to produce psychological, exercise, and community benefits for participants, finding significant associations between mobility benefits and subjective wellbeing. Neither Spinney et al. (2009) nor Mollenkopf et al. (2005) included social exclusion in their analyses.

Not all studies have found consistent benefits of mobility on the full range of quality of life or wellbeing outcomes studied (for example, Spinney et al., 2009) and some research has explored potential mediators and moderators of the mobility-wellbeing relationship.

Measurement

The research undertaken by the authors and colleagues drew on the psychological measurement of wellbeing. Wellbeing is usually measured as subjective wellbeing (SWB), which expresses individuals' cognitive and emotional wellbeing (using psychometric measurement scales). Diener, Emmons, Larsen, and Griffin (1985) suggest that there are three components of SWB: positive affect (PA), negative affect (NA), and a cognitive component that measures satisfaction with life as a whole.

Affect (or mood) is often measured by a 20-item self-report scale (PANAS) which measures positive and negative affect to describe the way people feel, using a 5-point scale ranging from "very slightly or not at all" to "extremely" (Watson, Clark, & Tellegen, 1988). The cognitive component is often measured by the Satisfaction with Life Scale (SWLS) (Diener et al., 1985), which measures a person's assessment of their life through a five-item measure of satisfaction, rated on seven-point Likert scales. The Personal Wellbeing Index (PWI) (International Wellbeing Group, 2006), which the present authors have found to be highly correlated with the SWLS measure, may also be used for this purpose. The PWI measure requires people to rate their satisfaction from 1 to 10 on 8 dimensions for adults and five dimensions for adolescents.

Social Capital and Sense of Community

People are thought less likely to be at risk of social exclusion when they are embedded in social structures: family and friends, the community and society (Bronfenbrenner, 1979). The concepts of social capital and sense of community are relevant in this regard. Social capital is rarely linked with public transport and connections with community even less so. Putnam (1995, 2000) devotes little attention to mobility except to note that long car journeys may reduce social capital. Putnam notes that two-thirds of car trips (in the US) involve solo driving and that this is increasing, and that the time and distance of commuting is increasing, with the consequence that time is reduced for community engagement. He recommends less travel time and better design of communities to encourage more casual socializing. Urry (2002, p. 265) argues that co-presence is necessary and that mobility is "...central to glueing social networks together" and that the development of social capital depends on the range, extent, and modes of travel to prevent social exclusion. He talks about the need for co-presence for the development of trust, a component of social capital. However, this is questioned in more recent work, where it is argued that spatial distance and networks have changed with electronic communications and that face-to-face contacts (and therefore the physical need to travel) is not always needed for social capital development (Larsen, Axhausen, & Urry, 2006; Larsen, Urry, & Axhausen, 2006).

Gray, Shaw, and Farrington (2006) refer to lift-giving and social capital in rural areas, where some people without a car manage to "get by", social capital making up for transportation market failures. The importance of the lift itself as a source of social capital has been noted (J. K. Stanley & J. R. Stanley, 2004). An overview of social capital and transport was undertaken by Currie and J. R. Stanley (2008).

Community strengthening occurs where a sense of neighbourhood develops and people become actively engaged in the community. They feel socially connected, may become volunteers or leaders, and a sense of community pride is established (Vinson, 2004). As with social capital, positive views about, and involvement in, the community increase individual capacities and opportunities.

Measurement

Social capital is commonly viewed as the development of (1) social networks, (2) trust and (3) reciprocity between people (Putnam, 1995). Measurement requires (1) measures of the frequency with which respondents keep in touch with members of their close family, members of their extended family, friends/intimates, neighbours, work colleagues, people associated with groups in their community (such as church, sporting, clubs, school self-help or voluntary groups), and governmental officials or community leaders; (2) measures of the extent to which respondents trust other people; and (3) measures of reciprocity (for example, the extent to which respondents feel that people are willing to help out in their local community).

Two types of social networks are thought likely to be particularly relevant to risks of social exclusion: bonding and bridging networks (Stone, Gray, & Hughes, 2003). Bonding networks exist between family, friends, and neighbours and assist the process of "getting by" on a daily basis. Bridging networks allow people to "get ahead" by accessing resources and opportunities through contacts with work colleagues and people associated with wider groups, such as local government, schools, and sporting clubs. It is these types of contacts which facilitate access to new networks and opportunities.

A comprehensive measurement scale of community engagement, such as the Sense of Community Scale involves a wide range of contributory elements (McMillan & Chavis, 1986). A shorthand measure, highly correlated with the longer Sense of Community Scale, is available via the answer to the question, "I think my neighbourhood is a good place for me to live", which is one of the components of the Sense of Community Scale. The latter measure was used in the Australian research reported below.

Connections Between Mobility and Social Concepts

Method

To the best of our knowledge, J. K. Stanley et al. (2011b) is the only study that has attempted to establish connections between mobility (measured as trip making and aligning with engagement in activities), social exclusion (measured as the number of social exclusion risk thresholds, out of the possible five listed above, exhibited by people) and wellbeing (measured by the Personal Wellbeing Index) in an integrated model. Extensive and wide-ranging data was examined in interviews with 1,019 people (aged 15 and above) living in urban and rural locations in Victoria, Australia. As many surveys miss those who are socially excluded, a special survey methodology was developed which accessed this group through welfare agencies. The information gathered included the measures as defined above, as well as many other variables which may influence outcomes for people. For example, comprehensive demographic

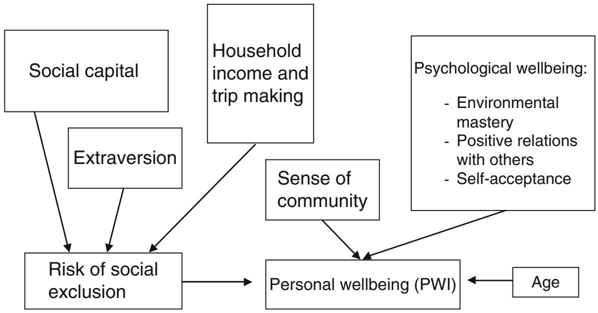

Fig. 1 Mobility, social exclusion, and well-being

factors, living conditions and locations, household composition, income, education, employment, views about their local community, safety issues, personality traits, affect, participation patterns and much about travel options, habits, choices and views, were collected.

Findings

Figure 1 sets out the approach that was modelled (using three-stage least-squares modelling). Partial correlation coefficients showed that trip rate was not significantly correlated with PWI (the Personal Well-being Index) but that it was significantly correlated with risk of social exclusion. This in turn is significantly correlated with wellbeing.

Inclusion of Other Characteristics

The key concepts embedded in modelling have been explained above. In addition to those elements, the model included a measure of personality, which is one of the most consistent and strongest individual difference factors associated with wellbeing (particularly the personality trait of extraversion) (Diener et al., 1999). The Ten Item Personality Inventory (TIPI) (Gosling, Rentfrom, & Swann, 2003) was used to provide a measure of extraversion. Age was also included, drawing on work by Mollenkopf et al. (2005), Spinney et al. (2009), and Van Praag and Ferrer-i-Carbonell (2004).

Separate models were estimated for Melbourne metropolitan area (about four million population) and for a regional area in Victoria (population about 100,000, spread between four main urban centres and rural areas). The major reason for developing the two separate models was to assess if the implied values for additional trip making (discussed below) were similar between the metropolitan and regional settings, this valuation exercise being a key motivation for the research. For consistency all the variables listed in Fig. 1 were thus included in both models.

The J. K. Stanley et al. (2011b) Melbourne analysis suggested that a lower relative risk of social exclusion is associated with people having contact with members of their close family more frequently than once a year but less than once a month, contact with members of their extended family, trust in people in general, relatively higher income, relatively higher trip rates, and being more extrovert. A person's personal wellbeing (PWI) was found to be likely to be greater the lower their risk of being socially excluded, the greater their sense of attachment to community, the greater their sense of mastery over their environment, the greater their positive relationship with others, the more positive their self-acceptance, and with age. Social capital variables were not significant in the regional model but sense of community remained a significant contributor to PWI, with the estimated coefficient suggesting a stronger link than in the Melbourne results. The data confirm that sense of community is measuring something different than social capital (simple correlation coefficients between measures of the two concepts in the research were all less than 0.2). Indeed, sense of community is related to, but not the same as, community strength, which shares a few commonalities with social capital. Sense of community reflects whether the persons like where they live, depending on how they view what is important to them.

The three Personal Well-Being variables were not significant in explaining variations in PWI in the regional model. This was unexpected and deserves further research. It may suggest that rural regions derive much of their life satisfaction from connection to community, which accords with our understanding of Australian regional life. City residents may have a broader range of ways available for achieving life satisfaction. It is also noteworthy that the regional PWI model was inferior to the metropolitan model in terms of overall explanatory power (J. K. Stanley et al., 2011b), suggesting the need to search for additional contributory variables.

Both household income and trip making had a significant influence on risk of social exclusion in both models. The relative coefficient estimates can therefore be used to impute the value of an additional trip. The implied value of an additional trip was $24.40 (2008 prices) in the Melbourne study and a very close $19.40 for an additional regional trip, in both cases being valued at the relevant sample mean household income. Modelling included household income squared as the best way to express that variable, which means the value of an additional trip is higher for those with lower household incomes.

These are high unit values, which can be used to value the benefits of increased trip making as it contributes to reducing the risk of social exclusion. Application of the Melbourne value in a case study of the benefits of that city's route bus system suggested that social inclusion benefits are the largest single benefit from the services, being greater than the total cost of service provision (J. K. Stanley & Hensher, 2011). Congestion cost savings were the second largest benefit. The high unit trip value was assessed as being relevant to about one in three trips on the Melbourne bus network.

Table 1 Dimensions on which 139 respondents with three or more risk factors were at risk

SE dimension	Number	Per cent
Income	115	83
Employment	98	71
Political engagement	82	59
Participation	50	36
Support	109	78

A very important implication of this research is that transport policy initiatives that seek to reduce the external costs of car use, such as greenhouse gas (GHG) emissions, should focus on trip lengths rather than trips. Trips have high value because of the activities they facilitate. The primary aim should be to enable this value to be realised with shorter travel distances. This underlines the importance of the land use/accessibility dimension.

The unit trip value derived in the Australian research was not mode specific. An implication is that in regional and rural areas, for example, where public transport service availability is usually thin and car dependence high, additional travel (by whatever mode) by people at risk of social exclusion has high value. This may be travel that relies on a lift-giver in a private car. The high value has strong intuitive sense in that setting. Equally, transportation improvements that enable cycling where it was not possible before, may also activate high values for new trips by people at risk of social exclusion.

Findings for Groups at High Risk of Social Exclusion

The Australian research devoted particular attention to understanding differences between people who were at high risk of social exclusion (exhibiting at least three of the five risk factors) and those at very low or no risk (no risk factors exhibited). Some 139 of 1,019 survey respondents were in this high-risk category, with the particular risk factors exhibited being broadly spread across the five risk categories (Table 1), while 355 had no risk factors.

Wellbeing

Table 2 shows that the wellbeing of those with 3+ risks of social exclusion was considerably lower than for the sample as a whole and lower still than for the sub-group with no social exclusion risk factors, on both the Personal Wellbeing and Satisfaction with Life Scales.

For the Satisfaction with Life Scale, the world average sits at 70 % + or –5 % (Cummins, 2011), which was the average for the full sample in this study. The percentage score at 54 % for the high-risk group in this survey is well below this

Table 2 Wellbeing measures for groups with different levels of social exclusion (SE)

Wellbeing measure	3+ SE risk factors (N = 139)	Total sample (N = 1,019)	No SE risk factors (N = 355)
Personal wellbeing scale (range 1–10)	5.5	7.1	7.7
Satisfaction with life scale (range 1–7)	3.8	4.9	5.4
Positive affect (range 1–5)	3.3	3.5	3.7
Negative affect (range 1–5)	4.8	1.8	1.7

level, thus suggesting those with three or more risks of social exclusion have decidedly low wellbeing.

For positive (PA) and negative affect (NA), the scales ranged from 1 to 5 (Table 2). Those with higher levels of risk of social exclusion had slightly lower positive affect and a much greater level of negative affect than both the total sample and more particularly than those exhibiting no risk factors. This again suggests that people with a high risk of social exclusion have a lower quality of life.

Those who have the greatest risk of social exclusion have lower levels of bonding and bridging networks and are less connected to the community. They have lower positive affect and higher negative affect. Thus, it would seem that if we are concerned about an individual's wellbeing, it is important to raise the levels of the personal and social interaction variables.

Mobility

The average number of daily trips for the sample as a whole was 3.7. This diminishes by about 0.2 trips per unit increase in the number of social exclusion risk factors. Those with three or more risk dimensions were considerably less likely to own a car, had fewer cars in the household, were much more likely to use public transport more than once a week and reported transport difficulties more frequently than those exhibiting no social exclusion risk factors (Fig. 2). Twenty-five per cent of respondents with three or more risk factors reported they cannot do some activities because of lack of transportation. The most frequent activities nominated were enjoyment, getting out and about, and sporting activities. These activities are integral to social capital building, so the reported difficulties will impact on this capacity.

Those at most risk of social exclusion, ceteris paribus, had lower trip rates than more socially included people and their wellbeing was rated as lower. As noted above, trips were not closely correlated with wellbeing in this Australian research but were correlated with risk of social exclusion and that, in turn, correlates with wellbeing. Those with higher levels of risk of social exclusion are likely to do less trips. However, higher trip rates are associated with stronger bridging networks and to a lesser extent with bonding networks. These, in turn, are correlated with

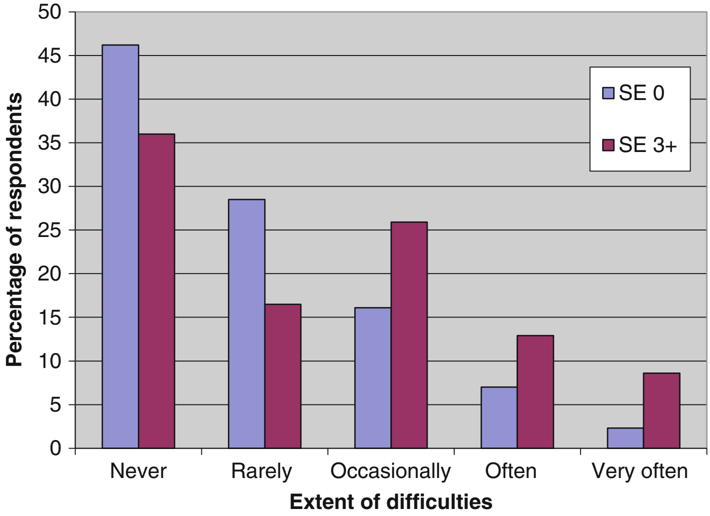

Fig. 2 Percentage respondents reporting difficulty accessing activities due to lack of transportation

wellbeing. Trips thus appear to have a direct link with risk of social exclusion and an indirect link with wellbeing, through supporting social networks, underlining the importance of adding a wellbeing dimension to social exclusion research.

Discussion

Lucas (2012) notes that the agenda for the travel behaviour research on social exclusion has grown considerably over the past decade. This growth is now including a stronger focus on wellbeing (e.g., Ettema et al., 2010; Mollenkopf et al., 2005; Spinney et al., 2009) and on links between transportation, social exclusion, and wellbeing (J. K. Stanley et al., 2011b).

It is likely that this research agenda will increasingly merge with growing wider accessibility research agendas, where the focus is on matters like understanding drivers of house/land prices, employment location decisions, and agglomeration economies. This will enable a more dynamic understanding of transport and social exclusion and help shift the policy focus towards a more integrated perspective, because of the strong land use element in accessibility research. This should help strengthen land use perspectives on policy directions to tackle social exclusion.

Lucas (2012) suggests that the social exclusion research agenda has had relatively poor policy take-up, Victoria (Australia) being noted as a possible exception. The Victorian effort, however, like efforts in many other places, is hitting limits from governmental philosophy and governmental funding barriers. Flexible transportation solutions, which are advocated by many proponents as effective ways to help reduce some travel-related social exclusion, are less likely to be delivered in this funding environment, because of their higher costs than fixed route public transport.

The political response to funding constraints is often to exhort "doing more with less". In many environments this is defensible. In the US, for example, public transport is considerably cheaper than paratransit on a passenger unit basis. The same is true in Australia for public transport compared to community transport. While some people will never be able to use public transport, and social justice arguments may strongly support attention to meeting their particular travel needs, those community transport passengers who are capable of using public transport should do so, to avoid wasteful system duplication.

There are often opportunities to make better use of existing travel opportunities, provided barriers can be overcome. For example, in regional areas there are often free school bus services with spare seating capacity that could be used by others. Welfare or other groups may have been provided with vehicles by community service agencies, vehicles which frequently sit idle. Some people are happy to volunteer to assist others. Capturing such opportunities will be increasingly important to sustaining social inclusion in regional areas in times of tight governmental budgets. Given the significant role played by attachment to community in regional wellbeing, social enterprise type business models for tackling travel-related social exclusion at local levels, involving service providers, people needing transport and client agencies (e.g., hospitals, welfare agencies), may be productive in this environment. This means local empowerment, ideally with strong positive support from higher levels of government.

Doing more with less is most likely to be fruitful where properly integrated approaches are taken to transportation. This includes integration across public transport, paratransit/community transport, and school transportation but, more particularly in urban areas, integrating transport policies and programmes with land use and also with social policy. The broadening approaches starting to emerge on accessibility are supportive of more integrated approaches.

An increase in mobility to improve inclusion and wellbeing could be viewed as conflicting with the need to reduce GHG emissions from travel. However, both social and environmental sustainability can be achieved, and indeed there can be clear co-benefits, if improved mobility is achieved primarily by improvements to public transport, walking, and cycling opportunities. These modes typically have lower GHG emissions and also deliver positive allied benefits in terms of, for example, lower congestion costs, improved safety outcomes, and reduced obesity risks. Steps can then be taken to limit potential rebound impacts, where a resultant lessening of congestion might encourage people back into cars. This includes measures such as reducing available road space and increasing green space or other public uses, together with prioritisation of remaining road space to high occupancy vehicles and freight transportation.

Conclusions

Research suggests that, the lower the level of realised mobility (and hence the fewer activities in which people are likely to engage), the higher the likelihood that people are at risk of social exclusion with mobility origins, and reduced wellbeing. It also shows the importance of the mediating factors of social capital and sense of community to achieve social inclusion and self-rated satisfaction with life, which in turn confirms the importance of the ability to have mobility. In Sen's (1992) terms, this suggests a role for mobility (as a means of achieving accessibility) as an important capability that should be pursued through transport and social policy.

Australian valuation work advances the scope for including transportation initiatives that are intended to improve the mobility of people at risk of social exclusion within more conventional cost-benefit analysis frameworks. This work shows high unit values of initiatives that enable increased trip making, which implies increased engagement in activities.

Travel is vital in achieving access to opportunities and accessibility-oriented approaches have been particularly important in framing UK approaches to reducing social exclusion with travel origins. The strength of an accessibility approach is that it helps to focus attention on both travel opportunities and on activity locations and perhaps the need to adjust services as possible ways of reducing social exclusion, underlining the need to seek solutions in both spaces.

Increasing interest in accessibility as one part of effective density and a driver of agglomeration economies opens up opportunities to further build understanding of the role of accessibility in residential and business location decisions, which will strengthen understanding of social exclusion in a more dynamic context and should support the development of more integrated approaches to transport and land use, one of the hottest topics in transportation at present.

The danger with an accessibility-based approach is that it invites politicians and planners to specify those activities to which they believe people should have good access. This frequently means employment, health care, shops, and community services. The authors' research, however, suggests that people at risk of social exclusion use the opportunities provided by improved mobility to build their social capital, often through leisure-type activities. This is important in both reducing risk of social exclusion and promoting wellbeing. Personal control over choice is also important to wellbeing. Accessibility-based approaches should be careful to not impose narrow values about how best to improve the wellbeing of people at risk for social exclusion. There is benefit in people being free to exercise their own choices.

Government budget pressures are likely to mean less focus on transportation programmes to tackle travel-related social exclusion. Responding to these pressures in a way that does not see significant loss of progress in programme delivery seems likely to require a more concerted focus on the interrelationship between transport, land use, and social policy and programme integration and on new governance arrangements, involving greater cross-stakeholder local empowerment.

Directions for Further Research

More work is needed on filling in the gaps relating to the place of transportation in meeting the broad social policy agenda. Research reported here suggests that travel has an important role returning high benefits for those with low wellbeing when travel is facilitated. The authors suggest that the place of transportation in achieving other aspects of wellbeing (safety, social interaction, self-esteem, and self-actualisation) now needs further exploration. An interesting and largely unexplored finding which has arisen from the above research, which needs further examination, is the place of personal control. The instrument "Locus of Control" (Rotter, 1966) was used in the Australian research to examine personal beliefs about controlling events. The strong association identified between a belief about low levels of personal control in the group of people who experienced the highest social exclusion and the high levels of beliefs about personal control in those who had high bridging social capital suggests the connection with transportation may be important. It suggests that issues like choice in transportation is likely to be important, with the implication that transportation needs to be as mainstream as possible, in preference to some models of community transport, which offer little choice about travel destinations, times, and fellow passengers.

Thus, while the field is growing, the social goals of transport need considerably more research. Some social goals have been partly examined. These include an examination of the ability to be mobile, for those who have low mobility. It accords with a common sense of justice that social goals have concentrated on these groups. The requirements to be able to acquire basic needs, such as access to shops, and to gain access to some intermediate goals such as employment, which build capabilities to satisfy needs, are also considered in transportation research. However, there are gaps in the exploration. The need for friendships and to connect with others is often overlooked in transport policy. This is the important role of interaction with others in building opportunities (for example, gaining jobs through network contacts) as well as building capabilities, self-esteem, and promoting self-actualization.

Related to this is the overlooking of leisure and recreational activities as a means of building networks and other opportunities. Leisure is the most important trip purpose with respect to travelled distance, even overtaking commuting travel (Schlich, Schönfelder, Hanson, & Axhausen, 2004). The ability to get to leisure activities is very important but often given low priority in terms of urban planning and in relation to priorities in the community. Many of these overlooked activities, including the opportunity for choice and control, build capabilities, thus offering preventative approaches and cost-effective solutions.

Social policies relating to those who might not be defined as transport disadvantaged also need considerably more examination. This includes issues around accessibility, urban agglomeration and the possibility that some people might have "too much mobility" (e.g. in terms of direct understanding about impacts on wellbeing and less directly in terms of GHG emissions).

The authors conclude that the social goals of transportation are still to be adequately examined, the importance of transportation in meeting social goals and maximising wellbeing remaining only partly understood. We still believe that its significance is, most probably, grossly undervalued.

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Rose Tinted Memories as a Cause of Unsustainable Leisure Travel

Jeroen Nawijn and Paul Peeters

Introduction

Most basic human needs are met in affluent societies (Maslow, 1970). This allows individuals to work towards "reaching their full potential" (Maslow, 1968; Rogers, 1963). This search for a purpose or meaning in life supposedly coincides with pleasant feelings and better life satisfaction. More recently, this phenomenon has led to an increased attention to happiness or subjective well-being (SWB), mainly within the fields of psychology and economics (e.g., Fredrickson & Losada, 2005; Kahneman, 2003; Kahneman, Wakker, & Sarin, 1997; Seligman, 2002). Terms as "happiness", "experienced utility" and "subjective well-being" have been introduced and are used in different ways by different authors in different disciplines. Happiness is considered an enduring type of satisfaction with life as a whole (Veenhoven, 2010). Generally speaking, it consists of two components; a cognitive component and an affective component. When assessing their happiness, individuals consider how well they feel and to what extent their life meets their needs and wants (Veenhoven, 2009). The latter appraisal is more long-term and cognitive, whereas the former is more short-term and affective in nature. Cognitive evaluations of SWB include judgements of life satisfaction and domain satisfactions. Affective evaluations include emotions and mood (Diener, 1984; Diener, Suh, Lucas, & Smith, 1999).

J. Nawijn (✉) • P. Peeters
Academy for Tourism, Centre for Sustainable Tourism and Transport, NHTV Breda University of Applied Sciences, Breda, P.O. Box 3917 4800 DX, The Netherlands
e-mail: nawijn.j@nhtv.nl; peeters.p@nhtv.nl

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Affect and Cognition

Cognitive theories hold that SWB is relatively stable. Both comparison theory and set-point theory posit that people have a genetically determined set-point from which they defer only temporarily due to certain life events. They return to their set-point through adaptation and comparison processes, also referred to as the hedonic treadmill (Brickman & Campbell, 1971). This assumption of stable happiness is mostly based on twin studies (e.g., Lykken & Tellegen, 1996), which suggest that genetic factors may explain up to 52 % of an individual's SWB. However, empirical research has shown that it is possible for people to change their life satisfaction significantly and permanently (Diener & Lucas, 2006; Headey, 2008, 2010; Headey, Muffels, & Wagner, 2010). Still, as life satisfaction is mostly evaluated over a longer period of time (e.g., a whole year), events that are brief and mild in nature have usually little effect. This is the case with voluntary changes in leisure travel, which have no effect on an individuals' yearly life satisfaction (Nawijn, 2011b). However, this may be different after forced changes in behaviour. We discuss this later in this chapter.

So far, affect and cognition have been treated as almost separate phenomena. Yet, cognition and affect are interlinked. For instance, positive emotions can increase life satisfaction (Cohn, Fredrickson, Brown, Mikels, & Conway, 2009) and generally happy people have a tendency to experience more positive mood (Veenhoven, 1984). As mentioned earlier, the affective component of SWB consists of emotions and mood. Although these terms are used interchangeably, there are distinct differences between the two (Beedie, Terry, & Lane, 2005). For instance, according to Beedie et al.'s study (2005), emotions, in contrast to mood, are more clearly defined, more felt, more intense, but also more fleeting and volatile and have a specific cause. Thus, a major distinction between mood and emotions is that mood stems mostly from the person, whereas emotions are mostly caused by events or environmental aspects. For this reason, we focus specifically on emotions instead of mood.

Leisure Travel

Definitions of leisure travel vary. Differences exist and are based on the nature of travel, the language used, and the disciplinary background. A "holiday trip" is commonly defined as "a trip for leisure purposes outside of the usual environment for not more than one consecutive year" within the tourism and leisure literature. Depending on nationality or preferred language, the terms "holiday trip" (British English) or "vacation" (American English) are used. There is much confusion about the definition of a "tourist". Psychological literature mainly speaks of a "vacation", which can also be enjoyed at home. A "vacation" in the psychological literature is often regarded simply as a break or respite from work. A stay at home is not considered a true vacation in the tourism literature, but is rather referred to as a "staycation". Strictly speaking, "leisure travel" may also refer to daily leisure travel, without the requirement of an overnight stay.

In most official statistics, such as those of international organizations as the World Tourism Organisation (UNWTO), the OECD or the European Union (see UN, 2000), three main motives for tourism are considered: business, leisure and visiting friends and relatives (VFR). The shares of leisure (55 %), VFR (30 %) and business (15 %) seem relatively constant over time and are envisaged not to change much in the future (UNWTO, 2011). However, many scholars in the wider tourism and leisure literature do not consider business travel as true tourism and are not decisive about VFR. As the tourism infrastructure (i.e., transportation and accommodation) serves all three motives in a mixed way, there is scope for the global UNWTO definition.

For our purpose, the main question is whether the psychological mechanisms differ between the three main forms of tourism. Obviously, the characteristics of business, VFR, and leisure travel will differ in terms of spending, cost, accommodation choice, and destination choice, but the psychological mechanisms to choose within these constraints might be rather similar (Dresner, 2006; Neulinger, 1974), particularly as business travellers often mix different forms of tourism such as visiting friends or engaging in leisure activities while visiting family (Jackson, 1990). In this chapter we stick principally to the broad definition of tourism, though much of the psychological mechanisms described are based on leisure travel alone. Consequently, we define leisure travel in accordance with the UNWTO (1995, p. 1) definition of tourism as "[t]he activities of persons travelling to and staying in places outside of their usual environment for not more than one consecutive year for leisure, business and other purposes."

Environmentally Sustainable Tourism and Leisure Travel

Sustainable development is generally envisaged as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987, p. 43). Environmental impacts of tourism range from air and water pollution and climate change to finite resource use, land-use and noise nuisance (Button, 2003; Gössling, 2002; Gössling & Hall, 2006; Holden, 2008). The impacts occur at all scales from the local (e.g., at the destination on landscape, nature, local air and water quality, waste, noise; Holden, 2008), the national and regional (e.g., contributions to acidification through tourism transport; Peeters, Szimba, & Duijnisveld, 2007) to the global (e.g., climate change, water use, resources use, and some impacts on biodiversity through the dispersal of alien species; Gössling & Hall, 2006).

Tourism may have strong local impacts on water use (Gössling et al., 2012), landscape and nature, noise, and local air quality (Peeters et al., 2007). However, a study on the externalities of tourism and tourism travel indicates that the global impact on climate change takes the largest share (Peeters et al.). Therefore, we will take the contribution of tourism to climate change as a proxy for the unsustainability of tourism.

Tourism's global contribution to climate change ranges between approximately 5 and 14 % of global greenhouse gas (GHG) emissions (Gössling, Hall, Peeters, & Scott, 2010; Scott, Peeters, & Gössling, 2010; UNWTO-UNEP-WMO, 2008). Despite the fact that this is a significant contribution, the main sustainability problem is the projected development of these emissions. Assuming a sustainable development of global GHG emissions (e.g., 3–6 % reduction per annum; Parry, Palutikof, Hanson, & Lowe, 2008) and continued growth of tourism emissions, several studies show that by mid twenty-first century, tourism's emissions alone will be larger than total emissions considered to be sustainable, effectively blocking the sustainable development (Scott et al., 2010; UNWTO-UNEP-WMO, 2008). This projection even takes into account realistic technological development of fuel efficiency in transportation and accommodations.

Current tourism-related CO_2 emissions (including leisure, business, and VFR) are mainly caused by transportation (72 %), followed by accommodations (24 %) and local tourism activities (4 %) (Peeters & Dubois, 2010). In terms of GHG emissions and a consequent contribution to global warming, the impact of air transportation is much higher. It could be up to 75 % of all tourism emissions, while aviation serves less than 20 % of all tourism trips (Gössling et al., 2010). These facts have consequences for the way to reduce emissions towards a sustainable path. Two systems approach studies found that far-reaching improvement in technological solutions (i.e., energy efficiency) does not suffice to reduce emissions significantly (Dubois, Ceron, Peeters, & Gössling, 2011; Peeters & Dubois, 2010). Moreover, these studies showcase that rather strong changes in current behavioural trends are necessary. Most interestingly, an economically optimized (i.e., maximum net revenues) tourism system in 2050, emitting 70 % less with reference to the 2005 emissions shows only two outcomes. Either it would combine current volume of air transportation with a large shift from car to train or bus for all other trips, or it would strongly reduce the amount of air transportation, combined with current global modal split between car and other surface transport. In both cases, large changes in travel behaviour are required and need to be facilitated by the sector. These changes comprise (1) less flying and therefore also a shift from long haul to medium and short haul travel, (2) less use of the private car and more use of train and bus, and (3) less frequent travel, but for a longer length of stay, to compensate for the economic loss of less trips (Peeters, Gössling, & Lane, 2009). Thus, to develop sustainably, tourism needs to use less transportation (i.e., shorter distances travelled by choosing on average more destinations close to home), longer lengths of stay, more use of environmentally friendly travel modes such as bus, train or even bicycles (e.g., Eijgelaar, Piket, & Peeters, 2011; Peeters et al., 2007, 2009; Peeters & Dubois, 2010).

Role of Subjective Well-Being for Unsustainable Leisure Travel

The "Rosy View" in Decision Making

Numerous consumer behaviour decision-making models and specific tourism decision-making models exist. Sirakaya and Woodside (2005) provided a useful overview of these models and concluded that several propositions can be made from the existing models and empirical evidence. According to their analysis, tourists adopt a funnel approach when choosing a holiday destination. A number of variables play a role in this process, such as motivations, images, attitudes, beliefs, and time and money constraints. Options within choice sets decrease over time until a choice is made. Tourists tend to reduce risk as much as possible and prefer personal sources of information over non-personal. Obviously, prior experience reduces the need for information search. The level of involvement in the decision-making process influences the final decision.

Most existing studies use the point in time when the decision to go on vacation is made as the starting point of the decision-making progress. In doing so, the processes that take place before that decision is are seemingly ignored. For our purpose, the more relevant question is why one wants to go on a vacation in the first place?

The "rosy view" phenomenon tells us that tourists overestimate the happiness experienced during vacations (Mitchell, Thompson, Peterson, & Cronk, 1997). The actual experience is perceived less enjoyable than anticipated experience and recollected experience. Wirtz, Kruger, Scollon, and Diener (2003) further analyzed future vacation choice by investigating how the anticipated, on-line (i.e., during vacation), and remembered vacation experience in terms of emotions, predicted the desire to take a similar vacation in the future. They found that not on-line or predicted experience, but remembered experience predicted the desire to repeat the vacation. Thus, a rosy memory – accurate or not – is a major determinant for future plans for vacation travel. More recent neurological research supports these empirical observations revealing that the area in the brain that gives humans the ability to imagine the future is the same area that allows recollection of the past (Schacter, Addis, & Buckner, 2007).

Human emotional functioning is best interpreted by looking at the ratio of felt positive to negative emotions during a certain time period (Fredrickson & Losada, 2005). In everyday life, individuals generally experience a ratio of positive to negative emotions of 2-to-1 (Fredrickson, 2009; Fredrickson & Losada, 2005; Zelenski & Larsen, 2000). This is very different on vacation. The ratio of positive to negative emotions exceeded 4-to-1 in Wirtz et al. (2003) and this finding has been replicated more recently (Nawijn, 2011a). Different theories exist of how people remember past experiences and what they remember. For instance, the peak-end rule implies that peaks and ends of a vacation are best remembered (Fredrickson, 2000), but empirical evidence fails to support this rule for leisure travel trips (Kemp, Burt, & Furneaux, 2008). A likely explanation for this failure is that happiness levels are quite stable over the course of a trip (Kemp et al., 2008; Nawijn, 2010, 2011a; Nawijn, Mitas, Lin, & Kerstetter, 2013). Thus, people feel much better during vacation compared to everyday life and they do so throughout the entire course of the trip. Moreover, this peak in tourists' feelings is viewed through rose-tinted glasses after return home (Mitchell et al., 1997). Consequently, extremely positive memories may function as a driver for future travel. However, as behaviour is changing towards more use of fast transportation and travelling longer distances to destinations for a shorter stay, apparently the rosy memories are not constant. Only by assuming another mechanism it is possible to understand this dynamic. We hypothesize that a mechanism may be found in the social dynamics as is described in the next section.

Social Dynamics and Flow of the "Rosy View"

Happiness is not fully an individual phenomenon, but it is part of social dynamics. According to Fowler and Christakis (2008, p. 1), "[p]eople's happiness depends on the happiness of others with whom they are connected. This provides further justification for seeing happiness, like health, as a collective phenomenon." Furthermore, Fowler and Christakis (2008) show through longitudinal studies that the social clustering of happy people is not the result of similar types of people gathering together, but it is representing the flow of happiness itself. Bond et al. (2012) found that ideas spread through social networks, both in the real world and online. As in the work by Fowler and Christakis (2008), they measured impacts up to the third level of relations (friend-of-friends-of-friends). The role of social networks has also been acknowledged in the development of tourism (Decrop, 1999) and tourism markets (Potts, Cunningham, Hartley, & Ormerod, 2008). Although no specific study on flow of the "rosy views" of travel memories has been published, it is likely that the way memories are viewed by tourists is easily influenced by the social networks, thus enhancing the rosiness of the views exchanged.

The question can now be posed how the social norm would drive the "rosy view" into a certain direction. For this we need to understand that not all tourists are equally susceptible to social norms or peer pressure. E. Cohen (1972) divided tourists in four groups: the organized mass tourist, the individual mass tourist, the explorer, and the drifter. These groups differ in the degree they divert from the "beaten track". The supposed mechanism is that drifters – a small group of 9 % (Lepp & Gibson, 2003) – shift boundaries of behaviour (e.g., exploring long haul destinations). Consequently, they shift the social norm to their non-drifters peers, who now view long haul trips more favourably than before. This idea is in line with insights from behavioural economics, where the role of shifting reference points to the psychological valuation plays a crucial role in understanding people's shifting behaviours (as in prospect theory, see for instance Kahneman & Tversky, 1979; Van de Kaa, 2010). The rosy view will shift slowly towards the drifters' norms.

These norms are towards travel as habit and an increase of distances travelled and fast transport modes to enable these habits, even leading to "addictive" forms of travel (S. A. Cohen, Higham, & Cavaliere, 2011).

Determinants of Vacationers' Happiness and Sustainability

In the preceding section a mechanism was proposed for the increase in distance tourists tend to travel. We argue that this is the main driver for the unsustainable development of tourism. Another important factor in this regard is length of stay. It appears that tourists feel generally good during vacations, but this is not affected by the length of stay (Nawijn, 2010; Nawijn et al., 2012). This is also reflected in the post-trip phase, where only a selected few still enjoy an "afterglow" effect of vacationing on their emotion balance, but this is again unrelated to length of stay (Nawijn, Marchand, Veenhoven, & Vingerhoets, 2010). In the same study it is also found that, in the pre-trip phase, vacationers experience a higher ratio of positive to negative emotions compared to non-vacationers. The argument is that this could be caused by anticipation of the upcoming trip. It would suggest that individuals would benefit most from their vacation days if they spread them out over the year, consequently reducing the average length of stay, while increasing their annual trip frequency.

Stress negatively affects the emotion ratio of leisure travellers on vacation (Nawijn, 2011a). Stressors during vacation are long travel periods, a lack of personal time and culture shock (Nawijn, 2011a; Pearce, 1981; Steyn, Saayman, & Nienaber, 2004). However, it appears that most tourists are not under much stress during vacation (Nawijn, 2010), which explains the low level of negative affect during vacation (Nawijn, 2011a; Wirtz et al., 2003; Zins, 2002).

But there is another issue regarding the relation between sustainable development of tourism and happiness: the impact of the changes required for sustainable development (less long haul, longer stays more by train and coach) on happiness itself. These factors have an unknown effect on vacationers' happiness. This is particularly evident for mode of travel. Some research on daily travel suggests that reduced car use would negatively affect individuals' SWB through satisfaction with performance of activities (Jakobsson Bergstad et al., 2011). Another important sustainability determining parameter is the distance people travel to the destination (i.e., destination choice). The limited empirical evidence available shows that travel is indeed an important stressor, negatively affecting tourists' emotion ratio during vacation (Nawijn, 2011a).

The high level of positive affect during vacation may best be explained by a higher perceived sense of freedom (Iso-Ahola, 1983; Nawijn & Peeters, 2010; Neulinger, 1974). Empirical evidence shows that the travel party and appreciation of the environment have a positive influence on travellers' emotions (Nawijn, 2011a; Slåtten, Mehmetoglu, Svensson, & Sværi, 2009).

Most of the aforementioned studies have dealt with the affective component of SWB. The cognitive component (i.e., life satisfaction) is more stable. Voluntary changes in trip frequency and vacation days fail to impact life satisfaction. This even holds for those who value leisure travel (Nawijn, 2011b). However, a major limitation of such studies is that these effects are static (i.e., people with a certain behaviour have a certain SWB). If people are forced to change behaviour (e.g., due to pricing or lower capacity of certain transportation systems), the impact on life satisfaction may be larger (cf., Abou-Zeid, Witter, Bierlaire, Kaufmann, & Ben-Akiva, 2012; Jakobsson Bergstad et al., 2011). On the other hand, all these studies assume a constant social environment and that the change is with the individual tourist, not for all their peers as well. It may be that peer pressure will dampen negative effects on happiness of changes against current trends.

Conclusions and Discussion

There is a need for substantial behavioural change in order to increase the environmental sustainability of leisure travel. Expected technological advances are inapt to tackle the issue of environmental unsustainability of tourism, specifically regarding climate change (Scott et al., 2010; UNWTO-UNEP-WMO, 2008). The required change is not expected to happen naturally. Although many tourists are aware of climate change and the impact their vacation travel has, they do not adjust their behaviour or lifestyles accordingly (Antimova, Nawijn, & Peeters, 2012; Gössling, Haglund, Kallgren, Revahl, & Hultman, 2009; Hares, Dickinson, & Wilkes, 2010; McKercher, Prideaux, Cheung, & Law, 2010). We have argued that one reason may be the recollected feelings of pleasure derived from past leisure-travel experiences (Carter & Gilovich, 2010; Mitchell et al., 1997; Van Boven & Gilovich, 2003; Wirtz et al., 2003). Even though actual effects of vacationing on SWB are small and short-lived (De Bloom, Kompier, Geurts, De Weerth, Taris, & Sonnentag, 2009; Nawijn, 2011b; Nawijn et al., 2010), people have a desire to vacate more (Solnick & Hemenway, 1998) because they expect this to generate many pleasurable feelings. We argue that this expectation is an important driver for consuming tourism products, because the decision to consume is made well in advance of the consumption itself.

The desire to travel more and to consume leisure experiences is reasoned to be also caused by norms transmitted through social networks and peer pressure mechanism (Schor, 1991, 1998). The standard in affluent societies seems to be to consume more and to keep up with apparent social standards of what constitutes "the good life". These standards are continuously shifted to new boundaries by an amalgam of the technical, physical, and economic opportunities in contemporary affluent societies (Peeters, 2010). Some people ("drifters") are pioneers in defining these standards.

The required behavioural change may be achieved through a change of the supply of tourism offers including travel in terms of price and capacity in a way that it better supports sustainable lifestyles. The impacts on happiness of such changes may be relatively large during the phase of change, but would likely fade away as soon as the new behaviour becomes the social norm. It is even conceivable that a new group of drifters starts to explore new phenomena such as “slow travel” – a form of travel with small carbon footprints (Dickinson & Lumsdon, 2010). This may also slowly, but gradually, shift the “rosy views” from current stereotypes, such as long-haul tropical palm-tree lined beach trips, to newer ones, perhaps of a more sustainable nature. At the same time it seems inevitable that policies sustain such developments by appropriate pricing, offering convenient slow travel options.

To counteract the potential loss of SWB due to, for instance, a restriction in long-haul flights, new ways of travel could be considered. More interest in the near surrounding (e.g., an increase in demand for trips in Europe for Europeans) may boost SWB. An opportunity for this is provided by slow tourism, which allows for more intense experience of the present, which has been proven to be beneficial to individuals’ SWB (Killingsworth & Gilbert, 2010). Additionally, slow tourism does neither require travel over long distances, nor an extensive length of stay. The latter is not related to SWB and the former even has a negative effect on SWB (Nawijn, 2011a; Nawijn et al., 2010). Multiple short slow tourism-styled trips are possible throughout the year. This would likely maximize SWB effects and minimize contributions to climate change. However, slow travel is currently not the social norm in many Western affluent societies. The question then is how this new social norm could be achieved? Booking a slow tourism trip is not common practice and these types of trip are therefore not readily bookable through tour operators or travel agencies. Dickinson, Robbins, and Lumsdon (2010) found that people going on a slow tourism trip first consider their mode of travel and next make their destination choice. For a large share of the regular tourists, it appears to be in the exact opposite order (Sirakaya & Woodside, 2005). Herein lies the biggest challenge for stakeholders: convincing the tourist to choose their travel mode first.

Future research should focus on developing and testing marketing strategies that persuade consumers to travel more sustainably by initially choosing the experience they seek and then their mode of travel instead of choosing the destination first, followed by experience, and finally travel mode. Potential features of such campaigns may be portrayal of this altered social norm through different communication channels, linked to a willingness to book a regular trip or a slow tourism trip. Other options are to focus on the experiential component of slow travel trips. This experiential component draws on mindfulness practices, which is currently enjoying a revival and is found to have positive effects on SWB (Brown & Ryan, 2003) and even more potentially stronger effects during leisure travel (e.g., Pearce, 2009; Pearce, Filep, & Ross, 2010). Finally, advertising could focus on the ‘desire for a safer, healthier planet, linked to desired types of travel.

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Health and Travel

Susan Handy

Introduction

Awareness of the many different connections between health and travel is growing, as is the range of voices calling for policies that recognize these connections. In the U.S., for example, the non-profit Partnership for Prevention recently published a report entitled "Transportation and Health" that seeks to support the "development of transportation policies that also promote the nation's health" (Partnership for Prevention, 2012). The World Health Organization (WHO) has advocated for a consideration of health issues in the development of transport policies (WHO, 2012a). In calling for action, these organizations and others focus on three health concerns: traffic safety, pollutants, and physical activity.

Safety has long been the pre-eminent health concern in the transportation field, beginning with the first reported motor vehicle-related fatalities not long after the first motor vehicles took the road. By the 1930s, the Automobile Safety League of America had been founded, and manufacturers had implemented several changes in vehicle design with the goal of improving safety. Still, in 1966, the National Academies of Sciences reported 1.7 million deaths from motor vehicle accidents in the U.S. over six decades (National Academy of Sciences, 1966). Since then, safety campaigns throughout the world have reduced but not eliminated fatalities, and so campaigns continue. Established in 1997, Sweden's Vision Zero Initiative starts from the premise that "no loss of life is acceptable" (Vision Zero Initiative, 2012). Launched in 2011, the United Nations' Decade of Action for Road Safety campaign aims to save five million lives by 2020 (Road Safety Fund, 2011).

The health impacts of harmful pollutants from motor vehicles became a public concern starting in the 1950s, when researchers first linked vehicle emissions to

S. Handy (✉)
Institute of Transportation Studies, University of California, Davis,
1 Shields Avenue, Davis, CA 95616, USA
e-mail: slhandy@ucdavis.edu

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severe air pollution in Los Angeles. In the 1960s, California established the first emissions standards for vehicles and requirements for emissions control technologies, and similar policy soon followed at the national level. Although many other countries have also adopted health-based emissions standards, the contribution of motor vehicles to air pollution remains a problem. Established in 2002, the United Nations Environment Programme's Partnership for Clean Fuels and Vehicles aims to "reduce air pollution through the promotion of lead-free, low sulphur fuels and cleaner vehicle standards and technologies" (UNEP, 2012).

Recently, concerns over the contribution of travel to levels of physical activity, with implications for obesity and related health conditions, have risen in prominence. The World Health Organization (WHO, 2010) has issued "Global Recommendations on Physical Activity for Health" that call for 150 min of moderate-intensity physical activity per week for adults, citing travel by walking and bicycling as important sources of physical activity and increases in "passive" modes as a cause of the global decline in physical activity. The U.S. Centers for Disease Control and Prevention also highlights walking and bicycling as ways to increase overall physical activity and calls on communities to improve infrastructure to make walking and bicycling easier and safer (Centers for Disease Control and Prevention [CDC], 2011).

The message that emerges from these efforts is that driving has negative impacts on health, while the alternatives can have positive impacts. In other words, the goal is not just to reduce the harms of driving but also to promote health through the use of alternatives. The WHO, for example, argues that "promoting healthy and sustainable transport alternatives [to driving] prevents the negative effects of transport patterns on human health" (WHO, 2012a). However, achieving this goal is not simple, as the connections between travel and health are complex. This chapter examines these connections from the perspective of daily travel behaviour and outlines potential strategies for improving health through transport policy.

Connections Between Health and Travel

Every day, people make choices about travel, including how much to travel, what mode of travel to use, and where and when to travel. These choices have a direct effect on their health, influencing their exposure to traffic crashes, their exposure to pollutants, and their levels of physical activity. In some cases, people have the freedom to choose the healthier options, in other cases, they do not. Choices about travel also affect the health of others, influencing their risk of injuries and fatalities, ambient concentrations of pollutants, the desirability of walking and bicycling. These are as known externalities, both negative and positive: costs or benefits that individuals impose on others for which they do not pay or receive compensation. Travel choices are central to all three health concerns – safety, pollution, and physical activity – though in different ways.

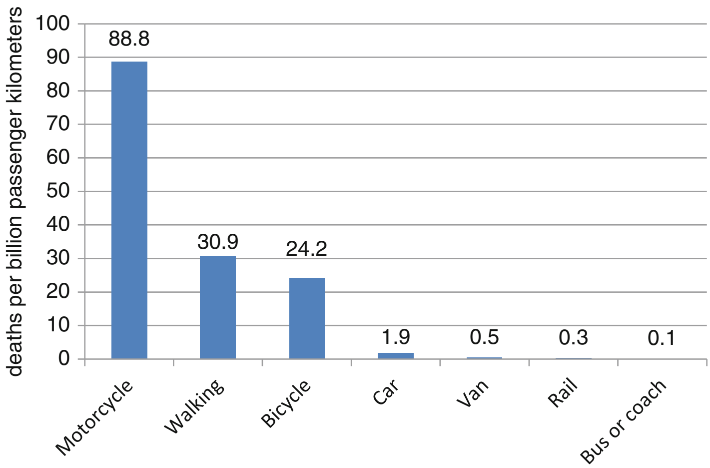

Fig. 1 Death rates by mode of transport in the UK (From Office for National Statistics [ONS], 2010)

Traffic Safety

Traffic safety is a global problem. The WHO reports that worldwide more than 1.2 million people die in traffic crashes each year, and between 20 and 50 million are injured (WHO, 2009). The problem is worse in low- and middle-income countries, which have 48 % of the world's vehicles but 90 % of the world's fatalities. Fatality rates in these countries are twice what they are in high-income countries, in part because of the high number of "vulnerable road users" – pedestrians, bicyclists, motorcyclists. Vulnerable road users are 70 % of fatalities in these countries, compared to only 35 % in high-income countries. Although fatality rates have been declining in many high-income countries in response to public efforts over the last four or five decades, still residents of these countries die in road crashes at a rate of 10.3 per 100,000 (National Highway Traffic Safety Administration [NHTSA], 2012a). Road traffic injury was the ninth leading cause of death in the world in 2004.

The choices that individuals make about daily travel influence their exposure to the risk of injury or fatality on the road. Most obviously, the more one travels, the more risk one faces. Mode of travel also affects risk. In the U.K., for example, motorcycles are by far the riskiest mode on a per-kilometre basis, followed by walking, bicycling, and driving (Fig. 1). It is important to note, however, that fatality rates by mode vary significantly by country; bicycling, for example, is far safer in the Netherlands than it is in the U.K. or the U.S. (Pucher & Dijkstra, 2003). Choices about driving will also influence risk. All else equal, driving on divided highways with limited access – freeways in the U.S., or motorways elsewhere – is less risky than on undivided highways where deadly head-on collisions are more likely. For all road users, travelling on roads with higher vehicle speeds is riskier than travelling on lower speed roads. Travelling at night by any mode is riskier than during the day, both because of poorer visibility and a greater likelihood of encountering drunk drivers – or being drunk oneself.

Drunk driving is just one example of how an individual's own choices about travel also influence the risk to others. The more one drives (even if not intoxicated), the faster one drives, and the heavier the vehicle one drives, the more that others are at risk. Distracted driving, driver fatigue, and aggressive driving also contribute to safety risk. Although some choices increase safety for the individual and for others (e.g. not driving drunk, driving at slower speeds), other choices improve the safety of the individual at the expense of the safety of others (e.g. driving a heavier vehicle). Conversely, choosing to walk or cycle decreases one's own safety (though it may increase one's health, as discussed below) but may increase safety for others. As one study shows, the more people there are walking and cycling, the less likely a driver is to collide with one of them (Jacobsen, 2003).

The risk of traffic crashes is not evenly distributed across the population. First, the risk of causing crashes varies. In the U.S., for example, the rate of involvement in crashes is highest for the youngest and most inexperienced drivers and lowest for those age 65–74, though it increases somewhat for those over age 74 (NHTSA, 2012a). Second, the risk of being injured or dying in crashes also varies. In the U.S., men have a higher fatality rate than women, but the injury rate is higher for women than men (NHTSA). While for younger people, the injury rate exceeds the fatality rate, for people over age 45, the reverse is true; for those over age 74, the fatality rate is more than double the injury rate, reflecting their greater vulnerability to the impacts of crashes (NHTSA).

Populations that are more dependent on walking and cycling are also more at risk. This pattern is evident in national comparisons, as in the statistics from the WHO reported above, but is also evident within countries and within cities. Those who are more dependent on walking and cycling include those with lower incomes, for whom driving is not affordable, as well as the young and the elderly, for whom driving may not be legally or physically feasible. To compound the problem, bicycle and pedestrian infrastructure is often of poorer quality in lower-income neighbourhoods, contributing to higher pedestrian fatality rates in these areas (Pucher & Renne, 2003). For the elderly, the decline in physical and mental abilities that make driving no longer safe can also make walking and cycling less safe. Uneven sidewalks, for example, can pose a perilous hazard to the frail elderly. In the U.S., the highest rate of pedestrian fatalities per capita is for those over age 70 (NHTSA, 2012b).

Air Pollution

Pollutants resulting from motor vehicle emissions have numerous health effects, both acute and chronic (Table 1). The "criteria pollutants" regulated by the U.S. Environmental Protection Agency primarily affect the respiratory system. Damage to the lungs from these pollutants can inhibit the absorption of oxygen

Table 1 Description, sources, and health effects of criteria pollutants

Pollutant	Description	Sources	Health effects
Carbon monoxide (CO)	Colourless, odourless gas	Motor vehicle exhaust, indoor sources include kerosene or wood burning stoves. *On-road sources = 52 %*	Headaches, reduced mental alertness, heart attack, cardiovascular diseases, impaired foetal development, death.
Nitrogen dioxide (NO2)	Reddish brown, highly reactive gas	Motor vehicles, electric utilities, and other industrial, commercial, and residential sources that burn fuels. *On-road sources = 44 %*	Susceptibility to respiratory infections, irritation of the lung and respiratory symptoms (e.g., cough, chest pain, difficulty breathing).
Ozone (O3)	Gaseous pollutant when it is formed in the troposphere.	Vehicle exhaust and certain other fumes. Formed from other air pollutants (NOx and volatile organic compounds (VOC)) in the presence of sunlight. *On-road sources = 22 % of VOCs*	Eye and throat irritation, coughing, respiratory tract problems, asthma, lung damage.
Particulate matter (PM)	Very small particles of soot, dust, or other matter, including tiny droplets of liquids	Diesel engines, power plants, industries, windblown dust, wood stoves. *On-road sources = 20 %*	Eye irritation, asthma, bronchitis, lung damage, cancer, heavy metal poisoning, cardiovascular effects.
Sulphur dioxide (SO2)	Colourless gas that dissolves in water vapour to form acid, and interact with other gases and particles in the air	Coal-fired power plants, petroleum refineries, manufacture of sulfuric acid and smelting of ores containing sulphur. *On-road sources = 1 %*	Eye irritation, wheezing, chest tightness, shortness of breath, lung damage.
Lead (Pb)	Metallic element	Metal refineries, lead smelters, battery manufacturers, iron and steel producers.	Anaemia, high blood pressure, brain and kidney damage, neurological disorders, cancer, lowered IQ.

Adapted from US EPA (2010); percentages for on-road sources are for U.S. in 2008

from the air and the removal of carbon dioxide from the blood stream. These pollutants also contribute to the occurrence of respiratory diseases such as bronchitis, emphysema, and cancer, and they increase the burden on the heart and circulatory system. According to the World Health Organization, urban outdoor air pollution causes 1.3 million deaths worldwide each year (WHO, 2011). On-road vehicles (gasoline- and diesel-powered cars and trucks) are not the only source of this pollution, but they are a major source.

The choices that individuals make about daily travel influence their exposure to these pollutants. In general, the more time one spends in the vicinity of vehicles, the more pollutants one breathes. Travelling by car or bus generally leads to higher exposures to vehicle emissions such as CO and volatile organic compounds, while travelling by bus or subway often leads to higher exposures to particulate matter (de Nazelle et al., 2011). Pedestrians and cyclists tend to have lower exposures to vehicle emissions simply because they are farther away from vehicles than the people who are in them, but they may have higher inhalation rates, given physical exertion, and breathe them for longer periods of time, given slower speeds, resulting in health impacts similar to the impacts for those in vehicles (de Nazelle et al.).

The choices that individuals make about daily travel also influence the concentration of pollutants in the air that others breathe. In general, the more one drives, the more pollutants one puts into the air. But how one drives is also contributing factor: more idling, faster acceleration, and low (less than 25 mph) or high (over 60 mph) speeds mean higher emission rates, all else equal (Handy & Krizek, 2012). Use of cruise control or overdrive technology can help to reduce emissions, while decisions about vehicle maintenance influence emissions as well, particularly engine tuning and tyre inflation. Perhaps the most significant factor is the type of vehicle one chooses to drive, whether powered by gasoline, diesel, or alternative fuels, and whether a passenger vehicle, sports car, sport utility vehicle, or light-duty truck. For public transit, per-passenger emissions depend on how many people choose to ride transit, as well as the technology of the vehicles. In some contexts, public transit will produce lower emissions per passenger mile than private vehicles, but in some contexts more.

As with safety, the health effects of air pollution are not evenly distributed. First, some groups are more susceptible to the effects of air pollution, including the elderly, infants, pregnant women, and those who suffer from chronic heart and lung diseases. The exposure of children to air pollution is of particular concern, given the immaturity of their lungs and immune systems and the amount of time they spend outdoors (Schwartz, 2004). Whether air pollution contributes to the development of asthma in children is still uncertain, but studies show that it at least contributes to asthma attacks (Bråbäck & Forsberg, 2009). Second, some groups are exposed to higher levels of pollutants because of where they live – which country, city, or neighbourhood. In urban areas, low-income households are more likely to live near busy roads and rail lines where pollutant concentrations are higher, as shown in studies in the U.K. (Wheeler & Ben-Shlomo, 2005) and California (Houston, Wu, Ong, & Winer, 2004).

Motor vehicles also impact health through their contribution to water and noise pollution, though these effects have not been as widely addressed as those of air quality. Water quality is affected when vehicles drip oil and other fluids and deposit toxic substances from tyres and brake pads onto roadways, which are then washed by rain off of the road into the stormwater system or roadside landscape, causing significant environmental harm and sometimes contaminating drinking water. Water supplies are also threatened by leaking underground fuel storage tanks. Benzene and other petrochemicals from these sources can cause cancer even at low levels of exposure; heavy metals can damage the nervous system and disrupt metabolic functions.

Motor vehicles are one of the primary sources of ambient noise levels. According to the WHO, about half of European Union citizens live in areas where noise from transportation exceeds comfort levels (Berglund, Lindvall, & Schwela, 1999). Vehicles generate noise from their engines, exhaust systems, horns, sound systems, and, most significantly, through their tyres interacting with the road. What kind of vehicle one drives and how one drives it (e.g. speed, acceleration) also influence the noise it emits. Studies show that high levels of noise can induce hearing impairment, hypertension and ischemic heart disease, annoyance, sleep disturbance, and decreased school performance, and they provide some limited evidence that noise can impact the immune system and may contribute to birth defects (Passchier-Vermeer & Passchier, 2000).

If viewed from a lifecycle perspective, the use of motor vehicles impacts the environment and thus human health in many more ways: the manufacture and disposal of vehicles (including cars, buses, trains, bicycles) and their tyres; drilling for, processing, and distributing petroleum-based fuels; building and maintaining roads. As an example, in the U.S. from 1985 to 2007, federal and state agencies oversaw the clean-up of nearly 351,000 underground storage tanks leaking fuel and other hazardous substances that often threaten the ground water that supplies local communities (EPA, 2007).

Physical Activity

As noted above, the WHO recommends that adults engage in 150 min of moderate physical activity per week. The health benefits of achieving this level of physical activity are numerous: prevention of weight gain, improved cardio-respiratory and muscular fitness, and lower risk of Type 2 diabetes, heart disease, stroke, and other unhealthy conditions (WHO, 2010). However, levels of physical activity are declining globally, though levels and trends vary considerably (Ng & Popkin, 2012). A study of 20 countries found that the share of adults who fell into the "low" physical activity category ranged from a low of 6.9 % in China to a high of 43.3 % in Japan (Bauman et al., 2009). In the U.S., 35.5 % of adults did not meet recommendations for physical activity (CDC, 2010). The WHO identifies physical inactivity as the fourth leading risk factor for mortality globally, responsible for 6 % of premature deaths (WHO).

Choosing physically active modes of travel can help one to achieve recommended levels of physical activity. Active modes include, most obviously, walking and bicycling, but transit is also often considered an active mode given that many transit riders walk or bicycle to and from the bus stops or rail stations; rollerblading, skateboards, and non-motorized scooters are also used as modes of travel in some places. The use of active modes of travel varies enormously across the globe. In the U.S., the number of bicycling trips more than tripled between 1977 and 2009 and the share almost doubled, but to only 1 % of daily trips; the share of commuters usually getting to work by bicycle is only 0.6 % (Pucher, Buehler, & Seinen, 2011). Levels of bicycling in Australia, the U.K., and Canada are not much higher. In contrast, 27 % of trips were by bicycle in the Netherlands in 2005 and 18 % in Denmark in 2001 (Pucher & Buehler, 2007).

Low levels of active travel are a particular concern for the same groups for whom traffic safety is also a particular concern: children, low-income populations, and the elderly. Adults are increasingly choosing to drive their children to school and other activities, rather than having them to walk or bicycle. In the U.S., walking to school dropped from 40.7 % of all school trips in 1969 to 12.9 % in 2001, while bicycling remained roughly constant at around 1 % (McDonald, 2007). In Davis, CA, the most bicycle-friendly community in the U.S., over half of high-school students drive or are driven to school (Emond & Handy, 2012). In comparison, in Denmark 45 % of children bicycle to school, though the share has been dropping (Cycling Embassy of Denmark, 2012). If children were able to walk or bicycle more, they would get more physical activity and their parents (predominantly mothers) would have less need to drive them. However, safety is a concern: rates of pedestrian and bicyclist fatalities and injuries per capita are highest for those under the age of 15 (NHTSA, 2012b, 2012c).

Low-income populations are less likely to meet physical activity recommendations (Gidelow, Halley Johnston, Crone, Ellis, & James, 2007; CDC, 2007). Yet, because only 73.5 % of low-income households in the U.S. own cars compared to 91.7 % of all U.S. households, their dependence on walking and transit (though not bicycling) is greater (Pucher & Renne, 2003). Non-motorized travel is thus a critical source of physical activity for this population. For example, 40 % of the lowest-income transit users meet the recommended levels of physical activity solely from walking to and from transit (Besser & Dannenberg, 2005). Without this walking, their total physical activity would be even farther behind the rest of the population. However, as noted above, the quality of non-motorized infrastructure is often lower in low-income communities, contributing to higher pedestrian fatality rates (Pucher & Renne).

The elderly, too, could benefit from increased walking and bicycling, but safety is a concern for this group as well. Among those 65 years and older, one in five does not drive, and more than 50 % stay home on any particular day in part because of a lack of transportation options (Bailey, 2004). For non-drivers, walking and bicycling as well as transit can provide an important means of getting to the doctor's office, the store, or a friend's house. However, as noted above, the decline in physical and mental abilities that make driving no longer safe can also make walking and bicycling less safe. Where safe conditions exist, increased walking and bicycling can improve physical and mental health (U.S. Department of Health and Human Services, 2008), as well as increase access to important activities.

Choosing active travel is good for others, as well as oneself. Countries with high levels of non-motorized travel also have fewer fatalities and injuries per mile than in the U.S. (Pucher & Dijkstra, 2003). In part, this difference is explained by better infrastructure, but the higher number of pedestrians and bicyclists itself increases safety by heightening driver awareness and attentiveness (Jacobsen, 2003). Higher numbers of pedestrians and bicyclists also helps to justify increased investments in infrastructure, further increasing safety, which, in turn, helps to encourage more walking and bicycling (Handy, 2010). In addition, seeing other people walking and bicycling may increase the social normality of active travel – the perception that walking and bicycling are normal, acceptable, and even expected ways to travel.

If one walks or bicycles instead of driving, the health benefits are even greater. Driving is a sedentary activity, and as research shows, sedentary activities have negative impacts on health beyond the effects of physical inactivity (Thorp, Owen, Neuhaus, & Dunstan, 2011). Aggregate data for the U.S. show that one additional mile of travel by vehicle for each licensed driver is associated with a 2.2 % increase in the national adult obesity rate six years later (Jacobson, King, & Yuan, 2011). According to a study in Atlanta, Georgia, for each additional hour of driving per day, the odds of being overweight increased by 6 % (Frank, Andresen, & Schmid, 2004). Substituting active travel for driving has benefits for others as well, by decreasing safety risks and pollution levels.

Improving the Healthiness of Travel

Efforts to improve the healthiness of travel first focused on reducing the harms of driving, beginning with efforts to reduce traffic risks in the 1930s followed by efforts to reduce air pollution starting in the 1960s. Now, motivated by a concern over climate change, many communities have set goals for reducing vehicle travel, which can also help to improve the healthiness of travel. At the same time, in response to the obesity epidemic, public health officials have advocated for policies and programmes to promote active travel as a way to improve health. Many of the strategies for improving the healthiness of travel are synergistic, in that they help to address all three health concerns simultaneously, either directly or indirectly, and in that they are more effective when employed together (Table 2).

Reducing the Harms of Driving

Strategies for reducing the harms of driving – the impacts on health from both traffic safety and air pollution – have historically focused on technological fixes but have also relied to some extent on behavioural changes. In both cases, national regulations have pushed much of the improvement.

Strategies for improving traffic safety fall into three general categories: vehicle design, road design, and driver behaviour. Changes in vehicle design to improve safety have been remarkably successful at reducing the risk of injuries and fatalities, as well as the risk of traffic crashes themselves. Improvements in road design, including traffic control systems, have also helped to reduce the risk and severity of

Table 2 Impacts of strategies on health concerns

Category	Traffic safety	Pollution	Physical activity
Reducing the harms of driving	Lower risk of crashes	Reduced emissions	*Improved conditions for active modes*
Reducing driving	Lower risk of crashes	Reduced emissions	*Improved conditions for active modes*
Increasing active travel	*Safer conditions for active modes*	*Reduced emissions if reduced driving*	Increased physical activity

Note: Indirect impacts are in italics

crashes. Efforts to encourage less risky driver behaviour have shown success as well, particularly seat belt and drunk driving laws. Several new vehicle technologies aim to eliminate driver mistakes; for example, back-up warning systems are now standard for many models. The national and global campaigns noted earlier focus on all three categories of strategies in their efforts to reduce or even eliminate fatalities.

Strategies for reducing vehicle emissions have also been multifaceted, focusing primarily on vehicle technology and fuel formulation. In the U.S. and Europe, vehicle emissions standards have led to improvement in vehicle technology that have dramatically reduced – but not entirely eliminated – emissions per mile of the criteria pollutants. Future reductions may come as a spin-off from efforts to improve fuel efficiency and reduce emissions of greenhouse gases. Electric and hybrid-electric vehicles, for example, are becoming increasingly affordable and are likely to grow in popularity. Driver behaviour has also been a target, for example, through the setting of speed limits. The practice of "eco-driving" appears to be growing in popularity as in-vehicle driver information systems that give real-time data on fuel efficiency become more common (Handy & Krizek, 2012).

In past decades, strategies to reduce the harm of driving have been politically popular. Improvements in vehicle technology and changes in road design do not require a change in behaviour, and the strategies to reduce risky driving behaviour do not go so far as to require drivers to drive less or use alternative modes. But proposals for more stringent requirements often meet political resistance, at least in the U.S. Even requirements for additional safety features have been criticized as increasing the price of vehicles and reflecting an overly protective approach on the part of the government. Speed limits, previously based on fuel efficiency and traffic safety considerations, have gradually been raised, thereby offsetting earlier health gains.

Reducing Vehicle Travel

Strategies for reducing vehicle travel fall into two basic categories: "carrot" strategies that make the alternatives to driving more attractive, and "stick" strategies that make driving less attractive.

Carrot strategies include strategies to improving alternative travel modes, including improving conditions for active modes, as discussed below, as well as improving transit service. Improving the attractiveness of transit as an alternative to driving requires improvements to service coverage, frequency, and reliability, as well as safety and comfort, without significant increases in fares. Another carrot strategy is to improve the attractiveness of nearby rather than more distant destinations. Local economic development strategies can help to achieve this end. Yet another approach is to improve the attractiveness of *not* travelling. On-line shopping, home-delivery services, and work-place services, among others, make it easier for people to not travel while still meeting their needs. A variety of programmes can increase the likelihood that people will take advantage of such opportunities to change their behaviour, including social-marketing campaigns and travel behaviour feedback programmes.

Stick strategies include policies that make driving less attractive. Policies that increase the cost of driving include vehicle purchase taxes, vehicle licence fees, driver's licence fees, gasoline taxes, parking fees, and congestion charges. In general, out-of-pocket fees (e.g. parking fees, congestion charges) will have more of an impact on daily travel behaviour than fees that a driver pays once (e.g. vehicle tax) or occasionally (e.g. annual vehicle licence fee) though the latter can reduce auto ownership (Handy & Krizek, 2012). Driving can also be made less attractive through restrictions on where and when vehicles are allowed. Car-free zones in urban centres can make alternative modes faster and more convenient than driving, for example.

Such strategies have the benefit of reducing vehicle travel and thus the harms that it produces, while also encouraging active travel and the health benefits it produces. However, it is important to note that there are many positive benefits from travel in general. For example, studies show that leisure travel is associated with life satisfaction and mental well-being which in turn can influence physical health. Thus, strategies that aim to reduce vehicle travel without restricting the ability of individuals to travel where, when, and how much they want may do the most to improve health.

Increasing Active Travel

Although they are often lumped together in plans and policies, walking and bicycling have very different potential as modes of travel: walking is possible for more people because it requires no equipment and less confidence and skill, but it is considerably slower than bicycling; bicycling is at least theoretically possible for more trips because it is considerably faster than walking, but it requires equipment as well as skills and confidence that many lack. Given the low-density patterns of development in the U.S., which put destinations beyond walking distance in most places, bicycling seems to offer greater potential for expansion, particularly given the low levels currently found in the U.S. (Handy, 2010). The same may be true in areas outside of the urban core in Europe and elsewhere.

For active modes to be viable, two conditions are essential. First, destinations must be within reasonable walking or bicycling distance. What is “reasonable” varies by individual, depending on physical ability and time available, but planners often aim for under 500 m for walking and under 5 km for bicycling. Second, the conditions for walking and bicycling must be safe and comfortable, as well as attractive and appealing. Protection from motor vehicle traffic is the key to safe and comfortable conditions, though physical separation from traffic in the form of off-street facilities is not always necessary, particularly for bicycles. Qualities such as trees and greenery, interesting things to look at, and the absence of trash and graffiti help to create comfortable, attractive, and appealing conditions.

For individuals to choose active modes, they must also be motivated to do so. In some situations, active travel modes are the easy choice, being cheaper and/or faster than driving. Public policies affect the attractiveness of active travel relative to driving both by improving walking and bicycling conditions and by increasing the cost or inconvenience of driving, as discussed above. Even where active travel modes are not cheaper or faster than driving, individuals may be motivated by other benefits of active travel, including the benefits to oneself of physical activity or the benefits to society of lower environmental impacts. Some evidence suggests that enjoyment of walking or bicycling is an important factor (Handy & Xing, 2011). Promotional programmes and community events can help to increase the motivation to use active travel modes, as can other efforts designed to change behaviour, including social marketing campaigns and behaviour feedback programmes.

Although most of the attention in both research and planning is given to walking and bicycling, other active modes such as skateboarding, in-line skating, and non-motorized scooters may be significant in some places, particularly those with young populations. In some places, legal restrictions on these activities limit their usefulness as travel modes (Fang, 2013). As noted earlier, transit is also considered an active travel mode, given that many transit users use active modes to get to and from bus stops or rail stations. Strategies that increase transit use will also help to increase active travel, while strategies to improve walking and bicycling conditions and to motivate individuals to walk and bicycle could also help to increase transit use. Both may have the added benefit of helping to reduce vehicle travel.

Electric bicycles present a particular challenge, in that they can be both an opportunity for and a threat to improving health. On one hand, the use of electric vehicles in place of driving helps to reduce emissions and may increase physical activity, with positive effects on health. In particular, they may enable older people to continue bicycling for more of their trips (Gordon, Shao, Xing, Wang, & Handy, 2013). On the other, their use as a replacement for conventional bicycling is likely to reduce physical activity and may make conditions worse for pedestrians and bicyclists, thereby discouraging active travel; they may also be more dangerous for riders, particularly older riders (Hembrow, 2012). The Netherlands currently faces the problem of increasing use of motorized bicycles, often ridden in bicycle lanes and on off-street bicycle paths.

It is important to note, however, that reductions in safety risk and pollution levels occur only to the degree that active travel substitutes for vehicle travel. A substantial share of walking and bicycling is for recreation rather than transportation, and even some walking and bicycling trips to destinations are made in addition to rather than instead of driving trips (Handy, 2010). A recent study in the U.S. estimated that the share of bicycle trips that substituted for driving trips ranged from 25 to 86 % depending on location (Piatkowski, Krizek, & Handy, 2012). Of course, any increase in walking and bicycling trips is likely to represent an increase in physical activity (as long as it does not substitute for other forms of physical activity) and thus is likely to have positive impacts on health, but the benefits to health are even greater if these trips also replace driving trips.

Conclusions

Given the substantial connections between health and daily household travel, as outlined in this chapter, it is important that health impacts be considered in the formation of transport policy. The connections between health and both long-distance passenger travel and the movement of goods and freight are no less substantial and thus equally of concern. Equity considerations add to the imperative: our most vulnerable populations – the young, the old, and the poor – face more risk to their health from transportation and stand to gain the greatest health benefits from efforts to reduce the harm of vehicles, increase active travel, and reduce vehicle travel.

As noted at the beginning of this chapter, the World Health Organization and many national health agencies are calling for increased attention to the connections between health and travel in the development of transport policies. Just as processes were adapted to incorporate a consideration of the environmental impacts of transport starting in the 1960s, so too are processes now being adapted to incorporate a consideration of the health impacts of travel. For example, the use of Health Impact Assessments, modelled after Environmental Impact Assessments, is growing as a way to gauge the health effects of proposed policies, projects, and programmes (WHO, 2012b). Travel demand forecasting models are being extended to produce measures of health as well as traffic impacts (e.g. Metropolitan Transportation Commission [MTC], 2011). The movement towards "sustainable transport planning" offers an unprecedented opportunity to bring health considerations into the mainstream by recognizing health as a critical component – and perhaps the ultimate objective – of sustainability.

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Business Travel and Sustainability

Anne Aguiléra

Introduction

Work-related travel falls into two categories: on the one hand, commuting – regular travel between home and a fixed place of work – and on the other hand business travel which, unlike commuting, refers to work-related travel to somewhere other than the regular workplace. Business travel may be undertaken for a wide range of reasons: a meeting on another company site or with a customer, attendance at training courses, corporate conventions or conferences, and others.

Business travel, in particular long-distance business travel (at home or abroad), defined as any journey further than 50 miles (80 km) from home, which is the topic of this chapter, has received significantly less research attention than commuting (Faulconbridge, Beaverstock, Derudder, & Witlox, 2009). Yet this kind of travel is characteristic of certain modern work patterns, and is an essential component of working life for many self-employed people, executives, and managers (Haynes, 2010).

Overall, the demand for business travel is growing. There are numerous factors behind this: market globalisation, the increase in the number of multisite companies, the introduction of teamwork between sites, the growing reliance on outsourcing, and partnerships with other companies (Aguiléra, 2008). These changes have helped to increase companies' need to communicate with geographically separate stakeholders: customers, suppliers, and others (Fig. 1), leading to an expansion in work-related travel (Aguiléra, Lethiais, & Rallet, 2012; Haynes, 2010). Information and communication technologies (ICT) can only meet certain communication needs, in particular because ICT fail to provide the richness of face-to-face communication when the content of discussion is complex and requires collaboration between multiple parties (Aguiléra, Guillot, & Rallet, 2012). Face-to-face meetings therefore remain essential in a good number of cases.

A. Aguiléra (✉)
Department of Planning, Mobility and Environment at Ifsttar, LVMT, University of Paris East, 14-20 boulevard Newton, Champs sur Marne, 77447 Marne la Vallée, Cedex 2, France
e-mail: anne.aguilera@ifsttar.fr

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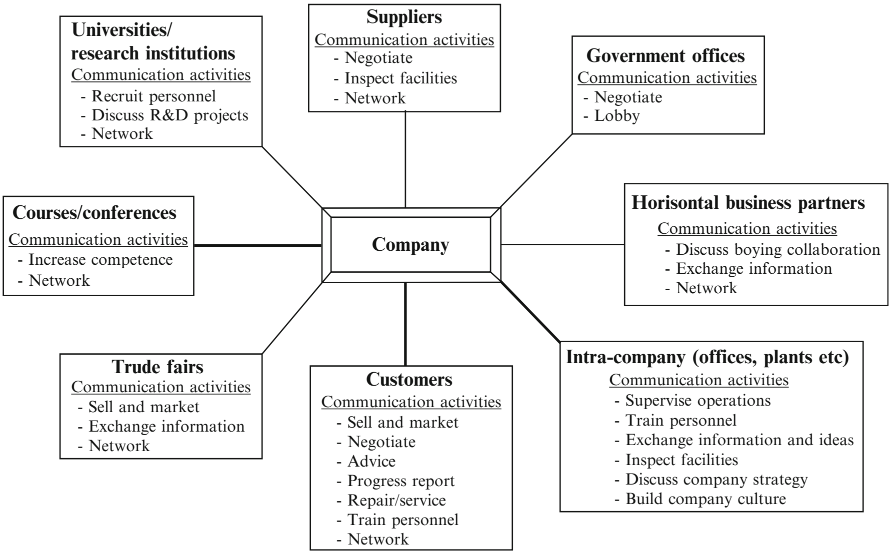

Fig. 1 Major connections and communication activities within business travel (Adapted from Lian & Denstadli, 2004)

Although it contributes significantly to the demand for transport, in particular air transport (Mason & Miyoshi, 2009), business travel has been relatively neglected in thinking about the strategies needed to promote more sustainable travel (Roby, 2010). This chapter provides a two-stage approach to this topic.

We begin by showing how the sustainability of business travel is relevant not only in environmental terms, but also from an economic and social perspective. On the one hand, this form of travel helps to generate jobs in numerous business sectors, not just in transport. In particular, it is a major source of revenue for the airlines: inside the European Union, in fact, business travellers account for almost half of all air passengers (Mason, 2002). However, their economic impact extends well beyond the transport sector alone, affecting the restaurant and hotel industries, conference organisers, and more (Hankinson, 2005). On the other hand, the social dimension cannot be ignored either, since business travel is often a source of fatigue and stress, and can generate or exacerbate both health problems (Westman & Etzion, 2002) and family problems (Espino, Sundstrom, Frick, Jacobs, & Peters, 2002). In the second stage, we consider the strategies that companies and governments can adopt to move business travel in a more sustainable direction. Our analysis, in particular in the first part where a number of statistics are provided, relates primarily to Europe and the USA.

Consequences of Business Travel

This first section successively covers the environmental, economic, and social aspects of business travel.

Travel Demand and Environmental Sustainability

Reducing the environmental effects of transport in the coming decades is an important and worldwide challenge. Firstly, the transport sector is a major user of fossil fuels and is a significant contributor to climate change through greenhouse gas (GHG) emissions. According to the International Transport Forum (2010), the transport sector accounts for approximately 15 % of overall GHG emissions. CO_2 emissions represent 23 % (globally) and 30 % (OECD) of overall transport-sector CO_2 emissions from fossil fuel combustion. Global CO_2 emissions from transport have grown by 45 % from 1990 to 2007, led by emissions from the road sector in terms of volume and by aviation in terms of highest growth rates. Hence the transport sector is at the forefront of the sectors in which immediate action must be taken to attain the goal of reducing GHG emissions by a factor of four by the year 2050. Secondly, the transport sector and especially road transport contributes to local pollution of air which has particularly negative effects on health (Kryzanowski, Kuma-Dibbert, & Schneider, 2005). Thirdly, another environmental effect of transport is noise which has also negative effects on health and cognitive development (Clark & Stansfeld, 2007).

Business travel contributes to the demand for travel and in particular in the demand for road and air travel. However, it is not easy to arrive at an accurate estimate of the share of business travel in total travel demand, even if the analysis is restricted to Europe and the US. Various data arising from national travel surveys and also a number of other studies, amongst them the "World Travel Monitor" report, suggest that the estimated contribution of business travel to total long-distance travel is currently close to 15 %, both in Europe and the US.

The national travel survey conducted in 2002 in the US estimates that 60 % of all journeys by Americans in excess of 50 miles from home (i.e. including overseas travel) is associated with business travel. For Europe, the World Travel Monitor's 2008 data show that 15 % of trips abroad by Europeans were taken for this purpose (as compared with 69 % for vacations and 16 % to visit family and friends). In France, the 2008 national travel survey shows that 13 % of French journeys entailing distances of more than 50 miles from home were made for business. Finally, the World Travel Monitor data estimate that in Germany business travel accounted for 14 % of domestic journeys and for 13 % of trips abroad. In France, the Tourist Travel survey estimates that 15 % of French trips abroad are for business purposes. If only considering travel between Europe, the Americas, and Asia, the three regions of the world where the majority of global economic exchanges are concentrated, the share of business travel is higher, between one fifth and one quarter depending on the region, according to the World Travel Monitor.

The car, followed by the airplane, and train (in Europe, and particularly in France) are the main modes of business travel. The role of the airplane increases markedly with trip distance. In the US, whilst an average 81 % of business travel is by car, according to the 2002 National Survey, and its market share is more than 90 % for journeys of between 50 and 249 miles, this percentage falls to 30 % for trips of between 500 and 749 miles, and flying accounts for 90 % of travel for distances of more than 1,500 miles. In France, more than three-quarters of business trips within the country are undertaken by car, but rail travel attracts almost 20 %, notably because of the efficiency of the high-speed trains (TGV).

Business travel therefore plays an important role in travel demand, particularly in air travel. In Norway, for example, it accounts for half of domestic air journeys, according to the 2011 National Air Travel Survey (Denstadli & Rideng, 2012). In addition, a proportion of business trips also give rise to vacation or tourist travel, or visits to family or friends (Hoyer & Naess, 2001; Shan & Wilson, 2001; Kulendran & Witt, 2003). In other words, if limiting the analysis strictly to business travel as such, the demand for transport generated by business trips is underestimated because it is difficult to make an accurate estimate of the proportions. Ultimately, business travel contributes significantly to the expansion in travel demand, although events (9/11, financial crisis, fuel price rises) can temporarily slow down the trend. The World Travel Monitor data thus show, each year, that the vast majority of business people surveyed expect to make at least as many, if not more, business trips in the coming year. Those who expect to make fewer primarily cite economic reasons or, to a lesser degree, a career change. The statistics confirm these findings: in Europe, the number of business trips abroad grew by 9 % between 2006 and 2008, compared with an increase of 5 % for vacation and tourist trips and unchanged levels for visits to family and friends, again according to the World Travel Monitor.

Economic Sustainability

The links between business travel and economic sustainability need to be analysed firstly at the global level (city, region, country, world), as generators of employment, and secondly at the level of the companies concerned, both as a cost item and as a factor of success and business development.

Business travel generates significant spending in many sectors: transportation, hotels and restaurants, travel agencies, and more. It therefore affects global economic activity. According to the Oxford Economics report on "Return on Investment of US business Travel", business travel in the US generates spending of $246 billion and 2.3 million American jobs; $100 billion of this expenditure and one million American jobs are linked directly to business meetings and events. For every dollar invested in business travel, companies experience an average of $12.50 in increased revenue and $3.80 in new profits. A 10 % increase in business travel spending would increase multi-factor productivity, leading to a US GDP increase of between 1.5 and 2.8 %. In Germany, it is estimated that business travel accounts for 24 % of spending generated in the transport sector by trips of at least one night within the country. According to a 2007 report by the Business Tourism Partnership in Britain, conferences, exhibitions, incentive travel, corporate hospitality, outdoor events, and individual business travel account for a growing share of total inbound tourism into the UK. In 2005, expenditure by business visitors represented 28 % of all inbound spend compared with 32 % of spend by holiday visitors. In total the sector is estimated to be worth in excess of £22 billion.

Business travel's contribution to world economic activity is not only direct, with each business trip generating a range of spending, but it is also indirect since business travel is often combined with tourist activities (Kulendran & Witt, 2003), which take place either as part of the business travel itself (before, during, just after), or later, since business travellers may be prompted to return as tourists to a country, a region or a city that they first encountered on a business trip. This is all the more common as business travellers are on average likely to be high earners, since most of them hold high positions in their companies (Aguiléra, 2008; Lian & Denstadli, 2004). In the US in 2002, for example, the national travel survey indicated that 27 % of business trips were made by people belonging to households with annual income in excess of $100,000, which is more than double the proportion of these households in the US population as a whole.

For companies, business travel represents however a significant source of costs, constituting the second highest expenditure item after payroll. An article by R. Collis published in the *New York Times* in January 2001 reports that "large and midsize businesses in the United States spent $157.1 billion on travel and entertainment in 2000 – up 8 % from $145.4 billion in 1998. European companies, too, are estimated to have spent $157 billion. Air travel accounts for 45 % of the average company's travel and entertainment budget, with lodging expenses at 17 %, compared with 44 and 22 %, respectively, in 1998."

However, business travel does not only represent a cost for companies: in many sectors it contributes positively to business development, especially abroad. Belenkiy and Riker (2012) estimate that each additional international business trip increases US commodity exports to the visited country by on average $36,693 per year.

Social Sustainability

Only a very small fraction of working people travel for business. Thus, no more than 10 % of French working people had taken a business trip in the 3 months preceding the last national survey dated 2008. The statistics available for the US for 2009 are similar: according to the US Travel Association, one in five US adults were expecting to take business trips in the next 6 months.

Another characteristic of business travel is the marked overrepresentation of men (Harris & Ateljevic, 2003). In the US the 2002 travel survey shows that 77 % of business travel were made by men. This male predominance is explained by the fact that men occupy the majority of high positions in companies. This is coupled with a reluctance on the part of women to travel far from the workplace, particularly when they have children, because of the pressures it places on family life (Espino et al., 2002; Gustafson, 2006). Not only adults but also children and especially young children are negatively affected when one parent has to make frequent long-distance business travel because they generate stress and contribute to create conflicts in the family.

Business travel has also negative impacts on health, not only because it contributes to air pollution and noise. Business travel is indeed a source of stress and fatigue (Westman & Etzion, 2002). It can also cause or aggravate health problems. A review (Rogers & Reilly, 2000) reveals that 36–54 % of travellers experience physical health problems such as diarrhea, insomnia, respiratory problems, and skin problems; 6–18 % report accidents and injuries while abroad. According to the same review, psychosocial data support that international business travellers may experience stress, anxiety, culture shock, and adjustment problems while travelling overseas.

Strategies for More Sustainable Forms of Business Travel

The first section showed the potential synergies but also contradictions between the three dimensions of sustainability. In this second section, it is shown that it may nevertheless be possible to achieve a compromise between environmental, social, and economic factors. Different strategies are proposed that companies and governments may implement to foster the emergence of more sustainable practices.

Towards a Compromise Between Environmental, Social and Economic Factors

Achieving a significant reduction in GHG emissions in the transport sector is a priority in abating climate change. Business travel, which is on the rise and makes heavy demands on air transport, cannot be exempted, which means that three objectives need to be pursued simultaneously: (1) The first is a medium-term and long-term reduction in the demand for business travel, which in the short term means stopping its growth; (2) The second is to reduce the number of miles of business travel, which means prioritizing whenever possible nearby destinations; (3) The third is to shift the modal share towards sustainable modes of travel, such as train (replacing the airplane and the car) and "cleaner" vehicles, such as hybrid cars. There are partial synergies between this objective and the others above, since reducing travel distance would make possible to use slower modes than flying.

The social and economic consequences of business travel are complex to assess. However, we believe that, under certain conditions, the positive consequences would outweigh the negative consequences. Firstly, a reduction in the number of business trips as well as in the distance travelled per trip, and a shift towards more sustainable modes of travel would produce positive social outcomes. There is little doubt as to the benefits of these reductions in terms of stress and fatigue, provided that the reduction applies to each individual, in other words that each employee is encouraged to reduce the number of business trips they take annually. In addition, cutting business travel could have another positive effect in encouraging more women to take up positions that they had previously considered too hard to reconcile with family demands.

Secondly, reducing the distances covered could also help to diminish stress and fatigue, and lead to a better work-life balance. However, this will only materialize if the reduction in distances does not lead to a deterioration in travel conditions, and if it generates time savings that will, in particular, cut the number of nights spent away from home.

Thirdly, a change in modal share may contribute to this, or conversely lead to poorer travel conditions and longer travel times. The high-speed train represents a good alternative to driving and flying, because train travel is more conducive to relaxation and also to working during travel (Lyons, Jain, & Holley, 2007). For these different reasons, ideas about distance and modal choice should be explored simultaneously, with a focus not only on the environmental but also the social sustainability.

In the economic sphere, things are more complicated and more nuanced and can be contradictory according to the scale of analysis (the company versus the global economy). From the perspective of companies whose business requires travel, a reduction in business trips (number and distance) may cut costs in the short term, but in the medium and long term may adversely affect activity (Belenkiy & Riker, 2012). To resolve this, business trips need to be approached with discrimination, in terms of the purpose they fulfil. The aim cannot be to cut all business trips indiscriminately, but to keep only those that generate a significant business benefit. This will be returned to later.

The economic impact of a change in travel modes is also not easy to assess. Firstly, there is a cost to companies in acquiring hybrid vehicles, whereas the benefits (low fuel consumption) are only felt in the medium to long term. On the other hand, government subsidies can help reduce this cost. Secondly, a cut in the number of business trips may, as will be discussed later, require investment in ICT and then generate additional costs. Thirdly, with low-cost airlines, flying to certain destinations is cheaper than travelling by train, hence modal change may be costly. Fourthly, cutting the number of business trips is likely to have positive effects on the productivity of the employees concerned, but the gain is difficult to evaluate precisely. Ultimately, it nevertheless seems possible that the combined effect of a reduction in the number and length of trips, and a different modal share would have a positive economic impact on companies.

Assessing the consequences for the world economy is markedly more complex. Reducing the number of trips, in particular by air, presents a direct threat to jobs. However, a more global assessment suggests a number of positive economic effects because many jobs could be saved or created in different economic sectors. First, increased demand for ICT and hybrid vehicles (or electric vehicles or other, yet to be developed, technologies) could stimulate the telecommunications and automotive sectors and create many jobs. Secondly, shifting the modal share to the train could both stimulate the rail sector (on existing lines) and also create employment if governments decide to develop new lines. Thirdly, reducing journey distances should divert travel to certain regions and countries, which will reap economic benefits. Fourthly, it is possible that new services and businesses will develop to improve the management of business travel, both within companies and in travel agencies, and more broadly in the business tourism sector. In particular, one may envisage "ecological" forms of business tourism, along the lines of ecotourism.

Incentives and Strategies for Companies

Companies today place increasing emphasis on the implementation of sustainable practices (production, distribution, working conditions, and other), at least in the industrialised countries (Hogevold, 2011; White, 2009). Managing the movement of goods and people (employees and customers) is an important dimension of this trend that often results in the implementation of a Company Travel Plan (OECD, 2010). However, business travel is rarely, or only superficially, included in these approaches (Roby, 2010).

This does not mean that no effort is made to regulate business travel, but such efforts generally focus only on the costs associated with it (in particular travel costs). Remember that business travel may be the second largest corporate expenditure item, after salaries. Business travel management has become a function in its own right in certain companies that have introduced a Corporate Travel Management (CTM) Department (Anderson, Lewis, & Parker, 1999). The latter decides on the class of service that employees are allowed to fly, negotiates corporate fares with airlines and rates with hotels as well as sets conditions for the use of the corporate credit card. Companies seek to reduce travel costs by reducing the cost per trip, for instance by establishing a contract with a travel agency and requiring employees to travel in economy class (Van Trommel et al., 1998) or with a low-cost airline (Mason, 2002). The impetus to cut the costs of business travel is likely to increase in future years, because of the economic crisis and the rise in energy costs. However, given that this approach does not lead to a reduction in the total number of trips, but only in their unit cost, it will not lead to more sustainable practices. Companies therefore need to set an explicit strategy based on the objectives outlined above: reducing the number of trips, the distances covered, and changing the modal share. CTM should be in charge of this strategy. To do this, companies need to identify where changes can be made. So the question, in the short and medium term, is: which trips can most easily be suppressed or altered (new destinations or new modes of travel)? There are two avenues to be explored.

The first is to identify which reasons for travel can most easily be suppressed or changed in terms of itinerary or transport mode, without adversely affecting business. We think that this applies most to certain internal trips (between sites belonging to a single company) and also to trips associated with training, corporate incentives, conferences, and trade shows, which together carry a significant cost. For instance, according to the 2008 French National Travel Survey, courses, conferences, and conventions accounted for 21 % of long-distance business travel in France in that year. For the Norwegian employees (travelling by air) interviewed by Lian and Denstadli (2004), 42 % of domestic business travel related to conferences, courses, and conventions. In Sweden about one fifth of long-distance business trips (exceeding 100 km each way) relate to conferences and other events, whereas meetings, customer visits, and other purposes represent about one half (Frändberg & Vilhelmson, 2003).

The second approach is to identify trips that can be replaced by remote interactions (Beecroft, Chatterjee, & Lyons, 2003). Up to now, researchers have found that the interactions between ICT and physical travel, including business travel, are complex, and not merely a matter of substitution (reduction in travel demand), but are instead complementary or even mutually reinforcing (Aguiléra, Guillot, & Rallet, 2012; Lyons et al., 2007; Mokhtarian, 2002). This finding applies even to the technologies that most closely resemble face-to-face meetings, such as videoconferencing (Aguiléra, Guillot, & Rallet, 2012; Arnfalk & Kogg, 2003). However, one should not be too quick to conclude that ICT cannot contribute to cutting the number of corporate business trips. Indeed, the findings only mean that, in the absence of a strategy that links ICT and reductions in business travel, these technologies are not, or not sufficiently, employed "spontaneously" for that purpose. Consequently, while it would be absurd to maintain that equipping companies and employees with ICT will automatically reduce the demand for mobility, it could be that if these technologies are explicitly implemented in companies for the purpose of reducing the need for travel, significant results may be achieved.

However, substantial changes in business travel will not be possible unless there is a specific focus on the changes needed in the way that work is organised across companies: frequency of meetings involving people from multiple sites, acquisition and use of ICT, and more. Indeed, the need for business travel and the possibilities for "partial" replacement by ICT, depend closely on individual and collective working patterns and practices (Aguiléra, De Coninck, & Hauchard, 2007).

Moreover, it seems essential that awareness-raising campaigns on good practices should be introduced, with the aim firstly of changing the positive and status-enhancing image associated with business travel, and secondly of involving mobile employees, who are generally well aware of the negative effects of travel on their family life as well as their health and productivity. For the moment, however, the negative consequences of business travel are something of a taboo topic because of the positive image associated with travel in our societies. A survey by Aguiléra et al. (2007) revealed that frequent business travellers do not publicly complain. The reason given is that the company expressly views professional mobility as an example of the flexibility and responsiveness of its organisation and staff. Lassen (2004) noted a similar situation for Hewlett Packard in Denmark, which exerted "institutional pressure" to be mobile.

However, the scale of the issues, in particular the environmental issues, is such that corporate involvement has to do more than simply reorganise its management of business travel. The sustainability of business travel is not simply a matter of travel practices. In fact, the need for such travel is the result of upstream strategic choices about the spatial location and organisation of the company's different functions (when it has several offices) and about marketplaces or outsourcing strategies (Aguiléra, 2008). This means that it is essential that the medium- and long-term sustainability of these choices should also be considered. Obviously, this is a tricky matter, which is tied up with the sustainability of the entire world's system of production.

The Role of Governments

The involvement of governments is essential and covers at least four major issues, on top of research and development on clean vehicles and the development of train links to replace certain air routes.

Firstly, governments need to continue to encourage companies to introduce travel management strategies, and in particular emphasise the need for business travel to be included in the process. This can be done within the framework of existing Company Travel Plans, or by the introduction of specific Business Travel Plans focusing on the development of sustainable business travel (Beecroft et al., 2003).

Secondly, governments should explicitly encourage the use of ICT as a support tool in the sustainable management of business travel. This means that they need to be proactive in encouraging companies to acquire these technologies and to change working patterns accordingly. They can also use financial incentives to prompt companies to acquire clean vehicles (or encourage intercompany leasing or sharing solutions).

Thirdly, the role of governments is to contribute to stressing the social implications of business travel (well-being and health, female advancement), but also its implications for business productivity. In particular governments could encourage research in this field and also make campaigns about the various negative consequences (ill-health, gender inequalities, and reduced productivity) of business travel for companies.

And fourthly, their role is to make companies better aware of the impact of their global spatio-organisational choices (like the number and location of their production sites, the number and location of their partners and customers) on their need for business travel. Of course this is by far the most complex challenge. Governments could encourage companies to take this aspect into account when they elaborate a travel management strategy.

Conclusion

Business travel is in several respects inconsistent with sustainable business practices, even when companies have established a mobility management strategy. In environmental terms, business travel contributes significantly to travel demand, particularly in air transport. Business travel also has significant social consequences, because it can cause or exacerbate health problems, and also because it further complicates the maintenance of a work-life balance. Finally, the worldwide economic impact of business travel is substantial, not only on the transport sector, but also on tourism.

The need to cut the greenhouse gas emissions arising from this form of travel entails reducing the total number of business trips and average trip distance, and shifting modal share towards less polluting transport methods. These three objectives will have consequences that are globally positive with respect to social consequences, and also economically beneficial for the companies concerned (reduced costs and likely increase in the productivity of employees who travel a great deal). Worldwide the economic outcome is less clear-cut, though this chapter seeks to show that it is not necessarily negative.

Making business travel practices more sustainable would demand commitment from three categories of stakeholders: employees, corporations, and governments. The latter, in particular, have a major role to play in raising awareness of the issues, in particular the environmental issues, associated with business travel, but also in raising awareness of the active role that ICT can play in reducing the need for travel.

However, as with other forms of travel, business travel cannot be made more sustainable through initiatives that focus solely on travel (Stead & Banister, 2001). This is because business travel is the outcome of the upstream choices that companies make about their spatial organisation, and therefore the organisation of the worldwide system of production. Changes are therefore needed at this level. Here too, governments have a major role to play in raising global awareness, getting behind ideas and building strategies that go beyond the borders of individual nations.

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Part IV
Future Sustainable Travel

Do Future Land-Use Policies Increase Sustainable Travel?

Bert van Wee and Susan Handy

Introduction

Transport causes negative impacts on the environment, such as emissions of carbon dioxide (CO_2) and pollutants, and noise nuisance. To reduce these impacts policy makers have multiple options available. Regulations for maximum emission levels of pollutants and noise have proven to be very effective, and typically are the responsibility of the supranational (EU), national or state (USA) level. National governments can also implement pricing policies, for instance to stimulate consumers to purchase fuel efficient cars, and develop national infrastructure policies. At the urban or regional scale additional policies are available, in particular parking pricing and road pricing or tolls, public transport policies, infrastructure policies, and land-use policies. This paper focuses on the last category: land-use policies. These policies are often proposed by both researchers and policy makers as a strategy for reducing negative impacts on the environment. Frequently proposed policies include densification, mixed-use development, transit-oriented development, car-free zones, and streets designed to accommodate users other than vehicles. Proponents argue that such policies can help to reduce vehicle travel: transit-oriented development in conjunction with rail infrastructure at the urban or regional scale; densification, mixed-use development, car-free zones, and street design largely at the neighbourhood scale.

B. van Wee (✉)
Faculty of Technology, Policy and Management, Delft University of Technology,
P.O. Box 5015, 2600 GA Delft, The Netherlands
e-mail: g.p.vanwee@tudelft.nl

S. Handy
Institute of Transportation Studies, University of California, Davis, 1 Shields Avenue,
Davis, CA 95616, USA
e-mail: slhandy@ucdavis.edu

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But does research support the argument that land-use policies can reduce vehicle travel? Over the past few decades research in the area of the impact of land use on travel behaviour has evolved considerably. Until the late 1980s published studies mostly investigated correlations between land-use variables and travel behaviour variables at an aggregate scale. The best known of these was the study by Newman and Kenworthy (1988) on the impact of urban densities on average energy use for travel per person for major cities in the developed world. This study (as well as comparable other studies) was highly criticized for ignoring socio-economic and demographic variables. Since the late 1980s, research studies into the impact of land use on travel behaviour have usually accounted for the effect of socio-economic and demographic variables, often modelling the relationships at the level of individuals or households. The mid-1990s saw the emergence of a growing body of literature emphasizing the importance of attitudes and life styles. Consequently, more complex model structures were developed to reflect the influence of land-use characteristics and socio-economic and demographic variables on travel behaviour, but also the influence of attitudes and life styles on residential choice, a phenomenon called self-selection. Whereas most studies in this field use cross-sectional data, many researchers have emphasized the importance of longitudinal studies to better understand these complex relationships. We will discuss the importance of methodological choices below.

While the available research leaves no doubt that travel behaviour is closely tied to land-use patterns and to the built environment more generally, the question of whether implementation of new land-use policies will significantly change travel behaviour remains hotly debated. Important related research questions are (a) Which land-use variables influence travel behaviour, and to what extent? (b) What benefits do land-use policies have in addition to their impact on travel behaviour and consequently the environment? (c) How should land-use policies be evaluated?

In this chapter we discuss whether land-use policies make sense as a strategy for reducing vehicle travel and lessening environmental impacts. We focus on the following propositions with respect to daily household travel: (1) Land-use policies can have a significant effect on travel behaviour depending on the scope and scale of the policies and on the particular context of the effort; (2) Even when land-use policies have a minimal effect on travel behaviour they confer benefits in the form of accessibility improvements, and; (3) Land-use policies should be evaluated for a much broader range of benefits rather than changes in travel behaviour alone.

Careful evaluation of candidate land-use policies is important because the built environment is relatively long-lasting, with a long-term impact on travel behaviour and the wider society. Increasing the density of housing or the mix of land uses in an existing development is much harder than designing and building a new development this way from the start – “repairing” or “retrofitting” poorly designed developments is difficult. Research findings provide an important basis for evaluating proposed land-use policies and can help guide communities towards the best ones for achieving their goals.

Land-use patterns have a potentially large impact on travel. This is because travel is mostly a derived demand: people travel because they want to participate in activities such as working, education, recreation, and social activities. The different locations of these activities – the land-use patterns – determine the options available to people with respect to what destinations are found at what distances from home. From the available options, people make choices about destinations and thus about travel. In this way, land-use patterns influence travel behaviour at a fundamental level, though it is important to note that they do not dictate travel behaviour. As an example, individuals often choose not to take advantage of closer options that would reduce their travel.

Land-use patterns are only one aspect of the built environment that influences travel behaviour. Land-use patterns are characterized by both the density of activity (e.g. population or jobs per hectare) and the mix of land-use categories (e.g. dwellings, shops, services) within a specified area. Higher densities and a greater mix of land uses mean that potential destinations are closer and access to public transit is generally better. Distances are also determined by the layout of the transportation network and the directness of the connections between destinations. A more interconnected street network, for example, generally leads to shorter distances. An extensive transit network or system of cycle paths also helps to reduce travel times for these modes, particularly when they link higher density destinations. In addition, the design of streets and other facilities as well as the aesthetic qualities of the environment more generally are important in making transit, walking, and cycling more attractive. Policies supporting densification, mixed-use development, transit-oriented development, car-free zones, and streets designed to accommodate users other than vehicles all help to achieve these qualities.

Travel behaviour research confirms the important role of distance and travel time, and many studies have also shown a significant influence of density, land-use mix, and network connectivity on various aspects of travel behaviour (Ewing & Cervero, 2010; Salon, Boarnet, Handy, Spears, & Tal, 2011). Despite this evidence, researchers are often in disagreement about the potential for land-use *policies* to significantly alter travel behaviour. There are two basic questions underlying this disagreement: how large a role does land use play in shaping travel behaviour, and how effective are land-use policies in changing land use patterns? We discuss each in turn.

The Role Played by Land Use

Although the vast majority of studies shows at least some effect of land use on travel behaviour, either directly or indirectly, the size of the effect as measured in these studies varies considerably. A major source of differences between studies in the size of the effect relates to research methods. Handy (1996) concludes that generally speaking more advanced research methods have generally found smaller and less significant effects of land use on travel behaviour. A handful of longitudinal studies, in which the *change* in behaviour resulting from a *change* in land use is assessed, have been completed, and these tend to show much smaller effects than the vast number of cross-sectional studies, which examine differences in travel behaviour between places with different land use patterns (Cao, Mokhtarian, & Handy, 2009).

Another important consideration is "self-selection", the possibility that people who would prefer not to drive choose to live in less car-centric places, so that the lower average amount of driving in these places is a function of their preferences rather than the built environment. Many recent studies have addressed this possibility by accounting for attitudes towards travel and preferences for different kinds of environments, but several other techniques have been used as well (see Cao et al., 2009). Overall, these studies show that the built environment has an effect on travel behaviour even after accounting for self-selection.

Other factors add to the complexity of determining how large a role land use plays. Several researchers have suggested that the effect of land use is not linear, that is the effect of changes in land use are greater in places that are less car-centric to begin with (e.g. Niemeier, Bao, & Handy, 2011), but few studies have explored this possibility. Researchers have also discussed the probability that certain characteristics of the built environment work together – synergistically – to influence travel behaviour, in other words, that the full effect is greater than the sum of the effects of the individual characteristics. Such effects are likely to be seen when densities are increased in the area surrounding a new rail station. Non-linear and synergistic effects contribute to variations in the role of land use from region to region, as do other factors such as differences in travel-mode preferences and cultural norms. Finally, time horizons must also be considered: the impact of a change in the built environment may increase over time as people gradually move to new locations, change their attitudes, and adjust their behaviour.

As a result of these considerations, it is difficult to predict the size of the effect of implementing one or more land-use policies in a particular place. Researchers in the US have recently attempted to estimate general effect sizes for different policies based on the existing evidence (Ewing & Cervero, 2010; Salon et al., 2011), but these estimates tend not to take into account non-linear effects, synergies, or the specific conditions of the region. Travel demand forecasting models are better at addressing these issues, but are usually limited in their ability to assess the effects of land-use policies and investments in non-motorized modes, among other strategies for improving travel sustainability (Cervero, 2006). Many current research initiatives aim to improve the tools available for estimating the effect of land-use policies on travel behaviour.

Effectiveness of Land-Use Policies

The second question is whether land-use policies, particularly when adopted in existing metropolitan areas, are effective in changing land use enough to produce a significant change in travel behaviour. The travel behaviour of people living in a high-density, public-transport oriented city such as Tokyo may differ substantially from the travel behaviour of people living in a low-density, car-oriented city such as Los Angeles. Clearly, even the most aggressive land-use policies would be insufficient to convert Los Angeles to the urbanisation patterns and infrastructure systems like those found in Tokyo and thereby achieve its low levels of car use. Although land use influences travel behaviour, land-use *policy* may thus not be an effective instrument to influence travel behaviour.

Generally speaking, researchers who assume relatively strong impacts of policy on land use are more optimistic about possibilities to influence travel behaviour by land-use planning than those who have not made this assumption (Anderson, Kanaroglou, & Miller, 1996). In the US some researchers have argued that any changes in land use that could be achieved through the adoption of new land-use policies would represent such a marginal change to the overall structure of an existing metropolitan region that their impact would be essentially nil (Gordon & Richardson, 1989; Giuliano, 1989). Yet, efforts to radically change the built environment in targeted areas, as through policies to promote transit-oriented development, can have a significant effect on travel behaviour in those areas (e.g. Boarnet, Day, Anderson, McMillan, & Alfonzo, 2005). With enough of these targeted changes, the structure of the entire city begins to change.

So while land-use policies may have a negligible effect in the short run, they have the potential to significantly reshape a metropolitan area and thus the travel of its residents over time. However, this potential depends on the aggressiveness of the land-use policies as well as the governmental funding available to support their implementation, factors that vary greatly by time and place. Note that in developed countries like the US or in Europe, the potential impact of future land-use policies is more limited than in rapidly urbanizing and developing countries like China and India. However, more research is needed to determine the effectiveness of plans and policies in shaping land use and the built environment more generally (Boarnet, 2011).

"Smart Growth" Land-Use Policies Improve Accessibility

Research in the area of land use and transport has generally placed itself in the context of environmental gains: land use could contribute to lower levels of car use and an increase in the use of walking, bicycling, and public transport, thus reduce environmental impacts. However, as noted above, researchers continue to debate the effectiveness of land-use policies in reducing car use. In line with insights from economics, it can be argued that if changes in land use potentially would decrease motorized mobility in terms of passenger kilometres driven (including car use), but in practice people do not travel less using motorized travel modes, then the accessibility benefits they accrue as a result of their travel must exceed the potential decrease in transport costs (time, money, effort) they would save by taking advantage of the opportunity to reduce their motorized travel. Therefore, evaluating land-use policies on (only) travel behaviour and environmental gains is insufficient. Accessibility benefits need to be added. Van Wee (2011, p. 1530) expands on this proposition as follow: “If the potential (theoretically possible) impact of land use on travel behaviour does not occur in practice, there must be accessibility benefits for travellers that they value at least as highly as the benefits of the potential decreases in Generalized Transport Costs.”

We define accessibility benefits as all the benefits that provide utility to travellers, related to the activities they carry out at different locations (working, shopping, visiting friends, and more). These benefits should be corrected for the disutility of travel, measured as generalized transport costs, including monetary costs as well as travel time and effort. A simple hypothetical example helps to explain the proposition. Suppose that a certain region “shrink” to 25 % of its original area. Assume a closed region (no external trips). In addition assume that all other determinants of travel remain constant, in particular the locations of activities and infrastructure characteristics. In that case, trip distances would be reduced by 50 % (surface area changes quadratically with a change in radius). Finally, we assume all trips are made by car. If there were no behavioural changes other than distance reductions, people could participate in the same activities at the new, nearer location by travelling only half of the kilometres and would need only half of the original travel time. More generally, Generalized Transport Costs (GTC) would be reduced by 50 %. But according to the theory of constant travel time budgets (TTB), the average time spent on travel would remain stable, at least in the aggregate, and is in the order of 60–75 min per person per day (Mokhtarian & Chen, 2004). As people trade-off the benefits of activities and the GTC, it can thus be expected that at least some people will choose more distant destinations. They could, for example, visit another, more distant supermarket because it is cheaper or offers more products. Or they could choose another job at a greater distance from their home because it pays better, is more challenging, or offers better career perspectives. Note that not all people would change their behaviour, and certainly not everyone will travel as many kilometres as before the area reduction. If the potential decrease in travel does not appear, there must be accessibility benefits with a value that at least equals the potential savings of GTC, both at the individual level and in the aggregate. If not, people would take advantage of the shrink to decrease GTC.

Of course reality is more complex than our example. People can adapt their behaviour in more respects, such as a travel mode change or a change in trip frequencies. Shrinking a region, as in our example, might lead to a decrease in average travel speeds due to higher densities on the road network and to parking capacity problems. These complexities change the potential reduction of GTC but do not change the principle that the behavioural changes after the shrink other than simply reducing travel distance and time must have benefits that at least equal the value of the benefits of the potential reduction of GTC.

The same line of reasoning applies for other changes to the built environment, such as an increase in land-use mix, or a reduction of distances to public transport nodal points: thanks to the land-use changes a potential reduction in GTC is possible due to distance reduction or mode change, and that is valued positively. If in practice people do not travel less (but travel to destinations further away) there must be accessibility benefits that the travellers value at least as much as the benefits that would be possible due to the reduction of GTC.

To conclude, if the goal is to make people better off, then even if the research showed that land-use policies that allow for a reduction in travel behaviour would not result in people actually reducing, such policies should not be rejected out of hand, because they confer significant accessibility benefits.

Broader Evaluations of Land-Use Policies

The last section is a plea for a broader evaluation of land-use policies, but only for one specific aspect: the benefits of higher accessibility. We now extend this scope to all important pros and cons of land-use policies. Land-use policies that create less car-centric environments have many other benefits that should also be weighed when communities consider their adoption (Van Wee, 2002), particularly in light of the uncertainty over the degree to which such policies will reduce car use.

Travel Behaviour Indicators

As explained above, most research (and policy documents) on the impact of land use on travel behaviour places the topic in an environmental context: land use could improve the environment by reducing car use and its negative impacts. Research generally uses the following indicators to express this impact (1) kilometres (vehicles, passengers), mostly by mode, often by trip purpose, and (2) the number of trips, mostly by mode, often by trip purpose. Furthermore, some studies also focus on trip distances. Travel behaviour indicators are relevant from a scientific point of view, but it is important to consider whether they are also relevant from a policy perspective. We think the answer is affirmative, but only as intermediate indicators: what really matters are environmental indicators and accessibility indicators that relate to travel behaviour.

Environmental Indicators

Though much of research into the impacts of land use on travel behaviour is placed in an environmental context, only a small minority of such studies provide values of environmental indicators, such as CO_2 emissions, particulate matter (PM) and mono-nitrogen oxides (NO_X) emissions. CO_2 emissions contribute to climate change and the locations of these emissions do not matter. But locations do matter for acidification and local air pollution (NO_X, PM): the same kg of emissions in different locations would have different impacts. In the case of local air pollution, it is highly relevant if pollutants are emitted on a road with many people living, working or recreating in its vicinity as opposed to a road in an agricultural area. Also noise effects are highly dependent on being in the direct vicinity of a road or railway.

Accessibility

In addition we think studies of land use and travel behaviour should evaluate accessibility impacts: to what extent does the change enable people to travel between locations they want to visit and to participate in the activities they desire? Indicators could be those used in the area of infrastructure (congestion levels, travel times on networks), in geography (potential accessibility; time-space related accessibility indicators), and in the area of welfare evaluation, in particular utility-based indicators (see Geurs & Van Wee, 2004, for a literature review of accessibility indicators), and location-based (as opposed to infrastructure-networks based) travel time indicators (e.g. Schwanen, Dijst, & Dieleman, 2002).

Option Value

Current evaluations focus on user benefits only, but in addition non-user benefits, in particular the option value, may be important. The option value in the context of land use and transport can be described as an individual's valuation of the opportunity to be able to use a particular travel mode or element of infrastructure in the future that is not being used in the present, or the option to have access to a specific destination that is currently not visited (Geurs, Haaijer, & Van Wee, 2006). For example, car-owners may value the ability to use a public transport service when they cannot make use of the car, for example due to unavailability or a breakdown, bad weather, increases in fuel prices or other car costs, or the loss of the ability to operate a car. Or a person may value access to not currently visited stores because of the possibility of doing it in the future (see Geurs et al., 2006, for an empirical study on option values).

Safety

Safety impacts of land-use and transport alternatives may differ, not only because of changes in overall travel behaviour indicators, but also distributions of kilometres over classes of roadways. If they do, such impacts should be included in the ex ante evaluation of these alternatives.

Health Impacts of Exercise

More people travelling by slow modes has not only environmental and safety advantages but also health advantages (e.g., Frank, Saelens, Powell, & Chapman, 2007; Saelensminde, 2004).

Preferences

Much is known about residential choice preferences (see, for example, Dieleman, 2001). Many people prefer living in spacious homes on extensive plots. On the other hand, building at low densities results in less accessibility to opportunities and to the public transport system. Building at low densities also results in a larger space claim on residential areas and thus in less green space between cities and towns. How do people value such items? We hardly know. But people's opinions are relevant for an overall view of the pros and cons of land-use scenarios.

We may know even less about what people think of job location. What do people prefer – a job location at the edge of town, near a motorway or in the inner city near a railway station? Almost certainly different groups of people have different preferences. Such valuations would be relevant for the ex ante evaluation of land-use concepts.

Financial Aspects

The relevant factors here include the costs for construction, maintenance, and exploitation of land use and transport alternatives. More is known about the financial aspects of the transportation system, in general, and more about infrastructure costs, in particular, than about costs of land-use alternatives. The impact on the gross domestic product (GDP) and unemployment is also relevant. The (valuation of) indirect effects of land-use and transport alternatives (such as effects on the labour and housing market) are much more difficult to estimate than the direct effects (see Banister & Berechman, 2000 or SACTRA, 1999 for a discussion on indirect effects of infrastructure). A distinction should be made between costs for society as a whole, for the government and for the users.

Robustness

Another issue is the robustness of the integrated land-use and transportation systems. In other words, how vulnerable is society to, for example, an expected or unexpected limitation in energy availability for transportation? Energy limitations may be the result of political instability in oil-producing countries, much higher oil prices (for example, due to "peak oil") or stringent environmental (climate) policies. Also, preferences of consumers and firms may change in the future. In addition, what will happen if sustainably produced energy becomes available at reasonable prices? The question then will change from how can land use contribute to reducing transport problems, to how can land use enable people to perform activities in different places under different conditions? This changing role is not only important for land use but also for the role of public transport, walking, and cycling, and for Information and Communication Technology (ICT). Probably land-use policies that are positively valued with respect to travel behaviour impacts (e.g. less car dependency) will be relatively robust. Such strategies include compact development, mixed land uses, and good access to high quality public transport.

This discussion points to the conclusion that land-use policy options related to land use should be evaluated in a broader way than is generally done, before determining their desirability.

European Urban Context

The discussion so far has been quite general. And most studies referred to were made in the US – much less research on this topic originates from the EU. An important question is: how relevant are these findings at the European urban scale? The evidence suggests that the main land-use variables that influence travel behaviour also apply to European countries. A special issue of the *European Journal of Transport and Infrastructure Research* on land use and sustainable mobility gives an overview of empirical research in the UK, Norway, Denmark, Austria, and the Netherlands, as well as the US. Meurs and Van Wee (2004) discuss the results of the country-specific studies. In general there is little difference between European countries and the US with respect to the land-use variables that seem to have an impact on travel behaviour.

However, several differences between the US and the EU may still contribute to a larger effect of land-use variables on travel behaviour in the EU. First, as Cervero (2004) notes, the impact of land-use characteristics on travel behaviour may depend on the costs of travel. More specifically, low prices for travel in the US may swamp the effect of land-use policies, whereas the much higher fuel prices in the EU countries may result in that land-use policies have more impact. For example, the impact of transit-oriented development on travel behaviour may be larger if fuel prices are higher, increasing the competitive advantage of public transport. Second, slow modes are much more important in most European cities than in the US. This is true for walking in general and for cycling in some European countries, particularly in the Netherlands and Denmark. Because slow modes are an alternative for the car at relatively short distances, the impact of densification and mixed-use development on travel behaviour may be larger in European cities compared to

US cities. Third, in general European cities have a more developed public transport system (rail and bus, and often tram and metro), making more destinations accessible by public transport and thus increasing the potential of an increase in public-transport use. A fourth difference is related to planning: some European countries have a much more explicit urban planning tradition – the role of governmental bodies in planning has traditionally been larger in many EU cities and countries compared to the US, making it easier to implement land-use policies designed to influence travel behaviour.

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Integrated Transportation Solutions: Images of the Future

Robin Hickman, David Banister, Jian Liu, and Jimin Zhao

Introduction

The search for greater sustainability in travel is proving to be more difficult than envisaged. Part of the problem is perhaps in the definition and framing of the problem. Sustainability, as a concept to transition towards, incorporates a very wide collection of concerns and objectives brought together by a variety of actors and often with competing directions (Hajer, 1995). Though there are important economic, social and cultural dimensions to sustainable travel, the focus in this chapter is on the environmental aspects, and in particular carbon dioxide (CO_2) emissions.

The current trends in transportation are uncertain and appear to be, in terms of rising CO2 emissions, unsustainable in the long term. Despite this, forecasting studies remain the dominant approach in transportation planning, based largely on extrapolating historic and existing trends and relationships. Stable relationships are often assumed, such as those between incomes and car ownership, and they are usually non-context specific, for instance they may use national data in the absence of local. Scenario analysis provides a different approach to transportation analysis, taking as its premise that trends can (and should) change over the longer term. Scenarios are aimed at developing different images of the future, and eventually to

R. Hickman (✉)
Bartlett School of Planning, University College London,
22 Gordon Street, London WC1H OQB, UK
e-mail: r.hickman@ucl.ac.uk

D. Banister • J. Liu
Transport Studies Unit, University of Oxford, South Parks Road, Oxford OX1 3QY, UK
e-mail: david.banister@ouce.ox.ac.uk; jian.liu@ouce.ox.ac.uk

J. Zhao
Division of Social Science, Hong Kong University of Science and Technology,
Clear Water Bay, Kowloon, Hong Kong, Hong Kong
e-mail: jiminzhao@ust.hk

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lead to new policy trajectories. These types of approaches, though perhaps beyond the mainstream in research and practice, have become increasingly used in transportation planning, with a series of studies developed over the last 20 years (Åkerman & Höjer, 2006; Banister et al., 2000; Dreborg & Steen, 1994; EU POSSUM, 1998; Steen, 1998; Geurs & Van Wee, 2004; Hickman & Banister, 2007; Hickman, Ashiru, & Banister, 2010; Organisation for Economic Co-operation and Development, 2000). Much of the research has been concerned with climate change or energy use, and the role that transport should play over the longer term. The work has been used to help think through possible futures and investment strategies, often linked to some level of participation and debate. Studies are usually normative in nature; expressing value judgements as to where society might like to be, or go, relative to the current situation. There has been an increasing focus on scenarios being quantified, the method participatory, and even adaptive to trends (Banister & Hickman, 2012; Eriksson & Weber, 2008). Van der Heijden (1996), in addition, proposes the "strategic conversation", a discussion around the scenarios as developed and likely implications.

This chapter draws on some of this work to put forward a methodology for developing visions of the future in transport, quantified wherever possible, using case study material from London (UK) and Jinan (China).[1] It considers the conceptual origins and theoretical basis to scenario analysis, and develops images of the future for the case studies that are likely to reduce transport CO_2 emissions to a significant degree, but are still implementable in the different contexts identified.

Conceptual Origins and Theoretical Basis

The scenario analysis approach has had a lengthy gestation, with its conceptual roots developed in the 1960s and earlier by Kahn and Wiener (1967) and others. Scenarios were defined as: "Hypothetical sequences of events for the purpose of focusing attention on causal processes and decision points" (Kahn & Wiener, 1967, pp. 54–55). The early work by Kahn was developed at the RAND Corporation concerning military scenarios, and later at the Hudson Institute. Kahn developed scenarios for the Air Defence System Missile Command and a radical critique of US military strategy in the thermonuclear age (Kahn, 1960, 1962, 1965). He believed that military planning tended to be based on "wishful thinking" rather than sensible expectations. One of his most well-known scenario-based studies was

[1] Much of the analysis reported in this chapter draws on work carried out by the authors and wider team members in the Visioning and Backcasting for Transport in London study (VIBAT-London), UCL UrbanBuzz Programme, 2007–2009, and VIBAT-Jinan study, University of Oxford Future of Cities Programme, 2010–2011. See Hickman, Ashiru, and Banister (2009) and Zhao, Liu, Hickman, and Banister (2012).

originally developed for the US federal government in the 1950s to study how nuclear wars might start and develop (Van der Heijden, 1996).

Scenario analysis was popularised as a business tool in the 1970s by organisations such as General Electric, Shell Oil (Pierre Wack) and the Stanford Research Institute (Peter Schwartz). Shell's management team used scenarios to assess how consumers and countries might react to oil shortages, and Shell was able to respond better than many of their competitors in dealing with the shock of the oil crisis in 1973 and its aftermath. Wack (1985) also emphasised that scenarios were not predictions, simply a perception of likely futures, articulating this as "the gentle art of reperceiving". Scenario analysis has since become extremely well used, with much use in business management for forward planning and strategy development, particularly in view of dealing with uncertainty in the corporate world (Frommelt, 2008; Schwartz, 1996). Businesses often find scenario analysis attractive because they face increasing problems with "traditional" prediction methods in relation to their ongoing market position. As noted previously, scenario analysis has also been developed in the energy, climate change and transport sectors, with a rich body of work emerging.

Futures studies have responded to the problem of uncertainty and are often used to illustrate what might happen to society in order to permit the individual, or society itself, to adapt to perceived future trends. The position taken by Popper (1957) was that the level of future uncertainty was only partly determined by the present conditions and trends of society as we know them. Dreborg (1996) terms this problem as "indeterminacy", explaining that a change in public policy may not only affect an exogenous policy variable, but may change "the rules of the whole game". An actor's decisions are largely determined by the ideas and knowledge available; new knowledge may tip the balance in favour of another known alternative, and may even open up entirely new options.

Uncertainty is hence a key concept within futures studies, indeed the driver for much of the analysis. This can be viewed in various ways – for example, as a lack of "sure knowledge" of past, present, future or hypothetical events (Downs, 1957); and the difference between the amount of information required to perform a task and the information possessed (Galbraith, 1977). Courtney (2001) defines levels of "residual" uncertainty, that is what cannot be known, rather than what is known (Fig. 1). These levels are (1) A clear single view of the future – here a single forecast is precise enough for strategy development, and residual uncertainty is irrelevant to decision-making; (2) An alternative future – there are a few alternative possible outcomes or discrete choices; (3) A range of futures – defined by a limited number of key variables, and the outcome may lie anywhere along a continuum, and; (4) True ambiguity – multiple dimensions of uncertainty interact to create an environment that is virtually impossible to predict; and further, it might not be possible to identify the relevant variables that define the future.

Perhaps the transportation domain is at level three on the Courtney scale, insofar as there is a range of possible future trajectories to be faced, with key dimensions such as economic growth, climate change, and oil scarcity seemingly very uncertain. Van der Heijden (1996) illustrates how the degree of predictability falls with a

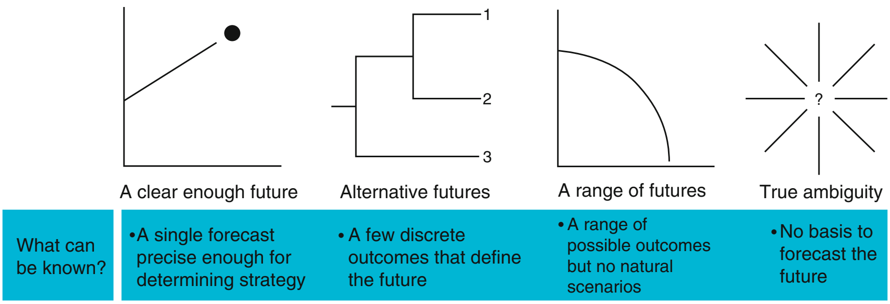


Fig. 1 Levels of residual uncertainty (After Courtney, Kirkland, & Viguerie, 1997; Courtney, 2001; Frommelt, 2008)

reduced knowledge of pre-determined trends, and the uncertainty rises, the further one looks in time. In the very long term, everything is uncertain and strategy is based, at best, on "hope". One continues to forecast and model transportation futures as though they are at level one – evidently not yet exploring the possibilities for travel behaviours and cities adequately.

Images of the Future in London and Jinan

The method for deriving future scenarios in transportation is developed below, drawing on previous work in this area (such as Frommelt, 2008; Schwartz, 1996; Van der Heijden, 1996), and illustrated through the two case studies. The scenario development process creates alternative "images of the future" against different external factors. The process works well if carried out in a workshop setting with key stakeholders; this can assist in the plausibility of the chosen images and perhaps even the acceptability. The scenarios can be developed to open up conversations around future possibilities, but also seek to perform well against chosen performance indicators and achieve particular goals. If this latter addition is chosen, then quantification of the scenarios becomes important. A scenario is viewed here as a "storyline" of a possible future, and includes a cluster of policy measures, each selected at varying levels of application, typically simplified to a low, medium or high level of application.

The case study contexts may in brief be summarised as follows.[2]

London is the capital city in the UK, with an international "World City" reputation (Sassen, 2000). The population is 7.5 million in Greater London, and

[2] More commentary can be found in the original VIBAT-London and VIBAT-Jinan studies (see footnote 1).

12–14 million in the extended metropolitan regional area (Greater London Authority, 2009). Average gross domestic product (GDP) per capita is at £35,586. The urban fabric comprises relatively compact densities; with a dense central area and in polycentric centres in the outer areas. London is known as "the city of villages" – there are two defined international centres (the West End and Knightsbridge), ten metropolitan centres (e.g. Ealing, Kingston, Croydon and Bromley), together with a series of major centres and numerous district centres. The city has a strong tradition of utilising strategic urban planning and public transportation investment, with an extensive underground train network, developed over the last 150 years, and some major investments planned or being built such as Crossrail (a new east–west link across London, scheduled for opening in 2018).

Jinan, China is a sub-provincial city, located on the east of the country, 400 km south of Beijing, and 200 km from the east coast. Jinan is the provincial capital of Shandong and in recent years has evolved into a major administrative, economic, and transportation centre, with a population of around 6.4 million and average annual GDP per capita of £6,030 (about 9,000 Euro). The city is booming economically, with a GDP growth rate of 17.7 % in 2009 (China National Bureau of Statistics, 2009), though this is likely to have fallen since. The modern day name of Jinan derives from south of the Ji (waters), referring to the old Ji river that flowed to the north of the city.

The scenario development process is carried out in three key stages as follows.

- **Stage 1: Define study focus**. This stage involves the development of the key issue, perhaps formulated as a set of research questions, upon which to build the scenarios. This may concern society, a sector such as transportation, or any other unit of interest; and potentially include a broad or narrow focus. In this case we are interested in how transport CO_2 emissions might be reduced in London and Jinan. Pre-workshop interviews are used to understand people's viewpoints and current strategic thinking concerning the future. The results can be shared at the following scenario workshop to rapidly build a knowledge base of understanding concerning the external environment.
- **Stage 2: Understanding the context**. There are three main elements here: (a) Driving forces including trends and uncertainties which have large causal impacts on the main issue and scenarios in question. They are usually external to our control and consist of macro political and economic trends, or even strategic technological developments or environmental degradation. Some of these involve pre-determined elements (demographic change, an ageing population) whilst others are more uncertain (economic growth, migration flows and directions, traffic growth, vehicle technology penetration rates). Some may be critical uncertainties, as these will have large impacts (climate change, environmental awareness in the public and politicians, governmental approach) on the actual policy options being considered. (b) The pre-determined elements and critical uncertainties are closely related and need to be reviewed; perceived pre-determined elements should be questioned and it may be possible to move

some into the uncertainty category. (c) Issues can be ranked by participants by degree of importance and uncertainty, and the key factors (usually the top two) are identified as likely to have most impact yet be the most uncertain. These issues are used to derive the scenarios. Table 1 outlines the important contextual trends and uncertainties for each of the case studies as developed during workshop sessions. A tick is given if there is a likely to be a large change in trend or there is major uncertainty in the trend, as well as this being likely to impact on travel in the case study. The two highest priority issues, in terms of their uncertainty and/or impact, are selected for each case study (#1, #2).

- **Stage 3: Scenario creation**. This is perhaps the most creative of the scenario building stages, drawing on the contextual review, and again involving a series of steps. (a) The scenario is built around a storyline with some structural logic, describing how the driving forces might develop in the future. Several storylines may intersect; a classic example is the "winner and loser" (Schwartz, 1996). (b) Two of the most important uncertainties are used to develop a set of four initial scenario themes, and this can be presented in a two-by-two matrix. Determining the axes is an important step in the scenario generation process (Schwartz, 1996; Schoemaker & Gunther, 2002). The scenario is then extended to include fuller detail consistent with the key theme. All the uncertainties, or at least those deemed as most important, can be used to create the detail of the scenario. If pre-determined factors are used in developing the axes, then the process becomes more akin to forecasting; this is a common confusion with use of scenarios in transportation planning. For example, in the London and Jinan scenarios the key uncertainties used are GDP growth (x-axis, London) and migration (x-axis, Jinan) and environmental stewardship (y-axis, for both London and Jinan) (Fig. 2). The scenarios are illustrated as similar in strategic outline for both cities. If they are developed at a more detailed level, then large differences can be illustrated according to context. Certainly the policy measures and transportation investment projects would be markedly different within each city. Perhaps the most plausible are Scenarios 3 or 4, with the key uncertainty being levels of funding available for sustainable travel modes. Certainly both cities espouse sustainable travel aspirations, yet within this there are still major variants possible, according to the strength and coverage of policy measures, the political lead, and also environmental attitudes and behaviours in the public. Without major progress in these areas, Scenarios 1 and 2 become more likely. (c) Wild cards should be considered to cover possible discontinuities (Drucker, 1968) which may have high impact and high uncertainty. These are also known as the "Black Swans" (Taleb, 2007). Examples might be technological developments (e.g., rapid development of the Internet, or a radical new vehicle or information technology), political (the change of government or regime), physical (an earthquake, volcanic eruption or weather event), economic (financial meltdown), individual (fundamental changes in public attitudes) or other factors. Very different worlds may emerge if a number of wild cards emerge, including together (Drucker, 1968). The scenarios should be revisited for robustness in the light of the wildcards, indeed can be adapted over time.

Table 1 Contextual trends and uncertainties to 2030

Trends and uncertainties	London (ranking)	Jinan (ranking)
Economy and governmental		
Economic growth rate (GDP)	☑ Limited current growth (#1)	☑ Very high current growth
Political stability (national and local)	Stable, but becoming more neo-liberal	Stable, but greater intervention in central planning possible
Globalisation, international trade and movement	☑	☑
Income levels, income inequality	☑	☑
Employment and manufacturing sector growth, including motor vehicle manufacturing	Limited manufacturing base	☑ Very high current growth
Tourism and leisure industry growth	☑	☑
Socio-demographics		
Rural to urban migration and population growth	Limited	☑ (#1)
Age profile (ageing population)	☑	☑ Additionally influenced by one child policy
Household size	Marginal reduction	Marginal reduction
Aspirations and culture – 'western consumption' or 'other' model	☑ Potential large change	☑ Potential large change
Social equality, social welfare, urban–rural balance	☑	☑
Social stability	☑	☑ Very important, strong efforts to maintain
Technologies		
Technological innovation	☑	☑
Clean vehicle technologies	☑ Uncertain penetration rates	☑ Uncertain penetration rates
Energy and power supply – renewable sources	☑ Low current use of renewable, high growth unlikely?	☑ Low current use of renewable, high growth possible
Environmental		
Climate change	☑ Very uncertain, but potentially large impacts in estuarial flooding	☑ Very uncertain, but potentially large impacts in river flooding and temperature change
Major environmental shocks – earthquake, drought, flooding, water supply	☑	☑
Change in environmental quality	☑	☑
Urban issues and transport planning		
Environmental issues – stewardship, extent of 'seriousness' given to them in policy making and implementation	☑ Uncertain as to effectiveness of governmental approach (#2)	☑ Uncertain as to effectiveness of governmental approach (#2)
Urban design quality	☑	☑

(continued)

Table 1 (continued)

Trends and uncertainties	London (ranking)	Jinan (ranking)
Extent of urban sprawl	☑ Relatively effective strategic planning and Green Belt	☑
Aspirations towards sustainable travel, level of investment in public transport, walking and cycling	☑	☑
Extent of car dependency	☑ High base, but recent reduction in car usage	☑ High motorisation aspirations, but low base
Intra-city movements	☑ High public transport usage	☑ Many two wheelers and developing bus rapid transit network

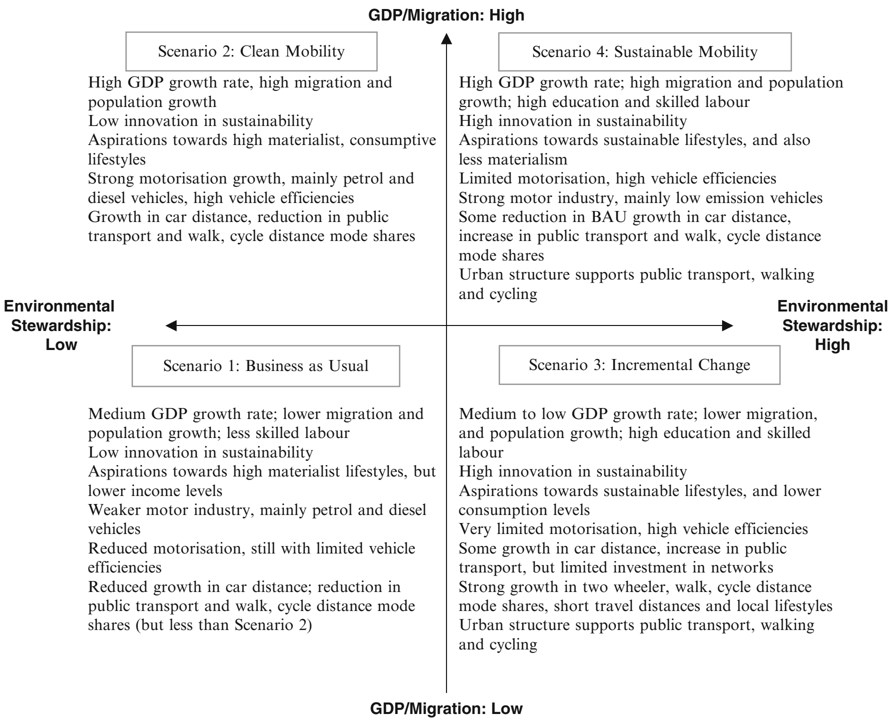


Fig. 2 Scenario matrix. (The scenarios above are "meta scenarios" for London and Jinan, similar in strategic outline for both cities. If they are developed at a more detailed level, then large differences can be illustrated according to context. Policy measures and transportation investment projects would be markedly different within each city)

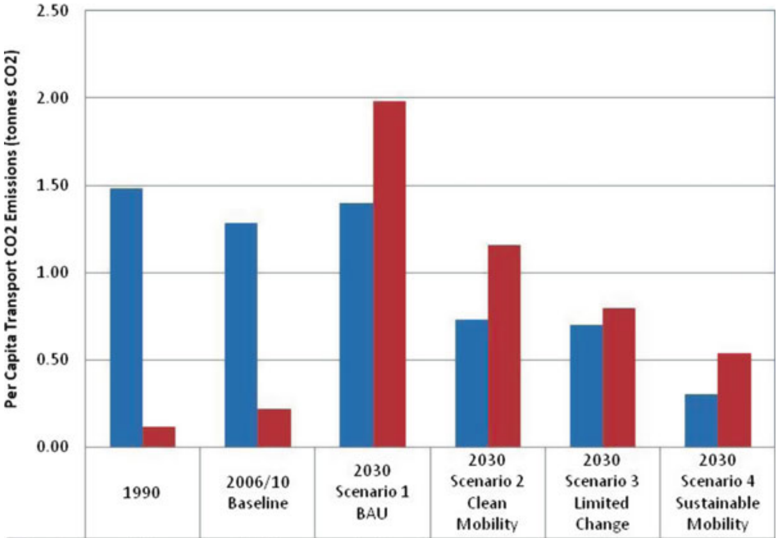
Scenarios can perform different roles according to the rationale for their use. In transport planning their use can be anticipatory, in helping to understand likely future policy trajectories, and assessing the risks behind certain policy positions. For example, "windtunnelling" (Van der Heijden, 1996; Ringland, 1998) can be used, that is testing the robustness of the current policy approach against each of the developed scenarios. "Path dependency" can also be a useful concept here, that is there may be issues of inertia in the policy pathways taken. Scenarios can again be examined for path-dependent effects and flexibility.

Quantification of Scenarios (Stage 4)

This is where many scenario studies conclude, and there is some validity here in that debates can be opened up as the strategic decisions to be made within policy making. However, we go further in the analysis in attempting to quantify the above scenarios by the different context.[3] This can be seen as a Stage 4 in the scenario development process. There are a number of emerging issues as outlined below.

- **Baseline**. The London baseline transport CO_2 emissions per capita are much higher than in Jinan, reflecting the much high motorisation rates and income levels. For example, London has CO_2 emissions of around 1.28 tonnes CO_2 per capita (2006), relative to 0.22 tonnes CO_2 per capita in Jinan (2010).
- **Scenario 1**. London is on a downward, or at least relatively flat, transport CO_2 emissions trajectory, reflecting a saturated level of car ownership and use, high investment over many years in public transport, and relatively well developed traffic demand management strategies. Transport CO_2 emissions are expected to remain at around 1.40 tonnes CO_2 per capita by 2030 under the current "business as usual" (BAU) policy approach. Jinan has the potential to grow rapidly in transport CO_2 emissions under a BAU approach, and perhaps is less certain in terms of the future pathway for increased motorisation. Current levels of car ownership growth are rapid, and under this BAU approach we assume a continued rapid and sustained increase in motorisation and a movement away from the current high mode share for walking, cycling, and electric two-wheelers. The core assumption is that Jinan moves from its current 72 vehicles/1,000 population (2005) to 590/1,000 population (2030), around an 8 % growth per annum in motorisation (2000–2030).

[3] The modelling approach is very different by city – with a much more detailed dataset and modelling capability available to use in London; Jinan utilised the transportation data available locally such as motorisation rates. More details can again be found in the VIBAT-London and VIBAT-Jinan studies (see footnote 1).



	1990	2006/10 Baseline	2030 Scenario 1 BAU	2030 Scenario 2 Clean Mobility	2030 Scenario 3 Limited Change	2030 Scenario 4 Sustainable Mobility
London	1.49	1.28	1.40	0.73	0.70	0.30
Jinan	0.12	0.22	1.98	1.16	0.8	0.54

Fig. 3 Modelled scenarios. (The VIBAT London study used a baseline of 2006, the VIBAT-Jinan study of 2010, according to different data availability. Both used a forecast year of 2030. Only passenger travel within the city is calculated, hence this omits freight movement, intercity travel, and aviation)

- **Scenario 2**. A clean mobility scenario, where traffic is allowed to grow, but becomes clean in terms of vehicle technologies and fuel usage, reduces transport CO_2 emissions in both cities to a significant degree, but many of the gains from cleaner vehicles are offset by the increased level of motorisation.
- **Scenario 3**. Incremental change, again offers some benefits in transportation CO_2 reduction, but the limited investment in public transport and limited environmental stewardship means that many opportunities for CO_2 reduction are missed.
- **Scenario 4**. It is only under the sustainable travel scenario that the greater gains are made in both cities. In London there is large investment in the underground train system and rail networks and in light rapid transit, the latter particularly in the suburbs. In Jinan, there is large investment in the bus rapid transit system, creating an extensive network; two-wheelers remain important. Walking and cycling mode shares are high in both contexts; and the vehicle fleet is clean with an average for the total fleet at below 90 g CO_2/km, that is at a level similar to the current best vehicle technologies globally. Urban structure is an important enabling factor in that the higher-density clusters of development are developed around the public-transport network, particularly at key interchanges. The sustainable travel strategy hence is only possible under an integrated approach (Banister, 2008), whereby many policy measures are put together in a consistent strategy tailored to the particular problems and opportunities in each context (Fig. 3).

Conclusions: The Potential for Changed Travel Behaviour

In many cities, motorisation has become a way of life and central to society – and this is certainly the dominant development model globally. Yet many are beginning to question this developmental pathway: whether the likely climate change impacts, and the wider health, social inclusivity, and city design impacts, of high levels of private motor car usage are actually worth the perceived advantages. In 2010 the numbers of cars in the world reached one billion, and the projections are that this number will double by 2020 (Sperling & Gordon, 2009). It is very unlikely that this level of growth in motorisation is possible given environmental policy goals, and it is this core problem that is facing transportation planning in the next 20 years.

Scenario analysis provides a very useful framework for considering transportation futures within the context of uncertainty, and can be carried out in all cities as an input to strategic decision-making. The key stages – of defining the study focus, context review, scenario development, and quantification of scenarios – allow to consider possibilities beyond the "business as usual" trajectory, and it is exactly this that is required in the current transportation planning domain. The process works best if carried out in a participatory manner, usually in a workshop setting or through the use of interviews.

Many of the policy measures that are required to significantly reduce transport CO_2 emissions are well known, yet their potential levels of application, likely contributions, and most effective packaging with wider measures are poorly understood. Only a wide-ranging and integrated approach is likely to significantly reduce transportation CO_2 emissions, involving infrastructure investments in public transport, walking and cycling; urban planning to support the use of public transport; travel planning and traffic demand management; and the use of low-emission vehicles. Many of the more radical "discontinuity" measures appear difficult to implement, and these need to be thought through and developed in terms of their improved implementability. These include measures such as road pricing, urban planning, high levels of investment in public transport, and different means of accessing car use (such as car clubs). Improved participatory methods are a critical part of the future transport package; it is only by involving decision makers, wider stakeholders, and the public more in decision-making that a greater "ownership" of sustainable travel futures might be achieved. Improved awareness, transference of information to participants, legitimacy of strategy, and acceptance for difficult measures can all be made much more likely.

Transportation and city development is entering a key moment in its history – governments at various levels (with very different political make-ups), civil society, the motor and development industry, and the public, all need to confront the inherent instability in the transportation system over time. In almost all cities there is an insufficient scale of investment in sustainable travel and much inertia in the current motorisation system. In developing sustainable travel strategies, one should ask the fundamental question: What is travel for? The answers should not really be to increase vehicle use or sell more cars, but instead to improve the quality of life in and sustainability of cities.

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High Quality Public Transport: Gaining Acceptance of Bus Rapid Transit Systems

David A. Hensher, Corinne Mulley, and Zheng Li

Introduction

Cities continue to grow for a whole host of reasons, resulting in levels of traffic congestion that have rarely been observed in the past. The "predict and provide" approach, so common in urban transportation planning, typically recommends more road building, accompanied by a dominant rejection of road pricing reform. This, however, does not contribute in the long term to delivering sustainable city performance necessary to securing economic efficiency and distributive justice objectives.

Public transport investment is touted as a key springboard for a sustainable future, especially in large metropolitan areas with growing populations. Public transport, however, is very much multi-modal and should not be seen as a single mode solution as is so often the case with many ideologues (Hensher, 2007a, 2007b). Hence, any commitment to improve public transport has a growing number of options to pursue. Although enhancement in rail systems typically looms dominant in many strategic statements on urban reform (Edwards & Mackett, 1996; Sislak, 2000), ranging from heavy rail to metro rail and light rail, there is a growing interest worldwide in making better use of the bus as a primary means of public transport, and not limited as a service that in many countries (especially in Western societies) predominantly feeds a rail network (Canadian Urban Transit Association, 2004; Callaghan & Vincent, 2007; Hidalgo 2005; Hensher, 1999, 2007a, 2007b).

It is 20 years since publication of the influential paper by Hensher and Waters (1994) on choice or blind commitment to specific public transport modes, and follow up papers by Hensher (1999, 2007b) in which the merits of a bus-based system were promoted as a serious alternative to light rail in particular, but also to

D.A. Hensher (✉) • C. Mulley • Z. Li
Institute of Transport and Logistics Studies, The University of Sydney Business School, The University of Sydney, Sydney, NSW 2006, Australia
e-mail: David.Hensher@sydney.edu.au; Corinne.Mulley@sydney.edu.au; Zheng.li@sydney.edu.au

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heavy rail in some situations. Central to the argument to give bus-based systems (especially Bus Rapid Transport (BRT) systems) credibility is the recognition that services for a metropolitan area must be regarded as comprising of a system in which the key elements of connectivity, frequency, and modal visibility are dominant considerations in establishing public transport providing value for money. Connectivity refers to the provision of door-to-door services with minimum delay and almost seamless interchanges. Visibility is knowing where the mode is coming from and going to, and when. The focus on projects and corridors (and the associated public-private partnership model), in contrast to a model of a public transport system and its associated network has done considerable harm to the delivery of public transport service in many metropolitan areas. The key question of interest in this chapter is "How can BRT deliver as good an outcome (in all aspects) as a rail-based system, given the relative scarcity of funds and the need for governments to prove value for money?" However, this question by itself is not sufficient since governments have multi-dimensional objectives which are wider than simply value for money (Hensher & Stanley, 2008). So this question needs to be answered in the context of meeting the broad objective(s) of government to provide a good quality, integrated and continually improving transit service for a fair price, with reasonable return to operators that gives value for money under a regime of continuity and community obligation.

BRT conjures up different images for different members of the community and so this chapter starts by clarifying what BRT is and the way in which different BRT systems can be compared by reference to their design through a discussion of the BRT standard. Design and performance are clearly linked and the chapter proceeds by presenting an empirical study linking the design features of the definition to the performance outcome of ridership. As this introduction has highlighted, BRT systems in place around the world are innovative and new, especially in comparison with the rail-based systems that have been in place for many years. Implementation issues for BRT systems are complex and the experience of different countries in design and operation of their BRT systems has highlighted common issues which are discussed after the empirical evidence. Before turning to the conclusions, this chapter reviews the bus versus rail debate in the light of the evidence presented. The conclusions synthesise the evidence for the question of interest of this chapter "How can BRT deliver as good an outcome as a rail-based system, given the relative scarcity of funds and the need for governments to prove value for money, within the broader context of providing a good quality, integrated and continually improving transit service for a fair price, with reasonable return to operators that gives value for money under a regime of continuity and community obligation?"

Definition of Bus Rapid Transport (BRT) Systems

There are many ways in which bus transport can be developed as part of an integrated network-based public transport system, typified by the best practice BRT systems in South America such as Curitiba in Brazil and TransMilenio in

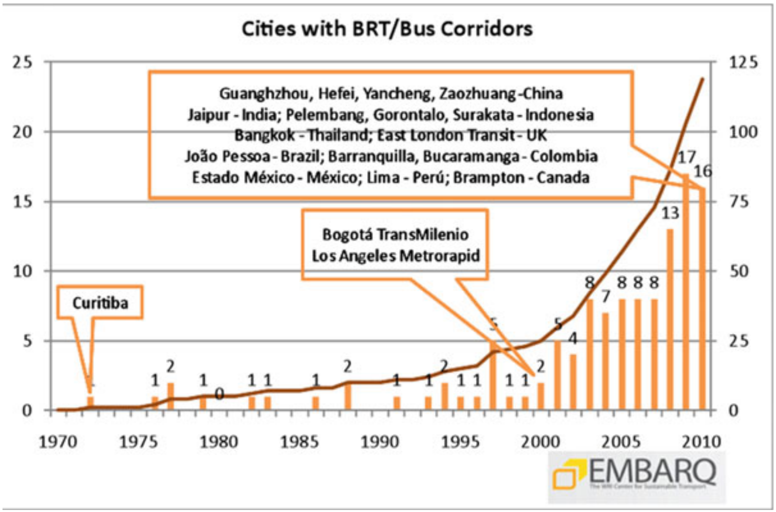

Fig. 1 Tracking the growth in BRT systems

Bogotá, Colombia. BRT is growing in interest globally (Fig. 1 and Hensher & Golob, 2008). BRT is defined as a high-quality bus-based transit system that delivers fast, comfortable, and cost-effective urban mobility through the provision of segregated right-of-way infrastructure, rapid and frequent operations, and excellence in marketing and customer service. BRT essentially emulates the performance and amenity characteristics of a modern rail-based transit system but at a fraction of the cost.

BRT as a "mass transit" system has typically been characterised by high running speeds, passenger capacity, frequency, and operating on an exclusive right-of-way (ROW). In assigning "mass transit" in its name, BRT shares these characteristics with Mass Rapid Transit (MRT) and Light Rapid Transit (LRT) but with the major difference of the vehicles running with pneumatic tyres rather than on rails. BRT systems can be delivered at the fraction of the cost of a rail-based system, between 4 and 20 times less than a LRT system and between 10 and 100 times less than a metro system for the equivalent level of service (in contrast to vehicle) capacity per hour (Wright & Hook, 2007; see also Levinson, Zimmerman, Clinger, Rutherford, Smith, & Cracknell, 2003; Menckhoff, 2005; Transit Cooperative Research Program [TCRP], 2007). It is this lower cost system that emulates the performance and amenity characteristics of a modern rail system, which has led to the growing global interest in BRT as a urban passenger transport solution in situations typified by maximum peak hour ridership at least up to 20,000 passengers, but often in the range 20,000–45,000 passengers per hour.

Although there are a number of components dictating the overall performance of a BRT system, as suggested by the formal definition above, there is no strict definition of what constitutes a BRT system. Its efficiency and effectiveness as a *system* depends on the combination of the three components of infrastructure, the rolling stock, and operation. However, each of these components can be at different standards; so for infrastructure, the running way can be fully grade-separated over its whole length or sometimes in mixed traffic; the stations can be simple stops or enhanced intermodal terminals, and there may be intelligent transport system treatments present. For rolling stock, vehicles can be highly specialized with low floors and branding identifiers or simply ordinary bus vehicles. In its operation, BRT can have off-vehicle fare payment with or without smart or electronic payment or fare payment can be on-bus. This illustrates the difficulty of defining a BRT system, unless consideration is given to the standard of these components (see the next section on defining a Gold Standard).

In examining BRT systems around the world, it is clear that these characteristics are combined in a myriad of different ways, giving rise to a continuum of quality in a BRT system definition. It would be easy to define good BRT as having the highest quality possible on each of these characteristics. But the real world evidence shows that BRT systems in place are a response to the needs of the urban area and have a mixture of quality standards for these characteristics, giving rise to labelling of the spectrum from BRT lite (better than a high quality bus system) to good BRT. In particular it is difficult to compare a BRT system with several state of the art characteristics perhaps in operation and frequency against a BRT system which is a good "all arounder" in terms of desirable characteristics.

Standards Distinguishing BRT Systems

Whilst the characteristics of the system do have an impact on its performance, there are a number of efforts to provide guidelines on what is a good BRT (often described as full BRT). A team of specialists[1] (who have worked on many of the world's best BRT systems) have catalogued the main design features of BRT systems and have scored them as a way of signalling to consumers, decision makers, and the general public that a particular BRT system or proposed system is of a certain quality in relation to best practice.

To provide guidelines on the role of variations in BRT systems, the BRT Standard 2012, as it is now referred to, has recently been developed as a scoring system, for the purpose of recognising Bus Rapid Transit systems around the world which have the characteristics of the world's best BRT systems (Institute for Transportation and Development Policy [ITDP], 2012). The best BRT systems are the ones that combine system efficiency with passenger comfort and convenience. Only the BRT Standard Committee is currently authorised to confer the BRT Standard Gold, Silver, or Bronze brand on a BRT system.

[1] Walter Hook and senior staff, Institute for Transportation and Development Policy, Lloyd Wright, ADB, Dario Hidalgo, EMBARQ, Gerhard Menckhoff, World Bank (retired), Institute for Transportation and Development Policy, Vice President, Wagner Colombini Martins, Logit Consultoria, and CarlosFelipe Pardo, Slow Research.

Table 1 summarises the BRT Standard 2012 approach. The methodology of this scorecard approach is based on the award of points to elements of system design where these system design elements are known to consistently improve system performance, thus indirectly linking the BRT Standard to performance outcomes. The points combine to a total score on which the relevant standard is assessed (Gold = 85 or more points, Silver = 70–84 points, and Bronze = 50–69 points) (ITDP, 2012).

The point system acts as a proxy for quality of customer service so that higher speed or better comfort or greater capacity as examples, attract higher points. The BRT standard (ITDP, 2012) gives detailed information as to how to score, including the rationale behind a system which achieves the maximum score, and systems which rate less well. The BRT Standard is an attempt to measure the BRT system relative to best practice in system design with the metrics being applicable to a full range of BRT systems.

Whilst the different design elements are not explicitly weighted (although implicitly so through the maximum points available), the intention is to reward good design specifically rather than to performance per se. Although there is a strong link between good design and good performance, performance is additionally affected by the characteristics of the corridor, with favourable characteristics improving performance and vice versa.

Many important indicators of performance (such as door-to-door travel time and bus speed) have more to do with the innate characteristics of the BRT corridor than with the strength of the design. For example, higher bus speeds, which usually mean better performance, can be achieved by operating on limited access freeways with very few station stops. Slower speeds may be realised when the system passes through the city centre with higher stop frequencies and more traffic signals. As such, giving points for higher speeds would create a wrong incentive to reward project developers who put their BRT systems on limited access freeways and avoid downtown areas.

Perhaps more importantly, the BRT Standard is motivated by a need to help planning BRT rather than simply assessing the outcome of built systems. In this way cities and residents have a basis for comparison and the information to be able to ask for a higher quality system at the design stage which is more likely to lead to better performance.

Performance of BRT systems is however important, despite data are often lacking or hard to obtain. The reality for most cities is that performance data either do not exist or are difficult to obtain, and a standard-based on performance would be difficult to measure and independently verify. However, whilst the basis of the BRT standard is to concentrate on design standards, on the basis that certain characteristics are associated with higher performance, there is a lack of quantitative evidence as to the extent to which these different system characteristics have on overall ridership which is the key measure of success. Everything else remaining constant, BRT systems that carry more passengers, are more successful.

The next section presents empirical evidence on the drivers of patronage for BRT systems thus providing an additional dimension to the BRT score-card approach with a causal link between system characteristics and patronage, and an evidence base for the scoring process.

Table 1 Bus Rapid Transit (*BRT*) scoring standards

Category	Max score
Service planning	
Off-board fare collection	7
Multiple routes	4
Peak frequency	4
Off-peak frequency	3
Express, limited and local services	3
Control centre	3
Located In top ten corridors	2
Multi-corridor network	2
Infrastructure	
Busway alignment	7
Segregated right-of-way	7
Intersection treatments	6
Passing lanes at stations	4
Minimizing bus emissions	4
Stations set back from intersections	3
Centre stations	3
Pavement quality	2
Station design and station-bus interface	
Platform-level boarding	6
Safe and comfortable stations	3
Number of doors on bus	3
Docking bays and sub-stops 2	
Sliding doors in BRT stations	1
Quality of service and passenger information systems	
Branding	3
Passenger information	2
Integration and access	
Universal access	3
Integration with other public transport	3
Pedestrian access	3
Secure bicycle parking	2
Bicycle lanes	2
Bicycle-sharing integration	1
Total	100
Point deductions	
Low commercial speeds: minimum average commercial speed below 13 kph (8 mph)	−10
Peak passengers per hour per direction (pphpd) below 1,000	−5
Lack of enforcement of right-of-way	−5
Significant gap between bus floor and station platform	−5
Station encroaches on sidewalk or busway	−3
Overcrowding	−3
Poorly-maintained buses and stations	−3
Distances between stations too long or too short	−2

From ITDP (2012, pp. 10–11)

Drivers of Ridership of BRT Systems – A Case Study of Service Quality

A number of studies have conducted reviews of BRT systems (e.g., Deng & Nelson, 2011; Hensher & Golob, 2008; Hidalgo & Graftieaux, 2008). Among these existing BRT review studies, only Hensher and Golob (2008) conducted a formal statistical analysis to comparatively assess BRT systems (e.g., their infrastructure costs and ridership) in existence prior to 2006. The case study reported here focuses on patronage drivers to deliver greater comparative and analytical power relative to traditional literature reviews, using a comparative analysis to determine which BRT system factors systematically affect BRT patronage. The study uses a sample of 46 systems, including BRT systems which have opened between 2006 and 2010, and takes a close look at the relationship between BRT system characteristics and patronage (e.g., whether there is an integrated network of routes and corridors and whether the system has pre-board fare collection and fare verification). A contribution is made to the strengthening of evidence on the BRT system characteristics that promote patronage growth. The results should be taken into account alongside the best-practice approach described above when designing and planning BRT systems.

Data

Information on 46 BRT systems from 15 countries (Latin America: Brazil, Colombia, Ecuador and Mexico; Asia: China, Indonesia, Japan, Taiwan, India, and Thailand; North America: USA and Canada; Europe: France and the Netherlands; Oceania: Australia) opened between 1974 and 2010, was collected from a large number of disparate sources including direct contacts with current operators, BRT web sites and from specialist groups engaged in BRT system planning (such as Embarq). The number of total system passengers-trips per day has a mean of 372,464 and a standard deviation of 1,276,264. Daily ridership per corridor (passenger-trips/number of corridors) for the 46 BRT systems is shown in Fig. 2.

A descriptive profile of the key data items is given in Table 2.[2] In addition to a number of continuous explanatory variables such as fare and total length of the BRT network, the role of a number of categorical variables has been investigated. These include whether the BRT system has segregated busways, only roadways, an integrated network of routes and corridors, enhanced station environment, pre-board fare collection and fare verification, location of doorways on buses, competitively-bid and transparent contracts and concessions, quality control oversight from an

[2] Only variables that are available in all 46 observations are reported and used in the model, given some variables have missing data, for instance, vehicle capacity, average non-peak headway, total length of existing feeder routes.

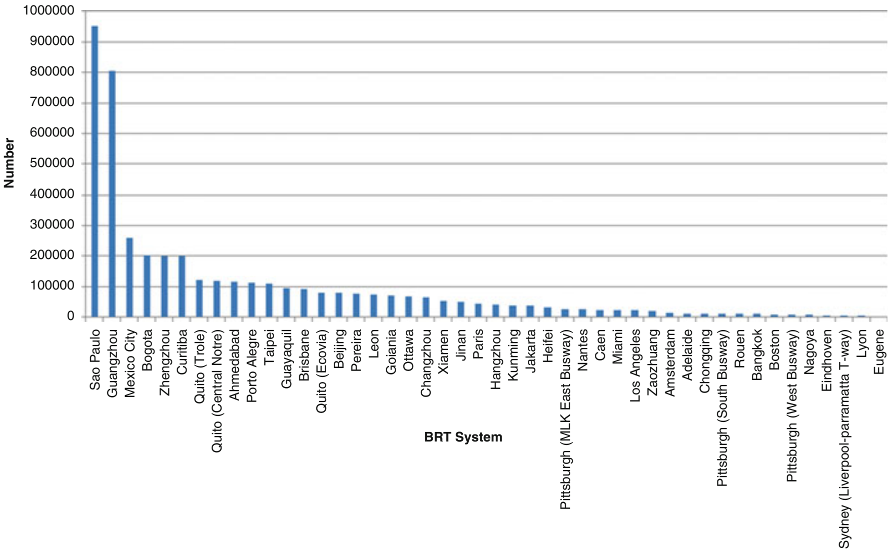

Fig. 2 Daily ridership per corridor (46 systems)

Table 2 Profiles of candidate variables

Variable			
Quantitative variables	Unit	Mean	Standard deviation
Fare	US$2006	1.04	1.30
Total length of BRT network	Kilometres	27.38	22.90
Number of existing trunk corridors	Number	2.30	2.27
Number of stations	Number	38.33	43.96
Average distance between stations	Metres	926.76	735.14
Average commercial speed	Kilometres per hour	25.68	12.40
Average peak headway	Minutes	3.35	2.80
Trunk vehicle length	Metre	16.69	3.85
Year operations started compared to 2011	Years	3.89	2.01
Qualitative variables: whether the BRT system has:			Percentage as "Yes"
Segregated busways for bus-only roadways			78.3 %
An integrated network of routes and corridors			52.2 %
Enhanced station environment			71.7 %
Pre-board fare collection and fare verification Location of doorways (median and curbside)			47.8 % 3.0 %
Competitively-bid and transparent contracts and concessions			26.1 %
Signal priority or grade separation at intersections			47.8 %
Distinctive marketing identity for system,			71.7 %
Quality control oversight from an independent entity/agency			41.3 %
High-quality customer information			76.1 %
Modal integration at stations			23.9 %

Note: All fares are converted into a common currency (US$) and period (2006) independent entity/agency, signal priority or grade separation at intersections, distinctive marketing identity for system, quality control oversight from an independent entity/agency, high-quality customer information, and modal integration at stations (e.g. bicycle parking, taxi stations, and easy transfers between public transport systems). All categorical variables are coded as dummy variables (yes or no) in a regression model.

Methodology

In Hensher and Golob (2008) ordinary least squares (OLS) regression is used to investigate potential sources of systematic variation in BRT patronage. A key assumption of OLS regression is that all observations are independent. However, in the present study, multiple BRT systems are located within one country (e.g., 11 systems in China, six systems in the US, five systems in France, four systems in Brazil). Given this, observations within a single country could be correlated to some extent, given some common characteristics of the country. To capture this, instead of an OLS regression model, a random effects regression model (Eq. 1) is used.

$$y_{it} = a + \boldsymbol{\beta}'\mathbf{x}_{it} + u_i + \varepsilon_{it} \tag{1}$$

Here, $\mathbf{x}$ is a vector of regressors associated with the i^{th} country and t^{th} BRT system; ε_{it} is a random error term, with $E[\varepsilon_{it}] = 0$ and $\text{Var}[\varepsilon_{it}] = \delta^2$; u_i is a country-specific disturbance with $E[u_i] = 0$ and $\text{Var}[u_i] = \varphi^2$, also $\text{Cov}[\varepsilon_{it}, u_i] = 0$; i represents a country ($i = 1, 2 \ldots 15$), and t is the number of BRT systems located within each country. A random effects regression model works by allowing each ith country to have a unique disturbance (u_i); hence within a set of observations drawn from the same country, the disturbances are no longer independent. The model is estimated by generalised least squares. In this random effects regression model, the number of sampled BRT systems within each country varies from 1 (e.g., Canada) to 11 (i.e., China).

The use of mean estimates can lead to multicollinearity being a concern. Whether or not this concern was evident in this data was investigated using the variance inflation factor (VIF) approach which uses the effect of the inter-correlation of the regressors on the variance of the least squares parameter estimates. VIF is defined by Eq. 2 where R_k^2 is the overall explained variance (R^2) obtained when the kth regressor is regressed on the remaining variables.

$$VIF_k = 1/(1 - R_k^2) \tag{2}$$

The optimal value for this statistic is 1.0, which occurs when R^2 is zero or when R^2 is orthogonal to the other variables. There is no consensus on what values of the variance inflation factor merit attention, or on what one should or can do with the results although. some authors (e.g., Chatterjee & Price, 1991) suggest that values in excess of 10 are problematic.

Table 3 Random effects regression model

Explanatory variable	Parameter	t-ratio	VIF
Continuous variables			
Nature logarithm of fare (US$2006)	−0.366	−2.11	3.20
Nature logarithm of headway (minutes)	−0.243	−2.57	1.86
Number of existing trunk corridors	0.223	4.18	3.17
Total length of BRT network (kilometres)	0.558	3.40	3.36
Average distance between stations/population density (metres)	−0.174	−2.08	1.52
Years difference relative to 2011	0.167	2.22	3.2
Dummy variables			
Existence of an integrated network of routes and corridors (Yes)	0.414	2.22	1.42
Modal integration at stations (Yes)	0.453	2.04	2.01
Pre-board fare collection and fare verification (Yes)	0.628	2.89	2.92
Doorways located on median and curbside (Yes)	2.099	4.03	3.21
Quality control oversight from an independent entity/agency (Yes)	0.761	4.45	1.33
Latin America (Location of BRT)	0.625	2.09	1.81
Constant	7.244	11.69	–
Disturbance term effects			
Country-specific disturbance (u_i)	0.133		
Random error term (ε_{it})	0.156		
Sample size	46		
Adjusted R^2	0.875		

Dependent variable is the natural logarithm of daily passengers-trips

Sources of Systematic Variation in BRT Ridership

The best random effects regression model is reported in Table 3. The natural logarithm of ridership is used as the dependent variable. This model explains 87.5 % of the variance in daily passengers-trips of the 46 BRT systems, where all parameter estimates are statistically significantly different from zero at or over the 95 % confidence level. VIF values are well below 10 on all regressors (see last column of Table 3), and an adverse impact from the presence of significant multicollinearity can be confidently rejected.

In this model, the natural-logarithmic transformation is further applied to two continuous variables: the fare variable and headway variable and, given that the dependent variable (ridership) is already in the natural logarithm form, the double-logarithmic form directly delivers the mean estimates of direct fare elasticity and headway elasticity, which measure the impacts of fare and headway on daily passenger-trips. The estimated fare elasticity is −0.366 which is substantially higher than the estimate of Hensher and Golob (2008) at −0.12, but is close to common estimates of fare elasticities associated with conventional and bus and rail systems. In a meta analysis of 241 observations, Hensher (2008) reports a mean estimate of −0.395 for fares which is close to −0.38 reported in Holmgren (2007) for 81 observations and other reviews such as Goodwin (1992), Oum, Waters, and

Yong (1992), and Litman (2005). Nijkamp and Pepping (1998) found that price elasticities of PT demand for European countries is between −0.4 and −0.6.

Our model estimates a headway elasticity of −0.243 which is close to −0.287, the mean estimate reported in Hensher (2008), calculated based on 21 observations ranging from −0.076 to −0.70. This headway elasticity is effectively a variable describing the frequency per hour (=60/headway) and an elasticity of 0.243 suggests that a 100 % increase in frequency would increase ridership by nearly 25 %, holding other factors constant. Improved frequency has an important role in the take-up of public transport by reducing wait and dwell times (which are more heavily weighted by passengers than in-vehicle time), and consequently reducing uncertainty and anxiety.

In addition to fare and headway (or frequency per hour), we also identify other systematic sources of variation which significantly influence ridership. The number of existing trunk corridors represents the capacity of a BRT system. A positive parameter estimate suggests increasing the number of corridors would lead to an expected increase in ridership given that increased capacity in terms of trunk corridors would stimulate demand. The length of the BRT network is another dimension of the capacity of a BRT system, and this also has a positive impact on ridership given a positive parameter estimate in the model.

The average distance between stations normalised by population density has a negative parameter estimate, which in turn suggests that ridership would be increased through reducing distance between stations (i.e., adding more stations). This finding shows the importance of connectivity (as defined in a previous section) in encouraging patronage, that is the shorter distance between BRT stations (or having more stations) would improve access and egress, even though in-vehicle times might be increased if the service is an all-stop one. This also translates into a cost effective potential advantage of BRT over other mass transit such as heavy rail, as it is much easier to add a new station in a BRT system both for a relatively low cost and also in terms of design constraints.

A number of categorical variables are found to have a statistically significant influence on ridership, providing further insights into the design and planning of BRT systems. Our statistical model suggests that two levels of integration are crucial to patronage, namely between systems (existence of an integrated network of routes and corridors), and at stations (modal integration at stations). A BRT system needs to be integrated with other PT routes to allow for more convenient transit (e.g., door-to-door service) so as to attract more users to public transport. Integration at stations is also important, such as bicycle parking, taxi stations, and easy transfers between public transport systems. At the planning stage, these two levels of integration have to been carefully considered.

Other things being equal, the model suggests that a BRT system equipped with pre-board fare collection and fare verification would attract more ridership. Pre-board fare collection and fare verification would significantly reduce the boarding time, and hence contribute to the reduction in total journey time and time variability, as well as less crowding at stations and reduced congestion amongst buses. These improvements would substantially improve user benefits and consequently increase public transport patronage. The finding is in line with Tirachini and Hensher (2011) who found that the pre-board system is the optimal choice for bus fare collection from a cost-effective perspective. We also find that buses with one or more doorways at both the median and curbside relative to other configurations such as one or two doors on one side only, has a positive influence on patronage, since it enables a more efficient flow in and out from either one side or both sides of a bus. Finally we found a positive relationship between ridership and the number of years a BRT system has been in operation.

If there is quality control oversight from an independent entity/agency, this model suggests patronage would be higher, holding other influences constant. This finding highlights how important it is to ensure the service quality of BRT. Our model also shows that the BRT systems operating in Latin America have significantly higher ridership than BRT systems in other locations, all other factors remaining constant. Among the top 10 BRT systems in terms of daily passenger number sampled, seven systems are located in Latin America. We speculate that an important underlying reason for high ridership of Latin American BRT systems is the relatively higher population density and lower car ownership. For example, urban density in Bogotá (Colombia) is around 14,000 persons per square kilometre as compared to approximately 800 persons per square kilometre in Pittsburgh (USA); while the car ownership in Bogotá is around 150 cars per 1,000 people, significantly lower than the ownership in Pittsburgh (nearly 700 cars per 1,000 people). Asian cities also have high population density[3] and low car ownership; but Asian BRT systems have a much shorter history (with the majority beginning operation after 2008), and have lower capacity relative to Latin American BRT systems. Most BRT systems in Asia (in particular in China) are still expanding or undergoing active expansion. For example, the initial BRT system network in Hangzhou (opened in 2006) is 27.2 km,[4] and has doubled in length to 55.4 km (opened in 2008 and 2010). The plan is to further expand the network to 395 km by 2020. Given our findings that the capacity of a BRT system is positively associated with patronage, BRT patronage in Asian cities is expected to grow substantially in the future.

Given the expectation that the economic and spatial base of a metropolitan area has an influence on BRT patronage, we investigated the role of the gross domestic product (GDP) per capita, car ownership rates and population density. GDP per

[3] We are only able to identify population density at the city level, not at the BRT corridor or catchment area level. We did investigate the potential role of population density in the ridership model shown in Table 2, however, this very aggregate measure, defined as both continuous and dummy variables (low, medium, high population density), is highly correlated with a number of system variables and consequently was found to be statistically insignificant. We also tested GDP per capita at the city level, which was also not statistically significant, in terms of continuous or dummy variables for the same correlation logic.

[4] The passenger-trip number of Hangzhou BRT was collected in 2006. Therefore, only one line (27.2 km) is used as its total length.

Table 4 Correlation matrix of selected system and context variables

	LnRidership	LnFare	BRT network length	GDP per capita	Population density
LnRidership	1	−0.392	0.758	−0.594	0.417
LnFare		1	−0.204	0.844	−0.309
BRT network length			1	−0.380	0.449
GDP per capita				1	−0.331
Population density					1

capita is highly positively correlated with car ownership[5] and population density, and hence including all three influences in the model is problematic. An additional random effects regression model was run to examine the influence of GDP per capita (in US$2006 thousands) and population density. As expected, higher GDP per capita (linked to higher car ownership) is associated with lower BRT ridership; and higher population density supports potentially higher demand for BRT ridership. However, these macroeconomic and geographical effects could not be included in the same model as the significant system and locational effects shown in Table 3 because of the high levels of partial correlation (see Table 4), supporting our view that the macroeconomic and aggregate spatial influences are adequately captured.[6] For example, the correlation between GDP per capita and the natural logarithm of fare (LnFare) is 0.844, stronger than the correlation between GDP per capita and the natural logarithm of daily passengers-trips (LnRidership). Population density also has a much higher correlation with the length of a BRT system network than with the dependent variable. As shown in Table 3, population density lined to distance between stations was a significant influence compared to stand alone distance between stations, suggesting that the average distance between stations should be cognizant of population density.

Understanding the drivers of patronage and the design features that characterise good BRT systems does not, however, make BRT systems necessarily easy to implement. There are significant complexities for the decision makers in creating the environment where BRT is acceptable and successfully delivered. These are discussed in the next section.

[5] We have not been able to obtain data on car ownership at the city level for all of the BRT system locations.

[6] The model estimated is not a demand model in the fuller sense of accounting for competing modes and the influence of the socio-economic and spatial context; rather it is a representation of a model designed to identify the potential influence of BRT design, service, and fares on passenger trips per day, holding all other possible influences constant at an average level that is captured by the model constant.

Complexities Facing Decision Makers in Developing and Implementing BRT[7]

Reviews of existing development and implementation of BRT systems around the world reveal common challenges and lessons from bus system improvements and BRT. Whilst the institutional context provides an overarching framework as to what is possible, issues relating to planning, implementation, and operations of BRT systems, and their interconnections with financial, institutional and regulatory constraints create complexities in implementation which this section discusses.

Implementing BRT is a learning process and as the number of systems increase around the world so does an understanding of how to avoid common problems. But each new implementation faces unique issues in relating the design and performance aspirations to the specific nature of the geographical area. All new systems will of course have "teething" problems, and for many cities the initial problems have been resolved in the early period of operation. In other cities, initial problems have identified more profound issues leading to a need to change, improve, and adapt over time. This section addresses these complexities with a view to identifying the complexities facing decision makers from the time BRT is decided upon until its successful implementation.

Political support is vital in the development of the BRT system idea. Rail and light rail solutions may be favoured on emotional or ideological grounds, leading to a failure to recognise the potential contribution of a BRT system. This is particularly true of developed countries, although the example of Brisbane (Australia) demonstrates how a successful implementation can lead to enhanced political support and to extensions of the BRT system network (Golotta & Hensher, 2008). Political commitment plays a key role in the overall speed of BRT project planning and implementation. However, if there is no clear high-level commitment, project implementation can take several years. In contrast, where the mayor or other political leaders have a clear vision for the project, a scheme can be implemented quickly.

Whilst a strong political champion is often seen as an asset in the development and implementation, there are risks too. Political leaders may rush through project planning and implementation to ensure its completion before the end of an election cycle, leading to incomplete or low-quality systems. Or, if a project is too strongly associated with a particular administration or political party, its fate can be adversely affected if political leadership changes.

The decision to initiate a BRT project can be top-down or bottom-up. Top-down decision making originates in the upper echelons of the political hierarchy such as elected officials and cabinet-level authorities, while bottom-up initiatives typically come from staff proposals at the planning or implementation agencies or from comprehensive long-term planning processes. Top-down processes generally take less time and are characterised by fewer conflicts between agencies through the

[7] This section draws on material in Carrigan, Hensher, Hidalgo, Mulley, and Muñoz (2011).

design stage (although these may appear later). Many examples of top-down approaches exist, whereas bottom-up approaches are rarer and take longer because of the need to justify the approach and often occur through a lack of funds to implement a rail alternative.

Operational issues are amongst the most complex to resolve in the implementation of any public transport system, and implementing BRT is no easier. Many BRT system implementations are motivated by the value for money in capital expenditure terms but the ongoing collection of revenues from passengers are rarely sufficient to make urban transit systems financially sustainable. This is not peculiar to BRT but a general feature of urban public transport. The temptation is often to set fares low with the intention of raising patronage, since political buy-in is often based on how many people travel. But fares that are too low can put in jeopardy the BRT project's financial stability. In the development phase, low fares will mean low projected revenue, and planners may then shy away from the more expensive features of a high-quality BRT system such as high-capacity and low emission buses, advanced fare collection, control systems, and user information systems. Yet, these are the very features which define the high quality service which will convince people to transfer from car to transit, and bring sustainability to the city. Setting fares related to knowledge of the costs and an understanding of subsidy requirements is necessary to ensure financial sustainability for operators and funding authorities, as well as continued political buy-in.

As BRT systems are generally introduced into an existing network of services, integrating the operation of old and new services is a challenge. It is therefore common for cities to incorporate existing operators into the new BRT system so as to minimise political and contractual risks. But in many cases, and particularly in developing countries, the public authorities often want to transform an unregulated transport system of small owners and businesses into formal companies as part of their BRT implementation. Cities have encouraged small transport businesses and operators to organize themselves into formal companies through restricted bidding for operation contracts, or through direct negotiations. This has had varying degrees of success, with the main lesson to be learnt is that the implementation of BRT needs to have a carefully defined set of policy objectives and strategies to meet the objectives.

How the operators should be structured within the network containing a BRT system is critical, especially if the implementation objectives include a restructuring of the public transport industry. The open bidding of operation contracts can lead to protests by incumbent operators, but allow the public to take advantage of the competitive process. In some cities competitive bidding was introduced by the politically powerful transportation authorities and whilst the existing bus operators protested, the public benefited from the outcome of the competitive process. On the other hand, negotiating contracts directly with existing operators can result in smoother implementation and avoid protests, but often, although not always, leads to higher costs and weak contractual agreements.

Both the BRT scorecard and the empirical study have highlighted the relevance of integration to successful implementation. Integration can be defined at different levels: physical where the infrastructure enables and supports interchange between

BRT and other modes, operators, and fares; and operational with the coordination of schedules and fare integration. The evidence suggests that all levels of integration are important but the integration of service provision has been shown to be particularly important to users.

BRT systems in operation feature a diversity of scope and level of integration. There are single-corridor projects without fare integration with feeder services and other transport modes; projects with sequential implementation of non-integrated corridors; schemes that gradually implement physically integrated corridors; and others that deploy extended route reorganisation. Even though BRT systems as part of a network provide value for money, especially in relation to rail-based travel modes, high quality BRT is still costly to implement. The evidence points to sequential implementation with physical and fare integration of bus and other public transport services being preferable to developing isolated corridors with a reorganisation of existing services to include the BRT system being the best conceptual approach, as this enables optimum reuse of much of the existing infrastructure and planning frameworks.

Finally, the most neglected element of implementation is often the marketing of the BRT and its branding. BRT, as with all public transport systems, requires a strong brand to attract new users from the car, as well as to retain existing public transport users and secure political and financial support from government. A marketing strategy must begin early in the project planning process and address the disruption caused by construction which might otherwise erode public support for the project.

The Debate on Bus and Rail

Despite the growing interest in BRT systems as part of a package of multi-modal options, there remains in many jurisdictions a rail-centric view of the role played by public transport in delivering efficient and effective sustainable transport to large metropolitan areas. This ideological view is enshrined by the historical reputation of the bus as a mode that operates in mixed traffic where delays and congestion are common, in vehicles that are propelled by environmentally inappropriate fuels, with limited vehicle capacity, in contrast to rail, be it light or heavy. Overlaying this image is the often cited claims that bus systems do not have a desirable influence on land-use changes (and especially the incentive for property developers to invest around bus stops), as well as an inability to move in tunnels like a rail system.

Research shows the appeal of BRT in Los Angeles when comparing the Orange line BRT with the Pasadena, California Gold Line light rail (LRT), both of which connect to the Red Line subway and have similar service patterns and length. The BRT is performing considerably better than the LRT. The latter costs considerably more and carries fewer riders. Capital costs (in $2000) per average weekday boarding for the BRT line are $US16,722 in contrast to $US45,762 for the LRT line; cost per revenue service hours for BRT and LRT are respectively $US243.18 and $US552.54; and cost per passenger mile are respectively $US0.54 and

$US1.08. These are impressive pieces of evidence of the value for money from BRT compared, in this instance, to an LRT system. Metro rail and heavy rail would be even more unattractive within the service capacity range studied.

The most important lessons learnt from the most successful BRT system, and the growing number of BRT systems around the world is that connectivity and network integrity are vital, reinforcing the view that successful public transport is all about creating a network and not corridors per se. This is understandable when thinking about the myriad of origins and destinations that a public transport system must serve and the way in which connections within a network support these opportunities. The evidence from BRT systems in operation suggests that BRT is capable of playing a role in the achievement of a wider set of objectives including sustainable accessibility and urban renewal when implemented as part of a holistic package of integrated strategies. Importantly successful systems have shown a commitment to a *network* of BRT routes (and not a corridor view of planning), which has given these metropolitan areas the opportunity to enhance the accessibility and reap urban renewal benefits at relatively low capital costs and within a relatively short time frame (up to 5 years often).

It is not uncommon to see BRT promoted as a transition to light rail, metro and even heavy rail, partly to get something started within constrained budgets, but to also appease anti-bus groups who see public transport as singularly rail. But whether BRT is a transition strategy to other modes of public transport or an end in itself should be determined by how the market responds. The evidence suggests that the success of many of the implemented BRT systems has resulted in BRT expansion without the need to go to a rail solution. The encouragingly high carrying capacities of BRT are demonstrating that the case for a rail mode, simply on capacity grounds, is not necessary.

Language and words are powerful ways of communicating simple but important points of view but are also critical barriers to understanding the merits of alternative ways of promoting and delivering sustainable transport. For example, in the debate between LRT and BRT, supporters of LRT often argue that it can carry far more people than BRT per hour. But what these supporters mean is that LRT can carry more people per carriage (or carriage set) than a bus or BRT. However, for users of public transport it is service capacity that is important not the capacity per vehicle. A demonstration that much more bus service capacity can be delivered per hour than LRT service capacity, in addition to flexibility in service in connecting with feeders, often leads to a glazing over of the LRT eyes. The simple message is that for users it is service capacity per unit of time, not vehicle capacity, which is important.

Conclusions

This chapter has argued, with evidence, that BRT can provide the level of service that cities need, given sensible design features and implemented in a fashion to create benefits for the urban public transport network as a whole.

The evidence from BRT systems which have been implemented is often difficult to interpret because each location is unique and existing infrastructure, geographical and economic context can have a significant impact. Moreover, consistent and good quality data are hard to acquire. For this reason the BRT standard takes the approach that good BRT systems should be referenced to design principles where good design elements are known to be associated with good performance.

Using information on 46 BRT systems from 15 countries to investigate the potential patronage drivers, this chapter has provided additional evidence to support and quantify the BRT standard approach. The empirical study shows that a number of sources of systematic variation are identified which relate to elements of design and these have a statistically significant impact on daily passenger-trip numbers. This empirical evidence allows the relative importance of the design characteristics to be quantified and thus contribute, particularly at the planning stage, to the design of a BRT system that meets policy objectives. The evidence shows statistically significant price sensitivity with an estimated fare elasticity of −0.379; the importance of frequency with a statistically significant estimated headway elasticity of −0.299; the relevance of the capacity of a BRT system to patronage generation with the length of the BRT network and the number of corridors being significantly positive to total system passenger-trips per day; the necessity to build in connectivity with shorter average distance between stations stimulating the demand for BRT and the significance of integration between BRT and other public transport modes and at stations (allowing for more convenient transfers). Other factors increasing the patronage of BRT includes pre-board fare collection and fare verification because this reduces travel time, travel time variability, crowding and congestion, and quality control to enforce service levels. In summary, BRT must be treated as a part of a network and not an individual corridor.

Design and performance are clearly important, but BRT as an evolving public transport mode faces a complex range of issues in its implementation. Decision makers need to be aware of this complexity and ensure that multi-dimensional policy objectives are properly recognized if implementation problems with potential ramifications for future development are not to be realized.

The findings presented in this chapter offer valuable advice on what characteristics of BRT systems really matter to users, which can be used to assist in planning and designing BRT systems to attract more users, especially from cars to public transport.[8] It answers the question posed at the start: "How can BRT deliver as good an outcome as a rail-based system, given the relative scarcity of funds and the need for governments to prove value for money, within the broader context of providing a good quality, integrated and continually improving transit service for a fair price, with reasonable return to operators that gives value for money under a regime of continuity and community obligation?" BRT has great potential as a sustainable transportation system, which can deliver high levels of

[8] This would be helped by some appropriate pricing mechanisms such as congestion pricing so that private car uses face more realistic price signals.

frequency, regularity, connectivity, and visibility for a relatively lower cost than fixed rail systems, resulting in an attractive value for money outcome for an entire metropolitan area. Framing the implementation of BRT with an eye on the design principles which generate high performance, tempered by the evidence on the elements of design which contribute most highly to patronage, is the key to developing a successful BRT system.

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Non-motorized Travel as a Sustainable Travel Option

Christina Bernardo and Chandra Bhat

Introduction

Non-motorized travel is a clean, efficient, and healthy travel option that, however, accounts for a very small fraction of all trips undertaken in developed countries. This fact may be associated with societal attitudes towards walking and bicycling, sprawling development patterns, increased trip-chaining behaviour, and longer distances between residential locations and activity-participation locations (Currie & Delbosc, 2010; European Environment Agency [EEA], 2006; Lemieux & Godin, 2009). Even in developing countries, where the non-motorized share of trips has traditionally been much higher than in developed countries, there is a general trend of decreasing non-motorized trip share. This trend may be associated with economic growth and the resulting increased motorization, as well as with motorized vehicle ownership being viewed as a symbol of status and wealth (Belwal & Belwal, 2010; Bongardt, Breithaupt, & Creutzig, 2010; Wan et al., 2011). The net result has been increasing urban traffic congestion in both developed and developing countries, with the concomitant consequences of air quality degradation, more inactivity and sedentary lifestyles in the population, and rapidly increasing greenhouse gas (GHG) emissions and associated climate change effects.

Many transportation authorities and public health agencies around the world are taking a more proactive role today to identify and implement strategies that attempt to reverse (or at least stem) the trend of decreasing non-motorized travel, through investments in projects such as non-motorized mode infrastructure enhancement, bicycle sharing programmes, improved land-use planning, and information campaigns. This has naturally led to more research into the determinants (both facilitators and deterrents) of non-motorized travel. In this chapter, we highlight

C. Bernardo • C. Bhat (✉)
Department of Civil, Architectural, and Environmental Engineering, University of Texas at Austin, 301 E. Dean Keeton St. Stop C1761, Austin, TX 78712-1172, USA
e-mail: chrissybernardo@gmail.com; bhat@mail.utexas.edu

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this research and provide a summary of the findings to date. Before doing so, we first discuss the potential benefits of non-motorized travel, and then present descriptive statistics of the level of non-motorized mode use in select developed and developing countries. Next, after discussing the deterrents of non-motorized mode use, we provide an assessment of the potential effectiveness of alternative non-motorized mode use promotion strategies. We end the chapter by providing some concluding thoughts and a look forward.

Potential Benefits of Non-motorized Travel

Traffic Congestion Alleviation

Traffic congestion is a costly societal problem in terms of the resulting loss of time and work force productivity. For example, between June 2011 and June 2012, drivers in each of the ten most congested cities in the UK wasted between 29 and 70 h in congestion (INRIX, 2012), and commuters in urban areas in the US were delayed an average of 34 h in 2011 (Schrank, Lomax, & Eisele, 2011). In 2012, this congestion is estimated to cost the European Union (EU) about 1 % of its total gross domestic product (GDP) (van Essen & van Grinsven, 2012), while the corresponding figure for the US is estimated to be 0.7 % in 2010 (Schrank et al., 2011; World Bank, 2011). Among developing countries, traffic congestion in India has been estimated to cause a loss of Rs. 60,000 crores (12.2 billion in 2011 US dollars) per year (Transport Corporation of India & Indian Institute of Management Calcutta, 2012), which amounts to 0.65 % of India's GDP.

An obvious approach to reduce roadway traffic congestion caused by motorized vehicle use is to explore strategies to shift travel from motorized modes to non-motorized modes. At the most basic level, a shift from motorized trips to walk trips reduces the number of motorized vehicles on roadways. A shift to bicycling will also reduce traffic congestion if the paths for bicycling and motorized traffic are delineated in some fashion (of course, in the case of a narrow street with no space to separate motorized and bicycle movement, a shift to bicycling can increase rather than decrease traffic congestion). A report by SQW (2007) on the effects of cycling in the UK estimates that a single traveller shifting from driving to cycling will save other travellers on the roads an average of £0.22 per kilometre (about 57 cents per mile) in urban areas, and £0.11 per kilometre (about 28 cents per mile) in rural areas.

In addition to reducing congestion directly as discussed above, facilitating non-motorized travel can also have an indirect benefit by encouraging the use of mass-transit travel modes. For example, if there is a well-maintained sidewalk or bicycle lane along a person's path of access or egress to mass transit, that person may be more likely to choose transit over private motorized options (Federal Highway Administration [FHWA], 2012). Such transit vehicles, even if they share lanes with general traffic, offer a more spatially efficient mechanism for transportation, reducing the number of motorized vehicles on the road.

Reduction in Energy Consumption

Non-motorized transportation also provides an avenue to reduce energy consumption. Many countries need to import conventional fossil-based fuels to meet their energy demands, particularly to fulfil motorized transportation demands. On the other hand, non-motorized travel requires no energy from conventional fuel sources (rather, it utilizes energy metabolized by individuals), and can help to reduce the energy demand and consumption of a given region. The SMARTRAQ study which investigated the reduction of vehicle use in the Atlanta, Georgia region has estimated that two-person households located in "walkable" neighbourhoods use 262 fewer gallons of gasoline each year (or 25 % less fuel) relative to two-person households in the most car-oriented areas (Goldberg, Frank, McCann, Chapman, & Kavage, 2007). More generally, Lovelace, Beck, Watson, and Wild (2011) found that policies that encourage bicycling and discourage driving reduce energy consumption, but the amount of the reduction depends on a number of location- and policy-specific factors.

Decrease in Family Transportation Expenditures

In part due to a decrease in energy consumed by each individual who uses non-motorized rather than motorized transport, non-motorized travel presents transportation savings at the household level. Non-motorized travel allows households to cut spending not only on fuel, but also on vehicle maintenance, roadway user fees, and parking fees. This is an important benefit for many households, as transportation costs account for a significant portion of households' regular spending. In 2010 16 % of the average US household's total expenditures were spent on transportation costs (Bureau of Labor Statistics, 2010). The SMARTRAQ study in Atlanta, Georgia, found that two-person households in walkable neighbourhoods expend about 25 % less on annual transportation fuel expenditures relative to households in auto-oriented areas (Goldberg et al., 2007).

Air Quality Improvement

The combustion of fuels to power motorized vehicles releases a number of pollutants that are harmful to human health, including volatile organic compounds, nitrogen oxides, sulphur oxides, particulate matter, and carbon monoxide. These compounds contribute to numerous short- and long-term health problems, including respiratory diseases such as asthma and allergies (Palmgren, Wahlin, Kildeso, Afshari, & Fogh, 2003). Concern about transportation-related emissions is especially high in urban centres, particularly in the developing world where fuel and vehicle technology regulation may be minimal and population and road network density are high (Gwilliam, 2003; Westerdahl, Wang, Pan, & Zhang, 2009).

A shift toward non-motorized travel in developed countries, or a slowing down of motorization in developing countries, can contribute toward reducing the harmful effects of transportation-related emissions (Rahman, D'Este, & Bunker, 2010). Non-motorized modes are usually used for short-distance trips, and such short-distance trips produce large amounts of emissions when undertaken by motor vehicle, due to cold starts effects and idling (Litman, 2012). A study on the value of cycling in the UK estimated that shifting from driving to bicycling provides an air quality improvement benefit of £0.11 per kilometre (about 28 cents per mile) in urban areas (SQW, 2007). Thus, policies that lead to a shift from motorized vehicles to non-motorized modes are expected to cause a reduction in harmful emissions and improvements in air quality.

Greenhouse Gas (GHG) Emissions Reduction

An increase in the share of non-motorized trips in urban areas also has the potential to curb GHG emissions (Nygard et al., 2012). While the inhalation of GHGs such as carbon dioxide (CO_2) is benign from an individual health perspective, the potential harmful effects of GHG emissions are, by any objective standards of analytic assessment, substantial in terms of global climate change (even if the precise extent of GHG effects on global climate change may still be in question) (IPCC, 2007). Global climate change, in turn, disrupts global agricultural processes, floods coastal regions, causes extreme weather conditions, and disrupts wildlife habitats, among other possible outcomes that threaten the very existence of our way of life.

Public Health Improvement

In addition to the benefits that non-motorized travel provides through the more efficient and cleaner use of roadways and energy, it also improves public health, in terms of both physical and mental well-being. In the context of physical well-being, non-motorized travel can help address both obesity and physical inactivity problems and pollutant exposure problems. Over 35 % of US adults and 17 % of US children are classified as obese (Centers for Disease Control and Prevention [CDC], 2012). In 2000 the Australian National Physical Survey showed that 54 % of adults did not undertake adequate physical activity to receive a health benefit, and 15 % pursued no physical activity at all in their leisure time (Australia Institute of Health and Welfare [AIHW], 2000). A number of studies in recent years have investigated the relationship between non-motorized travel (sometimes referred to as active travel) and public health. For example several studies have found that residents of "walkable" neighbourhoods (i.e. areas with more sidewalks, bicycle paths, mixed land use development, and high density) are more likely to be physically active and less likely to be overweight or obese (Bhat & Sener, 2009; Copperman & Bhat, 2007; Lathey, Guhathakurta, & Aggarwal, 2009; Russell-Evans & Hacker, 2011; Sallis et al., 2009; Sener, Eluru, & Bhat, 2010; see De Nazelle et al., 2011 for a review of the existing literature on public health and active transport). That is, transportation planning and policies that encourage non-motorized transportation have the side benefit of increasing physical activity and decreasing obesity problems.

Non-motorized travel may have an ambiguous effect in terms of exposure to emissions and respiratory health. As described earlier, pollutants emitted from the combustion of fuel cause a variety of health problems in both adults and children, particularly in dense urban areas. While non-motorized travel reduces the rate of pollutants emitted by reducing fuel use, it may also increase the risk of exposure to these pollutants as people travel on sidewalks and streets adjacent to roadways.

In terms of mental well-being, people can get stressed and fatigued while driving, which may contribute to depression and general negative emotions (Desmond & Matthews, 2009; Kato, Kawanaka, Bhuiyan, & Oguri, 2011). Replacing driving with non-motorized modes of travel (or facilitating public transit in conjunction with non-motorized transport) provides an opportunity to alleviate these negative mental health effects.

Extent of Utilitarian and Recreational Non-motorized Travel

Selected Developed Countries

Children. In the US, children tend to use non-motorized travel modes at higher rates than adults or senior citizens. According to the 2009 National Household Travel Survey, children aged 5–15 years walk or bicycle for a greater proportion of their trips than any other age group, making about 19 % of their trips by non-motorized modes (relative to 11 % for adults). Children's non-motorized travel in the US is primarily associated with the utilitarian travel to get to school, and recreational travel to play at a park or simply go for a walk or bicycle ride around the residential neighbourhood. In 2009, 13 % of US students in kindergarten through 8th grade (or about 5–13 years of age) walked or rode a bicycle to school (National Center for Safe Routes to School [NCSRS], 2011).

Children in the Netherlands also use non-motorized modes more than other age groups. However, all segments of the population utilize non-motorized travel to a far greater extent in the Netherlands than in the US. According to the 2009 Dutch National Travel Survey, children in the Netherlands use the walk or bicycle mode for about 64 % of trips (compared to 19 % in the US).

Adults. Non-motorized travel plays different roles in different developed countries. On average, about 55 % of all non-motorized trips made by adults ages 18–59 in the US is for utilitarian purposes such as running errands or commuting, while the remaining 45 % of non-motorized trips may be characterized as recreational (National Household Travel Survey [NHTS], 2009). Overall, non-motorized trips account for 11 % of US adults' (ages 18–59) annual trips (NHTS, 2009). In contrast, in the Netherlands, walking and bicycling together make up about 42 % of total trips for adults in the 18–59 year group (National Travel Survey [NTS], 2009). Of these, only 27 % are for recreational purposes, with the remaining majority being used for utilitarian travel.

Senior Citizens. In the US senior citizens use non-motorized travel less than any other age group (only 9.6 % of trips made by senior citizens are by non-motorized modes) (NHTS, 2009). Walking and bicycling create a physical strain and may become exhausting for older individuals. However, within the pool of non-motorized trips made by seniors, about 54 % of the trips are for recreational purposes, while the remaining 46 % of non-motorized trips is utilitarian. This may be because many senior citizens are retired and have fewer daily obligations, such as errands, childcare, and travelling to work. However, seniors also tend to be the least mobile segment of the population, and are most likely to respond to enhanced accessibility for non-motorized travel (Cao, Mokhtarian, & Handy, 2010).

In contrast, Dutch seniors use non-motorized travel more than adults. Bicycling and walking account for about 50 % of their total trips (NTS, 2009). Of these non-motorized trips, only 39 % are for recreation, and the remaining 61 % are for utilitarian purposes. This may be due to both the more dense urban form in the Netherlands, as well as the strong bicycling culture.

Developing Countries

Travel survey data is collected far less regularly and widely in developing countries than in developed countries. For these reasons, a very general overview is provided here regarding the extent of non-motorized transport utilization in developing countries.

The mode share of non-motorized travel tends to be much higher in developing countries than in developed countries. Personal vehicles are available to a relatively small fraction of the population in the developing countries, development patterns are often more dense than in the developed world, and public transit networks more well-developed than in many developed countries such as the US. In urban cities in India, in 2007 the walk mode had a 28 % mode share and bicycling had an 11 % mode share (Ministry of Urban Development and Wilbur Smith Associates, 2008). In Curitiba, Brazil, where Bus Rapid Transit (BRT) has the largest mode share at 45 %, the share of non-motorized modes is about 26 % (International Council for Local Environmental Initiatives [ICLEI], 2011). Several of China's largest cities also exhibit a very large mode share for the non-motorized modes.

In Beijing, bicycling and walking account for 32 and 21 % of the city's mode share, respectively, and in Shanghai bicycling and walking account for 10 and 27 % of the mode share (Land Transport Authority [LTA], 2011).

Deterrents to Non-motorized Mode Use

Travel Patterns

In most developed countries, private motorized forms of transport are accessible to a vast section of the population. Combined with built environment and land-use development patterns, the net result has been the domination of the private car mode share for all trip purposes. Further, the travel distances by the private car have been increasing steadily for each trip purpose. For instance, the average trip length across all trip purposes increased from 9.5 miles in 1995 to 10.0 miles in 2001 and 10.1 miles in 2009, according to the National Household Travel Survey (NHTS). Canada has seen a similar increasing trip length trend, with the median commute distance rising from 7.2 km in 2001 to 7.6 km in 2006 (Statistics Canada, 2006). This trend of increasing trip length is one impediment to non-motorized mode use. Another trend is the increasing chaining of activities in a single sojourn from home or work (for example, picking up groceries or children from a day care on the return home from work). Such chaining makes it more difficult to wean individuals away from driving alone (Bhat & Sardesai, 2006).

In developing countries, although non-motorized modes tend to have a relatively large share, the infrastructure for non-motorized modes is generally limited and marginally maintained. This may be an impediment to non-motorized modes in terms of both safety issues and in maintaining the attractiveness of non-motorized modes as motorized options become increasingly available. For example, many roadways in developing counties do not have sidewalks or pedestrian signals, or the sidewalks are crowded with vendors or other encroachments that push pedestrians into the roadway. A study of pedestrian behaviour in Karachi, Pakistan found that 35 % of pedestrians crossing the street caused traffic to swerve to avoid them (Khan, Jawaid, Chotani, & Luby, 1999). Additionally, in a review of road traffic injuries in developing countries, Hazen and Ehiri (2006) recommend sidewalks and physical barriers between pedestrians and vehicles as a primary strategy to reduce pedestrian crash injuries.

Land-Use Patterns

In many developed countries, particularly outside of major urban centres, land-use patterns favour vehicular passenger travel. Spread-out, sprawling cities and towns with large single-use developments make it difficult for residents to access points of interest by non-motorized modes (even if the points of interest are in close geographic proximity). Numerous studies have found a correlation between population density and land-use mix and walking for both utilitarian and recreational purposes (e.g., Bhat, Sener, & Eluru, 2010; Hankey et al., 2012; Saelens & Handy, 2010; Winters, Brauer, Setton, & Teschke, 2010).

Different developing countries may vary in terms of land-use patterns. However, it is expected that mixed-use development similarly facilitates non-motorized travel in both the developing and developed world.

Safety and Built Infrastructure Patterns

As alluded to previously, safety concerns can play a large role in the use of non-motorized modes in both developing and developed countries. Built infrastructure affects the safety of travel by all modes, but it has a particularly strong impact on non-motorized modes. Walkers, bicyclists, and users of non-motorized rickshaws are more physically vulnerable to injury in the event of a crash than users of most motorized vehicles (with the exception of motorcycles) (Beck, Dellinger, & O'Neil, 2007). Providing a separate pathway for non-motorized traffic (such as a sidewalk or bicycle lane) may be helpful in improving safety for non-motorized modes (Mohan, 2002; Sener, Eluru, & Bhat, 2009a. 2009b). This is particularly relevant in developing countries where non-motorized infrastructure may be limited. In developed countries, non-motorized infrastructure such as sidewalks may increase the perception of safety, and therefore increase the likelihood of a person choosing a non-motorized mode (Ferdous, Pendyala, Bhat, & Konduri, 2011; Rodriguez & Joo, 2004). In addition to safety related to road traffic incidents, people may hesitate to take non-motorized modes because of a fear of being vulnerable to crime. Particularly, this has been found to influence parents' decision to allow their children to walk or bicycle to school (Seraj, Sidharthan, Bhat, Pendyala, & Goulias, 2012).

Perceptions and Attitudes

In both developed and developing countries motorized modes are perceived to be preferable to non-motorized modes. For instance, Heinen, van Wee, and Maat (2010) observe that many urban residents of developed countries perceive cycling as an "uncharacteristic" mode of transport, that a cycling trip will be uncomfortable or taxing, and that there will be too much traffic to safely bicycle. On the other hand, the perception that bicycling provides a health benefit tends to increase a person's tendency to commute by bicycle, as observed by Heinen, Maat, and van Wee (2011).

The situation is somewhat different in developing countries, where motorized travel can be a sign of wealth or social status. For example, Zhu, Zhu, Lu, He, and Xia (2012) find that Chinese university students, who expect to have greater purchasing power after graduating, exhibit a strong desire to own a vehicle, and associate owning a car with a sense of freedom and convenience. These associations tend to permeate developed countries as well, but the social pressure to own a vehicle to demonstrate success is greater in an environment where a majority of people do not own one (Mercier, 2009).

Potential Effectiveness of Alternative Non-motorized Mode Promotion Strategies

Information Campaigns

Information campaigns can be an effective method of encouraging non-motorized travel and creating a "culture" of walking and bicycling. Such campaigns can include media announcements about the benefits of non-motorized travel, bicycle repair and maintenance workshops, bicycle safety classes, cycling and pedestrian organization meetings, and public rides or walks. Studies have found that such campaigns increase the awareness of bicycling and walking as well as the rate of walking and biking amongst local residents (Stangl, 2011; Zahran, Brody, Maghelal, Prelog, & Lacy, 2008). For example, the Metropolitan Washington Council of Governments initiated a "Street Smarts" campaign in 2002 that was shown to increase awareness of bicycling and walking, particularly regarding safety and incident avoidance (Metropolitan Washington Council of Governments, 2003). The GetAbout Columbia project in Columbia, Missouri increased, from 66 to 80 % in 3 years, the proportion of residents who agree that the city is pedestrian- and bicycle-friendly (FHWA, 2012). Such attitudinal and perception changes can have important effects on travel behaviour. For example, Cao, Mokhtarian, and Handy (2009) found that a series of statements constituting a "pro-bike" or "pro-walk" attitude had a statistically significant impact on the choice of a non-motorized mode for non-work travel.

Travel Behaviour Modification Strategies

A number of different strategies exist that policymakers may employ to modify travel behaviour that encourages non-motorized travel. These may include altering the price of one mode relative to another, such as increasing the tax on fuel or adding a toll charge to a major thoroughfare. Additionally, policies may aim to modify motorist behaviour to improve travel conditions for non-motorized modes, for example through traffic calming measures or speed limit reductions (Schneider, 2011).

Built Environment Policies

Policies that affect the built environment may have the potential to encourage and facilitate non-motorized travel. A large and growing number of studies have examined the effects of the built environment on travel behaviour (see Ewing & Cervero, 2010, for an overview of the literature on the built environment and travel behaviour). In particular, there has been a recent interest in isolating the direct effect of the built environment on behaviour from residential self-selection effects. The concern is that simply increasing density or the mix of land use in any neighbourhood may not have the expected impact on mode share, because people who prefer to use non-motorized transportation may be more likely to live in high-density, mixed-use areas with sidewalks and bicycle lanes already. Thus, transport policies that intend to increase non-motorized travel in less pedestrian- and bicycle-friendly areas may be less effective than expected because residents of these areas may have a strong preference for motorized modes. In response to these concerns, researchers are creating new frameworks to account for these effects and isolate the impact of built environment factors on travel behaviour. For example, one study of the San Francisco Bay area modelled both residential choice and car ownership decisions, and found that built environment attributes have a significant influence on both (Bhat & Guo, 2007). Bhat and Guo also found that different segments of the population experienced these built environment effects to varying extents, a finding shared by Forsyth, Oakes, Lee, and Schmitz (2009). Cao et al. (2009) found that, after accounting for residential self-selection through personal attitudes revealed by survey responses, the built environment still impacts travel as expected. For example, a higher land use mix discourages personal car travel and encourages the use of transit and non-motorized modes, after accounting for residential preferences and attitudes. Bhat and Eluru (2009) found a similar result by accounting for residential self-selection through copula methods. Research on the topic of built environment effects is still developing (Pinjari, Eluru, Bhat, Pendyala, & Spissu, 2008), but current results suggest a clear causal impact (even if not of a high magnitude) of built environment attributes on levels of non-motorized travel.

Integration with Public Transport

Non-motorized modes and public transport modes are both integral parts of a seamless multi-modal transportation system. Integrating non-motorized travel with public transport systems allows non-motorized modes to be used as one segment of a trip that is too long to be practically made by walking or cycling alone. Furthermore, improved non-motorized accessibility may also increase public transit use. For example, Rodriguez and Joo (2004) found that the presence of sidewalks on the access or egress route to transit increased the likelihood of persons using transit for their commute. In addition to simple accessibility measures, such as sidewalks or bike lanes along access or egress routes, non-motorized travel can be integrated into the public transportation experience itself. For example, allowing bicycles in train cars, providing bicycle storage on buses, or providing bicycle parking or bicycle sharing programmes near transit stops all make public transport more accessible (Krizek & Stonebraker, 2010). Together, non-motorized and public transport can help to provide an integrated and sustainable transportation system.

Recommendations for a Pathway Forward

There are a number of promising ways to achieve the numerous benefits of non-motorized travel throughout both the developing and developed world. A variety of policy measures are available to planners and governments facing environmental and travel-related challenges. In developed countries, pricing strategies such as congestion charges can be effective in reducing car travel in city enters and encouraging residents to use a combination of non-motorized and public transport options. In developing countries, it may be helpful to promote non-motorized travel over the private car, and to attempt to challenge the social stigma that owning a car equates to personal success and freedom. Local authorities everywhere can look towards dense, mixed-use development to encourage non-motorized travel and promote more active lifestyles.

It is also critical that researchers continue to investigate both the factors that affect non-motorized travel behaviour and the effectiveness of associated transport policies. As policymakers work to integrate non-motorized travel into their transportation systems, and planners pay more attention to the effects of land use on travel behaviour, researchers must continue to investigate how, why, and to what extent these new policies are effective in providing safe and reliable transportation to all travellers. In addition to evaluating existing policies, research should also investigate new possible avenues for facilitating non-motorized travel, and provide innovative solutions to both old and new transportation problems. As always, studies must explore the effects of transportation policies on the health and safety of both the public and the environment.

In summary, as countries, cities, and towns throughout the world work toward improving the way their transportation systems serve their residents, promoting non-motorized travel presents an attractive option to relieve congestion, improve public health, and reduce emissions.

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E-Commerce: Implications for Travel and the Environment

Orit Rotem-Mindali

Introduction

The deterioration of the environment is to a large extent attributed to the externalities of the current transportation system. The negative externalities include those resulting from the energy used to move vehicles over space, the effects of the infrastructure needed to facilitate movement, and the indirect effects resulting from transportation impacts on land use and development patterns. In the last few years leisure-related and shopping-related travel has taken on a major role in urban transportation. Evidence of the rise in the share of shopping-related travel and its diverse temporal and spatial distribution has emphasized its growing potential impact on the environment.

Shopping activity, hence referred to as consumption, has a direct effect on the environment, not only through the travel it generates. The rate of consumption is rising rapidly in modern society. Consumption is a complex process which involves the extraction, production, disposal, and transportation of goods. Every stage of consumption activities may influence the environment. The rapidly increasing level of consumption in the developed world is considered unsustainable and has the potential to dramatically increase human impact on both the local and global environment.

A major trend which has recently received much attention is the adoption of new technologies in retailing. Early studies asserted that Information and Communication Technologies (ICT) will generate a revolution in the retail sector due to its potential to reduce transaction, transportation, and search costs. This involves a shift from some aspects of the traditional store format toward the introduction of electronic means of executing retail activities. E-retail, e-commerce, and e-shopping or tele-shopping have become common terms for electronic, mainly internet-based transactions. E-commerce is the generic term that will be used here.

O. Rotem-Mindali (✉)
Department of Geography and Environment, Bar Ilan University, Ramat Gan 52900, Israel
e-mail: orit.rotem@biu.ac.il

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Transport geographers distinguish four effects that may result from e-commerce. The first to be addressed is substitution. It occurs when e-commerce reduces the number of shopping person-trips and person-distance travelled. Substitution may occur if consumers shop without travelling to a store. A second effect is complementarity. When e-commerce leads to more personal shopping trips or increased lengths of shopping trips, it is considered a complementarity effect. Various reasons exist why it is plausible to hypothesize that multiple shopping trips will not be substituted by e-shopping. It is suggested that often online transactions replace other modes of teleshopping instead of replacing in-store shopping. Finally, modification and neutrality occur in cases where e-commerce has a limited or even a neutral impact on the number of shopping trips and distance travelled for shopping (Andreev, Salomon, & Pliskin, 2010; Mokhtarian, 1990, 2002; Salomon, 1985, 1986).

Conducting e-commerce may also have large implications for freight transportation. Product delivery may lead to changes in load units, vehicle size, order and delivery size, delivery location, number of stops, and number of trips. It is hypothesized that it may cause more freight trips and more freight transport kilometres. Freight transportation may also increase if e-shopping stimulates people to spend more money on consumption.

In the last two decades, the amount spent on e-shopping in developed countries has grown exponentially experiencing only brief lulls due to recessions. The share compared to total retail sales is still relatively small. For example, in 2010 e-commerce sales represented 4.4 and 4.8 % in 2011 of US total retail-trade sales (US Census Bureau, 2012). In the UK e-commerce sales represented 16.9 % of total sales in 2010, up from 16.1 % in 2009 (Office for National Statistics, 2011). And the share of business-to-consumer (b2c) e-commerce of total retail sales in Italy grew from 4 % in 2009 to 6 % in 2010 (yStats.com GmbH & Co. KG, 2011). In addition to the growth in b2c e-commerce, a recent phenomenon is for consumers to frequently buy and sell from one another via the Internet; also referred to as consumer-to-consumer (c2c) e-commerce.

This chapter will discuss the impacts of online shopping on both consumption patterns and supply chains, and its implications for sustainable travel. A general review of current consumption patterns and the main developments in the retail system will be presented as well as an analysis of the potential impacts of e-commerce on freight transportation and personal travel by addressing changes in shopping patterns, consequences of spatial dispersion of shopping activity, and assessments of the aforementioned effects on travel.

Changes in Retail and Consumption Patterns

Shopping, both as an activity and in its functional-structural property, has undergone significant transformations since the ancient market was convened in the city square. In general shopping activities can be separated into two main features. On the demand side, evidence suggests that the general tendency towards the increasing importance of shopping has accelerated in recent decades (Court & Myers, 2002). As such, researchers have positioned contemporary society within the "consumption era" or "consumption culture", referring to it as the "consumer society" (Baudrillard, 1998; Clarke, 2003; Goss, 2004; Lee, 2000; Miles, 1998; Slater, 2000; Zukin & Maguire, 2004). This reflects the increasing importance of shopping in everyday life. Shopping is generally classified according to daily (e.g., groceries) and non-daily/convenience shopping (e.g., books, electronic devices, and clothing). However, by aggregating the different types of shopping, the potential significance of shopping activity is reflected in daily life. Moreover, shopping is generally classified as a non-work activity or maintenance activity, thus excluding leisure (Fan & Khattak, 2009; Reichman, 1976; Zhang, 2005). However, in contemporary societies consumers participate in shopping activities, not merely to obtain products, but to enjoy and experience shopping as recreation (Arnold & Reynolds, 2003; Bloch, Ridgway, & Dawson, 1994; Guiry, Magi, & Lutz, 2006). Shopping is considered a favourite form of recreation reflected in its growing significance as a non-work activity (Guiry et al., 2006). On the supply side, organizational structure, technology, and location have evolved from the archetypical bazaar and marketplace into the specialized and sophisticated contemporary retail typologies, although the underlying logic has remained the same (Beyard & O'Mara, 1999; Maitland, 1985).

In recent years the retail market has experienced continuous growth. Much of this growth has been attributed to increases in household income (due to economic improvements), the participation of women in the labour market, and the demand for greater diversity among products accompanied by lower prices.

In many Western nations retail locational patterns have undergone fundamental changes since the 1970s and facilities have conformed environmentally to accessibility considerations. Usually, this is as applicable to town centres and neighbourhood street-corner stores, as it is to the strip development emerging along highways in the automobile-dependent suburban landscape. The advent of expressways or freeways gave rise to the development of shopping centres in the form of huge malls at highly accessible network nodes, and thereby replacing strip development. Accessibility has become synonymous with the accessibility of cars. The car reduces travel time to destinations and increases freedom of choice regarding when and where to travel. Large-scale processes of suburbanisation have created a geographic shift in which affluent populations have moved away from the urban cores into the suburbs (Andersen, Møller-Jensen, & Engelstoft, 2011; Bromley & Thomas, 1993; Mulhern, 1997).

Car travel for the purpose of a shopping activity is increasingly considered to be a contributing factor to suburban congestion, and consequently harmful to the environment. Thus, it has also become a focus for travel demand management policy measures. The impacts of e-commerce as an acquisition mode are of interest mainly because shopping-related travel may be reduced. Studies of the impacts of e-shopping on transport usually assume that the delivery trip, by the retailer or a third party, to multiple customers is more efficient than individual trips (Rotem-Mindali & Salomon, 2007).

E-commerce has been in the limelight over the past two decades. To evaluate the impact of e-commerce, it is important to understand its three elements that may, but need not be separate activities: information gathering, purchasing, and delivery. Each component of the shopping process may involve different numbers of agents that use different transportation modes at different time frames. These diverse patterns of activity result in significant mobility implications for e-commerce.

Nowadays, consumer e-commerce is concentrated mostly around items such as books, software, music, travel, hardware, clothing, electronics, and an expanding groceries sector. As stated earlier, e-commerce sales have grown exponentially. Yet, it seems that people are browsing the Internet more for information than for online purchases (Forsythe & Shi, 2003; OECD, 2002; Teo, 2002). Research into the influence of the Internet in the US revealed that for every single US dollar that a consumer spends online, another five or six are spent on offline purchases which are influenced by online browsing (Buderi, 2005). The Internet affords the consumer easy access to information on merchandise where it is possible to gather vertical information (make comparisons), screen the offerings, and locate the lowest prices (Alba et al., 1997; Chiang & Dholakia, 2003; Childers, Carr, Peck, & Carson, 2001; Gupta, Su, & Walter, 2004; Peterson & Merino, 2003). Yet, when online shopping is compared with offline shopping (traditional store shopping), the latter is preferred in most cases. The typical customer wants to be able to touch and examine the goods. Tangible physical contact with a product acts as a stimulus for purchase. In addition, personal interaction with the retailer or salesperson may generate a sense of a more successful purchase (Mokhtarian, 2004).

Many studies have tried to identify the reasons behind the successes and failures of e-commerce as a substitute for physical retailing. Consumers benefit from more competitive prices, more information on goods and services, and a wider choice of products. In addition to this, trust is a main factor accounting for the low adoption rate of online shopping (Grabner-Kraeuter, 2002; Visser & Lanzendorf, 2004). Grabner-Kraeuter (2002) argues that trust is not just a short-term issue; it is also the most significant long-term barrier for realizing the potential of e-commerce. The reason for this is that buying through the Internet involves several risks, mainly in the transaction process. Two such perceived risks are directed at the product and security. Product risks are connected with the consumer's inability to examine the products online. Security risks are connected with the consumer's fear that the open internet network will compromise personal data (Bhatnagar & Ghose, 2004).

Accessibility has two meanings when applied to e-commerce. First, it refers to physical access, that is the consumer's ability to access the retail facility or the retailer's ability to access the consumer's home: physical delivery is still necessary for most types of product. Second, it refers to ICT access. E-shopping offers several benefits compared to offline shopping. First, it saves time, given that the consumer attains the necessary skills and experience for shopping online. So the more experienced the consumer is in using ICT, the more time-effective the Internet becomes (Koivumäki, Svento, Perttunen, & Oinas-Kukkonen, 2002). For retailers, e-commerce offers more market activity (and efficiency) in the form of increased access to customers and information, as well as lower operating and procurement costs (Mokhtarian, 2001; Rao, 1999; Rosen & Howard, 2000).

In recent years, the popularity of Smartphones has risen dramatically due mainly to advances in technology – a fact not ignored by retailers. Retail stores have expanded their traditional store format to include diverse online store formats to suit Smartphone platforms.

Alongside these developments, various new Smartphone applications have improved the shopping experience and potential purchase saving has become widespread. Comparative shopping has developed as one of the main applications (apps) used by Smartphone users for shopping purposes. This type of shopping may offer the best deals by the dissemination of emails with a time constraint (i.e. discount coupons), whereby Smartphone users gain an advantage by receiving notification with the possibility of purchasing the product at the discount price immediately.

Other shopping apps offer the Smartphone user scanned images and information on the location that offers the best deal. Some would say that in these days of Smartphone use, the product itself is less important; locating the best deal becomes the main issue. Thus marketing-wise advertising on comparative shopping apps is becoming very effective. It is suggested that impulse purchases increase when the mode of shopping is the Smartphone.

According to a study by Arc Worldwide the traditional shopping journey is changing. It is estimated that half of Americans are using a mobile device for shopping activities which include comparing prices, ordering, and reading reviews. As a result, traditional retailers are encouraged to offer shopping apps for the purpose of answering consumer demand for mobile experiences.

E-Commerce Effects on Social Sustainability

Social sustainability is considered as one the effects that may be attributed to e-commerce. It is a common assertion that the Internet reduces the importance of distance for economic activities. This has the potential to cut the costs of performing isolated economic activities for population residing in rural areas. Therefore, the Internet may serve as a substitute for urban agglomeration and benefit disproportionately those living in geographically remote areas (de Blasio, 2008). E-commerce is also considered an important technological instrument for improving access to goods for consumers with physical disabilities that are often excluded from out-of-town shopping centres and other "bricks and mortar" stores. E-commerce offers many advantages, including access to a greater variety of products and services, lower prices, as well as increased levels of information about products (Keeling, Macaulay, & McGoldrick, 2007). Nevertheless, other disadvantaged groups in the population are at risk of "e-exclusion". Those groups are characterized by low income or low educational levels. They may also belong to an older age cohort who has little experience of ICT (Keeling et al., 2007; Kvasny & Keil, 2006). Accordingly, many people in these groups are either unable to access the Internet or lack PC-based access. Thus, low education, language barriers or low technical skills may be the reasons. But the reason may also be lack of credit or high costs for access (Keeling et al.).

Results of studies on social sustainability implications of the Internet are mixed. On the one hand, Farag et al., (2006) showed that in the Netherlands both people living in a highly urbanized area and those with a low store accessibility have a higher likelihood of buying online. On the other hand, studies have demonstrated that Internet use is found to be more frequent in urban areas than in more remote areas. Espiritu (2003) and Sinai and Waldfogel (2004) suggested that this could be attributed to urban/rural differences in connectivity or relatively poorer and less educated people living in rural areas.

E-Commerce Effects on Personal Travel

As mentioned earlier, studies that explore the impacts of e-commerce on mobility usually distinguish four effects: substitution, complementary, modification, and neutrality (Salomon, 1985, 1986; Mokhtarian, 1990, 2002). These four effects have provided the baseline for the development of the main hypotheses in the literature with regard to the implications of e-commerce for personal travel and freight transportation.

Substitution effect occurs when e-commerce reduces the number of shopping person-trips and person-distance travelled. These effects are often hypothesized, since consumers can conduct every stage of the shopping process without leaving their home. For the most part, when purchases of physical goods are made online, in-store shopping will be replaced by home delivery (Anderson, Chatterjee, & Lakshmanan, 2003; Capineri & Leinbach, 2004; Dodgson, Pacey, & Begg, 2002; Fichter, 2003; Golob & Regan, 2001; Mokhtarian, 2004; Nemoto, Visser, & Yoshimoto, 2001; Sui & Rejeski, 2002). Another way in which reduction can occur (at the margin) is through the elimination of unproductive travel to one or more stores seeking an out-of-stock product when an online search can provide inventory information (at either physical or online stores).

However, a series of changes may occur to compensate for the reduction in personal shopping-related travel due to e-shopping. In view of this, many argue that effects other than substitution are expected to take place. Various studies assert that e-commerce will have a limited or even a neutral impact on the number of shopping trips and distance travelled. The literature offers a range of reasons why. Telephone or mail often serve as a substitute for Internet transactions as an alternative to in-store purchases (Keskinen et al., 2001; Mokhtarian, 2004), particularly in the case of purchases made from catalogue firms and service providers (e.g., insurance companies, banks, travel agencies). In addition, if an Internet purchase replaces an in-store purchase, it may not always result in less travel. This may arise in cases where shopping trips are combined with other activities, also referred to as trip chaining (Golob & Regan, 2001; Keskinen et al., 2001; Mokhtarian, 2004; Visser & Lanzendorf, 2004). For instance, if consumers visit a shopping centre on their way home from work or vice versa, then reducing that visit may have only a negligible impact on their travel. Skipping the stop at a shopping centre may reduce an engine start, and there are presumably some traffic benefits at nearby intersections. However, there may be no impact on distance travelled.

Furthermore, people frequently make multiple purchases during a single shopping trip (Mokhtarian, 2004). As a result, the substitution of e-shopping for only some in-store items does not necessarily decrease the number of shopping trips and will not decrease travel distance. Moreover, as discussed earlier, shopping is not always regarded as a chore; it is frequently perceived as a recreational activity, a pleasant means of physical movement, and as a means for social interaction. As such, physical shopping is difficult to replace with e-shopping, since it lacks the face-to-face dimension. In summary, this may limit the substitution of traditional shopping (Golob & Regan, 2001; Graham & Marvin, 2001; Lyons, 2002; Mokhtarian, 2004).

Finally, it is also hypothesized that e-commerce may have a complementarity effect leading to more or increased lengths of shopping trips. As rising numbers of new and existing retailers develop websites as a means of marketing their business (Boschma & Weltevreden, 2005; Currah, 2002; Steinfield et al., 2001), consumers who search online for interesting products and bargains may be wary of retailers they were previously unaware of. As a result, online search activity may result in increased shopping trips to remote locations (Farag et al., 2006). Location-aware marketing technology or social networking applications are often used by retailers that as a consequence generate travel (Ngai & Gunasekaran, 2007).

Additionally, Internet purchases are not always delivered to a customer's residence, some online orders are collected (and paid for) at a store, a post office, or a collection-and-delivery point (CDP) or distribution centre. It is also important to note that the growing use of e-shopping leads to increasing incidents of online purchases that are returned to the sender. Consumers usually return these items via a post office or a CDP. While a number of these trips for collecting and returning goods may be chained with other activities, this may occasionally lead to more personal travel.

Growing numbers of consumers currently use the Internet to sell or buy goods to and from other consumers. This is commonly known as consumer to consumer (C2C) e-commerce. It is expected that more personal travel will result, since many of these c2c orders will be picked up at the home of a distant private seller (Farag et al., 2006). C2c e-commerce is known for its anonymity and ease of registration. However, this also entails the risk that a product will not be sent or that its quality does not match the buyer's expectation (Yamamoto, Ishida, & Ohta, 2004). The risk of not receiving the product may stimulate self-delivery, which generates personal travel to locations not previously considered prior to the introduction of c2c e-commerce and which probably involve longer travel distances (Farag, 2006). Moreover, since pick-up destinations for c2c orders are mainly located in residential areas, trip chaining may be less likely as compared to b2c orders.

The implications of e-shopping for shopping-related travel vary greatly as consumer shopping efforts differ from product to product (Girard, Korgaonkar, &

Silverblatt, 2003; Korgaonkar, Silverblatt, & Girard, 2006; Rotem-Mindali & Salomon, 2007; Visser & Lanzendorf, 2004). Retail activities entail a wide variety of goods and services which can be classified in a variety of ways. A product class refers to a range of attributes that distinguish one group of products from another. For example, size and weight distinguish furniture and major appliances from most other goods, perishable grocery products create a class of their own, even when compared to non-perishable grocery products, and price may distinguish between a home computer and a book. Belonging to a particular product class has implications for how individuals gather information, purchase, and choose among alternative modes of delivery. In the physical world many items commonly purchased online are purchased together with other goods. As such, it is likely that when items are delivered at home instead of purchased in a store, freight transportation will increase, while personal travel will not always decrease. On the other hand, for convenience goods such as groceries and health and personal care items, a reduction of personal travel is more likely as consumers often make these as singular trips. However, convenience goods are less frequently purchased online (Weltevreden, 2007).

E-Commerce Effects on Freight Transportation

When evaluating the total effect of e-commerce on transportation, the number and distance of freight trips by trucks should be counted, data not recorded in surveys of personal travel (Sasaki & Nishii, 2010). Similar to the effects of e-commerce on personal travel, several impacts on freight travel are hypothesized. Numerous studies suggest that e-commerce may lead to more freight trips and more kilometres mainly because e-shopping will lead to substitution of personal travel with home deliveries (Anderson et al., 2003; Cohen, 2000; Dodgson et al., 2002; Golob & Van Wissen, 1989; Mokhtarian, 2004; Nemoto et al., 2001; Transport en Logistiek Nederland, 2000). More freight transportation kilometres are assumed as the Internet expands the market size and offers consumers the opportunity to contact and purchase from remote retailers and manufacturers that can be located anywhere on the globe (Hesse, 2002; Mokhtarian, 2004; Nemoto et al., 2001; OECD, 2002; Transport en Logistiek Nederland, 2000; Visser & Lanzendorf, 2004). It should be noted that, door-to-door delivery of loading units generally involves delivery by smaller trucks and more frequent deliveries, therefore producing neighbourhood disturbances and external costs such as noise, air pollution, traffic accidents, and congestion (Janic, 2008).

Using data base marketing e-commerce can directly stimulate people to consume more, thus resulting in increased freight transportation (Weltevreden & Van Rietbergen, 2004). Online retailers can easily collect customer data via the Internet which they utilize to provide personalized offers. This may result in purchases that would not otherwise have occurred without the Internet. E-shopping also stimulates the purchase of products that are hard to find in a store (e.g., collectors' items) or that are only available online (e.g., customized CDs) (Capineri & Leinbach, 2004; Mokhtarian, 2004; Transport en Logistiek Nederland, 2000). Another reason why additional goods movement is likely is prices offered via Internet purchase. It is often suggested that electronic-based retailers can offer lower prices than traditional retailers due to lower search costs for buyers and lower operating costs for sellers (Mokhtarian, 2004; Nemoto et al., 2001).

With the advent of e-shopping, freight transportation has grown. This self-reinforcing process stems from the fact that an increase in home delivery also leads to a growing need for reverse logistics, which generates more freight trips and more vehicle kilometres travelled. Earlier studies estimated customer return rates at 6–15 % for mass merchandisers and up to 35 % for catalogue and e-commerce retailers (Dowlatshahi, 2005; Sarkis, Meade, & Talluri, 2004). However, since freight transportation is more efficient than the personal travel it replaces, due to multiple customer deliveries in the same trip, it may still reduce travel. Freight transportation is considered more efficient since it offers the delivery of goods to several customers' residence or offices in one trip compared to making individual trips, which often take place in personal travel (Browne, 2001; Cohen, 2000). Whether freight transportation is in fact more efficient than shopping trips by consumers largely depends on the extent to which the substituted personal trip was part of a chained trip, and the trade-off between efficiency and timeliness of the delivery – the more quickly delivery is demanded, the less efficient the delivery trip may be (Mokhtarian, 2004).

It should also be mentioned that shopping trips are also made by foot, by bicycle or public transport. If these trips are substituted by freight transportation it is no benefit for road congestion, energy consumption, and air quality (Keskinen, Delache, Cruddas, Lindjord, & Iglesias, 2002). Thus, the extent to which a shift from personal travel to freight transport is good for the environment depends on the modal split for shopping-related travel. As a result, the impact of freight on mobility heavily depends on the delivery method undertaken before using e-commerce, which is largely determined by the type of goods sold online (Rotem-Mindali & Salomon, 2007). Cairns et al. (2004) distinguish five types of goods according to their logistical requirements: groceries, clothing and footwear, two-person delivery items, one-person delivery items, and postable items. First, the majority of shopping trips undertaken are for groceries. As such, e-shopping for groceries is likely to lead to a shift from personal travel to freight transportation. Second, e-shopping for clothing and footwear is likely to poach on catalogue sales by mail and telephone and is characterized by high return-rates. Third, for two-person delivery items (e.g., furniture, large electrical appliances), home delivery has always been important and as such, no large effects on transportation are expected. Fourth, for one-person delivery items (e.g., small electrical appliances, sports equipment) an increase in freight transportation is expected. Finally, postable items (e.g., books, CDs, software, jewellery) may have relatively little impact on freight transportation since these goods are largely delivered through conventional postal services, but the effect of using commercial package delivery services instead, as is often the case, is unknown. Cairns et al. suggest they could have the effect of expanding the conventional postal market. However, this market is contracting due to the substitution of the Internet for bill-paying, sending personal letters, and other activities (e.g., Cohen & McBride, 2011). Another important product distinction is between digitalised and tangible items (Cohen, 2000). The former can be delivered without physical transportation, while the latter type of goods generally requires freight transportation.

Summary and Conclusions

E-commerce represents a growing part of retail activities which may have broad implications on their organization and spatial structure as well as shopping patterns. Such impacts depend greatly on consumer response to technological change. E-commerce, like many other information technology-based activities (e.g., telecommuting, telemedicine), also offers a potential substitution for personal travel by means of telecommunications. Traditional shopping activities typically consisted of a visit to a store in which product information was sought and a purchasing decision was made. Pending that decision, the product was obtained and most often self-delivered by the consumer or store-delivered to the consumers' home. Each of these activities may involve different numbers and types of agents that use a different transportation mode in a specific timing. With regard to e-commerce, consumers can acquire information, make a purchase transaction, and choose a delivery arrangement from any location. These options may reduce transportation, as virtual shopping and delivery by the supplier is potentially more efficient than traditional store- shopping activities.

This chapter examined the potential effects of e-commerce on the environment through the impacts on transportation. It is an intricate task to assess the net effect of e-commerce on the environment since consumption behaviour is a complex activity, concerns almost every individual, and varies daily. The effect of e-commerce may have both short term and long term implications for activities at large. The short term implications involve environmental externalities and transport flows. The long term implications include effects on urban nature and structure through its possible effect on retail spatial structure.

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The Need to Change How People Think About the Consequences of Travel

Tommy Gärling, Dick Ettema, and Margareta Friman

Introduction

In the different chapters of this volume consequences of travel have been highlighted. Our point of departure in this final chapter is that these consequences may be assessed on several dimensions – benefits versus costs, individual versus societal, immediate versus deferred, and local versus global. Such assessments differ depending on travel mode (e.g. private motorized transportation versus public motorized transportation versus non-motorized transportation) and travel distance. We argue that moving towards sustainable travel in democratic societies requires that citizens and politicians shift from thinking about the short-term individual benefits of travel to thinking about the long-term societal costs.

In the reminder of the chapter we first identify the individual and societal benefits and costs of travel. In the following section we then briefly review explanations of why people think about short-term individual benefits instead of long-term societal costs. In the final section we discuss how messages about long-term costs of travel disseminated through different sources need to change to make people shift their thinking about these consequences.

T. Gärling (✉)
Department of Psychology, University of Gothenburg, P.O. Box 500, 40530, Göteborg, Sweden
e-mail: Tommy.Garling@psy.gu.se

D. Ettema
Faculty of Geosciences, Utrecht University, Heidelberglaan 2, P.O. Box 80115, 3508TC Utrecht, The Netherlands
e-mail: d.f.ettema@uu.nl

M. Friman
SAMOT/CTF, Karlstad University, 65188 Karlstad, Sweden
e-mail: Margareta.Friman@kau.se

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Consequences of Travel

Individual

At the most basic level movement is necessary for the survival of a terrestrial animal such as *Homo sapiens*. In cooperative groups of stone-age people, not every member needed however go for hunting. Likewise in contemporary societies, not every member of families needs to commute to work. Yet, urban sprawl has for almost everyone resulted in a need for complex travel beyond the isolated home-to-work journey (see chapters "Spatial, Generational and Gendered Trends and Trend-Breaks in Mobility" and "Benefits of Travel: Needs Versus Constraints in Uncertain Environments" in this volume). Shopping, leisure activities, and many other chores require travel. Needs, obligations, and desires are motives for engaging in such out-of-home activities, frequently at far distances from home.

The availability of fast travel increases opportunities for purchasing the most attractive goods at the lowest prices, patronizing the best restaurants, visiting unique recreational places, attending entertaining and cultural events, and more. It also allows people to interact face-to-face with other people, relatives and friends living at a distance. Evidence is accumulating that travel for these purposes has a positive impact on the wellbeing people subjectively experience (chapters "Satisfaction and Travel Choice" and "Social Exclusion and Travel"). Non-motorized travel may have positive health effects (chapters "Health and Travel" and "Non-motorized Travel as a Sustainable Travel Option"), and (motorized) travel may be enjoyed for its own sake (Cao, Moktharian, & Handy, 2006; Moktharian & Salomon, 2001). Examples include driving a new fancy car (chapter "Psychological Motives for Car Use"), enjoying a recreational boat trip in the sunshine or riding a museum train. Today for busy people in the work force, travel may provide the privacy and time needed for recovery from stress (Hartig, 2007). The time spent on travel may furthermore be used for reading and preparing oneself for meetings, or, indeed, with the currently available telecommunication devices, to work during travel, at a distance from the office (Ettema, Friman, Gärling, Olsson, & Fujii, 2012; Ettema & Verschuren, 2007).

Do people want to travel on a daily basis as much as they do? In general travel is in itself not a productive way of using time. For the benefits of the individual as well as the society, time for travel could be spent in better ways. Travel is also associated with individual costs, monetary costs, accident risks, exposure to potentially harmful substances, and stress reactions due to noise and congestion (chapters "Health and Travel" and "Business Travel and Sustainability").

Note that the individual benefits and costs of travel are all local and relatively immediate. Yet, many of the short-term benefits, for instance, from shopping goods, may extend in the future. Another long-term benefit is that travel gives families the opportunity to live in attractive residential areas, frequently in suburbs or in the countryside far from their work place in downtown. It may also be argued that individual costs such as health effects of exposure to harmful substances and stress are deferred.

Societal

High-speed transportation of people and goods is clearly essential in contemporary societies with their specialization of functions at different locations (chapter "Do Future Land-Use Policies Increase Sustainable Travel?"). Goods need to be transported between different units in the manufacturing process of goods as well as from producers to retailers (chapter "E-Commerce: Implications for Travel and the Environment"). People need to be able to travel to and from work, to and from stores, and to and from many other locations. A substantial share of travel is also work-related (chapter "Business Travel and Sustainability"). According to many observers (e.g. Moktharian, Salomon, & Handy, 2006; Sasaki & Nishii, 2010), it is unlikely that recent and future developments in telecommunication will substantially eliminate the need for physical travel. Long-term societal benefits are primarily associated with the development of the industrial sector and economic growth (chapter "Integrated Transportation Solutions: Images of the Future"). For this reason, governments frequently prioritize investments in infrastructure for truck, train, air, and sea goods transportation.

Motorized personal travel and goods transportation have local short-term and global long-term societal costs (chapter "The Unsustainability of Car Use"). Locally, urban environments are made less liveable due to accident risks, air pollution, noise, and infringement on land use by road infrastructure destroying historical and cultural values. The global long-term costs include the contribution to the antropogenic climate change from emissions of greenhouse gases (GHG) caused by motorized traffic. These emissions are substantial and increasing. The use of land that otherwise could be used to produce food for an increasing world population is another global long-term cost. A global cost that is becoming urgent is the consequences of overuse of material and fossil energy for making and running motorized gasoline-powered vehicles.

Constructing road infrastructure, controlling noise (e.g. replacing old road surfaces with new quiet ones, building protective walls along roads), preventing and mitigating damages from accidents, medical treatments of accident victims, and loss of work hours due to injuries and deaths are societal costs accrued to tax payers, insurance companies, and directly and indirectly to road users. Congestion is also considered to be a cost to societies that different transport policy measures aim at abating (chapters "Pricing Methods to Influence Car Use" and "Theoretical Underpinnings of Practical Strategies for Changing Travel Behavior"). Yet, in general deterioration of the environment, the loss of historical and cultural values, ill-health effects, and demolishment of farming land cannot be recovered. The revenues from monetary costs of travel charged to road users (e.g. gasoline taxes, insurance premiums, and tolls) or to all citizens (taxes) are largely a transport policy (pricing) measure used by societies to reduce demand for motorized travel, not primarily a compensation aimed at restoring the damages caused by motorized traffic.

Causes of People's Thinking About Consequences of Travel

Several possible explanations are conceivable of why people think less about the costs of travel for the society (and therefore indirectly for any individual including themselves belonging to the society as well as future generations) than they think about the direct benefits for themselves. Less knowledge of societal consequences than of individual consequence is one explanation. First, the societal consequences are more difficult to know about because they depend on the actions by many people, whereas the individual consequences are directly felt because they largely depend on individuals' own actions. Second, the societal consequences are more difficult to know about because many of them are deferred compared to the individual consequences that are more often ímmediate. Third, in contrast to the individual consequences, the societal consequences are more difficult to know about because many are global and not local such that they are directly encountered. A second explanation is that people are in general more concerned about their own well-being and the well-being of their close relatives than they are concerned about the well-being of unknown others. In the following we briefly discuss these key explanations in relation to individual versus societal consequences, immediate versus deferred consequences, and local versus global consequences.

Individual Versus Societal Consequences

In order to investigate factors that affect thinking of societal consequences compared to individual consequences, different research paradigms have been developed (Gärling, Biel, & Gustafsson, 2002). In the *Prisoner's Dilemma Game* (PDG) (Rapoport & Chammah, 1965; Pruitt & Kimmel, 1977), two persons face a choice of cooperation or competition (Fig. 1). If both either cooperate or compete (called defection), they will receive the same consequence. If one competes and the other cooperates, the former will receive a better consequence than the latter. The consequence is always better for the individual who chooses to compete. The dilemma is that if both do what is best for them individually (compete), the consequence for both will be worse than if both cooperate. In order to choose cooperation such that they both receive the joint best consequence, both need to be concerned about the consequence for the other and trust the other to cooperate.

A drawback with the PDG as a research paradigm for analyzing the salience of individual versus societal consequences is that it involves only two persons. It may therefore only apply to dyadic relationships (and to relationships between two groups, see Bornstein, 2008), but not to the relationships between individuals and the society. An extension of the PDG (the *N*-person game; see Komorita, 1976) has therefore been devised and used in research. Hardin (1968) referred to this extension as the "commons dilemma" that he argued is the root of current environmental problems, that is that many common resources such as material, energy, water, and

Fig. 1 The consequences of choice of cooperation (*C*) or defection (*D*) by the individuals *A* and *B* in the Prisoner's Dilemma Game (*PDG*)

		B: C	B: D
A	C	I A: 5 B: 5	II A: -8 B: 8
	D	III A: 8 B: -8	IV A: -2 B: -2

air are free to overuse or pollute. Climate change, sustainability issues, and other so called "collective action" problems in societies have been modelled in this way (Ostrom, 1990). For this and related extensions, Dawes (1980) coined the generic term "social dilemma" proposing the following defining features: (i) The consequences for each individual acting in their own interest (called defection) are better than the consequences for acting in the interest of the group (called cooperation), regardless of what other group members do, but (ii) all individuals are worse off if all defect than if all cooperate.

It is generally conjectured that individuals' cooperation in social dilemmas is contingent on how much weight they place on the different consequences of cooperate-cooperate, cooperate-defect, defect-cooperate or defect-defect. These weights reflect both how likely the consequences are believed to be and how attractive they are. People who have a pro-self value orientation tend to place a higher weight on consequences for themselves, whereas people who have a pro-social value orientation either place higher weight on the joint consequences or that the consequences are the same for everyone (Eek & Gärling, 2006; Van Lange, 1999). Pro-socials thus take into account both consequences for themselves and the collective (or society to which they belong), something which pro-selfs do not. Yet, pro-socials also take into account whether others do the same. Only if they belief others do, they will maintain their concern for the collective (Eek, Loukopoulos, Fujii, & Gärling, 2002; Joireman et al., 2001; Van Vugt, Meertens, & Van Lange, 1995). It is therefore essential that measures are taken to convince pro-socials that others (at least a sufficiently large proportion of others) have the same concern for the society as they themselves have. Pro-selfs would not be similarly affected by such a conviction; in fact it may even increase their rate of defection.

Even though pro-selfs are less concerned about others, they will still frequently act as they were. Several situational factors have been identified that make almost everyone act in the interest of a group or society (see reviews by Kopelman, Weber, & Messick 2002; Ostrom 1998). Sanctions, communication, and knowledge of and identification with the collective are the most important factors. As noted by Olson (1965), only the first two are however feasible to implement at a societal scale. The effectiveness of the third factor strongly decreases with the size of the collective.

Immediate Versus Deferred Consequences

It has been shown in research on temporal discounting (Frederick, 2006; Frederick, Loewenstein, & O'Donoghue, 2002) that people place a higher weight on immediate positive consequences than on the same positive consequences if they are deferred. This is referred to as positive temporal discounting. Several context-specific explanations have been proposed that question whether positive temporal discounting reflects a pure time preference (e.g. impatience or lack of self-control) as was originally believed. It is also inconsistent with this view that the reverse tend be true for negative consequences, that is that temporal discounting of negative consequences is negative. Furthermore, everything else equal, a higher weight is placed on negative than on positive consequences (Kahneman & Tversky, 1979). This speaks to that under some circumstances longer-term individual costs of travel would loom larger than immediate positive benefits for the individual. A drawback is still that the longer-term individual costs tend to be less known than the shorter-term individual benefits. Informing people about future consequences is also made difficult by the fact that uncertainty is believed to and in general also increases with time.

Local Versus Global Consequences

Local costs of travel include health-threatening effects of air pollution from motorized vehicles, traffic noise, and traffic congestion (chapter "The Unsustainability of Car Use"). All these consequences are more easily felt than the global cost of travel to contribute to the antropogenic climate change (Weber, 2010; Weber & Stern, 2011). Research has shown that people do not discount such future global costs when being aware of them (Böhm & Pfister, 2005; Gattig & Hendrickx, 2007; Sundblad, Biel, & Gärling, 2011). Furthermore, an empirical survey in 18 countries (Gifford et al., 2009) showed that in a majority of the countries people believe that environmental quality is worse in other countries than in their own. Ignorance of global costs is still observed both at an individual and national level (e.g. in countries with small total GHG emissions despite a high per-capita emission). Markowitz and Shariff (2012) argue that the explanation is that climate change is not considered by people to be a moral issue because it is global, complex, and not caused intentionally. This implies a failure of feeling responsible on the part of citizens as well as on the part of the politicians they vote for. As supported by a recent US survey (Kahan et al., 2012), the reason may however not be that knowledge of scientific facts is lacking but that people prioritize their own wellbeing and the wellbeing of their close relatives.

Sources of Influence on People's Thinking About Consequences of Travel

We believe that research findings documenting long-term societal costs of travel, as those presented in this volume, will eventually affect the general public through different sources including (1) governments, (2) mass media, (3) producers and providers of travel services, and (4) other people (word-of-mouth). Figure 2 illustrates a model of the flow of information from research findings disseminated in primary and secondary scientific publications, at conferences, and during hearings. The diagram is clearly a simplification. The process is likely to be less orderly linear than implied. The model still serves our present purpose of discussing how the messages conveyed by the different sources may be changed to influence people's thinking in the desirable way.

A primary receiver of research findings is governments who in general are also the main source of financial support for the research. In the transport sector governments decide about law regulations and taxation that has consequences for travel (chapter "Theoretical Underpinnings of Practical Strategies for Changing Travel Behavior"). In themselves these measures have the potential to increase people's thinking about the societal consequences of travel. Transport pricing policies are popular among politicians (chapter "Pricing Methods to Influence Car Use"). Yet, their narrow focus on behaviour may not have the substantial effect on people's thinking it could have. In general, if governments complement implementation of transport policies with information campaigns explaining the necessity to increase sustainability of travel (chapter "Social Marketing in Travel Demand Management"), it may have an augmented effect on public opinions and most likely result in an increased positive attitude toward complying (chapter "Psychological Contributions to the Development of Car Use Reduction Interventions"). A general observation made by Weingart, Engels, and Pansegrau (2000) is that politicians reduce the complexities and uncertainties of scientific findings. It may make the messages they send sound less alarming. In addition their messages are frequently ambiguous because governments make compromises between fiscal goals, goals of economic growth, and the goal of sustainable travel (Gärling & Schuitema, 2007; Johansson, Gustafsson, Falkemark, Gärling, & Johansson Stenman, 2003). Such ambiguity is likely to further dilute governments' messages.

The mass media is another source of influence. In general newspapers, radio, and TV all convey messages from the government, producers and providers of travel services, and organized groups of other people. Some of the messages, as exemplified by paid advertisements, are clearly one-sided, whereas other message aims to be balanced. Still, the mass media coverage of travel does not frequently highlight sustainability, and if it does, not consistently. One may argue that it is the mass media's task to present a balanced picture. But it may still be questioned whether their messages concerning travel are too much influenced by people's thinking of the short-term benefits. It also frequently seems to be the case that the mass media fail to distinguish scientific facts from ideological views. This failure

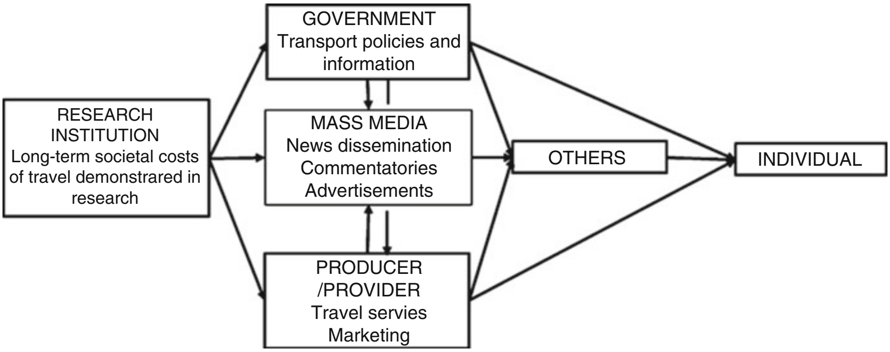

Fig. 2 Model of how information about long-term societal costs demonstrated in research is conveyed to the individual by different sources

leads to that the mass media take the stance that their dissemination of scientific facts should be balanced by ideological views or pseudo facts. This clearly induces more uncertainty about research findings than justified and thus downplays their significance.

Producers and providers of travel services are sensitive to what their customers' want, at the same time as they invest heavily in advertising their services in a way intended to influence their presumptive customers' attitudes and preferences. Governments seem to do little to regulate advertisement in the desirable way. Banning smoking or policies to reduce alcohol consumption are counter-examples – even though historically it took a long time to achieve the intended effects. Concern about traffic safety is another counter-example of where governments through their agencies have both legislated and launched information campaigns. In order to cater to some segments of their customers, travel agencies have started to market ecological tourism – although it may be questioned whether anything than less tourism travel would be sustainable (chapter "Rose Tinted Memories as a Cause of Unsustainable Leisure Travel"). Car makers have, partly forced by governmental regulations, started to target consumers' demand for cars making less damage to the environment. Providers of local travel services including taxi and public transport companies are making less damage to the environment an argument for attracting new customers (chapter "High Quality Public Transport: Gaining Acceptance of Bus Rapid Transit Systems"). This is clearly a positive development.

Some individuals singly, informally or formally organized in action groups, act as opinion leaders and are likely to have a direct influence on other individuals by filtering the messages from other sources (Hovland, Janis, & Kelley, 1953; Rogers, 2003). They primarily influence people by means of informal communication. This type of communication is in general tuned to the receiver and since the sender is likely to have a high credibility, the conveyed information is believed to be more trustworthy than the same information from less credible sources. Not infrequently opinion leaders individually or in organized groups deny relevant research findings, thus induces unjustified ambiguity about the validity of the research findings.

Table 1 Hypothetical rank order of consequences of travel from most salient (6) to least salient (1)

	Individual		Societal	
	Local	Global	Local	Global
Benefits				
Short-term	6	5	5	3
Long-term	5	3	3	2
Costs				
Short-term	5	4	4	2
Long-term	4	2	2	1

Conclusions

In this final chapter we have argued that people in general think about the short-term individual benefits of travel more than they think about the long-term societal costs. In Table 1 we summarize our arguments about the salience of the consequences of travel. We first add one point to all the consequences assuming that none is totally ignored, then another point if it is a benefit and not a cost, if it is individual and not societal, if it is short-term and not long-term, and if it is local and not global. In this way we obtain a rough rank order of the consequences from the most salient (6 points) to the least salient (1 point).

Our main argument is that in a democratic society a change to sustainable travel requires that the salience of the long-term societal costs of travel is increased. To accomplish this, information about research findings documenting the long-term societal costs should be conveyed by governments, mass media, producers and providers of travel services, and other people. This is necessary because in contrast to the immediate individual benefits, the long-term societal costs are not directly felt and therefore not easily knowable. Thus, increasing knowledge is a key factor. Knowledge may however not be sufficient since another key factor is that people tend to be more concerned about their own and their close relatives' wellbeing than they are concerned about the wellbeing of unknown others. Filtering out, denying or simply ignoring information about societal costs is a likely consequence. Yet, as we argue, some people (sometimes a majority) are concerned about others' wellbeing and will therefore, if they are adequately informed, act in the interest of the society. Others may be forced by the society to do this.

Would a reduction in motorized travel forced on people (not an unlikely future scenario) result in a shift in how they think about the long-term societal costs of travel? We believe not. In fact, it may have the counter-productive effect of strengthening a negative attitude towards such a reduction. Therefore, a trustworthy dissemination of research findings is even more important. We have noted several likely pitfalls in the process of disseminating research findings about long-term societal costs of travel. By doing so we hope to have increased awareness of these pitfalls as well as defining an agenda for research by travel behavior and other (e.g. communication) researchers who are able to contribute to improving the dissemination process.

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About the Editors

Tommy Gärling is Emeritus Professor of Psychology affiliated with University of Gothenburg (Göteborg) and Karlstad University in Sweden. He has conducted research on travel behaviour since the beginning 1980s, authored and co-authored close to 100 internationally published journal articles and book chapters, co-edited 2 books, is former member of the International Association of Travel Behaviour Research (IATBR), and currently is member of the editorial board of the journal *Transportation*. Economic psychology and environmental psychology are two other fields of research in which Tommy Gärling is active. He has contributed to more than 200 international publications in these fields, is former president of the environmental psychology division of the International Association of Applied Psychology (IAAP), member of the editorial board of *Journal of Environmental Psychology*, and Associate Editor of *Journal of Economic Psychology*.

Dick Ettema is Associate Professor in the Department of Human Geography and Planning of Utrecht University, The Netherlands. He has conducted research on time use related to travel and travel choice since the early 1990s. He has authored and co-authored over 50 internationally published journal articles and book chapters and co-edited 1 book. Dick Ettema is member of the Committee of Travel Behavior and Values of the Transportation Research Board, and member of the editorial boards of *Journal of Choice Modelling* and *Journal of Transport and Land Use*.

Margareta Friman is Professor of Service Research and Director of the Service and Market Oriented Transport Research Group (SAMOT) at Karlstad University in Sweden. Her research interests are primarily topics in consumer psychology and transport psychology. She is author or co-author of about 50 internationally published journal articles and book chapters. She is member of the editorial board of *Journal of Service Management*, elected member of the steering board committee for the International Association of Public Transport academic network, and expert member of the European Cooperation in Science and Technology in the transport and urban development domain.

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