Safety and Security in Transit Environments

Vania Ceccato
and
Andrew Newton

An Interdisciplinary Approach

Crime Prevention and Security Management

Series Editor: **Martin Gill**

Titles include:

Paul Almond
CORPORATE MANSLAUGHTER AND REGULATORY REFORM

Rachel Armitage
CRIME PREVENTION THROUGH HOUSING DESIGN
Policy and Practice

Joshua Bamfield
SHOPPING AND CRIME

Graham Brooks, Chris Lewis, David Walsh and Hakkyong Kim (*editors*)
PREVENTING CORRUPTION
Investigation, Enforcement and Governance

Karen Bullock
CITIZENS, COMMUNITY AND CRIME CONTROL

Mark Button
DOING SECURITY
Critical Reflections and an Agenda for Change

Vania Ceccato and Andrew Newton (*editors*)
SAFETY AND SECURITY IN TRANSIT ENVIRONMENTS
An Interdisciplinary Approach

Mitchell Congram, Peter Bell and Mark Lauchs
POLICING TRANSNATIONAL ORGANIZED CRIME AND CORRUPTION
Exploring the Role of Communication Interception Technology

Daniel Donnelly
MUNICIPAL POLICING IN THE EUROPEAN UNION
Comparative Perspectives

Paul Ekblom
CRIME PREVENTION, SECURITY AND COMMUNITY SAFETY USING THE 5IS FRAMEWORK

Adam Graycar and Tim Prenzler
UNDERSTANDING AND PREVENTING CORRUPTION

Janice Goldstraw-White
WHITE COLLAR CRIME
Accounts of Offending Behaviour

Bob Hoogenboom
THE GOVERNANCE OF POLICING AND SECURITY
Ironies, Myths and Paradoxes

Daniel McCarthy
'SOFT' POLICING
The Collaborative Control of Anti-Social Behaviour

Kate Moss
BALANCING LIBERTY AND SECURITY
Human Rights, Human Wrongs

Kate Moss
SECURITY AND LIBERTY
Restriction by Stealth

Tim Prenzler
POLICING AND SECURITY IN PRACTICE
Challenges and Achievements

Emmeline Taylor
SURVEILLANCE SCHOOLS
Security, Discipline and Control in Contemporary Education

Jan van Dijk, Andromachi Tseloni and Graham Farrell (*editors*)
THE INTERNATIONAL CRIME DROP
New Directions in Research

Kevin Walby and Randy Lippert
CORPORATE SECURITY IN THE 21ST CENTURY
Theory and Practice in International Perspective

Adam White
THE POLITICS OF PRIVATE SECURITY
Regulation, Reform and Re-Legitimation

Crime Prevention and Security Management
Series Standing Order ISBN 978–0–230–01355–1 hardback
978–0–230–01356–8 paperback
(*outside North America only*)

You can receive future titles in this series as they are published by placing a standing order. Please contact your bookseller or, in case of difficulty, write to us at the address below with your name and address, the title of the series and one of the ISBNs quoted above.

Customer Services Department, Macmillan Distribution Ltd, Houndmills, Basingstoke, Hampshire RG21 6XS, England

---

Safety and Security in Transit Environments

An Interdisciplinary Approach

Edited by

Vania Ceccato
Royal Institute of Technology (KTH), Sweden

and

Andrew Newton
University of Huddersfield, UK

palgrave
macmillan

Softcover reprint of the hardcover 1st edition 2015 978-1-137-45764-6

First published 2015 by
PALGRAVE MACMILLAN

Palgrave Macmillan in the UK is an imprint of Macmillan Publishers Limited, registered in England, company number 785998, of Houndmills, Basingstoke, Hampshire RG21 6XS.

Palgrave Macmillan in the US is a division of St Martin's Press LLC, 175 Fifth Avenue, New York, NY 10010.

Palgrave Macmillan is the global academic imprint of the above companies and has companies and representatives throughout the world.

Palgrave® and Macmillan® are registered trademarks in the United States, the United Kingdom, Europe and other countries.

ISBN 978-1-349-57179-6 ISBN 978-1-137-45765-3 (eBook)
DOI: 10.1057/9781137457653

This book is printed on paper suitable for recycling and made from fully managed and sustained forest sources. Logging, pulping and manufacturing processes are expected to conform to the environmental regulations of the country of origin.

A catalogue record for this book is available from the British Library.

A catalog record for this book is available from the Library of Congress.

This book is dedicated to all those who work tirelessly in transit systems, either providing transportation services or ensuring a safe journey for all users

This page intentionally left blank

Contents

List of Figures

List of Tables

Foreword

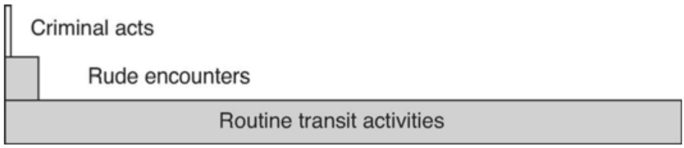
Transit security poses special challenges, both intellectually and empirically. A secure spot for 23 hours a day might become insecure one hour a day. A transit station might be 97 per cent secure, yet contain a single danger spot within it. Thus we must begin to think and measure more sharply in order to comprehend the dynamics of security in a transit environment and elsewhere.

That requires us to consider 'crime in motion'. I once taught a seminar with that title, and the same idea inspired a book, *Crime and Nature* (Thousand Oaks, Sage, 2006). However, at that time detailed data were still sparse compared to now. Today we know much more about how security shifts by day of week, hour of day, and minute to minute.

This volume makes use of such data. It includes papers about many nations, covering crime of different types and fear of crime, too. The authors teach us how transit problems vary from place to place, but they also show us important common elements that transcend cultures and transit systems. The authors make important distinctions. They know the difference between crime on a metro platform and crime in the station, between crime just outside the station and crime a block away. They know how fear and feelings of insecurity quickly shift, too. Their spatio-temporal specificity and attention to detail help us comprehend and enhance transit security.

We should not assume that public transit systems must be less secure than other modes of transport. Indeed, automotive aggression is commonplace, and car parking areas host a good deal of crime. However, the blame for automotive aggression is diffused among many, while blame for public transit crime is often attributed to the transit authority. That blame threatens their ability to secure revenues and enhance the public good. But there is good news: a relatively few transit officials can make decisions to reduce crime within their system and in its vicinity, thus providing a very important service to the larger community.

Insecurity in public transit systems is not just a matter of crime, or security from bodily injury, but also relates to rude behaviour. Bumping, cursing, insulting or annoying others is not only itself bad but can escalate into something worse. The following diagram gives an idea of how the bad is embedded within the normal. The vast majority of experiences in a transit system are routine. Within that mass of routine transit activities, a much smaller number of rude encounters can occur, most of them fleeting. A much smaller number of criminal acts occur. An important task is to comprehend how the three are interrelated. Causation tends to flow upward in the diagram, since routine transit activities can structure the quantity of bumping or other rude encounters. Some of these can escalate into criminal events. Other criminal events are not related to rude encounters, but still feed off routine transit activities.



Moreover, the subjective experience of transit security might be influenced more by rude encounters than by real crimes. Transit riders likely combine (in their minds) bad experiences with worst experiences, perhaps following this formula:

100 *rude encounters* + one *criminal act* = 101 *subjective criminal acts*.

That may seem like strange arithmetic, but it makes a point – that minor annoyances can have major consequences. On the positive side, well-designed and well-managed transit systems, by reducing bumping and other rude encounters, can indirectly diminish criminal acts and improve the subjective experience.

Researchers and theorists face at least four interrelated challenges in studying transit crime. The first challenge is to understand how the risk of bad experience shifts with each level of ambient population density. High-density times invite pickpocketing and bumping, but robbers usually feed upon stragglers at low-density times. The challenge to research is to map out these density differences.

The second challenge is to disentangle crowd effects for offenders, targets and guardians. That is not easy, since the same person might play any of these three roles. Arguably, the age-sex composition of a crowd is the best way to approach this problem empirically. As a general rule, security varies directly with the age of those present and the percentage of those female. Security varies inversely with the number of teenagers present. A research focus on the movement of adolescents may become central.

The third challenge is to disaggregate and elaborate our notion of public space. When Oscar Newman distinguished four types of space – public, semi-public, semi-private and private – he was referring mainly to residential areas. However, within transit systems, most areas are public space. That category needs further disaggregation, since not all public space is equally secure. One might begin by making intellectual distinctions among convergence areas, lingering areas, pedestrian areas, crowded areas, entry areas, exit areas, stable areas, shifting areas, bottlenecks, straggling areas – whatever else proves useful for comprehending how security varies from one public space to another. It also might be useful to distinguish locations that people (a) go by, but not through, (b) go through without stopping, (c) stop briefly or (d) remain a while. As researchers develop better locational categories, they will assist our understanding about pedestrian dynamics and supervision of transit spaces, and how these spaces generate or mitigate problems.

A fourth challenge emerges – to understand stragglers. The greatest risk may apply to those who leave last. Because straggling might be more episodic, it might not be as clearly structured or as easily analyzed. Yet transit systems and processes might in fact generate more stragglers at particular times and places, subject to scientific analysis. Analysis of pedestrian flows and dispersions might help us develop a science of straggling. Perhaps applied mathematicians will tell us quickly which of their tools apply to this. Some systems seek to funnel very late traffic into fewer staircases. Perhaps intuition alone can go a long way towards minimizing the straggler problem. There is nothing wrong with intuition, which often leads us forward, as engineers and other applied students of life well recognize.

Engineering is the ultimate test of science. It uses basic scientific theory and principles, in addition to human intuition and experience, and also a willingness to take a risk that the new bridge might collapse into the river. The study of crime and security is entering its engineering phase. Reducing transit crime is a major test of our capacities, and a major learning experience for all concerned.

Marcus Felson
Texas State University
December 2014

Series Editor's Preface

This is an ambitious book. As you will read, the transit environment is a complex one. It is highly mobile and transient. It contains many different types of passengers using a variety of transport systems located in diverse (and sometimes challenging) contexts. There are many crime risks to consider, and many potential ways of managing them. In addition to passengers undertaking their individual journeys, there are a range of other individuals who can be impacted by transport-related crime, amongst them staff involved in the delivery of transit services and those responsible for law/rule enforcement. Then there is the bus shelter, the railway track, indeed the broader transport infrastructure. Providing a crime-free environment is always going to be taxing. This book provides the most comprehensive insight yet into both the threats and potentially effective responses.

There are then many characteristics that make transit environments complex to understand and present challenging environments in which to manage crime. To help fill the knowledge gaps, the editors have brought together a multidisciplinary field of contributors incorporating criminologists, urban planners, transport planners, sociologists, transportation engineers, psychologists, geographers, architects, designers and security experts. The book draws upon a broad range of theories as well as empirical studies conducted in different parts of the world which offer insights that break new ground in this subject area.

There is much in this book that will be of interest to those interested in the study of security more generally. This includes an interesting discussion into the ways in which concepts of safety and security are operationalized by different authors; the importance of the very diverse range of characteristics that impact on rapidly changing risks; the perceptions of different users on the factors they contribute to their vulnerability; insights into crime types that have received very little academic coverage (for example, pickpocketing); the importance of guardianship in detecting and reducing crime, in terms of both the visibility and surveillance opportunity it affords (and where creating lines of sight becomes important); the dangers presented by crowds; the importance of design characteristics and management approaches in managing risks; as well as the potential of very specific measures to deal with specific problems, such as the potential offered by lighting, audio warnings and access controls.

A topic that is under-researched, matched by a collection of experts from different disciplines, provides excellent ingredients for a good edited collection. The editors have worked hard in their introduction and final chapter to ensure the reader understands the relevance of the wealth of material contained within these covers. It is a formidable achievement and one on which we must hope others will build.

Martin Gill
January 2015

Acknowledgements

We would like to add a note of acknowledgement to all referees who took time to read chapters of this book, make comments and directly contributing to improve the quality of the materials. They are: Aiden Sidebottom, Mathew Ashby, Oded Cats, Jason Roach, Lars Dolmen, Anthony Braga, Dianne Smith, Lucia Summers, Jason Roach, Anders Wretstrand, Bridget da Costa, Jeff Walker, Brian Lockwood, Lallen Johnson, Justin Kurland, Bo Grönlund, Ann Legeby, Elizabeta Troglio, Danielle Reynald, Fredrik Kopsch, Torbjörn Thedeen, Kate Bowers, Brian Blawton, Rachel Armitage, Eric McCord, Ned Levine, Thomas Stucky, Nicholas Corsaro, Martin Gill, Robert Haining, Dietrich Oberwittler, Lena Levin, Jana Sochor, Alex Hirschfield, Jason Goldstick, Henk Elfers, Ian Branton-Smith, Andrew Prelog, Meghan Hollis-Peel, Chunghyeon Seo, Remi Boivin, Mathew Hack, David Nicholson, Lorraine Gelsthorpe, Ines Madariaga, and Beth Hardie.

Notes on Contributors

Editors

Vania Ceccato is an associate professor at the School of Architecture at the Built Environment, Royal Institute of Technology (KTH), Stockholm, Sweden. Her research interests include urban and rural crime, transit safety, crime prevention and community safety. She is the author of *Rural Crime and Community Safety* (2015) and of *Moving Safely, Crime and Perceived Safety in Stockholm's Subway Stations* (2013) and the editor of *The Urban Fabric of Crime and Fear* (2012). She administers the user email list TCR-Network (Transit Crime Research Network), which is an open forum for discussions of research on crime and safety in transportation environments. She is Swedish representative in the European Union's COST Action network in Crime Prevention through Urban Design and Planning and in Gender (GenderSTE).

Andrew Newton is a senior research fellow at the Applied Criminology Centre, University of Huddersfield, and an honorary senior research associate in the Department of Security and Crime Science, University College London. He has worked in the fields of criminology, community safety and security since 1999, and his research interests include the geography of crime/spatial criminology, policy analysis and evaluation, society and technology, and mixed methods in applied research. His research has been funded by a range of organizations, including the Home Office and the Department for Transport. He has widely published and has presented at over 50 international conferences. In April 2014, he presented the findings of his research on theft on the London Underground as oral evidence to the House of Commons Transport Select Committee on 'Security on the Railway'.

Contributors

Ward Adams is a doctoral student in Criminal Justice under the direction of Marcus Felson at Texas State University. His research focus is the spatial relationship between facilities, such as parks and highway systems, and crime. Other areas of interest related to criminology include crime prevention, criminogenity of place, fear of crime, assaultive violence and fusion centres. Adams works in the Texas Department of Insurance, Austin, Texas, United States. His research examines return-to-work patterns of injured employees in Texas, and the adequacy of income benefit compensation among injured employees who have lost work because of a work-related injury.

Paul Allison is Professor of Sociology at the University of Pennsylvania, where he teaches graduate courses in methods and statistics. He has published eight books and more than 60 articles on topics that include linear regression, log-linear analysis, logistic regression, structural equation models, inequality measures, missing data and survival analysis.

Hervé Borrion is the Deputy Director of University College London's (UCL's) Security Research Training Centre. He was educated at the École Nationale Supérieure d'Aéronautique et de l'Espace (Master's) and at University College London (PhD). He developed a strong interest in modelling techniques for security applications at the Commissariat à l'Énergie Atomique, Los Alamos National Laboratory, University of Cape Town and Tsinghua University. He co-founded the International Crime Science Conference and the UK National Environmental Crime Conference, and contributed to a number of European Union (EU) projects, including RIBS, BASYLIS and PRIME. Borrion is a member of the European Reference Network for Critical Infrastructure Protection at the EU Joint Research Centre.

Charles Branas is Professor of Epidemiology, Director of the Cartographic Modeling Laboratory, and Director of the Injury Science Center at the University of Pennsylvania. Branas works to improve health and health care, and is recognized for his efforts to reduce violence and enhance emergency care. Much of his work incorporates human geography and spatial interactions. His studies have taken him to various places, including the neighbourhoods of Philadelphia and other cities, rural counties across the United States, and cities and small towns in Guatemala and other countries.

Oded Cats is an assistant professor in the Department of Transport and Planning at Delft University of Technology in the Netherlands. He is also affiliated with KTH Royal Institute of Technology in Sweden. His main areas of expertise include public transport planning and operations, transport modelling and policy. Oded holds a dual PhD from KTH and Technion – Israel Institute of Technology. He is a member of the US Transport Research Board Committee on Transit Management and Performance and Public Transportation Marketing and Fare Policy, and organizes international courses on public transport planning and design. His research interests include the dynamics of public transport operations and demand, multimodal urban network and simulation modelling, and the impacts of reliability, congestion and information on passengers' decisions. His research activities often support transport agencies and operators' decision-making.

Marcus Felson has been a leader not only in crime theory ('the routine activity approach') but also in applying that theory to reducing crime. His central argument is that everyday legal activities set the stage for the illegal activities that feed on them. Before teaching at Texas State University, he was a professor at the Rutgers University School of Criminal Justice and the

University of Illinois and has been a visiting scholar at the University of Stockholm. He is a foreign honorary member of the Netherlands Academy of Sciences. He holds a PhD from the University of Michigan. Felson has been a guest lecturer in Argentina, Australia, Belgium, Brazil, Canada, Chile, Denmark, El Salvador, England, Finland, France, Germany, Hungary, Italy, Mexico, the Netherlands, Norway, Poland, Scotland, Spain, South Africa, Sweden and Switzerland. He is the author of 100 professional papers, including 'Redesigning Hell: Preventing Crime and Disorder at the Port Authority Bus Terminal'. He is co-author of *Opportunity Makes the Thief* and author of *Crime and Nature* and *Crime and Everyday Life*, now in its fourth edition.

Taku Fujiyama is a senior lecturer in the Department of Civil, Environmental and Geomatic Engineering, University College London (UCL). Having been trained as a civil and transport engineer, he researches public transport and its environments, especially from the viewpoint of users. He has set up the UCL Resilience Research Group and conducts a range of research on transport environments and infrastructure.

Kendra Gentry is Assistant Professor in Criminal Justice at Nova Southeastern University in Ft Lauderdale, Florida. Her primary research interests include transit crime, environmental criminology and crime and the media. She is a graduate of the University of Pennsylvania, from which she received a Master's in Criminology. She earned a degree in Journalism from the University of Florida. Prior to graduate school, Kendra covered crime as a newspaper reporter in suburban Philadelphia, Pennsylvania.

Andy Gill is a performance manager at transport for London's Enforcement and On Street Operations (EOS) directorate. He has previously held roles with Government Office London/Jill Dando Institute of Crime Science (UCL) as a crime information analyst (team leader), and as a corporate data officer with Surrey Police.

Wensheng Guo is Professor of Biostatistics at the University of Pennsylvania. Guo's methodological research interests include time series analysis, functional models, longitudinal data analysis, nonparametric methods and dimension reduction. Research that he leads has been supported by several R01 grants from National Institutes of Health.

Kazunori Hanyu is Professor of Psychology at College of Humanities and Sciences of the Nihon University in Tokyo, Japan. He received his PhD from Ohio State University in 1995. He is an editorial and committee board member of several environment-behaviour research associations in Japan. His current interest is in meanings of places and environmental issues in crimes. He has written many articles and books on environmental psychology and other issues.

Timothy C. Hart is a senior lecturer at the School of Criminology and Criminal Justice, Griffith University, Australia. He holds a PhD in Criminology from the University of South Florida. His areas of interest include survey research, applied statistics, geographic information systems (GIS) and victimization. Prior to joining the faculty at Griffith, Hart worked as a statistician for the Bureau of Justice Statistics, a program analyst for the Drug Enforcement Administration, and a research analyst for the Hillsborough County (Florida) Sheriff's Office. In addition, he is the former Statistical Analysis Centre (SAC) director for the state of Nevada.

Tomoko Doi Hata teaches Psychology at Bunkyo Gakuin University, Japan. She holds a PhD in Psychology. Her research focuses on supportive and restorative environments for mothers and child caregivers. She has also done several studies on children's safety from crime. She is an editorial and committee board member of several environment-behaviour research associations in Japan. She has written and co-written articles and book chapters on these subjects.

Christopher R. Herrmann is an assistant professor at John Jay College of Criminal Justice, New York City. He holds a doctorate in Criminal Justice at the CUNY Graduate Center, where he specialized in crime analysis and geographical information science. His research focuses on the geography of crime and the intersections of space-time relationships. He is working on violence prevention initiatives with the multidisciplinary Punishment to Public Health (P2PH) research team at John Jay College of Criminal Justice, concentrating on gun violence in New York City. Prior to his appointment at John Jay College, he was a Crime Analyst Supervisor in the New York City Police Department, where he worked on longitudinal spatiotemporal trends of crime.

Antonio Iudici has a Master's in Psychology, with a specialization in Psychotherapy. He teaches the clinical psychology of interaction course in the Department of Philosophy, Education, Sociology and Applied Psychology (FISPPA), University of Padova. He is a research associate at the Institute of Psychology and Psychotherapy of Padova and is a specialist in school psychology and clinical psychology. His areas of research interest include intervention in the clinical setting, health promotion, disability, child protection, deviance, crime, school integration and education.

Karina Landman has a background in architecture, urban design and city planning. Before joining the Department of Town and Regional Planning at the University of Pretoria, she was a principal researcher at the Council for Scientific and Industrial Research (CSIR) in South Africa. She has extensive experience related to urban and spatial transformation, crime prevention in the built environment, housing and sustainable development. Other areas of research include the privatization of urban space, services and local governance; gated communities, urban segregation and sustainable development; medium-density mixed housing developments; affordable housing; and housing and sustainable development. Karina has published widely in these fields at national and international conferences and symposia.

Lena Levin holds a PhD in Communication Studies from the interdisciplinary Tema – Department of Thematic Studies, Linköping University, and since 2006 has been a member of the research unit Mobility, Actors and Planning Processes at VTI (The Swedish National Road and Transport Research Institute). Her research interests centre on how the transport system is shaped, developed and utilized by actors with various interests, perspectives and ascendancy, especially actors and planning processes in local and regional settings, for example, consultations and gender in planning processes. She also coordinates a project for VINNOVA (Sweden's innovation agency) aimed at developing methods to systematically integrate gender and equality in regional transportation planning, and she was appointed to lead developing research on travellers, at the K2 National Knowledge Centre for Public Transport located in the urban area south of Sweden Lund/Malmö.

Anastasia Loukaitou-Sideris is Associate Dean of the University of California, Los Angeles (UCLA) Luskin School of Public Affairs and Professor of Urban Planning. She has a background in architecture, urban design and city planning. Her research focuses on the public environment of the city, its physical representation, aesthetics, social meaning and impact on the urban resident, and includes documentation and analysis of the social and physical changes that have occurred in the public realm; crime prevention in the built environment, particularly as it relates to issues of transit safety and security; cultural determinants of design and planning and their implications for public policy; and quality-of-life issues for urban residents. She is the author of numerous articles, the co-author of the books *Urban Design Downtown: Poetics and Politics of Form*, and *Sidewalks: Conflict and Negotiation over Public Space*, and the co-editor of the books *Jobs and Economic Development in Minority Communities* and *Companion to Urban Design*.

Terance D. Miethe is Professor of Criminal Justice and Distinguished Barrick Scholar at the University of Nevada, Las Vegas. He is the author of 15 books and over 60 articles on violent crime, the comparative/historical study of punishment, and the analysis of criminological data. He has received multiple awards and grants from major federal agencies (NSF, NIJ) for his research in these areas.

Henry Partridge is a PhD student in the Department of Security and Crime Science at University College London. His research uses network spatial methods to analyse crime events that are constrained by linear configurations like streets and transportation systems. He works as a Policy Officer in Transport for London's Enforcement and On Street Operations (EOS) directorate.

Jed Poster is a candidate in the Masters of City Planning program in the School of Design at the University of Pennsylvania.

Therese Richmond is the Andrea B. Laporte Endowed Professor of Nursing in the School of Nursing at the University of Pennsylvania. Richmond conducts studies focused on the interaction of physical injuries and their psychological sequelae in order to reduce post-injury disability and improve recovery. She co-founded the Firearm and Injury Center at Penn and is now Research Director of the Penn Injury Science Center.

Christopher Sedelmaier has a background in applied criminal justice research and program evaluation. Before joining the Criminal Justice Department at the University of New Haven, he was a crime analyst and evaluation researcher at the Jersey City (NJ) Police Department. His areas of research interest include the impacts of transport systems on local crime patterns, crime and the built environment, crime prevention through environmental design and data-driven policing strategies. Sedelmaier has published and presented in these fields and more at national and international criminology conferences.

Seiji Shibata is Associate Professor of Human Psychology at Sagami Women's University, Japan. He holds a PhD in Psychology. He is an editorial and committee board member of several environment-behaviour research associations in Japan. His research interests include concerns and perceptions about safety and security in communities and the psychological restorativeness of an environment. He has written articles and book chapters.

Trudi Smit is working as a development planner at a private firm in Pretoria, South Africa, specializing in socio-economic analysis, demographic modeling and housing research and demand. She has a Bachelor's in Town and Regional Planning from the University of Pretoria in 2009. Trudi's mini-thesis in her final year was based on the responses to the challenges of climate change by South African cities, with a specific focus on responses by the City of Johannesburg and the City of Tshwane. She completed her Master's at the University of Pretoria in 2013.

Martha Smith is an associate professor at the School of Community Affairs, Wichita State University. She has graduate degrees in Criminal Justice and in Law, and an undergraduate degree in Psychology and Sociology. Previously, she taught at Cardiff University in Wales and the University of Nebraska at Omaha, and was a senior research analyst at the New York City Criminal Justice Agency. Her research interests include crime and disorder on public and private transport and paratransit; situational crime prevention; the use of civil remedies for crime prevention; and decision-making models related to offending, actions of potential victims, and search and seizure. She has written and co-written articles, book chapters and POP guides, and co-edited books and journals.

Jana Sochor is a postdoctoral researcher at Chalmers University of Technology in Gothenburg. She holds a doctorate in Transport Science from KTH Royal Institute of Technology in Stockholm, Sweden. Her research interests include how Information and Communication Technology (ICT) can be used in the transportation context to improve mobility and safety, both from the individual perspective in terms of assurance, privacy, inclusion and other ethical aspects, and also from the social perspective in terms of better utilization of shared resources and developing Mobility as a Service (MaaS). Advanced use of ICT in transportation is commonly referred to as Intelligent Transportation Systems (ITS), and Jana works with empirical data from multiple user groups in order to learn more about ITS' impacts on users' perceptions and behaviour.

Réka Solymosi has a Bachelor's from the University of British Columbia and an MRes degree in Criminology and Socio Legal Studies from the University of Manchester. At University College London (UCL), she is enrolled in the Security and Crime Science Doctoral Training Centre (SECReT) in the Department of Security Science as a PhD student based in the Department of Civil, Environmental, and Geomatic Engineering. She is also part of the Accessibility Research Group and the ExCiteS team. She works part-time in CEGE's Pedestrian Accessibility Movement Environment Laboratory (PAMELA). Her PhD dissertation aims to collect information about people's perceptions of safety during daily commutes by using mobile phone applications to log GPS coordinates and collect qualitative data about people's everyday experiences at these locations. This data may further be supplemented by quantitative coding of built environmental attributes and sensor data (e.g. from a mobile Galvanic Skin Response armband) which can be evaluated against the qualitative perception data.

Adriaan Cornelis Uittenbogaard is a member of the Housing and Safety Research Group at CEFIN, School of Architecture and the Built Environment, Royal Institute of Technology (KTH), Stockholm, Sweden. He has a background in urban planning and design. His PhD assessed dynamics of safety and crime in and around metro stations by assessing crime distributions over space and time in relation to the environmental and social characteristics of the city. His recent research investigates the nature and geography of suicides in transportation environments in Stockholm County. Adriaan has attended several international conferences over the past years and has published several articles in journals in the fields of planning, geography and criminology.

Christoffel Venter is Associate Professor of Transportation Engineering in the Department of Civil Engineering at the University of Pretoria, South Africa. He holds a PhD in Civil Engineering from the University of California, Berkeley. His teaching and research activities focus on transport and land use interactions, planning and policy around public transport investment, and travel demand modelling. Other recent work in the areas of transport and crime has focused on using mobile GPS loggers to track travel patterns of pedestrians in urban areas, and to assess the impacts of crime and the built environment on walking behaviour.

Nancy La Vigne is Director of the Justice Policy Center at the Urban Institute, where she leads a staff of over three dozen researchers, overseeing a research portfolio of 40 active projects spanning a wide array of crime, justice and public safety topics. Before being appointed as director in 2009, she served for eight years as a senior research associate at the Urban Institute, directing research on prisoner reentry, crime prevention and the evaluation of criminal justice technologies. She has published widely on these topics, appearing in a variety of scholarly journals and practitioner publications. She has testified before members of Congress on prisoner reentry and criminal justice reform, and she also serves as a media spokesperson, appearing on National Public Radio's (NPR's) Morning Edition, CNN and NPR, and has been featured in *Atlantic Monthly,* the *New York Times,* and the *Chicago Tribune*. She holds a PhD from the School of Criminal Justice at Rutgers, The State University of New Jersey.

Qian Wang holds a PhD in Transport System. She is a researcher in the Transport Science Department at the Royal Institute of Technology. Her research focuses on transport demand modelling and its various applications. She is also interested in multidisciplinary research with a transport focus.

Douglas Wiebe is Associate Professor of Epidemiology in the Department of Biostatistics and Epidemiology, Perelman School of Medicine, University of Pennsylvania in Philadelphia, Pennsylvania. His interests include environmental risk factors for injury, methodological challenges of activity pattern measurement and the impact of daily routines on health-related behaviour. He is President of the Society for Advancement of Violence and Injury Research.

Yoshiko Yamaoka is a certified clinical psychologist at Aichi Aoitori Medical Welfare Center, Japan. She is interested in environmental factors influencing people's psychological well-being. She has also studied environmental factors related to adolescents' solitude and self-insight.

Sung-suk Violet Yu is an assistant professor at John Jay College. She is a graduate of Simon Fraser University in Canada, and she earned her doctorate in Criminal Justice at Rutgers University-Newark. She joined John Jay College in 2010 after working at the Vera Institute of Justice as a senior research associate and principal investigator of research projects focused on sentencing and corrections. Yu utilizes ArcGIS, GeoDa, CrimeStat III, MS SQL, SPSS and Stata in her research, focusing on crime patterns, access to medical care, fear of crime, crime prevention, correctional health and impacts of various environmental correlates on spatial patterns of crime. Recently, she has worked on research projects investigating linkages between health challenges and criminal behaviours.

Part I

Introduction to Safety and Security in Transit Environments

1
Aim, Scope, Conceptual Framework and Definitions

Vania Ceccato and Andrew Newton

Introduction

Mobility is a basic requirement of modern society. Distance separates individuals' homes from places where they work, shop, do business, undertake leisure and recreational activities, and socially interact. Public transit plays a key role in reducing social exclusion by offering access to these fundamental life activities. For example, in Sweden and in Great Britain, one-quarter of households do not own a car (SIKA, 2008; DfT, 2012). Moreover, access to a car is not equally distributed amongst the population, and varies by age, gender, ethnicity and socio-economic status. Particular groups are more reliant on public transportation than others (Kunieda and Gauthier, 2007; Raphael et al. 2006). Furthermore, there are obvious environmental benefits in promoting public transport as a means of sustainable travel (Steg and Gifford, 2005). Since public transportation is a cornerstone of sustainable development, passengers deserve convenient and reliable transportation systems. However, getting people to use public transportation systems is not just a matter of making them efficient and cost effective. Passengers need to feel safe not just at stops and stations but also during their entire journey. Transportation systems encompass more than buses, trains and infrastructure. They constitute actual transit environments in which individuals spend time on a daily basis and are, therefore, important settings in everyday life. Indeed, one in five Europeans spend on average more than two hours a day commuting in these transit environments (Stepstone, 2012).

It can be argued that the environments of transit systems are unique in comparison to other settings. They generate areas of social convergence that have long been associated with crime susceptibility and are frequently perceived as unsafe (Ceccato, 2013). However, the risk of victimization is not uniform across the transportation system. Passengers' perceptions of risk in urban environments are also place and time dependent, which in turn affects mobility patterns and travel choices. Therefore, creating secure and safe transport environments should be viewed with the same level of importance as ensuring a person has low levels of risk of victimization and high levels of perceived safety outside of the transit system. To achieve this goal requires an integrated and cross-disciplinary set of theories and methods that are capable of analysing and making sense of increasing quantities of data and information, and examining information from a range of perspectives, akin to the new frontier of research and planning practice. Safety and security in transit environments are not issues that can be dealt with within the boundaries of a single science or discipline; rather, they require the knowledge and contributions of criminologists, urban planners, engineers, geographers, architects and psychologists, to name but a few.

The aim of this book is to illustrate safety and security conditions in transit environments from an interdisciplinary perspective, through the use of both theoretical and empirical approaches. It presents a collection of high-quality studies which cross traditional boundaries between different disciplines, yet share a number of important commonalities. These shared ideas are used to organize the material presented in this book and discussed in this chapter. This edited volume examines both the security and the safety conditions of transit environments, through a place-based approach to understanding crime and security within the different components of the transport journey, and also considers safety and security from the perspective of the transport user.

Firstly, the book reports on both *safety and security conditions* in transit environments, and in this volume these are associated with criminogenic conditions of crime and perceived safety, respectively. The criminogenic conditions of crime determine the statistical risk (actual probability) of an individual's becoming a victim of crime. According to Hale (1996), fear of crime can be defined as 'the fear of being a victim of crime and may include a variety of emotional states, attitudes, or perceptions' (Warr, 2000, p. 453). Passengers may feel safe in crowded, high-crime stations and fearful in empty, low-crime stations (Ceccato, 2013). Secondly, the book adopts an approach that puts the *transit environment* and *the journey* at the centre of the discussion on safety and security. This is very different from the more traditional approaches, which focus on criminals, criminality and why people commit crime. The book has therefore a *place-centred* focus on the context of crime, which provides a promising alternative to traditional offender-centred crime approaches (Weisburd et al., 2012). Most places have no crime, and most crime is highly concentrated in and around a relatively small number of places (Eck and Guerette, 2007). Some places are so crime prone that they are labelled hot spots of crime (Sherman et al., 1989). Research shows that crime follows patterns of activities and land uses that are rhythmic in space and time. If crime is concentrated at a certain time and a particular place, then there is no doubt that there is something about that place that results in a crime happening there and not somewhere else. Moreover, if these rhythmic patterns are identified, the argument holds that crime can better be prevented. Thirdly, the book attempts to open up the issue of safety and security in transit environments to a wider audience by illustrating the case of those who are in transit, and may sometimes become a victim of crime: *the users*. In doing so, the book takes the needs of different users into account, specifically young people, females, the elderly and disabled individuals. These groups are often highly reliant on public transport, may be at a high level of risk of victimization, and, moreover, may have elevated perceptions and fears of crime on transit systems.

In this volume it is argued that safety and security in transit environments is dependent on multiscale conditions that act at various geographical scales in the urban environment. These conditions are determined by the *micro-environmental attributes* of a node (a bus stop or a station); the characteristics of the immediate environment (short walk distance from the node); the type of neighbourhood in which the node, is located; and the relative position of both the station and the neighbourhood in the city, which constitutes *the node's meso and macro transit settings*. Safety and security should be examined in the content of the whole trip approach, the movement from 'door-to-door' incorporating all aspects of the passenger's public transport journey.

The book is perhaps the first volume devoted entirely to crime and perceived safety in transit environments from an international and interdisciplinary perspective. As the majority of the current literature in this topic to date is dominated by North American and British case studies, this book aims also to open this field of research up to other contexts. The book includes examples from transportation systems in Japan, Scandinavia, and Italy, and also draws from the Global South, including a case study examining public transit from a South African context.

The conceptual framework

This book examines safety and security adopting four distinct dimensions of the public transportation system, as depicted in Figure 1.1.

Micro transit environments

Transport nodes are examples of micro transit environments, such as bus stops and train stations. Lack of illumination at or along a pedestrian path to a node exemplifies the conditions that the immediate environment has on a node's vulnerability to crime, and furthermore this impacts on the perceived safety of passengers. The social environments that characterize these nodes also contribute to their criminogenic conditions as well as the perceived safety of them. The environmental features of these environments define the 'appropriate users' of these micro transit environments.

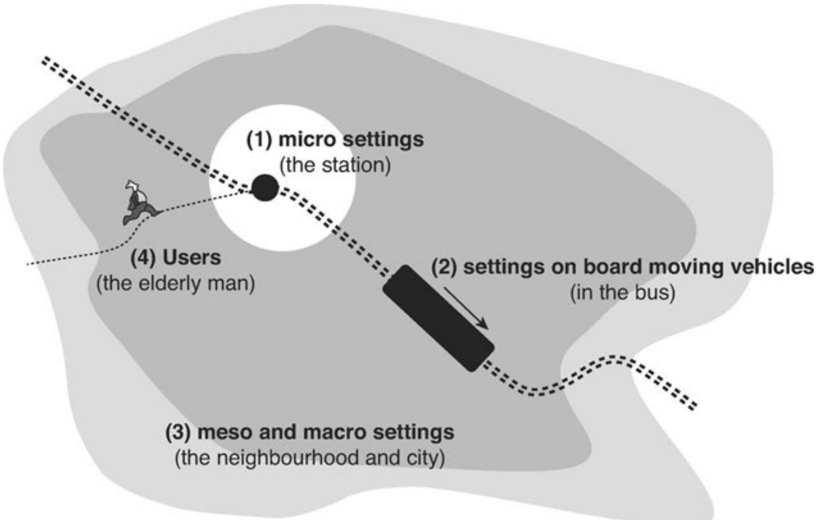


Figure 1.1 Security and safety in transit environments: the conceptual framework

If properly adapted, passengers with special needs may, for example, be afforded the same chance to use trains and buses as all users.

The journey

The decision that an individual takes to be on the move may unfortunately result in a reduction of their safety, depending on where and how they travel. Some crimes happen whilst a passenger is on the move, such as on a train. Crime also occurs when a passenger is waiting at a boarding point (for example, taxi/bus stops, train/bus stations, and modal interchanges) or travelling on board a mode of transport such as an underground train, bus or commuting train (Newton, 2004). Individuals may be unfamiliar with the risks they face as they move into an unknown environment, and the risk of becoming a target for offenders is increased. Transport sites are often crowded, yet can lack capable guardians. Persons who, sometimes just by their presence, or by a willingness to intervene, can discourage crime from taking place. Nowadays the use of mobile phones and Information Communication Technologies (ICT) can improve the chances that a crime might be reported as it happens, but the flip side of this is that these technologies can also become a crime target as they are desirable to offenders.

The meso and macro settings

This section of the book examines the relationship between transit systems and their safety and security as part of the wider neighbourhood or city. Places like transit stations have unique characteristics that mean conventional prevention techniques are often ineffective. They are mostly equipped with impersonal surveillance (for example, closed-circuit television [CCTV] cameras) that, in several transit stations, have been shown not to reduce crime, generally due to implementation failures. People who might be considered as informal guardians at a station often have no sense of ownership and are unwilling to get involved if something happens, which contributes to a feeling of 'detachment' in places where people are typically on the move and transient. In this context, transit crime covers a wide range of offences that can occur when the passenger is walking to, from or between transport facilities or stops (walking from a departure point such as a home to a taxi rank or back; from a taxi stop to a bus station; or from a train station to a destination point, for example, to a workplace or back). The risk of being a victim of a crime is not equally or randomly distributed over space. Some parts of a city are more criminogenic than others. Previous research has shown that a station may be more vulnerable to crime if it is located in a high-crime area with risky socio-economic and land use indicators (such as mixed land use, high-rise buildings, or located close to premises selling alcohol or with a high concentration of young males). The transit system itself is part of the wider function of the city it serves. This part of the book is devoted to examining the ecology of crime and perceived safety across the wider transportation environment and city context.

The user perspective

Mobility should be considered as an individual right, and as such this book explains why one should care about transit safety from the perspective of individuals. The book includes studies that examine safety and security in transit environments from the perspectives of gender, age and disability. These approaches to safety and security are essential, as being a woman and/or having a disability can influence the way in which spaces and places are used, how individuals perceive risks in these settings, and also whether, and how, an individual may become a victim of crime. A range of suggestions offered in these chapters include providing support for actions that foster gender and disability awareness, knowledge, and competence among citizens, and encouraging them to claim equal enjoyment of rights and benefits in safe urban environments, in this particular case, in transit environments. Therefore this section of the book investigates and demonstrates the relevance and importance of this topic to both academics and practitioners alike.

Transit systems are multifaceted and challenging to study due to issues such as the complexity and rapidly changing dynamics of transit environments; the potential vulnerability of public transit users; the difficulty of transforming an actual reduction in crime levels into reduced fear and perception of risk on the part of people; and the unique difficulties associated with analysing safety and security concerns related to transit settings and identifying an evidence base of what works for prevention. These challenges call for an interdisciplinary approach towards safety and security in transit environments. The road to achieving this goal is misty and tortuous, full of uncertainties and challenges, many of which will become evident in the following chapters of this book. However, there are also a number of promising developments in this area which this book seeks to highlight.

Book structure

The book is divided into six sections and 20 chapters. Part I sets out the scope and purpose of the book. Firstly, in Chapter 1 the structure and content of the book are outlined. This chapter includes a description of the conceptual framework which has been used to structure the volume, and some key definitions used in the volume. Chapter 2 then considers the extant and salient theoretical perspectives on safety and security in transit environments within the context of the conceptual framework developed in this chapter. This includes reference to past and current studies on safety in transit environments which illustrate the state of the art in the area.

Part II focuses on crime and perceived fear at the micro-level landscape (for example, bus stops, and platforms at a subway station). These transit nodes effectively mark the exit and entry points of transit systems, and are often a place where people converge. This has important implications for safety. The environmental features of these nodes and their relationship with safety are analysed across four case studies: Boston (Chapter 3), Stockholm (Chapters 4 and 5) and London (Chapter 6).

The *whole journey approach* to secure and safe transit environments is examined in the third part of this book (Chapters 7 to 9). Hypothetically, even if transportation nodes could be made entirely safe, there is also a consensus that it would not be easy to guarantee a completely safe journey from door to door. One hindrance to an individual's movement is the fear of being exposed to an uncontrolled or unexpected danger, such as being a crime victim. This part of the book considers the moving journey and examines safety from both the offender's and the potential victim's perspective. This part also deals with the space-time dynamics of crime and safety, and details some of the challenges in making this dynamic system safe. Two examples from the United States (Chapters 7 and 8) and one from the United Kingdom (Chapter 9) are presented in Part III.

The complexity of transportation systems in relation to the neighbourhood and the city is the focus of Part IV. Safety and security at transportation environments are not independent; they are fundamentally embedded to their surrounding local environmental conditions, land use, demographic and socio-economic contexts. The chapters in this part of the book are devoted to the ecology of crime and perceived safety across the wider transportation environment and urban context. Articles here illustrate this perspective from both North American cities (Chapters 10 to 13) and urban areas from the Global South (Chapter 14).

Part V moves the users' perception of safety in transit environments to the forefront of the discussion. As stated earlier, access to car ownership and reliance on public transportation are not distributed evenly across the population. Chapter 15 illustrates the perception of crime and disorder events in Tokyo, Japan, whilst Chapters 16 and 17 provide examples from the United States and Scandinavia from a female perspective. Chapters 18 and 19 focus on the challenges of providing safety and security to users with mental and physically impairments from Italy and Sweden respectively. Chapter 19 combines user perspectives with technological innovation, and illustrates the potential of using ICT for visually impaired users to improve safety when travelling.

Finally, Part VI draws together the discussions in the present volume. It synthesizes and critically reviews the key findings, identifying some of the key lessons learnt and highlighting key challenges facing those who wish to develop new research frontiers in safety within transit environments. It attempts to draw together the empirical findings and theoretical discussions adopted by the authors who have contributed to this text from a range of backgrounds and disciplines. It considers the utility of the proposed theoretical framework within which the science of transit crime can be examined. Moreover, it outlines future potential research avenues and also the future policy recommendations and practical outcomes that have been demonstrated by this collection. This includes both a number of challenges and potential solutions for both research and practice in the coming future.

Definitions

The authors who contributed to this book were asked to provide definitions of some of the common concepts used, including *safety and security*; *public transportation*; *transit environments/settings*; *transport nodes*; *and transit crime*. Their definitions are from a range of different fields and perspectives, and the following discussion draws these together and highlights commonalities of approaches and some alternative ideas. These concepts are used as reference throughout the book, but since the book contains contributions from different disciplinary traditions, they may not be limited to those expressed below.

Safety and security

Safety and security are contested concepts that remain somewhat arbitrary and open to debate as different disciplines attach different meanings to them. A common theme is that all definitions consider some aspect of the notion of lack of harm, or imply that this is essential as part of an individual's needs. Hence the search for a singular definition of either security or safety is illusory. There are clear overlaps of the meaning of these terms as defined by the book's authors. The main point which arises from these different conceptualizations is that both safety and security are considerably complex phenomena.

Two main groups of definitions can be identified, one that associates these concepts explicitly with the broad notion of harm (Sedelmaier, La Vigne, Wiebe, Landman, Smith, Levin, Loukaitou Sideris, Newton and others) and a second group that adopts a wider perspective, linking safety and security to crime and victimization (what), to measures to ensure safety and security (how), to the target directed at (whom), to ongoing conditions (processes) or to their impact (outcome), which are often associated with a particular setting (Hart and Miethe, Uittenbogaard, Gentry, Felson, Sochor, Shibata, Iudici, Ceccato). Instead of trying to compress the richness of the terms 'safety' and 'security' into a homogenizing blunt template, neglecting the existence of multiples concepts coming from an interdisciplinary field of research, we reveal in this book some of the differences by reporting examples of authors' conceptualization of safety and security. How have the terms safety and security been approached in this book?

Smith and Yu's definitions of safety and security are an example of associating this concept with the notion of harm. They state, 'Safety refers to the protection of an individual's bodily integrity or an object's structural integrity from harm caused by outside sources or actors', while 'security refers to the protection of an individual, object, or property from the harm resulting from actual acts of crime and disorder, as well as the protection from worry or fear a person may feel in relation to these types of potential acts or to the person's perceived personal vulnerability to such acts'. Sedelmaier suggests a similar definition: 'Safety is the condition of being protected from potential harm and hazard', while security is about 'the degree to which one is protected from potential harm and hazard'. Likewise, La Vigne refers to the term safety as 'the protection of harm from personal victimization', and security as 'the environmental design, management, and enforcement associated with prevention of both person and property crime'.

Loukaitou-Sideris expands the definition of safety to non-human dangers. Safety is defined as 'freedom from harm, human danger (e.g. crime, traffic) and non-human danger (e.g. natural disasters, poor environmental conditions)', while security, following Webster's dictionary, is 'the state of feeling or being free from fear, care, danger, etc'.

Newton suggests specifically for public transportation passengers and staff only that 'safety relates to the perceptions and feelings of individual passengers and staff and their right to feel able to travel without risk or harm'. The author notices however that there is a separate and wider notion of health and safety which refers to accidents and emergencies. Security in the context of public transportation refers to 'the risk levels and vulnerability of public transport systems to experience crime (low level criminal damage to serious major incidents) and disorder incidents, and the measures that can be put in place to reduce the risk of such threats. The notion of security may also be extended to include terrorism incidents'.

For Landman and others, safety involves victimization but also accidents. They suggest that 'safety refers to the extent to which residents in an urban area are protected from factors that may hurt them physically, for example being a victim of crime or being hurt by a vehicle when trying to cross a busy intersection'. The less tangible dimension is captured by their concept of security. For the authors, security often refers to 'a sense of feeling at ease or comfortable in a particular place due to the presence of factors that are linked to this perception such as the presence of visible policing, well-behaved people, security cameras or gates and fences'.

Levin highlights that, within transport research, safety has traditionally been examined through an engineering lens in terms of risk reduction (road safety, traffic safety) and that the notion of safety generally assumes events that involve significant risk of death, injury, harm or damage. However, from a behavioural and social science perspective, the author contends that it is crucial not to distinguish between real or significant safety issues and the perceived safety and that safety should include a combination of possible consequences and related uncertainties. Uncertainties, due to risk of accidents or criminal actions, may result in victimization of certain groups, or a greater consequence is that responsibility may be placed on particular groups. Levin suggests that within transport planning and transport research, security is viewed as a more socially laden concept than safety, and often defined in terms of individual or public safety, addressing the risk of harm due to criminal acts consciously performed by other persons (not accidents). In her chapter she focuses on subjects' communications, on experiences and values of safety/security from a gender perspective, in other words, how travellers verbalize meanings of safety/security in public transport and related environments. The concepts of safety and security in her chapter sometimes operate in parallel, and it is argued that safety and security issues have a discursive impact on people's everyday life and mobility options.

Sochor relates the concepts of safety and security closely with mobility. She associates security with 'measures taken to protect against an event or exposure to something that could affect potential mobility'; while 'safety is the state of being sufficiently protected from an event or from exposure to something that could affect potential mobility'. The author highlights the qualifying term 'sufficiently' here to reflect the impossibility of ubiquitous safety, and what is deemed sufficient safety depends on the respondent, target, activity, cost, and so forth. This definition of safety aims to encompass the needs of certain groups, such as those with limited physical or mental capacities, whether temporary or permanent. This reflects the United Nation's (UN's) right of equal access to transportation for the disabled, as well as many nations' transportation policy goals of accessible, high-quality, safe transportation systems. In the context of mobility, system security measures include modifying the physical environment and providing security personnel and surveillance systems, while individual security measures include carrying devices, from mobile phones to weapons, and behavioural responses such as avoidance, protective actions, and so forth. Furthermore, while creating a clearer demarcation between these concepts, it is her intention that these definitions not exclude alternative interpretations. For example, traffic safety clearly falls within this definition, the 'event' being a traffic accident. However, while such concerns may be a mobility barrier for certain individuals, traffic safety and accidents are not the focus of her chapter. Rather, the focus is on other issues affecting an individual's sense of assurance while moving in an urban environment.

Shibata, Uittenbogaard and Gentry link the concepts of safety and security closely with transit and transportation settings, which is perhaps unsurprising given the topic of this book. Shibata relates the concept of security to concerns over the safety of train carriages and railway stations. As a result of these concerns, measures may be introduced such as women-only carriages, emergency buttons on station platforms and on train cars, CCTV and the removal of trash bins as a precaution to prevent terrorist bomb attacks. Safety is articulated as the perception of a particular environment that may change over time. This issue is exemplified by reminding us about 25 March 1995, when many subway passengers were victimized by a sarin gas attack committed by a cult group in Tokyo subway station. Since then, railway stations have been perceived as being more unsafe than any other public facility.

Uittenbogaard defines safety as 'the extent to which a certain social or physical setting is vulnerable for crimes' while security entails 'the act of being able to deter, prevent and/or intervene in order to increase safety. This is valid for both social and physical settings and can be achieved by human or non-human actions'. Gentry also separates the meaning of safety and security in transit environments into two main groups: safety relates to the human dimension, in other words, 'all measures that address the people within transit: commuters, employees, victims/offenders, guardianship', while security incorporates 'all measures that relate to the physical environment of transit: equipment, CCTV, vandalism, access points, and travel time/distance'.

Wiebe and colleagues also adopt a more user-focused perspective to safety and security. They define safety as 'an individual's perception of how safe they are from the risk of being assaulted, as they navigate the transportation environment during daily activities' while they suggest 'security is about being free from the risk of being assaulted and security from feeling afraid of being assaulted'.

The origins of the concept of security are rooted in the Latin term *securitas*, which is associated with 'peace of mind, freedom from care, and also freedom from danger' (Ceccato, 2013). For Ceccato, security at transit environments concerns the risk of being a victim of a crime, whilst safety refers to feelings of perceived safety at, for instance, the station itself or on the way to or from a station. For her, security is a tangible dimension, indicated as the statistical risk of being a victim of crime. The risk of an individual's being a victim of a crime is dependent on a number of factors, some of which relate to an individual's characteristics and lifestyle, and others associated with the environments to which an individual is exposed. One might be exposed to a series of complex interactions on the journey to transportation nodes (bus stops, stations and interchanges) and whilst on the move (on subways, buses, and trains). Crimes tend to occur in particular geographical areas in a city, at certain hours of the day and even in association with specific demographic, land use and socio-economic aspects of the population (for a review, see Ceccato, 2012).

Safety is the less tangible dimension, the perception of the risk of being a victim of crime, although this does not necessarily exclude other sources of anxiety. Safety is dependent on individual characteristics, such as age and gender. For instance, in the UK, only about 30 per cent of men declare feeling unsafe in transportation settings after dark, compared to 60 per cent of women (Crime Concern, 2004). Fear also reflects an individual's capabilities. Individuals with disabilities are more likely to fear being a victim of a crime and feel unsafe when travelling alone in their community after dark, perhaps as a result of greater perceived inability to fight back if attacked (Loukaitou-Sideris, 2014). Fear is also influenced by the characteristics of the environment. A study of transit environments in the UK found women fear multistorey parking structures, whilst men fear waiting on underground station platforms (Crime Concern. 2004). There are potential local and global dangers that mediate fear and vulnerability in modern societies. Thus, fear is triggered by multiscale factors, and the media helps establish the link between global threats and local contexts, thereby affecting an individual's perceived safety.

Some of these factors are defined by the contexts in which people live. Ceccato (2013) points out that the conviction that a societal safety net will not be in place 'if something happens' may lead individuals to take extra precautions. For example, women's experiences, particularly in societies with high gender inequality, may have an impact on their fear as they rarely get the support they need in cases of sexual assault (Whizman, 2007). Similarly, if victimized by a crime, individuals may not report the crime to the police as they are sceptical about society's capacity to protect them (Day, 2009; Los, 2002; Pain, 2009). Fear also stems from the perception of powerlessness and distrust in societal institutions. Ceccato also notices that in the Swedish context within transport research, safety is a term often used to describe traffic safety (for example, risk for traffic accidents), while security is commonly associated with crime, perceived safety or terrorism threats.

Regardless of the definition adopted for safety and security, Iudici indicates that safety and security in the transportation context are relevant social issues that ought to be treated in a participatory framework, a product of the interplay between users and scholars who study the best conditions to ensure safe mobility.

Public transportation

In this volume, the editors consider the term 'public transportation' as a fairly broad view of the transit setting; indeed, it is evident that the contributing authors frequently use the terms 'transit systems' and 'public transport systems' interchangeably. North American readers are likely to identify with rapid or mass transit systems, whereas European readers with public transport. Public transportation can be loosely defined as a shared passenger transportation service that is available for use by the general public (as distinct from modes such as taxicabs, car pools or hired buses, which are not shared by strangers without private arrangement). Public transportation services are usually funded by government subsidies and fares charged to each passenger. Services are normally regulated and possibly subsidized from local or national tax revenue.

According to Newton (2014), public transport is employed to describe a system used by the public, often a means of transporting passengers in mass numbers, generally a for-hire system, relatively low cost, that occurs along fixed routes or lines and that follows a timetable. It is designed to take persons to areas that serve major societal functions. Public transport modes are wide ranging, but include railway (railroads, light rail, metro/subway/underground railway, high-speed rail and intercity rail); buses, trolleybuses and trams; ferries; coaches; airlines; water taxis, gondolas; and pedicabs. There is a debate in the literature as to whether taxi, cycle and pedestrian journeys fit the above definition. Some of this controversy is exemplified below in the different definitions of public transportation offered by the contributors to the book.

Newton suggests that these private services such as taxis should only be included when they form part of a wider public transport journey combined with one of the above modes of transport. Bicycle hire schemes are becoming more popular in urban areas and can be included as part of the public transport system, although they are not discussed in this volume. If public transport is directed to the needs of a specific group, for instance, the elderly or the disabled, it may be widened to include 'paratransit', an expression used in areas of low demand, for people who need a door-to-door service. Newton indicates that in some parts of the world, the term 'collective transport' is used within the context of public transport, for example, a minibus or fixed group taxi, such as in South America and Russia.

This is also highlighted by Landman and colleagues in South Africa, who consider public transport as constituting the different modes of transport that allow the general public to move from one place to another in the public realm, for example, municipal buses. In South Africa, these modes are usually operated and managed by a public agency, for example, municipal bus services, but can also be operated by a private company offering a service to the general public, for example, the metro rail and the mini-bus taxis in South Africa.

Uittenbogaard simplifies the definition of 'public transportation' to include all modes of transport that are not automobiles and that can carry several passengers. Public transportation moreover is the use of a transport vehicle not owned by one of the passengers themselves. Taxis are therefore not included here. Similar definitions are put forward by Wiebe, Yu and Smith and Gentry.

Sedelmaier identifies with the issue of shared spaces and privacy in public transportation. For him, public transportation is composed of several transport modes in which the vehicle typically makes frequent stops along a predetermined route to admit and discharge passengers, and in which the rider can typically expect to share space with strangers in the vehicle compartment. This would include most forms of rail, bus and ferry service, but not 'for hire' transportation such as taxicabs or commercial air travel. Interestingly, La Vigne, Hart and Miethe also highlight that public transportation should be considered as 'all publicly funded/supported' modes of transportation.

Several authors consider public transportation as a shared and fundamental infrastructure of large cities and metropolitan areas, including Felson, Loukaitou-Sideris and Shibata. Loukaitou-Sideris defines it as 'being all shared-use, public-access, intra-metropolitan transportation systems, such buses, railways, light rail, trolleys, trams'. Figure 1.2 illustrates a typical metro system, The Stockholm metro in Sweden (in Swedish, this is Stockholm's *tunnelbana*, literally 'tunnel track') has 100 stations, 47 underground and 53 above ground, operating across are three lines (green, red and blue). In 2013, this system carried 328 million passengers, approximately 898,630 riders per day. Shibata indicates that public transportation systems play a vital role in metropolitan cities like Tokyo. For example, in central Tokyo, 80 per cent of the modal share of the railway (including subway) is for commuting. Felson highlights the importance of public transportation for daily commuting and defines public transportation as 'public access transit systems used for daily or frequent commute within urban and metropolitan areas'.

For Levin, Sochor and Iudici, public transportation should be set in the context of the needs of passengers. As Levin suggests, public transportation

Figure 1.2 An example of a public transportation system: Stockholm metro system
Reproduced with permission of SLL (Stockholms läns landsting)

includes modes of transport provided for a larger number of travellers and available for all public use, and is often publicly funded. Systems may also include mobility service, as specific transport services designed for disabled persons can be categorized as public transport, and are often provided as a public paid service and connected to certain timetables and routes.

Transit environments/settings

Transit environments/settings are, according to Solymosi, 'a context where people are busy carrying out their primary goal of travelling using public transport'. This definition captures the dynamics of daily life and exemplifies the multiplicity of places passengers may encounter during the trip. Felson and colleagues consider the route environment in their definition and transit environments as '*public access vehicles, stations, routes, and their vicinities, including their parking lots and feeder areas*'.

However, most contributors (Gentry, Loukaitou-Sideris, Wiebe, Sedelmaier, Uittenbogaard, Ceccato La Vigne, Landman and others) consider transit environments/settings as static physical places, the physical environment of transit vehicles and transit facilities. As La Vigne states, 'they are constituted by areas in and around transit hubs and pathways', and are, according to Uittenbogaard, 'the environment that *hosts* public transportation. Transit settings are those spatial places where public transport operates, therefore it is composed of both the precise places, such as a station, and their immediate surroundings as well as along the transit lines on which the vehicles operate'.

Hart and Miethe consider another important dimension of transit environments/settings. They define them as 'a behaviour setting of human-environment interaction that encompasses a transportation node or facility'. Shibata and Levin also highlight the multifunctional role transit environments may have. In Japan, for instance, transit environments/settings are important as shopping areas. The author suggests that Japanese railway companies invest more on the shopping centre business than on transporting passengers, for example *eki-naka* (in station) and *eki-chika* (by station) shopping malls. As a result, many people come to railway stations not only to travel by train but also to engage in shopping or other leisure activities. Levin indicates that transit settings 'are the places for public transport stops and interchanges (underground stations, bus stops, train stations, etc.), and where travellers often also can buy tickets and gain information about the transportation service'. She places these services in a Swedish context by suggesting they are environments that also provide various types of services (for example, shops, restaurants and parking), which bring together many people with different errands and purposes, and attract those who are not travelling.

In summary, transit environments are multifaceted, they include the transport station or stop (hubs or nodes), and, furthermore, include journeys '*en route*' on board a number of different transport modes, for example, buses, rail and trams. Many studies have shown a relationship between safety and security at transport nodes and their nearby vicinity (Newton, 2014), and therefore the areas around transit stations are also relevant. These have usefully been termed transit environs (Block and Davis, 1996). Moreover, during a transport journey, a passenger may make changes onto a different line or route, using either the same mode of transport or even two or more modes of transport (bus to train, for example) via a transport interchange. Thus there are interchanges in addition to start and end stations. Therefore, transit settings and environments may include transport hubs, the immediate vicinity of transport stops and stations (transport environs), and travel 'en route', on board different modes of transport. However, for the passenger, the journey does not stop and start at the point of embarkation or disembarkation. They may, for example, walk or perhaps even cycle from home to the transit station at the start of a journey, and from transit hubs at the end of the journey to their end location, for example, work. If a passenger's journey is negatively influenced during any leg of this journey, they may decide not to use public transport systems for future journeys.

According to Newton, and Yu and Smith, these are the environs of public transport systems, and as such they encompass the entire range of the 'whole journey approach'. For Newton, 'this includes walking to and from stops, the stop or stations itself where public transport is boarded or disembarked, and travel on that vehicle. Stops and stations generally have a defined boundary within which the public transit setting is contained. However, there is a fuzzy boundary near to a transport setting which may be part of the transport environment. This definition should be based on a user's perspective of whether where and when they are is part of their public transport journey'. As highlighted by Yu and Smith, they include all parts of vehicles and routes used by passengers and staff during individual trips or as part of the journey from home to the rider's destination and back again.

Transport nodes

Three distinctly different classifications of transport nodes are suggested by the authors. A group of scholars considers transport nodes as points on the system, whether fully realized stations or roadside bus shelters (Sedelmaier, Wiebe, Hart and Miethe Ceccato, Newton), while another group earmarks the concept of transport nodes only as the main hubs of a public transportation network (Loukaitou-Sideris and Shibata). A third group agrees with the second group, but extends the definition to include also the surrounding areas of these nodes (Yu and Smith, and Landman and colleagues).

Ceccato, Sedelmaier and Wiebe define transportation nodes as places where people come together to (dis)embark on a trip in order to reach a destination. Transportation nodes can be bus stops, subway stations or larger structures where several transportation modes come together, such as a central station or a transportation hub. Transportation nodes include the station itself but also its immediately surrounding environments and may be considered as part of the transit environments or settings defined above. According to Hart and Miethe, they constitute 'a discrete point along a transportation network (i.e. a hub, stop, or station)', or in La Vigne's words, they are 'transit stations'. Newton contends that whilst they are often considered as 'the main hubs of the transport network that connect the routes', this should be extended to include all 'stops, stations, interchanges and hubs of the transport network where persons can alight or disembark from a vehicle'.

For Loukaitou-Sideris, transport nodes are 'places where multiple transportation modes meet'. Similarly, Felson define them as 'stations, bus stops, and transit centres where passengers transition to or from vehicles'. Uittenbogaard exemplifies a node by saying that 'nodes are often composed of several parts and not just a platform to enter or exit the vehicle but may for instance also include a ticket gate, shelter, stairs, shops, etc.'. Shibata adds that they are complex structures, such as underground stations in Tokyo. The author adds, 'in most of these stations, floor plan of the station building has been expanded one-by-one with the increasing number of passengers and the lines connected to the station'. Nowadays, the structure of these stations has become very complex and it is a challenge for a passenger to find their way.

Yu and Smith suggest that transport nodes should also include the surrounding area. 'Transit nodes are the points at which riders enter the system or board a vehicle as well as places where they leave the system or disembark from a vehicle. They also include places where individuals move between vehicles or across modes'. Landman and colleagues extend the definition of transport nodes to encompass the specific types of land use that these nodes include as part of the urban fabric. Transport nodes generally refer to 'significant areas of concentration of land uses and densities that allow the public to access or change from one transport mode to the other, for example a mixed used area situated around a major intersection which includes a taxi rank, bus stop or long distance bus station and/or train station in close proximity'.

Transit crime

Whilst most police recording systems do not identify transit crime as a unique classification in its own right, some may flag crimes that occurred on a transit system. Some systems have dedicated transit police who work exclusively on the system, such as the British Transport Police (BTP) who police the rail system in the UK, or a number of transit police forces found in Vancouver, Canada, or in Boston and Philadelphia (USA). Therefore any crime that occurs in a transit environment can be considered a transit crime. Smith and Clarke (2000) identify six crime categories which are typically present in transit settings, and these are crimes against passengers such as theft, robbery and assault; crimes against employees; vandalism and graffiti; antisocial behaviour; and line of route crimes. The latter of these are not crimes during journeys, but more so offences such as metal theft of track, which causes service interruptions. In addition, Newton (2004) suggests that it is useful to distinguish 'en route' offences from those at transport nodes. It is important to note however that transport systems are inherently transient, that they present often unique environments, and that their dynamic nature means that there is a constant flow of potential targets and victims (passengers, staff and infrastructure) across a rapidly changing environment. At a simple level of explanation, the environments created during very busy peak travel times and those created outside rush hour in more isolated situations pose very different safety and security concerns. How do contributors of this book define *transit crime*?

There is more of a consensus in the definitions of transit crime provided by the authors. Most adopt a simple definition of transit crime, as crime within transit environments or settings (Felson and Loukaitou-Sideris). However, there is some discordance about the acts this may encompass.

Drawing from his Swedish case study, Uittenbogaard defines transit crime as 'any crime and acts of public disorder occurring at or in the immediate surroundings of transit settings'. Levin completes the first definition adding that '*transit crime includes all types of crimes during the bus/tram/train trips or in connection to public transport areas e.g. at stations, bus stops, underground station. Certain crimes tend to occur in transit areas e.g. pickpocketing, fraud, assault, sexual harassment and racist violence*'.

Wiebe and colleagues suggest that in the United States, these crimes are likely to include all cases of '*violence (assault, rape), theft, and physical aggression in transportation settings, committed against passengers, workers, and police in those settings*'. Shibata also characterizes transit crime based on their case study. As a crime generator, they suggest, railway stations concentrate many possible targets, leading to many criminal activities such as groping or pickpocketing in crowded train cars or luggage lifting in railway stations. There is also occasionally trouble between passengers during rush hour.

In the UK context, Newton argues that, strictly speaking, '(transit) crimes do not include terrorist events, or antisocial behaviour or disorder incidents that are not crime per se. The latter two should be recorded as terrorist or ASB incidents and not crime'. Likewise, Gentry defines transit crimes as 'personal or property offenses that occur within a transit environment or within a transit mode'. Loukaitou-Sideris considers this 'crime taking place on transit vehicles or at transit settings'.

Another interesting feature when comparing these transit crime definitions is scholar's characterise the actual locations than constitute transit crime in different ways. For example, Landman and others define transit crime as '*various types of crime that occur within a transit setting, i.e. within or outside a transport interchange, station or bus stop or within a bus or train*'. This is a fairly limited area in comparison to La Vigne, and Hart and Miethe's definition, for example. La Vigne describes transit crime as '*personal and property offenses occurring in and around transit vehicles, stations, and settings*'. Likewise, according to Hart and Miethe, transit crime is '*a criminal offense that occurs along a transportation network, at a transportation node, or within the transit environment*'.

Newton points out that '*the walking environment and the area in the immediate vicinity of a stop or station may be part of a user's transport journey and thus a place where crime could occur. However it is unlikely that a crime in this* *area would be flagged as a transit crime as such on police crime records'*. Thus, Newton defines transit crime as 'any crime offence (as notifiable by the country of location) that occurs within the boundaries of the public transport setting'.

Concluding remarks

The aim of this book is to illustrate safety and security conditions in transit environments from an interdisciplinary perspective, through the use of both theoretical and empirical studies. The book is divided into 6 parts and 20 chapters. Part I sets out the scope and purpose of the book. Instead of trying to compress the richness of the terms safety and security into a homogenizing standard, neglecting the existence of multiples concepts coming from an interdisciplinary field of research, in this book, we reveal some of the differences in authors' conceptualizations of basic concepts in safety and security. The book is perhaps the first work devoted entirely to crime and perceived safety in transit environments from an international and interdisciplinary perspective. In the next chapter, the theoretical background for the book is presented by drawing mostly from urban criminology and sociology but also from geography, psychology, architecture and urban planning.

References

Block, R., and Davis, S. (1996) The Environs of a Rapid Transit Station: A Focus for Street Crime or Just another Risky Place, in Clarke, R. (eds) *Preventing Mass Transit Crime*: *Crime Prevention Studies*. Monsey, NY: Willow Tree Press, Vol. 6, 237–257.

Ceccato, V. (2012) *The Urban Fabric of Crime and Fear*. Dordrecht; New York; London: Springer.

Ceccato, V. (2013) *Moving Safely: Crime and Perceived Safety in Stockholm's Subway Stations*. Plymouth: Lexington.

CrimeConcern. (2004) *People's Perceptions of Personal Security and Their Concerns about Crime on Public Transport*. Department for Transport, London, UK.

Day, K. (2009) Being Feared: Masculinity and Race in Public Space. In Farrall, M.L.S. (ed.), *Fear of Crime: Critical Voices in an Age of Anxiety*. New York: Routledge-Cavendish, 82–107.

Department for Transport (DfT) (2012) National Travel Survey Statistical Release 13 December 2012. <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/35738/nts2011–01.pdf > [accessed 15/06/2014].

Eck, J.E., Clarke, R.V. and Guerette R.T. (2007) Risky Facilities: Crime Concentration in Homogeneous Sets of Establishments and Facilities. In Farrell G., Bowers K., Johnson S.D., Townsley M. (eds) *Crime Prevention Studies*, 21st edn. Decon: Willan.

Hale, C. (1996) Fear of Crime: A Review of the Literature. *International Review of Victimology*, *4*(2), 79–150.

Kunieda, M., and Gauthier, A. (2007) Gender and Urban Transport: Fashionable and Affordable. Sustainable Transport: A Sourcebook for Police Makers in Developing Cities. Eschborn: GTZ.

Los M. (2002) Post-communist Fear of Crime and the Commercialization of Security. *Theoretical Criminology*, *6*(2), 165–188.
Loukaitou-Sideris, A. (2014) Fear and Safety in Transit Environments from the Women's Perspective. *Security Journal*, 27, 242–256.
Newton, A. (2004) Crime on Public Transport: Static and Non-static (Moving) Crime Events. *Western Criminology Review*, *5*(3), 25–42.
Newton, A. (2014) Crime on Public Transport. In *Encyclopedia of Criminology and Criminal Justice*. London: Springer, 709–720.
Pain, R. (2009) Critical Geopolitics and Everyday Fears. In Lee, M. and S. Farrall (eds), *Fear of Crime: Critical Voices in an Age of Anxiety*. New York: Routledge-Cavendish, 45–58.
Raphael, S., Berube, A. and Deakin, E. (2006) Socioeconomic Differences in Household Automobile Ownership Rates: Implications for Evacuation Policy. Earlier Faculty Research series, A, 197–221: University of California Transportation Center. UC Berkeley: University of California Transportation Center. Available at https://escholarship.org/uc/item/7bp4n2f6#page-3, accessed 3 March 2015.
Sherman, L.W., Gartin, P.R. and Buerger, M.E. (1989) Hot Spots of Predatory Crime: Routine Activities and the Criminology of Place. *Criminology 27*, 27–55.
SIKA, S. I. f. k. (2008) Fordon 2007, tema Miljö (pp. 88). Stockholm: SIKA.
Smith, M. and Clarke, R. (2000) Crime and Public Transport. In Tonry, M. and Morris N. (eds), *Crime and Justice: A Review of the Research* (Volume 27) Chicago: University of Chicago Press, 169–233.
Steg, L., and Gifford, R. (2005) Sustainable Transportation and Quality of Life. *Journal of Transport Geography*, *13*(1), 59–69.
Stepstone. (2012) 1 in 5 Employees Loses over 2 Hours a Day Commuting. https://www.stepstone.com/about-stepstone/press/article?aid=637.
Warr, M. (2000) Fear of Crime in the United States: Avenues for Research and Policy. *Criminal Justice and Behavior*, *4*, 451–489.
Weisburd, D., Groff, R. and Yang, S.M. (2012) *The Criminology of Place: Street Segments and our Understanding of the Crime Problem*. Oxford: Oxford University Press.
Whizman, C. (2007) Stuck at the Front Door: Gender, Fear of Crime and the Challenge of Creating Safer Space. *Environment and Planning A*, *39*(11), 2715–2732.

2
Theoretical Perspectives of Safety and Security in Transit Environments

Andrew Newton and Vania Ceccato

Introduction

This chapter discusses the extant theories used to explain safety and security in transit environments, which are set out within the conceptual framework identified in the previous chapter. A number of theoretical perspectives have been developed to explain the prevalence of crime, disorder and associated fear in society. None of these are without criticism, and none have been developed explicitly for the purpose of explaining safety and security on public transport systems. This section examines current security and criminological theories, and ideas and perspectives from other fields and disciplines, to ascertain their utility for explaining safety and security specifically in the context of public transportation. The aim is to translate these theories into an integrated and theory-led conceptual framework within which safety and security on public transport systems can readily be examined.

Due to the range of theoretical perspectives evident in the research literature, this text concentrates on those considered most salient to the major components of the public transport system, namely, *transport nodes and the micro environment*, the stations and stops and their immediate surroundings; *the transport journey*, along transport corridors, lines and routes that connect the *micro* and *meso* environments; and the wider *macro environment*, considering the connections between the transport network and the context of the wider neighbourhood and regions that it serves. In addition, it is acknowledged that the transport network receives a range of inputs and outputs throughout the day, including users as possible offenders and targets of crime, and those who may deter crime from happening. Possible targets of crime include victims, for example, passengers and the peripatetic staff, and objects, the transport infrastructure, including mobile infrastructure such as vehicles, and fixed infrastructure such as stops, stations and tracks. Therefore the final component of this conceptual framework is to consider safety and security from the *user's perspective*.

Theorizing safety and security in transit settings

Arguably the criminological perspective most analogous to public transportation systems is crime pattern theory (Brantingham and Brantingham, 1993). This theory consists of three key concepts, nodes, paths and edges. A node is an activity space in which people carry out major activities and spend most of their time, for example, school, work and leisure. It is suggested that around these activity nodes users will develop awareness spaces, the settings with which they become familiar. On transportation systems the nodes can be considered as the stops, stations and interchanges of the system. The pathways that people take between these nodes, often with a fair degree of regularity, are what crime pattern theory terms paths. In the context of transport journeys these are the routes travelled by passengers during a journey, the *en-route* aspects of the transit settings aboard a particular mode of transport, for example, a bus, train or tram. The final concept of crime pattern theory is that of edges, beyond which persons are unfamiliar with. On the public transit system the edges can be perceived as the boundaries of the transport environment, in which the transport system ends and a different environment begins. However, in the context of the whole journey approach, these edges may become fuzzy, especially during the walking aspect of any trip.

Around these nodes, paths and edges is an awareness space, a term which applies to both offenders and non-offenders. In terms of explaining crime at nodes, crime pattern theory postulates that offenders will operate within or close to their awareness space. As transport nodes may represent a key component of a person's activity space, it follows that transport nodes may also embody settings with a likely convergence of activities, in which potential offenders and targets may meet. A question this raises for public transport is whether the offender's activity spaces focus solely on transport nodes and the nearby surroundings, or whether this extends to transport routes. Outside of the transit environment the paths taken between nodes by potential victims are, on the whole, unrestricted, except perhaps by natural barriers such as rivers, and paths are likely to be walking or driving routes. On a transport system the paths a victim can select are effectively restricted to the layout of the transport network and a number of finite fixed routes. An offender's activity space may therefore extend from activity nodes outwards onto paths, in other words, from stops and stations onto buses and trains. Therefore the transit system may itself represent an expansion of awareness space, thus extending possible areas for offending.

Micro transit environments and the transit node

Before the establishment of modern public transportation systems in 1800, Colquhoun showed how transportation nodes concentrated a large number of crimes triggered by the movement and assemblage of valuable goods in the Port of London. Nowadays, transit environments are no different. They represent the convergence points of the transportation network, and are often highlighted as criminogenic places in the literature. Together with the related consumer services they provide, they create areas of exceptionally high, short-term population turnover, which may create conditions that are particularly rewarding for offenders, as travellers move through areas with which they are not familiar, and thus may be particularly vulnerable to the activities of opportunistic motivated offenders. What makes transit nodes criminogenic, and what are the likely explanations for this? However, as with most place-based research, not all stations are high risk and some experience low levels of crime, and hence a fundamental question is why some transit are nodes more susceptible to crime and disorder than others.

Routine activity theory (Cohen and Felson, 1979) is closely tied with crime pattern theory and suggests that the occurrence of a crime requires the convergence of three factors in time and space: a motivated offender, a suitable target and the absence of a capable guardian. Within a rapidly moving transport system, there is a constant interchange of potential offenders, possible targets (infrastructure, passengers or staff) and potential guardians. These guardians can include ticket inspectors, police or other security, closed-circuit television (CCTV), general peripatetic staff or even passengers. However, due to the dynamic nature of the transit system and the high volume of passengers moving through confined spaces in a relatively short space of time, there may be several favourable opportunities for an offender to come into contact with a potential victim. There is also perhaps a reduced time frame for a suitable guardian to be present compared with situations outside a transport system, due to the volume and flux of passengers across the network. Passengers may be tired, less on their guard or unfamiliar with the possible risk of crime on a transport system, and hence a number of potential targets may be present at transport nodes. Therefore, crime pattern theory and routine activities theory together provide some potential insight as to why public transportation nodes may be criminogenic, as they are activity spaces that bring together a convergence of potential offenders, suitable targets and lack of capable guardians, and thus suitable opportunities for crime.

A key feature of many transit nodes, be they stops or stations, is that they have been designed, or redesigned, to incorporate a number of the principles of designing out crime (La Vigne 1997, Cozens 2004, Liggett et al., 2004). Many rail stations in the United Kingdom, for example, aim to conform to the Secure Stations Scheme, based on Secured by Design award principles, and managed by the Department for Transport (DfT) and the British Transport Police (BTP). Similar efforts have also been made in designing the security of bus stations (DfT, 2002). Examples of design features which have been introduced include sight lines and transparency with no obstacles, natural boundaries and illumination, and the removal of dark, hidden places and large obstacles that obstruct sight lines and transparency.

Within architecture, planning and urban design, there has been a substantial volume of work on how crime can be effectively designed out of environments. Some of the early origins of this approach are found in the work of Jane Jacobs, C. Ray Jeffery and Oscar Newman. Jacobs' research into the eyes on the street, later developed by others into what is now termed *natural surveillance*, and Newman's work on *defensible space* were key to the development of Crime Prevention through Environmental Design (CPTED) initially coined by the criminologist Jeffery (1971) and Situational Crime Prevention (SCP) (Clarke, 1995). More recently efforts have been made to develop a more theoretical and holistic approach to designing out crime (Armitage and Monchuk, 2011; Armitage, 2013).

Whilst many of the designing out crime principles hold for transport nodes, there are some limitations to be considered. It can be questioned to what extent some of the original ideas of Jacobs and Newman are applicable to transport nodes. For example, Jacobs identified three attributes as necessary to make a place safe: a clear demarcation of private and public space; diversity of use; and a high level of pedestrian use of sidewalks. There is debate as to whether high pedestrian usage is indeed conducive to better security at transit stations. Angel's 1968 second level density hypothesis suggests that, once a place becomes too crowded, certain low-level crimes such as pickpocketing may occur (Newton, 2014). Newman developed these ideas and suggested urban designers should encourage defensible space, areas within which inhabitants play a primary role in ensuring its security. This is perhaps difficult to achieve in a train station or bus stop environment with a transient population. A further general principle is that boundaries need to be created between public, semi-public, semi-private and private space. It can be questioned to what extent these distinct boundaries are present or can be created in public transit systems. Therefore, perhaps some of these issues of natural surveillance and defensible space should be reconsidered in the dynamics of rapidly changing transit environments. These are key questions that should be asked by proponents of CPTED and SCP, and secured by design prevention measures, when considering the nature of transit settings, and these issues are explored further in Part II of this book.

A clear finding from the research literature is that a small proportion of all nodes on a public transport system experience a large percentage of all the crimes at stops and stations (Pearlstein and Wachs, 1982; Levine et al., 1986; Loukaitou-Sideris, 1999). This is consistent with the literature on risky facilities (Eck et al., 2007). The majority of crimes at bars, hospitals, schools and parks, for example, are concentrated at only a minority of these facilities. Crime pattern theory and routine activities theory provide some explanations for this, as during their day-to day-routines, offenders develop particular awareness spaces that they favour, and some stations will be close to these and others not. Thus certain activity spaces are more likely to experience crime than others. Indeed, Brantingham and Brantingham (1995) developed the ideas of crime attractors and crime generators which are also particularly apt to transit nodes. A *crime attractor* is a place affording many criminal opportunities that are well known to offenders. Criminally motivated people are drawn to such locales, thus increasing the number of crime and disorder events. *Crime generators* are places in which large numbers of people are present, for reasons unrelated to criminal motivation. As a result of this convergence, new, unexpected criminal opportunities are created, which an offender who is present, by chance or routine, may then act upon. It is evident in the literature that transport nodes may act as crime attractors and or crime generators (Ceccato et al., 2013).

What is less clear is whether it is the transport node itself, or what is around the transit station, or a combination of the two, that drives crime at risky facilities. Bowers (2014) hypothesized that risky facilities may act as radiators of crime, the primary driver of risk radiating risk to the nearby surroundings, or as absorbers of crime, soaking up crime from the surrounding environment. Whilst the study did not consider transport nodes, both hypotheses are possible. The key notion is that of an interaction between the transport node and the land uses surrounding it. Block and Davis (1996) found that it is the environs of transit stations – the areas in the vicinity of transit stations – that are most at risk for robbery. Transit nodes cannot be examined in isolation from their surrounding environment, particularly considering the importance of the whole journey approach to public transport.

Research has demonstrated that the layout and design of a transport node, and conditions of the nearby surrounding environment, can both influence levels of crime at a transport node. Crime is a result of two dimensions: the environment of the transport node itself (for example, design of platforms, CCTVs, dark corners, hiding places) and social interactions that take place in these environments (for example, poor guardianship, crowdedness) (Ceccato et al., 2013). Such vulnerability can also be associated with the context in which transport nodes may be embedded (for example, Loukaitou-Sideris et al., 2002). There is conflicting evidence as to whether mixed land use around a station (as proposed by Jacobs) does actually reduce levels of crime, by increasing eyes on the street. An alternative hypothesis is that mixed land use may actually increase levels of crime, a territorial impact that results from a reduction in informal levels of social control (Browning et al., 2010). Therefore the next sections of this chapter consider the wider aspects of the transportation system, beyond the transport node.

The journey

Safety and security on transport journeys has received limited research compared to studies of transport nodes, not least due to the added theoretical complexities and analytical challenges presented when examining a moving vehicle (Newton, 2004). Whilst transport nodes are fixed in place, and receive a transient user population throughout the course of the day, a transport journey moves persons and vehicles around a complex system and rapidly changes in terms of the environments through which a vehicle passes and the users it transports between nodes. Parallels here can be drawn with the research in crime and place in general. There is a wealth of research into the place of crime (Sherman et al., 1989; Weisburd et al., 2012), but much less attention afforded to the combined spatiotemporal dimensions of crime. There is perhaps no other setting outside of transit systems that experiences such rapid change of people and place, and thus the combined influence of both time and place on transit systems should feature prominently in any theoretical explanation of safety and security on these systems.

Hägerstrand's research into time geography offers a potential framework for considering transit journeys, as this incorporates movement in both time and space. The discrete activities of individuals are mapped in sequential order over both time and space, by constraining each activity based on a discrete unit of time and place. Therefore, it is possible to segment a transport journey into sections, modelling this into a series of discrete journeys defined by start and end times and a linear space. There has been limited research into hot routes (Tompson et al., 2009) and hot segments (Newton, 2004; 2008; 2014). Part III of this book seeks to explore these issues in further detail.

Crime pattern theory and routine activities also provide a useful perspective for examining crime on transport journeys. As discussed previously, the fixed nature of transport journeys may extend the activity space of offenders from outside their usual nodes onto transport routes that radiate out from, or move back to activity nodes. The transport network has the potential to shape activity spaces, and therefore it is perhaps not surprising that concentrations of crime are evident on the network at particular locations, especially during peak travel times. An individual's knowledge and awareness space is developed during his/her daily and weekly routines. Taking this further, there may be particular routes and journeys regularly frequented by a passenger and/or an offender, and thus these sections of the transit network would form their awareness space, particularly for commuters. However, by their nature transit systems may also carry persons to unfamiliar places, and thus whilst they may begin in a familiar transit setting, they may be transported through less familiar locations during the transit journey.

Tobler's first law of geography states, *'everything is related to everything else, but near things are more related than distant things'*. When considering this temporally, this may imply that what is closer in time is more important than what is further away in time. Applying this to crime on transport journeys using time geography, near can be represented both in time and space, and the environment through which a vehicle has most recently passed, the environment in which it is currently, and the environment to which it is travelling next, are likely to be most relevant to crime risk, rather than earlier or later stages of a journey.

The absence of a capable guardian has been shown as influential in the occurrence of crime. Recent work by Reynald (2011) suggests a key factor for capable guardianship is a willingness to intervene. Persons are more likely to be willing to intervene and prevent a crime when they are in a place they know well, and are familiar with who is there and the context of that place. It can be argued that on a dynamic and moving transport system, potential guardians are less likely to intervene than if they were in their own residential neighbourhood. Even regular commuters who travel a journey frequently and know it well, are susceptible to unfamiliar elements, in that many other passengers who travel will not be known to them, and there is no control over who may board a vehicle at the next stop or station. Both of these factors reduce the likelihood of a guardian's acting to prevent a crime on public transport.

There has been limited research into the extent to which offenders use transport routes as part of their journey to crime, or actually to offend on transport routes. A fundamental question here is whether, and, if so, how and to what extent do offenders use public transport as part of their journey to crime or as a place for committing crime. If offenders do use transit systems as part of their journey to crime, are they attracted to particular locations in which they expect there will be good opportunities for crime (crime attractors), or do transit systems form part of their routine activities, and simply through this movement they come into contact with potential targets in what are deemed profitable yet unplanned crime opportunities (crime generators)? There has been some limited research into the offender's use of transit systems. Belanger (1997) found more offenders travel within their own borough to commit crimes, and Smith and Clarke (2000) found that offenders use transit systems to commit crime in central business districts and rarely travel to suburban areas outside of their own localities. Both of these findings are consistent with the literature on journey to crime and crime pattern theory. Offenders tend to commit offences near their activity nodes, and there is a distance decay effect: as one moves further away from these nodes, the less crime there is (Clark and Eck, 2005).

The meso and macro settings

A natural function of public transport systems is that there is an interaction between the transport nodes and their surrounding environs. This relationship between the micro environments of a transit node and their nearby vicinity can also be widened, to consider the interaction between a transit system network and its macro setting, in other words, the broader neighbourhood, city or region that it serves. Whilst this is not something explicitly examined by any current theoretical perspective, there is a range of ecological studies that can perhaps help explain these interactions.

A large body of work into the ecology of crime originated from the Chicago School, and a number of theoretical models of crime have been developed that examine the relationship between crime, society and the environment. An early proponent of this approach was the Burgess concentric model developed by Park and Burgess in 1925 (Byrne and Sampson, 1986), which divided cities into a number of zones based on ecological niches of similar characteristics and ecological pressures. The first zone is the central area, the central business district (CBD), and, moving outwards from this zone, the next zones are the industrial zone, the working-class zone, the residential zone, and finally the commuter zone. This model was viewed as evolving – as people became more affluent they moved out from the city centre and lived more on the periphery. Interestingly, the second zone, in which it was suggested most crime and disorder problems occurred, was also named the zone of transition, or the interstitial zone. Whilst this model did not incorporate transport networks, there are two points worthy of note. The first is that the zone of transition was identified as the most problematic for crime and disorder. The second feature of this model is that, although public transport networks are not included, it is conceivable in this model that transport networks could carry passengers between the different zones, and quite possibly into zones outside of their usual activity spaces, into zones and areas with which they are less familiar.

Shaw and McKay, in 1942, used maps to examine spatial variations in crime and delinquency and, building on the work of Park, Burgess and others at the Chicago School, they developed social disorganization theory (Byrne and Sampson, 1986). This theory argues that neighbourhoods that are socially disorganized are more likely to experience crime, and that despite the growth and development of cities it was zone two, the transition zone, that tended to remain problematic. They identified three primary features present in this zone that increased the risk of delinquency: high rates of residential turnover, a heterogeneous population and high levels of poverty. It can be argued that these characteristics are also found on public transportation systems. The ridership (user population) of many urban transit systems and nearby surroundings experiences a constant turnover, users are extremely heterogeneous and, in many cities, users are those with low incomes.

Sampson, Wikström and colleagues have conducted detailed studies into crime at the neighbourhood level, and their research focused on what they term social cohesion and collective efficacy (Sampson and Wikström, 2006). They argue that neighbourhoods that lack social cohesion and collective efficacy are more susceptible to crime, and particular risk factors they identify include lack of community involvement, lack of supervision and a reduced level of friendship, trust and social networks in a community or neighbourhood. Again many of these factors can readily be transferred to public transit settings. Situational action theory, proposed by Wikström (2005), also seeks to explain the link between individuals and their environment, through a single explanatory framework. This general theory of crime is comprised of four features, a person, a setting, a situation and an action. This theory was developed through a large-scale extensive longitudinal study of young people called Peterborough Adolescent and Young Adult Development Study (PADS), although the research findings do not explicitly refer to public transport systems. It contends that all actions may be seen as the outcome of any alternative actions a person perceives in a situation and the actual action choice that he/she makes. As this research was based on an extensive study of young people, two questions arise. Firstly, will the situational actions of different users of public transport such as the elderly or those on low income or those with disabilities be different to those of young people? Secondly, does public transport present a distinct set of situations unique from other non-transport environments?

Evolutionary psychology is an alternative and direct study of the relationship between an environment and how that environment affects its inhabitants. Within this field, behaviour, criminal or otherwise, is a product of psychological mechanisms combined with environmental inputs that activate or inhibit actions. This is flagged here, as it is currently a process that is becoming more active within safety and security research and provides a heuristic framework for examining both individuals and environments. However, at present the authors are not aware of any studies that use this technique to study transit settings.

The user perspective

In addition to understanding crime prevalence on the different components of the transport journey, it is also important to consider the perspective of the user when examining crime, disorder and associated fears. Therefore this section focuses on individuals rather than the transport system itself. An important aspect of crime on public transportation is that fear crime has been shown as a possible limiting factor to travel. Whilst there has been a large volume of research into both perception and fear of crime in general, there is a paucity of studies that apply this research specifically to transport systems. Some noticeable exceptions include Atkins, 1990; Cozens et al, 2004; and Smith 2008. These are explored in more detail in Part V of this book.

From the perspective of the offender, two useful theoretical standpoints are situational precipitators of crime (Wortley, 2008) and rational choice perspective (Cornish and Clarke, 1986). Both of these link to crime opportunity, but they separate two distinct stages of committing a crime. Situational precipitators are forces that ready an offender to commit a crime, and these happen temporally in a sequence. They are the precursors for rational choice, which then translates this readiness to commit a crime into actually deciding to carry out an offence. It is suggested that crime prevention should focus equally on both situational precipitators of crime and on the determinants of rational choice. On a transit journey there are a number of stresses and pressures an offender may experience, which are all precursors to a crime, and may place the offender in a state whereby he/she is willing to commit and offence. The secondary stage here is to make a rational choice to commit an offence. Rational choice perspective suggests that an offender will weigh the risk and potential rewards of a crime opportunity before deciding whether to commit an offence. This theory has been used within crime prevention literature as a mechanism for reducing crime opportunity by increasing the effort, increasing the risk, reducing the reward, removing provocations and removing excuses.

Outside of the transport system, two of the clearest findings from current crime surveys and research are that more people feel at risk than are likely to fall victim to crime and fear is only weakly correlated with personal experience of victimization and actual crime rates (Jackson and Gray, 2010). As a result, a number of studies have looked for alternative theoretical explanations of fear. The strongest relationships identified for fear are concerns over neighbourhood disorder, social cohesion and collective efficacy (Wyant, 2008). Social stability, collective informal control and other day-to-day concerns such as poor community spirit, and low levels of cohesion and trust, for example, have become synonymous in the public mind with issues of risk of crime and the breakdown of neighbourhoods. A complementary theoretical standpoint is that personal vulnerability is also important; an individual's perception of the likelihood, control over and consequence of victimization will operate in conjunction with social and environmental influences. Indeed, there is a multidimensional assessment of risk. Whilst an offender may make a rational choice about the likelihood of success in commissioning a crime, a victim may make an assessment of perceived susceptibility (Farrall et al., 2007).

Whilst personal vulnerability will vary from individual to individual, certain group types can be identified within which an individual's perceived risks are likely to be higher than others. Indeed, Hale (1996) suggests three vulnerable groups are those who are low income, females, and the elderly. As all three groups are often reliant on public transit systems as their only means of travel, this suggests that these individuals may feel a sense of heightened risk from both an individual assessment and an environmental influence. Therefore, measures to reduce fear should attempt to address fears and negative perceptions shaped by both individual risk factors (likelihood, control and consequences of victimization) and the environmental cues present within transport systems.

A recent consideration for users of transit systems is the increasing role that technological innovation plays in transit journeys. There have been significant improvements in travel information in real time recently, assisting a traveller in negotiating his/her way through a sometimes complex transit system. However, little attention has been afforded to whether this increased information also reduces passengers' concerns over safety and security (Beecroft and Pangbourne, 2014). Moreover, as this information becomes more mobile, there may be new opportunities for crime, such as the increased use of mobile phones on transit systems, the potential to utilize other forms of smart payment to travel fraudulently and perhaps even the impact of social media on perceptions of risk.

There are two theoretical areas that may be useful here. The first of these is the use of crime forecasting, which is tied into the literature on secured by design. As new technology is introduced, a consideration of safety and security should be included in the design phase of new product development, not added on afterwards as an afterthought once criminals have exploited this new technology. A second dimension is one used in the research literature for cybercrime, an exponentially growing crime problem. A useful distinction drawn here is the difference between *cyber-enabled* crime and *cyber-dependent* crime. The first are traditional crimes which can be committed without the use of information and communications technology (ICT), but have become enhanced through the rapid exponential growth of ICT, such as fraud. The latter are crimes which can only be committed using ICT. This way of thinking, of transit-enabled and transit-dependent crimes, could potentially be adapted as a possible categorization of transit safety and security.

Crime Science (Junger et al., 2012) is a relatively recent concept, and can be said to contain three distinctive elements: it is multidisciplinary, it uses scientific methodology rather than social theory, and it focuses on crime rather than criminality. A question here is what does a crime science of transit safety and security look like? Perhaps a more critical question is, can the social aspects of transit settings be incorporated as part of this science? Transit systems contain an inherent interaction between individuals and environments, of rapidly changing settings, of potentially vulnerable users, and often a low rate of capable guardians per passenger. Moreover traditional analytical techniques such as the spatial analysis methods used to examine crime in street- and grid-based settings may actually not be so applicable to transport networks. These all presents significant challenges to those faced with identifying, understanding and reducing problems of safety and security on transit systems.

This chapter has considered theoretical explanations of safety and security, to examine their potential application for understanding public transit environments. These were presented using the conceptual framework identified in Chapter 1. Each of these are now explored in more detail through empirical studies as per the key parts of this book, namely Part II; transport nodes; Part III, transport journeys, Part IV, transit settings in relation to their wider environment, and Part V, the user perspective.

References

Armitage, R. (2013) *Crime Prevention through Housing Design: Policy and Practice*. Basingstoke: Palgrave Macmillan.

Armitage, R. and Monchuk, L. (2011) Sustaining the Crime Reduction Impact of Designing Out Crime: Re-evaluating the Secured by Design Scheme 10 Years On. *Security Journal*, *24*(4), 320–343.

Atkins, S. (1990) Personal Security as a Transport Issue: A State-of-the-Art Review, *Transport Reviews*, *10*(2), 111–125.

Beecroft, M., and K. Pangbourne (2014) *Personal Security in Travel by Public Transport: The Role of Traveller Information and Associated Technologies*. Institution of Engineering & Technology, Intelligent Transport Systems. DOI: 10.1049/iet-its.2013.0166.

Belanger, M. (1997) Crime Trips in the NYC Subway. *Transit Policing*, *7*(2), 15–22.

Block, R., and Davis, S. (1996) The Environs of a Rapid Transit Station: A Focus for Street Crime or Just another Risky Place. In Clarke, R. (ed.). *Preventing Mass Transit Crime. Crime Prevention Studies*, vol. 6, Monsey, NY: Willow Tree Press, 237–257.

Bowers, K. (2014) Risky Facilities: Crime Radiators or Crime Absorbers? A Comparison of Internal and External Levels of Theft. *Journal of Quantitative Criminology*, *30*(3), 389–414.

Brantingham, P., and Brantingham, P. (1993) Environment, Routine and Situation: Toward a Pattern Theory of Crime. In Clarke, R. and Felson, M. (eds.) *Routine Activity and Rational Choice: Advances in Criminological Theory*. vol. 5, New Brunswick, New Jersey: Transaction Publishers, 259–294.

Brantingham, P., and Brantingham, P. (1995) Criminality of Place: Crime Generators and Crime Attractors. *European Journal on Criminal Policy and Research*, *3*(3), 5–26.

Browning, C., Byron, R., Calder, C., Krivo, L., Kwan, M., Lee, J. and Peterson, R. (2010) Commercial Density, Residential Concentration, and Crime: Land Use Patterns and Violence in Neighborhood Context. *Journal of Research in Crime and Delinquency*, *47*(3), 329–335.

Byrne, J., and R. Sampson (eds.) (1986). *The Social Ecology of Crime*. New York: Springer-Verlag.

Ceccato, V., Uittenbogaard, A.C., and Bamzar, R. (2013). Safety in Stockholm's Underground Stations: The Importance of Environmental Attributes and Context. *Security Journal, 26*, 33–59.

Clarke, R. and Eck, J., (2005) *Crime Analysis for Problem Solvers in 60 Small Steps*. Washington, DC: Office of Community Oriented Policing Services, United States Department of Justice.

Clarke, R.V. (1995) Situational crime prevention. *Crime and Justice*, 19, (Building a Safer Society: Strategic Approaches to Crime Prevention), 91–150.

Cohen, L., and Felson, M. (1979) Social Change and Crime Rate Trends: A Routine Activity Approach. *American Sociological Review*, *44*, 588–608.

Cornish, D., and Clarke, R. (eds.) (1986) *The Reasoning Criminal*. New York: Springer-Verlag.

Cozens, P., Neal, R., Hillier, D. and Whitaker, J. (2004) Tackling Crime and Fear of Crime While Waiting at Britain's Railway Stations, *Journal of Public Transportation*, *7*(3), 23–41.

Department for Transport (2002) *Get on Board: An Agenda for Improving Personal Security in Bus Travel: Good Practice Case Studies*, London: DfT.

Eck, J.E., Clarke, R.V. and Guerette, R.T. (2007) Risky Facilities: Crime Concentration in Homogeneous Sets of Establishments and Facilities. *Crime Prevention Studies, 21*, 225–264.

Farrall, S., Jackson, J. and Gray, E. (2007). *Theorising the Fear of Crime: The Cultural and Social Significance of Feelings of Insecurity*. Published on the Social Science Research Network: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1012393.

Hale, C. (1996) Fear of Crime: A Review of the Literature. *International Review of Victimology, 4*(2), 79–150.

Jackson, J., and Gray, E. (2010) Functional Fear and Public Insecurities about Crime, *British Journal of Criminology, 50*(1), 1–22.

Jeffery, C. Ray. (1977) *Crime Prevention through Environmental Design*. (Second Edition). Beverly Hills, CA: Sage.

Junger, M., Laycock, G., Hartel, P. and Ratcliffe, J.H. (2012) Crime Science: Editorial Statement. *Crime Science, 1*(1), 1–3.

La Vigne, N. (1997) *Visibility and Vigilance: Metro's Situational Approach to Preventing Subway Crime*. Washington, DC: National Institute of Justice.

Levine, N., Wachs, W. and Shirazi, E. (1986) Crime at Bus Stops: A Study of Environmental Factors. *Journal of Architectural and Planning Research, 3*(4), 339–361.

Liggett, R., Loukaitou-Sideris, A. and Hiroyuki, I. (2004) *Protecting Against Transit Crime: The Importance of the Built Environment*. UCLA School of Public Affairs. UCLA: UCLA School of Public Affairs.

Loukaitou-Sideris, A. (1999) Hot Spots of Bus Stop Crime: The Importance of Environmental Attributes. *Journal of the American Planning Association, 65*(4), 395–411.

Loukaitou-Sideris, A., Liggett, R. and Hiseki, I. (2002) The Geography of Transit Crime: Documentation and Evaluation of Crime Incidence on and around the Green line Stations in Los Angeles, *Journal of Planning Education and Research, 22*(2) 135–151.

Newton, A. (2004) Crime on Public Transport: Static and Non-Static (Moving) Crime Events. *Western Criminology Review, 5*(3) 23–40.

Newton, A. (2008) A Study of Bus Route Crime Risk in Urban Areas: The Changing Environs of a Bus Journey. *Built Environment, 34*(1), 88–103.

Newton, A. (2014) Crime on Public Transport. *Encyclopedia of Criminology and Criminal Justice*. London: Springer, 709–720.

Pearlstein, A., and Wachs, M. (1982) Crime in Public Transit Systems: An Environmental Design Perspective. *Transportation, 11*, 277–297

Reynald, D., (2011) *Guarding Against Crime: Measuring Guardianship within Routine Activity Theory*. Surrey, UK: Ashgate.

Sampson, R. and Wikström, P. (2006) How Does Community Context Matter? Social Mechanisms and the Explanation of Crime. In Wikström, P. and Sampson, J. (eds.) *The Explanation of Crime: Context, Mechanisms, and Development*. New York and Cambridge: Cambridge University Press, 31–60.

Sherman, L.W., Gartin, P.R. and Buerger, M.E. (1989) Hot Spots of Predatory Crime: Routine Activities and the Criminology of Place. *Criminology, 27*, 27–55.

Smith, M. (2008) Addressing the Security Needs of Women Passengers on Public Transport. *Security Journal, 21*, 117–133.

Smith, M., and Clarke, R. (2000) Crime and Public Transport. *Crime and Justice: A Review of the Research, 27*(6), 169–233.

Tompson, L., Partridge, H. and Shepherd, N., (2009) Hot Routes: Developing a New Technique for the Spatial Analysis of Crime. *Crime Mapping: A Journal of Research and Practice 1*(1), 77–96.

Weisburd, D., Groff, R. and Yang, S.M. (2012) *The Criminology of Place: Street Segments and Our Understanding of the Crime Problem*. Oxford: Oxford University Press.

Wikström, P-O. H. (2005). The Social Origins of Pathways in Crime: Towards a Developmental Ecological Action Theory of Crime Involvement and Its Changes. In: Farrington, D. (ed.) *Integrated Developmental and Life-Course Theories of Offending. Advances in Criminological Theory,* vol. 14. New Brunswick: Transaction, 211–246.

Wortley, R. (2008) Situational Precipitators of Crime. In Wortley, R. and Mazerolle, L. (eds) *Environmental Criminology and Crime Analysis*. Cullompton: Willan, 48–69.

Wyant, B.R. (2008) Multilevel Impacts of Perceived Incivilities and Perceptions of Crime Risk on Fear of Crime. *Journal of Research in Crime and Delinquency, 45*, 39–64.

Part II

Transport Nodes and the Micro Environment

3

Apple Picking: The Rise of Electronic Device Thefts in Boston Subways

Kendra Gentry

Introduction

This chapter focuses on crime within the micro setting of subway stations. In particular, it reviews the crime trend of mobile electronic device theft within the Massachusetts Bay Transportation Authority (MBTA) subway system in Boston. These devices include smartphones/cell phones, tablet and laptop computers, e-readers, handheld gaming systems and MP3 players. The MBTA subway system was selected because of its unique characteristics. First, Boston is among the cities that have experienced a spike in electronic device theft. Second, it is one of the few major underground subway systems in the United States to provide both cell phone coverage and WiFi (Internet connectivity) access on subway lines and at stations. Third, the MBTA specifically collects information about each type of electronic device stolen.

According to the MBTA Transit Police, several factors may contribute to the increasing problem of electronic mobile device theft within the Boston subway system. Perhaps a major factor is that a majority of subway riders now own smartphones, that is, cell phones with computer-like capabilities such as games, music, texting, e-mail, social media and camera functions. The prevalence of smartphones are one of the primary drivers of the increase in electronic device theft. Many smartphone owners carry their device with them at all times, and often display, check or use it on the subway, which visibly alerts offenders of potential suitable targets to steal. Police officers suggest that the need to stay connected and entertained while riding on public transportation is a major distraction to passengers, and that since subway riders are 'tuned in' to their electronic device screens while on the subway, they are often 'zoned out' from everything around them, and thus can become a target for theft.

The crime trend of electronic device theft is an important topic that should be considered by the academic community. Using transit police reports, this study applies crime opportunity theories to better understand which factors increased electronic device theft in Boston subway stations from 2003 to 2011. This approach addresses a gap in the literature regarding crime on public transportation, robbery and larceny on subways and electronic device theft as few studies have focused explicitly on the problem of electronic device theft in subways.

This chapter is organized as follows. The first section discusses the scope of the problem. The second section provides a review of the research literature about crime on public transportation; robbery and larceny on subways; and electronic device theft. The third section outlines the theoretical framework used in the study, which applies routine activity theory, crime pattern theory and rational choice theory. Next, the study area, research questions and hypotheses are discussed, followed by a section outlining the data sources and measures. Then, the results are presented. Finally, the concluding section details the study limitations, the impact of the findings for practitioners and future prevention, and offers some suggestions for future research.

An international problem

As mobile technology advances and increases in popularity – and the demand for WiFi and cell phone coverage booms – electronic device theft in public transportation systems is becoming a growing problem in several metropolitan cities around the world. According to a report by the New York Police Department, of the 16,000 robberies in the entire city of New York during the first ten months of 2011, about 50 per cent were of electronic devices (Parascandola, 2011). 'This makes electronics the single most stolen property type, surpassing even hard currency'. This report also stated that the Apple iPhone was the product stolen in 70 per cent of the thefts on New York City subways and buses. The problem in New York has also led to violence. In 2012, an 81-year-old man was pushed onto the subway tracks in Brooklyn while chasing down teenage thieves who stole his iPhone (Noel and Prokupecz, 2012). In 2013, a Philadelphia man dragged a woman onto the subway tracks after stealing her phone (Smith, 2013c). In the Shanghai subway, police say thieves snatch phones from unsuspecting victims who sit near doorways (Minjie, 2011). In 2010, 53 per cent of the 1,071 violent thefts on Paris subways, buses and trams involved smartphones (Campbell, 2011). This led Paris police to warn riders to guard all of their electronic devices, especially the iPhone, following the death of a woman who was pushed down the stairs of the subway by an offender after he stole her phone. Fliers provided by the police remind riders that their mobile phone is 'so valuable that others would like to get their hands on it too'.

The theft on electronic devices on public transportation systems is a crime type that has a number of similar characteristics with studies focused on 'crime and place' and 'crime and opportunity'. Electronic devices are the epitome of a 'hot', or risky, product, and public transportation systems can be described as a 'hot', or risky, environment, particularly at peak travel times in which there are many opportunities for theft. However, the literature to date has tended to examine these areas in isolation. There are studies on the theft of electronic devices and studies on crimes in public transport. However, there has been limited scholarly research on electronic device theft *within* public transportation systems. Therefore, this study addresses a key gap in the research literature and brings together this converging crime topic.

Literature review

Crime on public transportation

Public transportation ridership in the United States has grown during the last three decades. Since 1972, overall public transit ridership has increased about 55 per cent – with more than 10.2 billion trips recorded in 2010 on all modes of public transportation. Modes include buses, trolleys, light rails, subways, commuter trains, streetcars, cable cars, ferries, water taxis, monorails and tramways, van pool services, and para-transit services for senior citizens and people with disabilities (American Public Transportation Association, 2012).

Crime can occur on any of these modes of public transportation. It has been contended that the micro settings of public transportation provide a unique environment, creating situations that repeatedly bring potential victims/targets and motivated offenders together at a particular location at the same time. Crimes that can occur within public transportation systems vary and can be grouped into the following three categories: crimes against the transit authority (for example, fare evasion, vandalism, graffiti); crimes against transit authority employees (such as assault and robbery); and crimes against passengers (including theft, robbery, assault, sexual harassment).[1] Research regarding crime on public transportation often refers to the field of study as 'transit crime' (Hoel, 1992). Of the transit crime research that has been published, studies have focused on various modes of transit, including crime on buses and at bus stops, crime on light rail and crime on subways.

Robbery on subways

Electronic device theft in Boston subways is typically a crime against a passenger. The subway environment has many features, including subway platforms, mezzanines, corridors, turnstiles, waiting areas, ticket kiosks, token booths, exit stairways and opening/closing subway car doorways. Since the crimes that occur in a subway system are partly influenced by the environment's settings, all of these features can be conducive to electronic device theft, especially robbery and larceny (Richards and Hoel, 1980).

According to Smith and Clarke (2000), subway robbery occurs due to a lack of supervision, or a lack of capable guardians, which is one component of routine activity theory (Cohen and Felson, 1979). There are three key likely explanations for a subway robbery. First, offenders often seek vulnerable victims in deserted subway stations. For example, Falanga (1988) found that passengers are at risk of robbery in stations that are large and sprawling. During the day, these stations accommodate hundreds of people, but at night such large stations are sparsely populated. Individuals are also at risk of robbery when there is lower passenger density within subway cars and on platforms (Clarke et al., 1996). Second, passengers are at risk of robbery when waiting at isolated stations during off-peak hours (Shellow et al., 1975). Third, offenders can prey on victims as they exit –while leaving either the subway car or the platform (Block and Davis, 1996). This last approach seems to be popular in Boston, according to the MBTA. For example, police have explained that many offenders prey on victims who sit next to the subway doors, waiting to steal their devices and run when the cars stop at a station and the doors open (Seelye, 2010).

Larceny on subways

Electronic device-related larceny is different from robbery, as it does not include force, intimidation or a weapon. Pickpocketing (a stealth measure) and snatching, or 'snatch-and-grab' (a surprise measure), are forms of larceny. These types of larceny usually relate to the overcrowding of areas within the subway system. Four factors of overcrowding can facilitate such larceny offenses (Morgan and Smith, 2006). First, the distance between offenders and potential victims becomes reduced with overcrowding, without raising immediate concern or worry. Passengers who ride the subway everyday may become accustomed to crowded cars during rush hours. Second, the crowded conditions may distract other non-victims, people who might be able to detect or react to a theft in a less crowded environment. Third, the constant movement of passengers on subway cars and platforms may provide a convenient cover for offenders. Lastly, crowded areas may help offenders avoid identification and escape undetected.

Several studies have examined prevention measures used to combat subway crime. On the London Underground, Webb and Laycock (1992) found that closed-circuit television (CCTV) reduced robberies and increased passenger confidence, and Burrows (1980) found it to reduce theft. La Vigne (1996a) found spacious platforms, the use of kiosks and a lack of bathrooms, lockers and vendors were all factors that reduced crime in Washington, DC, subway stations. The design of stations also eliminated long, winding corridors in which offenders could hide. Chaiken et al. (1974) found an increase in the number of NYPD officers from 8pm–4am reduced subway robberies, and did not displace crimes to other times.

Electronic device theft

A range of portable electronic devices are susceptible to theft, including smartphones, mobile phones, tablet and laptop computers, e-readers, MP3 and other music players and handheld gaming systems. Most electronic devices have WiFi and Bluetooth (device connectivity). They are used for communication purposes (phone calls, texting, e-mail) and entertainment purposes (games, music, social media and camera). These functions make electronic devices highly desirable, and they are considered to be the epitome of 'hot products', items that are most suitable for theft by motivated offenders (Ekblom, 2008). In addition, such devices are also CRAVED, which is discussed later under the theoretical framework (Clarke, 1999). Given this, it is important that stakeholders in law enforcement and government understand spikes in thefts of criminogenic products like electronic devices, as they may lead to crime waves (Clarke and Newman, 2005a). Prior crime waves have included expensive sneakers (Nike Air Jordan), jackets (Starter and North Face) and media players (Walkman and iPod) (Roman and Chalfin, 2007). However, electronic device theft is perhaps unique from other crime waves, as the majority of Americans own at least one electronic device. For example, 85 per cent of American adults own cell phones, while 45 per cent have smartphones (Pew, 2012).

Electronic device theft is not restricted to the United States. In the Netherlands, cell phone theft has decreased by 50 per cent since Amsterdam police began using a 'bombing' strategy, which bombarded stolen cell phones with text messages from the police department, such as: 'You are in possession of a stolen cell phone. Did you know that stealing a cell phone is a crime punishable by imprisonment? Using a stolen cell phone is too, and you are risking a prison term of one year' (Harrington and Mayhew, 2001).

When attempting to prevent cell phone theft in the United Kingdom, the National Mobile Phone Crime Unit partnered with phone companies to register more than 22 million cell phones in a database, known as Immobilise. If a registered phone is stolen, police can identify it and make the device unusable – which has, according to this unit, reduced cell phone theft since its inception (National Mobile Phone Crime Unit, 2009). In 2012, similar legislation was proposed in the United States to create a database of all stolen cell phones with the intention of blocking thieves from continued use or resale (US Federal Communications Commission, 2012). Smartphone manufactures responded to pressure from law enforcement agencies nationwide in 2013 by promising to implement anti-theft features on future devices. One Apple feature is said to be a 'kill switch' that remotely disables a phone once it is reported stolen. Another applies an 'activation lock' that requires thieves to enter a password specific to a stolen phone before it can be accessed. However, some critics argue that these features will not deter thieves, who will learn how to work around them (Smith, 2013b).

A crime related to electronic device theft is cybercrime, and in particular identify theft (Allison et al., 2005; Clarke and Newman, 2005b; Gerard et al., 2004; Lynch, 2005; Wall, 2003), which is the stealing of personal information from a device for illicit or illegal use, and cell phone fraud (Clarke et al., 2001), which is the act of cloning cellular devices. However, this chapter focuses solely on the theft of the electronic device itself.

Applying crime opportunity theories

Environmental criminology perspectives are especially well suited to revealing more about electronic device theft on subways since all of them focus on the criminal event as opposed to the criminal offender. The three major theories here that focus on crime, place and opportunity are routine activity theory, crime pattern theory and rational choice theory.

Routine activity theory

Routine activity theory (Cohen and Felson, 1979) is focused at the macro, or societal level. The assumption is that a crime may occur when a likely offender and a suitable target converge in space and time with the absence (or presence) of capable guardianship. This is demonstrated in the modified crime triangle (Eck, 1994). A likely offender can be motivated by many factors, including gain, need or the desire to own some attractive consumer product. A suitable target can either be a person or an object. Finally, there can be numerous capable guardians, such as a police officer, a nearby person, retail employees, a well-lit area, a locked door or an alarm system. Applying this theory to electronic device theft in Boston subways requires a likely and motivated offender to find a suitable electronic device. Once the device is found, the offender will evaluate the capable guardianship available on the platform, mezzanine or in the subway car. If this is adequate and guardianship is judged to be lacking, the crime can proceed. As for the type of motivated offender, previous research found that in the United Kingdom, more than 50 per cent of the individuals who stole cell phones were youth offenders, around 16 years old (Harrington and Mayhew, 2001). Additionally, an overwhelming per cent of offenders were male. These data are similar to the accounts of MBTA Transit Police officers assigned to the subway detail. When asked to describe typical offenders who stole cell phones on the subways, the officers all agreed on teenage males.

When considering the suitable target, again, it is understood that electronic devices can be considered ‘hot products’ (Clarke et al., 2001). These devices also fit the CRAVED model of suitable targets; they are concealable, removable, accessible, valuable, enjoyable and disposable (Clarke, 1999). As with other items such as cash (Clarke, 1999), purses and wallets (Smith, 2003) and even exotic parrots (Pires, 2012), electronic devices in general are both CRAVED items and hot products. Electronic devices are small and not easily distinguishable, so they are concealable. Electronic devices are often free standing and lack any sort of tethering, so they are also very removable. The frequent use or display of electronic devices also allows the hot products to be easily accessible. Many models, especially smartphones, are expensive and exclusive, which makes them valuable. This also allows for cell phones to be highly entertaining and enjoyable devices. Given the demand for cell phones, the fact that many can be resold easily allows for a disposable product.

Another useful tenet of environmental criminology is the '80–20 principle', which states that 20 per cent of any particular group of things is responsible for 80 per cent of outcomes (Kock, 1999). When examining electronic device theft in Boston subways, it is evident that a small proportion of devices are stolen the majority of the time (MBTA Transit Police (personal communication, 10 January 2012). For example, of the dozens of cell phones available on the market, smartphones, such as the Apple iPhone, Android and BlackBerry, are the most popular phones stolen nationwide (Rocheleau, 2011; Lohr, 2009). Again, a fitting explanation could be that all three models have computer-like functions, cameras and music players, which are very desirable. In fact, the frequency of iPhone thefts nationwide has led many news outlets to refer to the burgeoning crime trend as 'apple picking' (Smith, 2013a).

Finally, when taking the guardianship portion of the crime triangle into account, a study found that a fewer number of people on subway platforms and in cars increases the risk of robbery (Clarke et al., 1996; Belanger, 1999). This research illustrates the absence of capable guardianship, which is opportunistic for offenders. The opportunity also arises due to lack of supervision, which reiterates the previous discussion on robbery in subways.

Crime pattern theory

Crime pattern theory (Brantingham and Brantingham, 1981) focused on the meso- or neighbourhood-local level. Crimes occur and cluster based on routine, daily activities, and this theory focuses on how offenders and victims converge in space and time along nodes, paths, and edges, with crimes occurring in activity spaces. Nodes are centralized activity places to and from which people travel, such as home, work or school. Paths are the actual routes that people take during these everyday activities, which usually involve major traffic thoroughfares or transit systems. Edges are the boundaries of areas in which people live, work or engage in other recreation or interaction. Most offenders follow the 'journey to crime' pattern (Phillips, 1980) and commit most of their crimes close to home in areas with which they are familiar. There is therefore an automatic distance decay, which means that offenders are less likely to commit crime further away from where they live. This also relates to the least effort principle, which explains that offenders exert the minimum effort possible when committing their crimes, such as engaging in limited travel.

Crime pattern theory can be applied to electronic device theft in Boston subways. In 2008, the Boston (MBTA) subway system included 669 subway cars and 121 subway stations. Each weekday, an average of 760,000 passengers ride the subway (MBTA, 2009), and 32 per cent of Boston residents use public transit to travel to work (US Census Bureau, 2008). This ridership saturation of the subway results in the convergence of offenders and victims along nodes, paths and edges. Nodes can represent a static, or stationary, subway station near an offender's or victim's home or workplace (Newton, 2004). Belanger (1999) found that New York subway offenders commit most crimes in stations and on subway cars near their homes, which follows the journey to crime and least effort principles. Paths can represent the non-static subway lines on which subway cars travel or transfer stations, which create intersections for offenders and victims to converge (Newton, 2004). These intersections generate a multitude of potential crime activity spaces. Additionally, relatively short travel times between stations allow offenders and victims to travel easily throughout the city to outer boundaries, which in turn transcend edges.

Analysis of crime patterns on subway systems reveals crimes concentrate at 'hot spots', stations in which the majority of crime occurs. A study by Smith (1986) in New York found 24 per cent of subway robberies occurring on platforms and 30 per cent occurring in cars, while in London, 50 per cent of subway robberies occurred in cars, while about 25 per cent occurred on a platform (Smith, 2003). Given these hot spots, subway systems, as a whole, may be considered crime attractors. An attractor is a place which offenders visit due to expected opportunities for crime. Electronic device theft in the Boston subway may represent such a situation. It may also be a generator for theft, meaning the convergence of many people may create favourable, but unplanned opportunities for theft. Del Castillo (1992) found that subway robbery within the New York subway system was disproportionate to the robberies that occurred above ground, suggesting it is more likely a crime generator.

Rational choice

Rational choice perspective (Cornish and Clarke, 1986) focuses on the micro or individual level and suggests offenders weigh the costs and benefits of committing crimes. It assumes offenders seek to benefit from crime and therefore consider the risks, efforts and rewards of each crime opportunity. Committing a crime involves a series of decisions and processes made by the offender. Several principles underlie the rational choice perspective, including the notion that criminal behaviour is purposive, rational and specific to individual crimes. Additionally, an offender's decision to commit a crime is based on the stages of involvement (initiation, habituation and desistance) or the specific criminal event being committed. These choices are then made during preparation, target selection, commission of the crime, escape following the crime and the crime's aftermath. All these decisions can be studied through the use of a crime script, the step-by-step procedures that offenders take into account during crimes (Cornish, 1994; Cornish and Clarke, 1986).

Numerous crime scripts can be generated for electronic device theft in the subway. Offenders must consider (a) the risks of getting noticed, caught, photographed, chased, arrested or sentenced; (b) the level of involvement and the time of day, location and area; and (c) the benefits of having anonymity in a crowded, unsupervised area and how the stolen device will be used. All of these decisions also involve target selection, how the theft will be committed, the method of escape and the outcome of the theft of the electronic device.

Study area

Boston has the fifth-largest public transportation system in the United States (American Public Transportation Association, 2012), and is considered a prime geographical area in which to study electronic device theft. The MBTA collects incident-level data of electronic device thefts, which is rare (Ketola and Chia, 2000). Additionally Boston is an appropriate research site because it is one of the first transit systems to add WiFi and phone coverage within subway cars and stations, which makes it more likely that phones and WiFi devices will be used.

The MBTA public transportation system has subways, buses and a commuter train rail (MBTA, 2009). For the purposes on this study, only Boston subways were considered. The subway system consists of the Blue, Green, Red and Orange subway lines. All four of these lines include 120 stations that are either underground, elevated or at grade level. Underground stations are located below ground, with trains travelling along tracks inside tunnels. Elevated stations are located above ground, with train tracks often situated on platforms hundreds of feet above. Grade-level stations are located on the street, with train tracks running along roadways. Of the four subway lines, some have special features. The Red, Orange and Blue lines are rapid transit lines, with either underground or elevated subway stations. The Green Line is a light rail line, operating streetcars both underground and at grade level on the street. Outside of the downtown Boston core, the Red and Green lines split into separate branches. The Red Line has two branches in the south: 'Ashmont/Mattapan' and 'Braintree'. The Green Line has four branches located in the west: 'B', 'C', 'D' and 'E'.

The MBTA subway system was a pioneer in bringing phone coverage to its subway stations and cars. In December 2007, stations located in the downtown core added cell service. In March 2010, the entire Orange Line received cell phone service, with the Red Line following two months later. In December 2011, the Green and Blue lines added cell service. Free WiFi service was introduced in December 2008 to the majority of subway stations and cars.

Electronic device theft in Boston subways

To better understand electronic device theft in Boston subways, two research questions were developed. The first asks which subway station features are associated with higher rates of electronic device theft. It is hypothesized, using crime pattern theory, that electronic device thefts will increase at stations with higher ridership, bus connections and parking lots. Belanger (1999) found that the higher the average ridership at a subway station, the higher the crime rate at that station, most likely because of increased numbers of offenders, victims and targets at the station, which in turn increases crime opportunities. Studies have found that crimes on subway platforms increase at stations with higher ridership (Burrows, 1980; Loukaitou-Sideris et al., 2002; Shellow et al., 1975). The same can be true for subway stations near bus connections, where commuters can exchange or transfer to a local bus once exiting the subway station (Yu, 2009). Yu found that bus stops are associated with increased crimes. Finally, subway stations near park-n-ride parking lots have more Type 1 crime, or Part 1 serious felonies as defined by the Uniform Crime Reporting (UCR) program (Loukaitou-Sideris et al., 2002). This study found that 60 per cent of crimes that occurred on a subway line actually occurred within the park-n-ride lots where commuters pay to park their vehicles near a subway station for short-term periods. Only 20 per cent of crime occurred on the platform.

The second research question asks how electronic device theft in the MBTA subway system compares to district crime rates near subway stations, as reported by the Boston Police Department. In Boston, precincts are considered districts. It is hypothesized that thefts will increase at stations with higher surface-level robbery, larceny and property crimes. This relates to both crime pattern theory and routine activity theory. Additionally, previous studies have found that some crimes increase at subway stations situated in high-crime areas (Richards and Hoel 1980; Pearlstein and Wachs, 1982; Falanga, 1988; DeGeneste and Sullivan 1994; La Vigne, 1996b).

Methodology

Data sources

This study includes electronic device thefts that occurred on or near the Blue, Green, Red and Orange subway lines. These thefts were compiled from MBTA Transit Police incident-level case reports between 19 August 19 2003 and 31 December 2011. During this time period, there were 1,163 electronic devices stolen at subway stations. The types of stolen electronic devices included cell phones (n=814), MP3 players (n=131), laptop computers (n=92), CD players (n=66), digital camera (n=37), video games (n=14) and DVD players (n=9). Following the CRAVED model, the devices stolen most often were smaller, such as cell phones and MP3 players. It is important to note that unlike the differentiation of CD players and MP3 players as music devices, the cell phone category includes both smartphones and regular mobile phones since the study period is from 2003 to 2011.

The 2007 *MBTA Blue Book of Ridership and Service Statistics* was used to collect subway station characteristics as this was the middle of the study period. For each station, it includes data on average weekday ridership; the presence or absence of a park-n-ride lot and whether there is a bus connection. Surface-level crime statistics were obtained for each district using the 2007 Boston Police Department and Massachusetts Crime Reporting Unit summaries.

Measures

The dependent variable is the number of electronic device thefts at all Boston subway stations during the study period (n = 1,163, mean = 9.69, SD = 15.861). The unit of analysis is each individual subway station because the MBTA Transit Police indicates the nearest subway station address only when reporting electronic device theft. Electronic device thefts occurred at 90 of the 120 subway stations on these lines, and this closely follows the '80–20 principle', as 73 per cent of all electronic device thefts (859 of 1,163) occurred at 20 per cent of the subway stations (24 of 120) (Kock, 1999).

The independent variables were property crime, larceny, robbery, ridership, bus and parking. Property crimes include larcenies and robberies. As shown in Table 3.1, the number of property crimes in each Boston Police district ranged from 238 to 4,950 (mean = 2310.60, SD = 1294.917). The number of larcenies in each Boston Police district ranged from 172 to 4,009 (mean = 1729.69, SD = 1075.657). The number of robberies in each Boston Police district ranged from 6 to 436 (mean = 160.62, SD = 129.621). The average number of weekday riders at each Boston subway station ranged from 48 to 23,500 (mean = 4386.88, SD = 4830.740). Of the 120 subway stations, 68.3 per cent had a bus station (No = 0; Yes = 1). Of the 120 subway stations, 21.7 per cent had a park-n-ride lot (No = 0; Yes = 1).

Results

Since this study involves count data, negative binomial regression was used (Hilbe, 2011). Thirty stations have zero thefts during the study period. Furthermore, as the variance of the dependent variable (251.57) is larger than the mean (9.69), overdispersion exists, and thus negative binomial regression was deemed appropriate, and the results of this are displayed in Table 3.1. The model is significant ($p < .01$), meaning that, when taken together, all of the predictors positively influence electronic device theft in subways. The independent variables explain 11.1 per cent of the variance of electronic device theft. An explanation here is that a number of subway characteristics and predictor variables are not included in the model. Additionally, all of the model predictors are significant, as indicated by the incidence rate

Table 3.1 Descriptives for precinct crime rates and subway station characteristics

	Variable	Description	Minimum	Maximum	Mean	SD
Precinct crime rates						
Boston PD, 2007	Property crime	Total number of property crimes	238.00	4950.00	2310.60	1294.917
	Larceny	Total number of larcenies	172.00	4009.00	1729.69	1075.657
	Robbery	Total number of robberies	6.00	436.00	160.62	129.621
Subway station characteristics						
MBTA, 2007	Ridership	Avg. number of weekday riders	48.00	23500.00	4386.88	4830.740
	Bus	Bus connection	(no=0)	(yes=1)	–	–
	Parking	Park-n-Ride lot	(no=0)	(yes=1)	–	–

ratios. The incident rate ratios (IRR) are obtained by exponentiating the regression coefficients. This determines the percentage change in the risk of electronic device theft for each unit increase in the independent variable. When an independent variable has an IRR value that is greater than 1, there is a positive change in the dependent variable. Conversely, when an independent variable has an IRR values that is less than 1, there is a negative change in the dependent variable.

District crime statistics

As shown in Table 3.2, for every additional property crime at the surface level, electric device theft in that district's subway station(s) increases by .0016. For every additional robbery above ground, electronic device theft increases .0040. Larceny is the only variable in the model with an IRR value that is less than 0, indicating that the number of larcenies at the surface level do not increase the number of electronic device theft at subway stations. Instead, for every additional larceny above ground, electronic device theft decreases by .0023. This could be because subway riders take more precautions with their electronic devices in known high-larceny districts

Subway station characteristics

On average, electronic device theft increases by .0001 for every additional subway rider at a subway station; 1.0893 when there is a bus connection at a station; and .9259 when there is a park-n-ride lot at a station. Ridership was significant at the 0.01 level, and while it is expected that this would be a strong predictor of electronic device theft, an examination of stations with the highest number of electronic device thefts found they do not all

Table 3.2 Negative binomial regression for electronic device thefts at MBTA subway stations, 2003–2011 (n = 120)

Variable	**B**	**(SE)**	**IRR**	**Z**
Precinct crime rates				
Property crime	0.0016	(0.0007)	1.0016*	2.18
Larceny	– 0.0022	(0.0079)	0.9977*	–2.88
Robbery	0.0040	(0.0017)	1.0040*	2.33
Subway station characteristics				
Ridership	0.0001	(0.00003)	1.0001**	5.60
Bus (no = 0; yes = 1)	0.7371	(0.2858)	2.0893*	2.58
Parking (no = 0; yes = 1)	0.6554	(0.2997)	1.9259*	2.19

Notes: *$P < 0.05$; **$P < 0.01$.
Psuedo R^2 = .1117 Log likelihood = –329.94494.
Likelihood ratio chi-square = 82.95.
Cronbach's α = 0.38.

have high ridership rates. In fact, many are substantially lower. There may be other subway station characteristics at these stations that facilitate electronic device theft, and future research is required to explore this further.

Conclusion

To summarize, electronic device theft is more likely at stations with a higher number of property crimes and robberies at the surface level, high weekday ridership, and the presence of bus connections and park-n-ride lots. These findings suggest that subway station characteristics may help transit police understand why certain subway stations serve as activity spaces for electronic device theft. It is also important for transit police to work with the city's police department to address district crime rates at the surface level, which also seem to influence whether or not subway stations in given districts experience electronic device theft. There are a number of limitations to this study that should also be considered. Using police districts as a unit of analysis may be problematic if most of the surface-level crimes do not actually occur near subway stations. Additionally, there are often multiple subway stations within a police district. Another limitation can be the presence of multicollinearity since the property crimes variable consists of both robberies and larcenies, two other model variables. Finally, electronic devices have evolved from the beginning and end of the study period to become even more CRAVE-able items. This should be considered when studying this topic.

Given that electronic device theft has increased in recent years and that cell phone and WiFi service has been added to subway stations and cars, it is recommended that the MBTA Transit Police develop theft prevention strategies in Boston subways. If not, the MBTA subway system may become a risky facility, with specific train stations or lines becoming havens for repeat offending and repeat victimization. The ignoring of such an important issue could also expose a leaky system within the MBTA, Boston Police Department or other government agencies. These institutions should come together and encourage corporate social responsibility of cell phone manufacturers, which would help harden vulnerable targets. This, along with community awareness, may also ease the fear of victimization for underground transit passengers in Boston.

This study contributes to the body of literature on crime and public transportation. The major impact of studying electronic device theft within the MBTA subway system is that transit police will be better able to identify problem stations, lines and locations. By addressing this issue, the problem-oriented policing approach will be used. This strategy applies problem-solving methods through scanning, analysis, response and assessment – with the goal being long-term crime prevention. This will be beneficial for law enforcement agencies in various countries that are experiencing this crime trend.

Prevention of electronic device theft can also lead to a diffusion of benefits that prevents, decreases or blocks other crimes, such as identity theft, the illegal selling of stolen electronic devices, assault within the subway system and crimes against transit employees. Also, riders will have a better sense of how and where to protect themselves against electronic device theft. Future studies should expand on the research presented here, with specific details as to where electronic device thefts occur on moving subway cars and the addition of more subway characteristics. It will also be beneficial to standardize ridership as a variable and explore other units of analysis, as well as highlight stations within certain socioeconomic regions and near schools, colleges, shopping centres and other criminogenic establishments. By doing so, more can be learned about how electronic device theft within subway systems contributes to the journey to crime and victimization.

Acknowledgements

I thank Chief Paul MacMillan and the MBTA Transit Police for providing the data. I also thank Dr Michael Maxfield for his guidance in preparing this chapter. This research would not be possible without the additional assistance of Manny DeSousa, Anand Kolipakkam and Athena Yerganian.

Note

1. Adapted from Transit Security: A Description of Problems and Countermeasures (1997) by US Department of Transportation – Federal Transit Administration and Secure and Tranquil Travel: Preventing Crime and Disorder on Public Transport (2006) by M. Smith and D. Cornish (eds).

References

Allison, S., Schuck, A. and Lersch, K. (2005) Exploring the Crime of Identity Theft: Prevalence, Clearance Rates, and Victim/Offender Characteristics. *Journal of Criminal Justice, 33*, 19–29.

American Public Transportation Association (2012) *2012 Pubic Transportation Fact Book* http://www.apta.com/resources/statistics/.

Belanger, M. (1999) *Crime Mobility and Public Transport: The Case of the New York City Subway*. Unpublished Doctoral Dissertation, Rutgers University, Newark, NJ.

Block, R.L. and Davis, S. (1996) The Environs of Rapid Transit Stations: A Focus for Street Crime or Just Another Risky Place? In Clarke, R.V. (ed.) *Crime Prevention Studies: Preventing Mass Transit Crime,* vol. 6, Monsey, NY: Criminal Justice Press, 237–257.

Brantingham, P.L. and Brantingham, P.J. (1981) Notes on the Geometry of Crime. In Brantingham, P. and Brantingham, P. (eds) *Environmental Criminology*. Beverly Hills, CA: Sage, 27–54.

Burrows, J. (1980) Closed-Circuit Television and Crime on the London Underground. In: Clarke, R. and Mayhew, P. (eds) *Designing Out Crime*: London: HMSO, 75–83.

Campbell, M. (2011) Parisians Told to Hold iPhones Tight after Thefts on Subways. *Bloomberg*, 11 January. http://www.bloomberg.com/news/2011–01–11/.

Chaiken, J., Lawless, M. and Stevenson, K. (1974) The Impact of Police Activity on Subway Crime. *Journal of Urban Analysis 3*, 173–205.

Clarke, R. (1999) Hot Products: Understanding, Anticipating and Reducing Demand for Stolen Goods. *Police Research Series Paper 112*: London, UK: Home Office Research, Development and Statistics Directorate.

Clarke, R., and Newman, G. (2005a) Modifying Criminogenic Products: What Role for Government? In Clarke, R. (ed.) *Crime Prevention Studies: Designing Out Crime from Products and Systems,* vol. 18, Monsey, NY: Criminal Justice Press, 7–83.

Clarke, R., and Newman, G. (2005b) Secured by Design: A Plan for Security Coding of Electronic Products. In Clarke, R. (ed.) *Crime Prevention Studies: Designing Out Crime from Products and Systems,* vol. 18, Monsey, NY: Criminal Justice Press, 203–230.

Clarke, R., Belanger, M. and Eastman, J. (1996) Where Angels Fear to Tread: A Test in the New York City Subway of the Robbery/Density Hypothesis. In Clarke, R. (ed.) *Crime Prevention Studies: Preventing Mass Transit Crime,* vol. 6, Monsey, NY: Criminal Justice Press, 217–235.

Clarke, R., Kemper, R. and Wyckoff, L. (2001) Controlling Cell Phone Fraud in the U.S.: Lessons for the UK 'Foresight' Prevention Initiative, *Security Journal 14*, 7–22.

Cohen, L., and Felson, M. (1979) Social Change and Crime Rate Trends: A Routine Activity Approach: *American Sociological Review 44*, 588–608.

Cornish, D. (1994) The Procedural Analysis of Offending and Its Relevance for Situational Prevention. In Clarke, R. (ed.) *Crime Prevention Studies,* vol. 3, Monsey, NY: Criminal Justice Press, 151–196.

Cornish, D. and Clarke, R.V. (eds.) (1986) *The Reasoning Criminal: Rational Choice Perspectives on Offending*. New York, NY: Springer-Verlag.

DeGeneste, H., and Sullivan, J.P. (1994) *Policing Transportation Facilities*, Springfield, IL: Charles C. Thomas.

Del Castillo, V. (1992) *Fear of Crime in the New York City Subway*. Unpublished Doctoral Dissertation, Fordham University, New York, NY.

Eck, J. (1994) *Drug Markets and Drug Places: A Case-Control Study of the Spatial Structure of Illicit Drug Dealing*. Unpublished Doctoral Dissertation, University of Maryland, Ann Arbor, MI.

Ekblom, P. (2008) Designing Products against Crime. In Wortley, R. and Mazerolle, L. (eds) *Environmental Criminology and Crime Analysis*, Cullompton, UK: Willan, 195–220.

Falanga, M. (1988) *Reducing Crime through Design in the Chicago Subway System*. Unpublished Doctoral Dissertation, University of Michigan, Ann Arbor, MI.

Gerard, G., Hillison, W. and Pacini, C. (2004) Identity Theft: The US Legal Environment and Organizations' Related Responsibilities. *Journal of Financial Crime, 12*, 33–43.

Harrington, V., and Mayhew, P. (2001) *Mobile Phone Theft*. Home Office Research Study 235: London, UK: Home Office.

Hilbe, J. (2008) *Negative Binomial Regression*. New York, NY: Cambridge University Press.

Hoel, L. A. (1992) Public Transportation Security. In Gray, G.E. and Hoel, L.A. (eds) Public Transportation, 2nd ed. Englewood Cliffs, NJ, Prentice Hall, 509–524.

Ketola, H., and Chia, D. (2000) *Developing Useful Transit-Related Crime and Incident Data*. Transit Cooperative Research Program, Project F-6A: Washington, D.C.: National Research Council.

Kock, R. (1999) *80–20 Principle: The Secret to Success by Achieving More with Less*. New York, NY: Doubleday.

La Vigne, N. (1996a) *Crime Prevention through the Design and Management of the Built Environment: The Case of the DC Metro*. Unpublished Doctoral Dissertation, Rutgers University, Newark, NJ.

La Vigne, N. (1996b) Safe Transport: Security by Design on the Washington Metro. In Clarke, R. (ed.) *Crime Prevention Studies: Preventing Mass Transit Crime,* vol. 6, Monsey, NY: Criminal Justice Press, 163–198.

Lohr, S. (2009) Smartphone Rises Fast from Gadget to Necessity. *New York Times*, 10 June, pB1.

Loukaitou-Sideris, A., Liggett, R. and Iseki, H. (2002) The Geography of Transit Crime: Documentation and Evaluation of Crime Incidence on and Around the Green Line Stations in Los Angeles. *Journal of Planning Education and Research*, *22*, 135–151.

Lynch, J. (2005) Identity Theft in Cyberspace: Crime Control Methods and Their Effectiveness in Combating Phishing Attacks. *Berkeley Technology Law Journal*, 259, http://scholarship.law.berkeley.edu/btlj/vol20/iss1/28.

Massachusetts Bay Transportation Authority (2009) *Ridership and Service Statistics, Blue Book*, http://www.mbta.com/about_the_mbta/document_library.

Minjie, Z. (2011) Thieves Target Metro Phones. *Shanghai Daily*, 9 November, A4.

Morgan, R., and Smith, M.J. (2006) Crime Against Passengers – Theft, Robbery, Assault and Indecent Assault. In Smith, M. and Cornish, D. (eds) *Secure and Tranquil Travel: Preventing Crime and Disorder on Public Transport,* London, UK: UCL Jill Dando Institute of Crime Science, 77–102.

National Mobile Phone Crime Unit. (2009) *What We Do*. http://www.met.police.uk/mobilephone.

Newton, A.D. (2004) Crime on Public Transport: 'Static' and 'Non-static' (Moving) Crime Events. *Western Criminology Review, 5*, 25–42.

Noel, J., and Prokupecz, S. (2012) Man, 81, Chases iPhone Thief, Gets Pushed onto Subway Tracks by 2nd Suspect, *NBC 4 New York*, 9 April, http://www. nbcnewyork. com /news/local/.

Parascandola, R. (2011) NYPD: Thefts of Smartphones and iPads Now More Prevalent Than Cash as Criminals Turn Focus on Electronics. *New York Daily News*, 6 December, http://www.nydailynews.com/new-york/.

Pearlstein, A., and Wachs, M. (1982) Crime in Public Transit Systems: An Environmental Design Perspective, *Transportation, 11*, 277–297.

Pew Internet and American Life Project (2012) Device Ownership, Trend Data (Adults), http://www.pewinternet.org/trend-data-(adults)/device-ownership.aspx

Phillips, P.D. (1980) Characteristics and Topology of the Journey to Crime. In Georges-Abeyie, D. and Harries, K. (eds) *Crime: A Spatial Perspective*, New York, NY: Columbia University Press, 169–180.

Pires, S.F. (2012) Parrot Poaching in the Neo-Tropics: A Literature Review, *Global Crime*, *13*, 176–190.

Richards, L., and Hoel, L. (1980) *Planning Procedures for Improving Transit Station Security.* (No. DOTOS-50233), Washington, DC: US Department of Transportation.

Rocheleau, M. (2011) MBTA Reports Rise in Crimes. *Boston Globe*, 5 February, pB1.

Roman, J., and Chalfin, A. (2007) *Is There an iCrime Wave?* Washington, DC: Urban Institute.

Seelye, K.Q. (2010) As Cellular Service Expands in Subways, Thefts Rise. *New York Times*, 17 April, pA11.

Shellow, R., Bartel, E.W. and Romualdi, J. (1975) *Security of Patrons on Urban Transportation Systems*. Transportation Research Institute Report No. 6. Pittsburgh: Carnegie-Mellon University.

Smith, G. (2013a) Apple Picking: How the iPhone Became an Object Worth Killing For. *Huffington Post*, 7 March, http://www.huffingtonpost.com/2013/03/06/apple-picking-stolen-iphones_n_2818488.html.

Smith, G. (2013b) Apple, Samsung Anti-Theft Features Tested in Smartphone Crime Probe. *Huffington Post*, 18 July, http://www.huffingtonpost.com/2013/07/18/apple-samsung-antitheft-features-tested_n_3613415.html.

Smith, J. (2003) *The Nature of Personal Robbery*, Home Office Research Study 254. London, UK: Home Office, Development and Statistics Directorate.

Smith, M. (1986) *Transit Crime Study. Volume II: Final Report*. New York, NY: New York City Criminal Justice Agency.

Smith, M., and Clarke, R. (2000) Crime and Public Transport. *Crime and Justice – A Review of Research,* 27, 169–233.

Smith, O. (2013c) Man Held after Woman Thrown onto Subway Tracks in Philadelphia. *CNN*, 18 January, http://www.cnn.com/2013/01/18/us/philadelphia-subway-attack.

US Census Bureau. (2008) American Community Survey [Data file], http://www.census.gov/ac.

US Department of Transportation – Federal Transit Administration. (1997) Transit Security: A Description of Problems and Countermeasures, http://www.fta.dot.gov /documents /TS_Problem_Coutnermeasures.pdf.

US Federal Communications Commission. (2012) Announcement of New Initiatives to Combat Smartphone and Data Theft, http://www.fcc.gov/document/announcement-new-initiatives-combat-smartphone-and-data-theft.

Wall, D. (2003) *Crime and the Internet,* New York, NY: Routledge.

Webb, B., and Laycock, G. (1992) *Reducing Crime on the London Underground*. Crime Prevention Unit Paper, #30. London, UK: Home Office.

Yu, S.V. (2009) *Bus stops and crime: Do bus stops increase crime opportunities in local neighborhoods?* Doctoral dissertation, Rutgers University, Newark, NJ.

4

An Assessment of Guardianship Opportunities as Provided by the Environments of Transit Stations

Adriaan Cornelis Uittenbogaard

Introduction

The international literature is rich with examples of how guardianship affects crime and safety (Hollis-Peel et al., 2011, provide an extensive review; see also e.g. Painter and Tilley, 1999, on surveillance in public space; Reynald, 2011b, on property crime in neighbourhoods; and Pennell et al., 1985, on types of guardianship). In transport nodes, such as bus stops or underground stations, the potential of exercising guardianship has also shown to impact crime and perceived safety (e.g. Cozens et al., 2003; Loukaitou-Sideris, 1999; Loukaitou-Sideris et al., 2002; Smith and Clarke, 2000; Block and Davis, 1996).

Gentry described in the previous chapter how theft of electronic devices has increased in transit environments, pointing out that passengers now seem more distracted and 'zoned out', not realizing what happens around them. Electronic devices may reduce opportunities for guardianship and decrease safety levels. Gentry's brief findings on ridership (possible targets), although not clearly pronounced, may indicate effects of guardianship opportunities, which will be explained further in this chapter. In the following chapter, Ceccato, Cats and Wang will relate crowding to opportunities for controlling pickpocketing at bus stops. The social and physical environment at transit nodes can provide both positive and negative impacts on guardianship opportunities depending on the type of micro-environment examined, such as platforms or exits.

Ceccato et al. (2013) showed that in Stockholm, possibilities for surveillance and visibility, in other words, opportunities for guardianship, explain a large portion of the variation in crime rates. Whilst their study showed how the environment relates to crime opportunities at underground stations, it did not show how guardianship opportunities are affected by the station's environment. Thus, a number of questions about the role of the environment in promoting opportunities for guardianship still remain.

Guardianship was originally defined as a crucial part of routine activity theory (Cohen and Felson, 1979) and includes any person or object that is able to supervise or simply watch other people or objects at any given point in time and at any place, which may force offenders to refrain from committing a crime (Felson and Cohen, 1980). From a victimization perspective, guardianship may create a 'layer of protection' for individuals and targets in which a particular setting may form that would not occur otherwise, possibly deflecting the offender.

This chapter assesses whether the micro-environment within and around transport stations contributes to creating or diminishing guardianship opportunities. The micro-environments assessed here are the different sections of underground stations as well as the immediate surroundings. Guardianship opportunities may increase safety in a place, but are defined by the physical design and social aspects of those micro-environments at transportation nodes.

The objective of this chapter is to assess the opportunities for guardianship as provided by the characteristics of the environment at underground stations. In this study, micro-scale environmental attributes, such as overviews (layout), blocked sightlines (obstacles), out-of-sight places (corners), surveillance tools (closed-circuit television [CCTV] cameras), illumination and potential guardians (security guards, passengers), are assessed by their potential to promote guardianship, that is, to make it easier for individuals to watch, supervise and intervene if anything happens. This study contributes to the current field of research by advancing the knowledge of crime prevention and the importance of guardianship at public transportation nodes. The study uses the Stockholm underground system as a case study as it constitutes an interesting addition to current research, most of which is based on cities in North America and the United Kingdom.

The chapter has the following structure. A description is provided of the background theories informing the study, after which the aims and hypotheses are presented. Then, the case study and data are described, followed by the methodology and the results of the analyses. The chapter rounds off with a discussion of the results, together with conclusions and suggestions on the topic of guardianship opportunities at transport nodes.

Theory on guardianship

This section reviews earlier studies on the concept of guardianship in public places, the environment at public transport nodes and the relationship between crime occurrence and urban design.

Guardians and guardianship

The concept of guardianship has been around for some time, possibly under different denominations. *Social disorganization theory*, for instance, calls it 'social control' (Shaw and McKay, 1942); *routine activity theory* suggests 'suitable guardians' as a key component for safety (Cohen and Felson, 1979); Jacobs (1961) expressed it as 'eyes on the street'; and there are certainly other references to be found in the literature. Whilst these concepts are not completely equivalent to the term 'guardianship', in that they may all serve different aims and explanations, they all, nevertheless, like guardianship, link to a similar, more general topic: *control*. Social disorganization theory advocates that decreases in crime levels can be achieved by means of local social ties, which link to creating guidance and acceptance for informal rules within communities, which then control the acts of crime internally (Shaw and McKay, 1942). Routine activity theory regards opportunities for crime as being defined by the amount of control which is exercised over a place, stating that crime decreases if more formal (as well as informal) control is exercised by guardians (Cohen and Felson, 1979). Another example of control is Jacob's 'eyes on the street', that is, the informal watchmen who keep an eye on what is happening and act as guardians of the place with a 'controlling view' and take responsibility, which may result in lower crime levels (Jacobs, 1961).

The concept of guardianship has since been refined and made operational so as to be more easily integrated into crime prevention schemes (e.g. Clarke, 1995). Recent theories of guardianship include 'handlers' (who look over the offender), 'place managers' (who control the place) and 'supervisors' (who look over the target) (Eck, 1994; Reynald, 2011a; Hollis-Peel et al., 2011). Guardianship can take many forms and can be performed by different types of persons or facilitated by objects. Guardians are those persons who can execute the role of guardianship (Reynald, 2011a). Even when an individual does not intend to play a guarding role, such a role can be performed, for instance, through the mere presence of that person (Hollis-Peel et al., 2011). Further, guardianship may also be the capacity and the willingness to monitor (Reynald, 2011a), including knowledge of and familiarity with the environment, and issues of responsibility in relation to that environment. Persons may feel more willing to intervene if they feel responsible for the space, if they are familiar with the place and/or person and if the environment makes intervention easy. Moreover, their willingness also depends on self-risk assessments and confidence: in order to intervene after the detection of criminal behaviour, one's own safety risks have to be considered low, which depends on training, the seriousness of the crime, physical abilities and so forth (Reynald, 2011a).

This chapter does not intend to address either the capacity of guardians or levels of guardianship; rather, it focuses on the environment's role in promoting guardianship. Reynald (2011a) points out the importance of (natural) surveillance as part of defensible space principles in residential areas, which provides possibilities for seeing what is happening outside. Visibility is closely related to this as it defines the extent to which a guardian can survey a place (Reynald, 2011a). However, visibility also defines the extent to which the guardian is visible. If visibility is poor, the offender will not notice the guardian and be discouraged from committing the crime (Reynald, 2011a). Moreover, if surveillance opportunities are good, this may increase the potential guardian's feeling of responsibility and willingness to act (Reynald, 2011a).

In the literature on guardianship and urban crime, the focus has mainly been on levels of active guardianship and guardianship opportunities within residential areas. Recent research in the Netherlands has assessed the capabilities and the role of residents in guarding against property crimes (Reynald, 2011b). In a study, Reynald (2011b) found that property crime decreases in street segments in which the intensity of possible, active guardianship is higher. The intensity of guardianship in residential areas was influenced by the area's physical attributes of the street environment, particularly accessibility and surveillance possibilities, its socio-economic status and its location (Reynald and Elffers, 2009). There remains however a need to extend the understanding of guardianship in other settings, such as at transportation nodes.

Guardianship at transportation nodes

Few studies have looked into guardianship possibilities in public spaces, such as underground stations. Security guards and police usually see to the safety of a public place. However, the major difference between public spaces and (semi-) private places (like neighbourhoods) is that people generally feel less committed to guarding a public place (Hollis-Peel et al., 2011; Hope, 1999). There is a difference in the roles of different actors that exercise guardianship in a public place (Eck, 1994). Handlers, place managers and supervisors control different levels of the environment (from the place to the individual) through different types of control (from active to passive control) (Eck, 1994). Active formal control may thus be viewed as having the primary responsibility for the place, yet other actors play an equally important role in supervising a place. The general public can play a larger role in securing a public place even when official security guards are not present. At transportation nodes, the dynamics of different actors are strongly related to their actions and responsibilities towards crime prevention; however, these roles and responsibilities are often ill-defined in the areas (public spaces) surrounding transport nodes (Ceccato, 2013). Compared to residential areas, public transport nodes may be located in a complex mixture of land uses, which may affect guardianship opportunities (Reynald and Elffers, 2009; Reynald, 2011a).

Transport nodes present dynamic places that concentrate a variety of different people, of whom some are potential victims and others motivated offenders, whilst others may act as guardians – passengers, shop owners, employees, drivers, tourists, residents, guards and so forth. There is a mix of handlers, managers, supervisors and passers-by, creating a large potential for guardianship by formal and informal means (Figure 4.1).

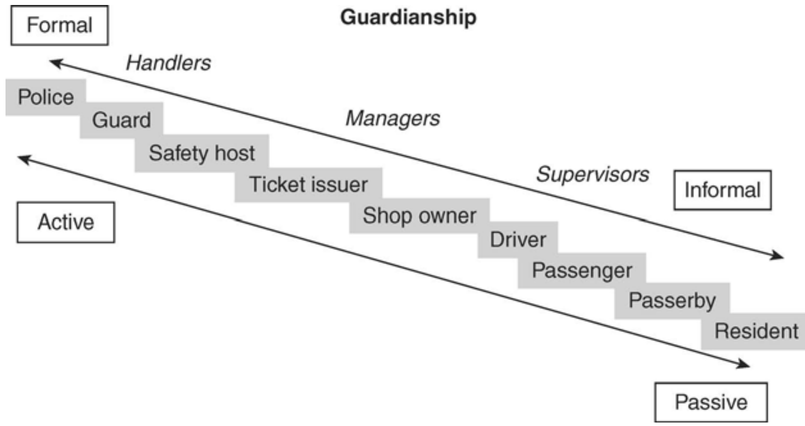


Figure 4.1 Forms of potential guardianship at underground stations by key actors

Moreover, transport nodes are often places with a complex layout over several levels, with tunnels or with multiple entrances, which affects the possibility of guardianship. Opportunities for guardianship are conveyed through the environment and the opportunities that it provides (Reynald and Elffers, 2009). As in Newman's (1972) *defensible space theory*, places can be planned, adjusted and improved in such a way as to optimize control and decrease opportunities for crime. Newman (1972) suggested that visibility can be enhanced to create direct and indirect social control, and that open layouts provide opportunities for the control and surveillance of a place. Underground stations often have varying layouts which provide different opportunities for guardianship. These opportunities can be poor when the layout of a station includes many corners, blocking walls and obstacles.

Potential guardians rely on the environmental state to provide them with good opportunities for guardianship. One aspect of guardianship, visibility, is strongly related to the physical environment, while the other aspect of guardianship, surveillance, depends both on the physical environment and the social environment. Both may be perceived differently by different types of guardians.

Visibility

This study approaches 'visibility' as the possibilities a person has for observing other others, others' belongings and objects elsewhere. The environment may determine the possibilities for visibility in such a way that sightlines, overviews, transparent screens and so forth will increase the opportunities for someone to be able to detect and notice other persons in the vicinity (Figure 4.2a). However, if many objects are in the way and

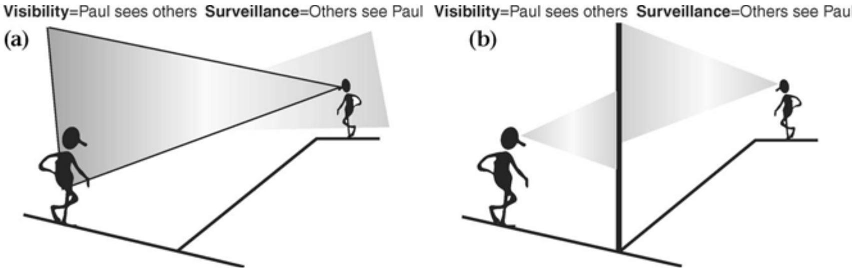


Figure 4.2 (a) The environment promotes surveillance and visibility opportunities; (b) The environment restricts possibilities for surveillance and visibility

block the view, for example, many pillars, the possibilities for visibility may decrease drastically because it will be more difficult for a person to notice other persons or objects (Figure 4.2b).

Visibility possibilities may also relate to the use of certain security tools. For instance, well-placed mirrors can increase visibility by providing the possibility for seeing what is around the corner. However, the effectiveness of such tools can be compromised by, for instance, the presence of many people in a section of the station. In a crowded place, visibility may be poor; one may not be able to distinguish between different people at the same time despite available security tools.

Surveillance

'Surveillance', in contrast, relates to the possibilities for others to observe a person, object or place. Surveillance possibilities may increase when a section is free of obstacles or pillars and provides a good overview because that makes a person visible (Figure 4.2a). However, if corners exist and the section consists of several levels, others will be less likely to notice a person and/or detect abnormal behaviour (Figure 4.2b).

Surveillance can be increased in areas by installing tools for guardianship such as CCTV cameras. CCTV may be able to see a person when other persons in the same place cannot. While crowdedness can provide good possibilities for surveillance, as many possible guardians are present, it may also lower the opportunity for surveillance via CCTV, as it may decrease the overview.

Hypotheses of the study

The analysis of this chapter is based on a conceptual model with the understanding that safe underground stations (low crime) present good guardianship opportunities, and vice versa, which consist of one's capacity to

exercise informal and formal control, which in turn is influenced by the environment. This study examines the opportunities for guardianship and the environment at transportation nodes as follows:
Hypothesis 1 – The potential for guardianship is affected by different environmental attributes at underground stations. Stations that exhibit poor layout (e.g. closed spaces, poor sightlines/overviews) and crime-prone features (e.g. hiding places, dark corners) provide fewer possibilities for surveillance and visibility.

Hypothesis 2 – Environmental attributes affect guardianship opportunities differently in different places. For instance, corners may have a strong impact on guardianship opportunities in exit areas, while not at platforms. In contrast, crowdedness may be an important factor at platforms, while not in exit areas.

Hypotheses 3 – Guardianship opportunities are a function of the conditions in which the stations are embedded. The environment of surrounding neighbourhoods plays a role in determining guardianship opportunities at stations: neighbourhoods with high population density, a busy square, housing and walking and bike lanes can positively affect the potential for guardianship. Aboveground stations are potentially much more exposed to surrounding surveillance opportunities than belowground stations, thereby presenting better guardianship opportunities.

The case study

The study area is composed of underground stations in Stockholm municipality. The municipality has a population of around 900,000 inhabitants (Stockholm Stad, 2013). The city consists of several islands with an integrated public transport system, including underground, trams, commuter trains and buses, which provide inhabitants with effective city-wide communication reaching to adjacent municipalities.

The underground system (Figure 4.3) has 100 stations distributed over three lines (green, red and blue) that in total transport around 1.2 million passengers per day. The main node in the system is Central Station (T-Centralen), which receives around 236,000 passengers daily and is located in the Central Business District (CBD) (Stockholm Public Transportation SL, 2012). Due to the lack of background data from surrounding municipalities, the study area is composed of the underground stations within Stockholm's boundary (Figure 4.3), which covers 82 per cent of all stations.

Data

During the fieldwork performed in 2010, two researchers visited all the underground stations in order to 'inspect' the stations' environments. The time spent at each station varied between 40 minutes and one hour.

Figure 4.3 The study area and underground system with stations

The first fieldwork round was executed during the summer; stations were visited between 10am and 4pm in order to avoid rush hours and get a 'clean' observation of a 'normal' day. Scaled-down revisits during the winter in the afternoon/evenings (4pm to midnight) showed the impact of the colder and darker season on the environment. During the visits, researchers checked for a list of possible environmental attributes, such as corners, cameras, illumination and so forth (based on previous studies, literature and theories), and afterwards these results were combined into a comprehensive database covering the environmental attributes, socio-economic aspects, and crime and disorder levels at all stations.

The environmental attributes were inventoried using 'yes/no' or 'high/medium/low' scales, providing a measure of the (level of) presence of each attribute (Table 4.1). During visits, variables reflecting the immediate surroundings of the underground stations were assessed within a radius of about 25 meters from the exits of the stations, representing the field of view. These variables cover the land use of, the activities occurring in and the layout of the surrounding space. For a more detailed description of the fieldwork and database, see Ceccato et al. (2013).

Table 4.1 Environmental attributes inspected at stations

	Attribute (abr)	Control model	Scale	Description of variable
Dependent variables	Surveillance (Sur)	–	h/m/l	The possibility to be seen by others. High, with a clean view and everybody would be able see the observer. Low, when few to nobody would be able to see the observer
	Visibility (Vis)	–	h/m/l	The possibility to see others. High, when observer was able see everybody. Low, when the observer was able to only notice a few people or nobody
Independent variables	Crowdedness (crow)	yes	h/m/l	Section was crowded or not; basically up to 10 people was assessed as low, high was 30+ people
	Illumination (illu)	no	y/n	Section well enough illuminated so that the whole place was lighted up
	Dark corners (corn)	no	y/n	Dark corners present in the section
	Hiding spots (hide)	no	y/n	Hiding spots present in the section
	Object blocking the view (blok)	no	y/n	Objects were obstructing a clean view of the section
	Overview (view)	no	y/n	Section provided a clear, good overview
	Security guards (guar)	yes	y/n	Security guards present at the section
	CCTV visible (secu)	yes	y/n	CCTV cameras positioned in a way that they were easily visible and recognizable in the section
	Mirrors (mirr)	yes	y/n	Mirrors located in the section
	Open layout (open)	no	y/n	Section had an open layout with easy view to all sides
	Shop/Café (shop/café)	yes	y/n	A shop located in the section (mainly in the lounge and exit/ entrance areas)
	Windows (wind)	yes	y/n	See-through windows located in the section
	Underground (under)	yes	y/n	Section located subterranean
	Long walking distance (walk)	yes	y/n	A long way to walk between sections
	Levels (lvl)	yes	y/n	Section consisted of several levels
	Number of CCTVs (CCTVno)	yes	count	Number of CCTVs in place at the station, SL data
	Passenger flow (Pax)	yes	count	Number of passengers going in and out of the station per day, SL data

Method

Logistic regression models were used for the analysis (Appendix 4A). Surveillance and visibility were set as dependent variables (guardianship), while environmental attributes were the independent variables (Table 4.1): overview, open area, dark corners, blocking objects, hiding places, windows, subterranean location, crowdedness, presence of guards, illumination, presence of CCTV cameras, mirrors, shops, cafés, passenger flows consisting of several floors/levels, long walking distance from the entrance to the lounge area, and to the surrounding residential area, public square, biking and walking paths, and taxi stands (Appendix 4A).

The two dependent variables were assessed through researchers' observations of the visibility and surveillance possibilities at the station (Table 4.1). This type of assessment opens up for causal loops between the dependent and independent variables (endogeneity). In order to control for this potential problem, a 'control model' was tested (Appendix 4B). This control model uses the same structure and steps as the original model illustrated in Figure 4.5, but excludes potential endogenous variables which relate to the layout of the sections (illumination, corners, hiding places, overview, open layout and obstructions).

This analysis is based on a model with continuous and ordinal data (Table 4.1 and Appendix 4A), suggesting the use of logistic regression, which, unlike OLS regression, can handle variables of different natures (Burns and Burns, 2009). The dependent variables were assessed as a three-level rating scale during the fieldwork. Although argued to be ordinal by some, rating scales can also be approximated as intervals (Norman, 2010). An interval approximation makes it possible to classify them as binary, which is required for dependent variables in logistic regression. The reclassification of both 'surveillance' and 'visibility' variables was based on the mean, where 0 (below mean) and 1 (above mean) represent low/poor and high/good opportunities for guardianship, respectively. A low level of opportunity means a poor possibility to see or be seen by others, and a high level of opportunity provides a good chance to be seen or see others (Figure 4.4).

The modelling follows several steps, as shown in Figure 4.5. First, each section of the station was assessed separately (see 'Model 1' in Figure 4.5): platform, transition, lounge, exits/entrances. For each section, the dependent variables ('Sur' and 'Vis') are associated with the attributes of that section only. For example, 'PSur' and 'PVis' are associated with attributes of the platform (P) (Appendix 4A). The significant attributes from each individual section provided the basis to analyse the total station (Step 2 in Figure 4.5). For the entire station, 'guardianship opportunities' are constructed using the mean of all the individual sections of a station (for example the sum of surveillance in each section divided by four equals the average. surveillance); in this method the mean is also used for the entire station, to classify

(a) (b)

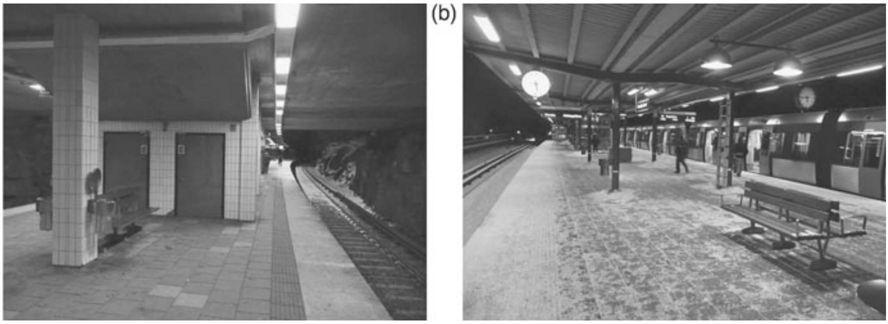


Figure 4.4 (a) Example showing poor possibilities for surveillance/visibility at Blackeberg station; (b) Example showing good possibilities for surveillance/visibility at Hässelby Strand station

the binary dependent variables: 'average surveillance' and 'average visibility'. Independent variables were not averaged because then it would only be possible to draw general conclusions for the whole station.

The second set of models assesses the impact of the immediate surroundings and characteristics of the neighbourhood on guardianship (Appendix 4A). The final step ('Step 4' in Figure 4.5) includes the significant attributes of Model 1 ('Step 2' in Figure 5) and significant attributes of the neighbourhood ('Step 3' in Figure 4.5). As further analysed by Newton, Partridge and Gill later in this volume, crime risks and guardianship at stations are related to surrounding environmental aspects. The surrounding environmental attributes may be particularly important for open stations, which can be viewed and 'controlled' from outside. Because the Stockholm system includes stations located aboveground and those which are subterranean, a selective model using only stations with aboveground platforms was tested in order to assess the potential difference between stations above and below ground.

Before running the models, all independent variables were checked for correlations. One of each of the highly correlated variable pairs (Pearson value > 0.6) was eliminated beforehand. For instance, the stations' 'open layout' is correlated with the 'view from outside' (0.733). The dependent variables were also subject to a correlation analysis, but did not show any statistically significant (Pearson value > 0.6) correlation.

Results

Findings show that around 50 per cent of the variation in guardianship opportunities (as indicated by Nagelkerke R-square 'NR^2' in the models) is explained by aspects related to the stations' overviews and sightlines (Table 4.2). The most significant attributes in Table 4.2, Model 1, illustrate that opportunities for guardianship improve as surveillance opportunities

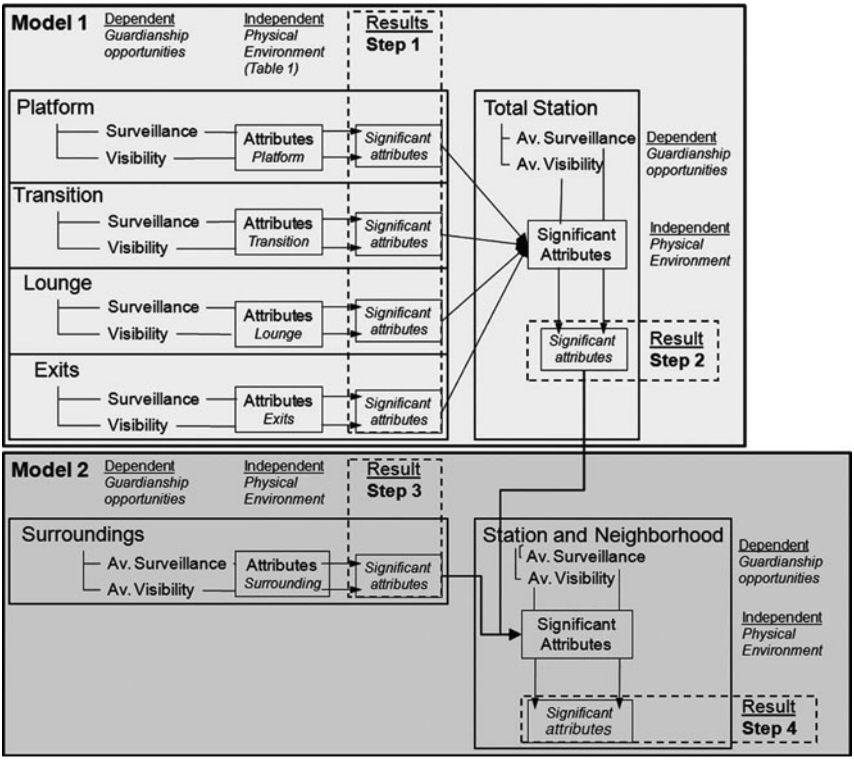


Figure 4.5 Stepwise regression modelling; presenting results for separate parts of the stations (Step 1), total station (Step 2), stations surroundings (Step 3) and overall assessment (Step 4)

improve, for example, in open lounge areas, transition areas and exits with few corners. A good overview of the exit areas also provides better opportunities for guardianship. A less crowded platform and fewer hiding corners in the lounge area increase guardianship opportunities because, as expected, visibility is better. Unexpectedly, stations that have many CCTV cameras installed exhibit a negative relationship to environments that provide good opportunities for guardianship.

There was a suspicion that some covariates, for example, overview and layout, 'were contained' within the dependent variables (visibility and surveillance). When controlling for endogeneity (Appendix 4B), results were similar to the original models' results, but the 'number of CCTV cameras' is no longer significant. It can therefore be said that the potential effect of endogenous variables has little influence on the results for individual aspects in this case, but that the possible endogenous variables do contribute to explaining the overall variances for both surveillance and

Table 4.2 Results of the logistic regression model: guardianship opportunities equal influence of environmental design aspects

Guardianship Model 1

	Platform	**Transition**	**Lounge**	**Exits**	**Total Station**
Surveillance	NR^2 = 47,4 +View*** –Crowded** +PassFlow*	NR^2 = 59,5 –Illumination* –Corners* –Hidings* +View** +Mirrors** +Crowded**	NR^2 = 46,0 –ViewPlatform** +Open* +View* –Underground* –CCTV*	NR^2 = 68,0 –Corners** +View***	NR^2 = 56,9 *n=16* –TCorners* +LOpen* –ECorners*** +EView** –CCTV*
Visibility	NR^2 = 65,8 –Corners** –Blocking* –Crowded** +PassFlow*	NR^2 = 53,1	NR^2 = 31,7 –Hidings*** +Guards**	NR^2 = 61,2 –Corners** +Open** +View** +SecuVis** +Crowded* +PassFlow*	NR^2 = 57,1 *n=11* –PCrowded* –Lhide** +ESecuVis*

Guardianship Model 2

	Total Station (Model 1)	**Surroundings**	**Station & Neighbourhood**
Surveillance	*NR2 = 56,9* *–TCorners** *+LOpen** *–ECorners**** *+EView*** *–CCTV**	NR^2 = 15,8	NR^2 = 46,3 *n=5* –TCorners** +LOpen* –ECorners*** +EView**
Visibility	*NR2 = 57,1* *–PCrowded** *–Lhide*** *+ESecuVis**	NR^2 = 40,6 +Bike* +PassFlow**	NR^2 = 51,1 *n=5* –PCrowded* –LHidings** +ESecuVis***

Significance: * 10% level (.05), ** 5% level (.01), *** 1% level (.005).
Note: *NR*2=Nagelkerke R-square, +, – = resp. positive, negative relationship between dependent and independent variables.

visibility (Table 4.2). For instance, the presence of an open layout (*'view'*) affects surveillance, but may not affect visibility (Table 4.2), as even if one can see others, it does not mean that others can see one directly.

Guardianship in different sections of the stations

The environmental attributes of platform, transition and lounge areas are the most important in explaining the variance in guardianship opportunities. At the *platforms*, where passengers await the arrival of their train, opportunities for guardianship can provide possibilities for detecting suspicious activities and protecting people subject to possible offences.

Guardianship opportunities relate to variables that explain the visibility at the platform: the possibility to engage in surveillance, and the presence of guardians. The opportunities for guardianship significantly increase when surveillance opportunities increase, through the presence of good overviews of the platform (Table 4.2). More dark corners and objects blocking the view decrease guardianship opportunities. Guardianship opportunities lessen when the platforms are more crowded, which may also have a negative influence on possible overviews and the ability to detect suspicious activities. However, better guardianship opportunities are partly explained by larger passenger flows, which may provide more possible guardians and 'eyes on the platform'.

Transition areas constitute stairs, escalators, elevators, several corners, and dark, invisible spaces. Here, guardianship opportunities are related to the availability of sightlines and views, as well as the use of surveillance tools such as CCTV. Guardianship opportunities are strongly related to attributes explaining variances in surveillance possibilities (Table 4.2), for example opportunities for guardianship increase with better overviews of the transition area, as well as with the presence of mirrors and more people.

In the *lounge area,* passengers are often waiting to continue to the platform a few minutes before the train arrives; here guardianship opportunities are also explained by variables representing the vulnerability of the passengers. The results (Table 4.2) show that a connection to other parts of the station is important for guardianship opportunities. Opportunities for guardianship improve with better possibilities for surveillance, such as those provided by an open layout and good overview, and lounge areas that are not located underground. Surprisingly, the presence of CCTV is negatively related to guardianship possibilities. This may have to do with the fact that more CCTV cameras can be found at larger stations, often accommodating a more complex layout and with several lounge areas. Furthermore, guardianship opportunities are suggested to be higher in lounge areas in which the view to the platform is poorer. This may prove that a clearly delineated space increases awareness of the lounge area, which increases opportunities for exercising guardianship in this section. The presence of hiding spots in the lounge area also strongly influences opportunities for guardianship: more hiding places reduce the opportunities. Also, the presence of formal guards in the lounge area contributes positively to the opportunities for guardianship, the guards themselves being a guardian and able to notice and act upon suspicious activities.

The *exits and entrances* of stations are places in which passengers just pass by, and do not usually stop. Here guardianship opportunities relate to the flows of people and possible guardians present, but also the opportunities for guardianship in the surroundings. Table 4.2 shows that guardianship opportunities in the exit areas increase as the overview of the place increases. Areas with few corners and a good overview and open layout strongly increase the possibilities for guardianship.

Guardianship and the environment surrounding underground stations

The findings show that the attributes of the surrounding environments of the station, including the presence of a busy square, biking and walking paths, residential surroundings and taxi stands, seem only to decrease the significant effect of the stations' environment on guardianship opportunities. First, only the presence of bike paths near a station and passenger flows showed an effect on the possibility of guardianship (Table 4.2). Secondly, the aboveground stations did not show increased relationships between the surrounding environmental aspects and guardianship opportunities at the stations (Table 4.3). This could corroborate the notion that neighbourhood aspects mainly highlight the levels of guardianship in the neighbourhood, rather than helping in providing opportunities for guardianship at a transport node (Reynald, 2011a).

Conclusions and looking ahead

This study's objective was to analyse whether aspects of the environment can affect guardianship opportunities in underground stations, an under-researched area. Findings show that the environment does affect the opportunities for visibility and the capacity to exercise surveillance. The results from the modelling show that half of the variation in guardianship

Table 4.3 Results of the logistic regression model using only stations with platforms aboveground: guardianship opportunities equals influence of environmental design aspects

Guardianship Model 2 (aboveground)			
	Total Station (Model 1)	**Surroundings**	**Station & Neighbourhood**
Surveillance	*NR2 = 56,9* *–TCorners** *+LOpen** *–ECorners**** *+EView*** *–CCTV**	NR^2 = 27,8	NR^2 = 24,7 *n=4* –ECorners*
Visibility	*NR2 = 57,1* *–PCrowded** *–Lhide*** *+ESecuVis**	NR^2 = 46,6 +Bike*	NR^2 = 36,5 *n=5* –LHidings* +ESecuVis*

Significance: * 10% level (.05), ** 5% level (.01), *** 1% level (.005).

*Note: NR*2=Nagelkerke R-square, +, – = resp. positive, negative relationship between dependent and independent variables.

opportunities at stations was explained by environmental factors in general. Moreover, the results confirm the second hypothesis that different aspects played a role in different places, such as the presence of people at platforms and transition areas, security guards in the lounge area, good sightlines and overviews at the platform and exit areas, and surveillance tools (like mirror and CCTV) in the less crowded transition and exit areas.

Contrary to what was stated in the third hypothesis, the importance of the station's surrounding environment did not contribute as expected in explaining guardianship opportunities at underground stations. This may suggest that guardianship is a rather local action in micro-scale environments. It may also relate to the different responsibilities guardians perceive to have in different places, for example, security guards inside versus outside stations. A point for further investigation could be to focus on the nature of guardianship, at the station and in the neighbourhood, and potential relationships between them.

What are the implications of these findings? Firstly, the environment of transport nodes should provide as good overviews/open sightlines as possible, in particular at platforms. Sightlines can be improved by having see-through structures and low-height objects. Objects hindering the view should be kept to a minimum. Corners should be rethought in terms of overall impact on visibility and surveillance. The possibilities for visibility, in particular, need to be improved at underground stations in areas which are desolate or less crowded, such as transition and lounge areas, in order to create better opportunities for guardianship.

Secondly, tools that help create better opportunities for guardianship (e.g. mirrors) should be better planned and, when necessary, tested and (re)located to locales that directly facilitate surveillance and visibility. These tools provide additional abilities besides human sight and presence, and can be extra helpful for guardians to control larger, complex places, sometimes with several floors, such as transport nodes.

Finally, in order to increase opportunities for guardianship, individuals need to be in place, either consciously (security guards, safety hosts, place managers) or circumstantially (passengers, passers-by). At underground stations, it is positive when more people are around, as they may provide informal control (although in other sections, overcrowded areas may decrease guardianship opportunities as the advantage of overview is diminished by the crowd). Providing spaces that are noticeably formally watched or supervised (via cameras or guards) and increasing the pleasantness of the section may attract passengers to wait in areas which were previously uncomfortable, desolate and unsupervised.

The findings suggest the need for a more thorough investigation of the role of the environment on people's movement at transport nodes. An analysis of the movement of passengers at stations can provide an idea for the best possible routes of guardians, where they should be present.

One has to keep in mind that altering the environment, if at all possible, is not easy, particularly in well-consolidated, central areas. Nevertheless, opportunities for guardianship can be improved by enhancing the current state of the environment, as has been suggested here.

A limitation of this study has been the nature of the fieldwork data. As with any observational technique, subjective judgment may lead to differences of opinion by the observers (the data was collected by two researchers). For example, visibility could be subject to the researcher's subjective assessment of the available view. Surveillance was more difficult to assess, as the researcher cannot stand in the shoes of both the other and the possible target. Moreover, there was no standard definition from the literature on how one can assess guardianship and opportunities for guardianship in transit environments (and guidelines from previous research on neighbourhoods are not suitable for the environment of underground stations). Better definitions and observational procedures should be developed to distinguish between opportunities of surveillance and visibility. In terms of analysis, possible causal relationships between environmental variables are difficult to disentangle. Although, as the 'control model' showed, at least for the whole station, the results are strengthened via showing that the same variables continue to influence the opportunities for guardianship even when endogenous variables are removed. Despite these limitations, this study makes a contribution to the field of research devoted to guardianship opportunities at transport nodes, drawing conclusions from the Stockholm underground system.

As this study is a micro-scale assessment of station environments, the actors who may make use of the findings and implications are transportation and security companies responsible for station environments. However, as highlighted before, responsibility issues for safety are vaguely defined, and there is a need to bring attention to the issue for all actors involved in public transport security. Transportation companies will find grounds for improving security in the different sections of the stations by different means. There are also results pointing at possible changes in the physical design of the stations in order to increase guardianship and therewith safety. Security companies may use the findings to better coordinate their efforts and deployment of both personal and technical security tools in order to provide increased safety and guardianship at stations. Urban planners may use the findings to develop thought-through designs of future transport nodes and incorporate them into restoration works of existing aging nodes. For research, the findings will have an impact on assessing guardianship in public environments, which so far has been lacking in the field. The chapter sets out a possible method for assessment and suggests ways of improving the analysis as well as definitions in the current state of literature and research on transportation and guardianship. Researchers may find a good starting point to further develop theories and comparative analyses of guardianship and social control related to, for instance, criminology, psychology, architecture and law enforcement.

Appendix 4A Modelling set-up

Dependent variables in the models

Guardianship variables per section			
Model 1 (Figure 4.5)		**Model 2 (Figure 4.5)**	
Surveillance	**Visibility**	**Surveillance**	**Visibility**
PSur, TSur, LSur, ESur	PVis, TVis, LVis, EVis	AvSur	AvVis

P=PLATFORM, T=TRANSITION, L=LOUNGE, E=EXIT AREA, Av=AVERAGE (sum of mean of sections/4)

Notes: Sur = Surveillance possibilities (0/1); *Vis*=Visibility possibilities (0/1).

Independent variables in the models

Environmental variables per section				
Model 1 (Figure 4.5)				**Model 2 (Figure 4.5)**
Platform	**Transition**	**Lounge**	**Exit/Entrance**	**Surroundings**
Pillu, Pcorn, Phide, Pblok, Pview, Punder, Psecu, Pmirr, Pguar, Pcrow, Pax, CCTVno	Tillu, Tcorn, Thide, Tlvl, Tview, Tsecu, Tmirr, Tguar, Tcrow, Pax, CCTVno	Lillu, Lcorn, Lhide, Lopen, Lwind, Lsecu, Lmirr, Lshop, Lcafe, Lguar, Lcrow, Pax, CCTVno	Eillu, Ecorn, Ehide, Ewalk, Eopen, Eview, Esecu, Eguar, Ecrow, Pax, CCTVno	Smeet, Sresi, Sbike, Speds, Staxi, Sguar, Sopen, Pax, CCTVno

P = PLATFORM, T = TRANSITION, L = LOUNGE, E = EXIT AREA, S = SURROUNDINGS.

Notes: *illu* = Sufficient/effective illumination (y/n); *corn* = Presence of dark corners (y/n); *hide* = Presence of hiding places (y/n); *blok* = Many objects blocking the view (y/n); *view* = Clear overview (y/n); *under* = Subterranean section (y/n); *secu* = CCTVs easily recognizable/visible (y/n); *mirr* = Presence of mirrors (y/n); *guar* = Presence of guards (y/n); *crow* = Overall crowdedness (h/m/l); *Pax* = Daily passenger flow at station (#); *CCTVno* = Number of CCTVs placed at station (#); *lvl* = Section consisting of several levels (y/n) *open* = Open layout of the place (y/n); *wind* = Presence of open windows (y/n); *shop* = Presence of shops (y/n); *cafe* = Presence of café; *walk* = Long distance between sections (y/n); *meet* = Immediate surroundings is a meeting place (e.g. square); *resi* = Immediate surroundings is residential; *bike* = Bike lanes present (y/n); *peds* = Pedestrian pathways present (y/n); *taxi* = Taxi pick-up/parking place present.

Appendix 4B Control modelling set-up, controlling for possible endogeneity

Independent environmental variables per section				
Model 1 (Figure 4.5)				Model 2 (Figure 4.5)
Platform	**Transition**	**Lounge**	**Exit/Entrance**	**Surroundings**
Punder, Psecu, Pmirr, Pguar, Pcrow, Pax, CCTVno	Tlvl, Tsecu, Tmirr, Tguar, Tcrow, Pax, CCTVno	Lwind, Lsecu, Lmirr, Lshop, Lcafe, Lguar, Lcrow, Pax, CCTVno	Ewalk, Esecu, Eguar, Ecrow, Pax, CCTVno	Smeet, Sresi, Sbike, Speds, Staxi, Sguar, Pax, CCTVno

P = PLATFORM, T = TRANSITION, L = LOUNGE, E = EXIT AREA, S = SURROUNDINGS.

Notes: *under* = Subterranean section (y/n); *secu* = CCTVs easily recognizable/visible (y/n); *mirr* = Presence of mirrors (y/n); *guar* = Presence of guards in section (y/n); *crow* = Overall crowdedness in section (h/m/l); *Pax* = Daily passenger flow at station (#); *CCTVno* = Number of CCTVs placed at station (#); *wind* = Presence of open windows (y/n); *shop* = Presence of shops (y/n); *café* = Presence of café; *walk* = Long distance from entrance/exit to lounge (y/n); *meet* = Immediate surroundings is a meeting place (e.g. square); *resi* = Immediate surroundings is residential; *bike* = Bike lanes present (y/n); *peds* = Pedestrian pathways present (y/n); *taxi* = Taxi pickup/parking place present.

References

Block, R. and Davis, S. (1996) The Environs of Rapid Transit stations: A Focus for Street Crime or Just Another Risky Place? In: Clarke, D. (ed.) *Preventing Mass Transit Crime*. Monsey, NY: Criminal Justice Press, 238–257.

Burns R. and Burns R. (2009) *Business Research Methods and Statistics Using SPSS*. Chapter 24: Logistic Regression. http://www.uk.sagepub.com/burns/default.htm, accessed 26 September 2013.

Ceccato, V. (2013) *Moving Safely: Crime and Perceived Safety in Stockholm's Subway Stations*. Lanham, MD: Lexington Books.

Ceccato, V., Uittenbogaard, A. and Bamzar, R. (2013) Security in Stockholm's Underground Stations: The Importance of Environmental Attributes and Context. *Security Journal*, *26*, 33–59.

Clarke, R.V. (1995) Situational Crime Prevention. In: Tonry, M. and Farrington. D. (eds) *Building a Safer Society: Strategic Approaches to Crime Prevention*. Chicago: The University of Chicago Press, 91–150.

Cohen, L.E. and Felson, M. (1979) Social Change and Crime Rate Trends: A Routine Activity Approach. *American Sociological Review*, *44*(4), 588–605.

Cozens, P., Neale, R., Whitaker, J. and Hillier, D. (2003) Managing Crime and the Fear of Crime at Railway Stations—A Case Study in South Wales (UK). *International Journal of Transport Management*, *1*(3), 121–132.

Eck, J. (1994) Drug Markets and Drug Places: A Case-Control Study of the Spatial Structure of Illicit Drug Dealing. Doctoral dissertation, University of Maryland, College Park.

Felson, M. and L.E. Cohen. (1980) Human Ecology and Crime: A Routine Activity Approach. *Human Ecology*, *8*(4), 389–405.

Hollis-Peel, M., Reynald, D., Bavel, M., Elffers, H. and Welsh, B. (2011) Guardianship for Crime Prevention: A critical Review of the Literature. *Crime, Law and Social Change*, *56*(1), 53–70.

Hope, T. (1999) Privatopia on Trial? Property Guardianship in the Suburbs. *Crime Prevention Studies*, *10*, 15–45.

Jacobs, J. (1961) *The Death and Life of Great American Cities*. New York: Random House.

Loukaitou-Sideris, A. (1999) Hot Spots of Bus Stop Crime: The Importance of Environmental Attributes. *Journal of the American Planning Association*, *65*(4), 395–411.

Loukaitou-Sideris, A., Liggett, R. and Iseki, H. (2002) The Geography of Transit Crime: Documentation and Evaluation of Crime Incidence on and around the Green Line Stations in Los Angeles. *Journal of Planning Education and Research*, *22*(2), 135–151.

Newman, O. (1972) *Defensible Space: Crime Prevention through Urban Design*. New York: Macmillan.

Norman, G. (2010) Likert Scales, Levels of Measurement and the 'Laws' of Statistics. *Advances in Health Science Education*, *15*(5), 625–632.

Painter, K. and Tilley, N. (1999) Surveillance of Public Space: CCTV, Street Lighting and Crime Prevention. *Crime Prevention Studies 10*. Monsey, NY: Criminal Justice Press.

Pennell, S., Curtis, C. and Henderson, J. (1985) *Guardian Angels: An Assessment of Citizen Response to Crime*. Washington DC. National Institute of Justice, US Association of Governments.

Reynald, M. (2011a) *Guarding Against Crime: Measuring Guardianship within Routine Activity Theory*. Farnham, United Kingdom: Ashgate Publishing.

Reynald, M. (2011b) Factors Associated with the Guardianship of Places: Assessing the Relative Importance of the Spatio-Physical and Sociodemographic Context in Generating Opportunities for Capable Guardianship. *Journal of Research in Crime and Delinquency*, *48*(1), 110–142.

Reynald, M. and Elffers, H. (2009) The Future of Newman's Defensible Space Theory: Linking Defensible Space and the Routine Activities of Place. *European Journal of Criminology*, *6*(1): 25–46.

Shaw, C.R. and McKay, H.D. (1942) *Juvenile Delinquency and Urban Areas*. Chicago: University of Chicago Press.

Smith, M. and Clarke, R. (2000) Crime and Public Transport. *Crime and Justice*, *27*, 169–233.

Stockholm Public Transport – SL (2012) *Fakta om SL och länet, 2011*. AB Storstockholms Lokaltrafik. http://sl.se/sv/Om-SL/Det-har-ar-SL/Rapporter/Fakta-om-SL-och-lanet/, accessed 02 October 2013.

Stockholm Stad. (2013) http://www.stockholm.se/OmStockholm/Fakta-och-kartor/, accessed 26 September 2013.

5
The Geography of Pickpocketing at Bus Stops: An Analysis of Grid Cells

Vania Ceccato, Oded Cats and Qian Wang

Introduction

> 'Pickpocketing needs a crowd'
>
> (Marcus Felson, ASC Conference, Atlanta, 2013)

Bus stops, as any other type of transport node, may be criminogenic places by nature. Evidence from North American and British studies has repeatedly shown that areas that 'contain' a bus stop are more criminogenic than those without (Levine and Wachs, 1986; Loukaitou-Sideris 1999; Loukaitou-Sideris et al., 2002; Newton and Bowers, 2007; Smith and Cornish 2006; Tsai et al., 2011). Yet despite such findings, the link between bus stops and crime has been controversial (Kooi, 2013) and highly dependent on North American and British evidence. If one randomly selects two areas, the first one containing a bus stop and the second not, is it more likely that the first area has more pickpocketing than the second one? Previous studies have attempted to isolate the effect of bus stops from that caused by the place's attributes (where bus stops are located) on crime. Surprisingly, the nature of bus stops is often neglected in the analysis. This article addresses this issue by assessing the potential impact of passenger flow and vehicle frequency on the geography of pickpocketing.

This is a relevant issue as bus stops are far from homogeneous entities (Levine et al., 1986). Some bus stops, particularly those in city centres, are busy settings, as passengers and potential offenders cluster around them, perhaps for short times because bus frequency may be high (see in this volume Uittenbogaard's article on the impact of the environment of transport nodes on the potential to exercise social control). On the one hand, crime may be facilitated by such fluid circumstances (passengers boarding/alighting buses), as people's willingness and ability to exercise social control is low in these circumstances. On the other hand, a high bus frequency may reduce passengers' waiting time and vulnerability to be victimized by thieves, while, at the same time, high frequency could mean that offenders may have an easy escape by taking the first bus after mugging a passenger. If buses do not arrive often, bus stops may suffer from inverse conditions. Thus, bus frequency and passenger flow at these transport nodes are suggested here to be an essential element for the understanding of the criminogenic conditions present at bus stops.

The aim of this chapter is to obtain a better understanding of the potential criminogenic effect bus stops have on their immediate vicinities. The study focuses on pickpocketing, a typical offence at transport nodes in Stockholm (Ceccato, 2013), which consists of purse snatching, wallet theft or other thefts, such as mobile phones or other personal belongings. This analysis is performed with two objectives in mind:

1. to assess whether pickpocketing is more likely to occur near bus stops
2. to investigate the distribution of pickpocketing incidents in relation to the respective flows of vehicles and passengers at bus stops

An important contribution of this article is methodological. The article is truly an example of multidisciplinary research as it brings data on passenger flow and bus frequency into crime analysis, which has so far been lacking in the international literature. Moreover, the study explores the use of equal-stratified sampling of grid cells generated from data using a geographical information system (GIS). Equal-stratified sampling of grid cells is commonly used in natural sciences (Hirzel and Guisan, 2002) but, to the best of the authors' knowledge, has not yet been employed in the context of understanding transit crime. The equal-stratified sampling was applied in combination with a Monte Carlo simulation to perform repeated random sampling of grid cells, an important step for hypotheses testing. This procedure was applied for an iterative sampling of grid cells that contain bus stops, and grid cells without any bus stop in order to compare the likelihood of pickpocketing incidents and their prevalence. Although safety at bus stops is recognized to be a multi-scale phenomenon (Loukaitou-Sideris et al., 2002; Ceccato, 2013), this article focuses primarily on the occurrence of pickpocketing at bus stop locations and their immediate vicinities represented by cells of 50 by 50 metres (similar to previous research, see Yu, 2009).

The structure of the chapter is as follows. A review of previous studies on crime and bus stops is first presented as basis for the hypotheses. Next, the study area is framed, followed by data, methods and then results. The chapter closes with a discussion of the findings and directions for future research.

Crime and bus stops: theory and hypotheses of study

Although crime in the transport system is a rare event, still the decision one takes to travel is often associated with a decrease in one's safety. A recent study in the United States demonstrated that the risk of victimization during travel between activities is more than eight times higher than staying at home and almost twice as high as any other activity outside the home. It is particularly high during commutes to and from school and work (Lemieux and Felson, 2012). International evidence shows that risk of crime varies by transport type (train, subway, tram and bus), within the system (large and small nodes) and by time (hourly, weekly and seasonally) (Levine and Wachs, 1986; La Vigne, 1997; Loukaitou-Sideris, 1999; Loukaitou-Sideris et al., 2002; Ceccato and Uittenbogaard, 2014).

Crime occurs at bus stops more often than inside buses (Levine et al., 1986; Loukaitou-Sideris, 1999). However, the condition and environmental settings of bus stops vary considerably. Some may be crowded spots in the city centre, others empty most of the time. They also differ in layout and location (Levine et al., 1986). Despite these differences, bus stops are often regarded as crime generators and/or crime attractors (Brantingham and Brantingham, 1995). They are often positioned in specific areas of the city that concentrate large flows of people, providing potential crime targets, or they themselves constitute a crime attractor, pulling motivated offenders, such as drug dealers, towards them. Bus stops are markedly different from train or subway stations, as train or subway stations form the urban landscape with tracks and large buildings, while bus stops often blend in with attributes of the landscape. Some bus stops only consist of a pole with a timetable located on the sidewalk, which marginally affects the urban landscape. Bus shelters that offer protection against rain, snow or sun are much more defined in space. These differences, although limited to a small area, are relevant for the way passengers wait for a bus and experience safety (Loukaitou-Sideris, 1999).

The level and types of crime that happen at a bus stop are determined by the characteristics of the bus stop and also by its context. In the United States, for instance, Loukaitou-Sideris et al. (2001) show that bus stops with high records of crime are associated with liquor stores, check cashing businesses, vacant buildings and general vandalism. Newton (2008) suggests that crime risk increases with greater concentrations of bus stop locations along a bus route. Yu (2009) shows that the geographies of both property and violent crimes are influenced by the concentration of bus stops, while Kooi (2013) finds that clusters of bus stops promoted increases in public-order offenses at the block level. It is therefore not surprising that the international literature has for decades shown evidence (sometimes contrasting) of the combined effect of bus stops and their contexts (Levine and Wachs, 1986; Loukaitou-Sideris et al., 2001; Yu, 2009; Kooi, 2013). However, Hart and Miethe (in this book) show that the bus stops alone are more likely to appear as determinants of robbery than any other environmental factor. These results suggest that the attention should turn from the *contexts* of bus stops to bus stops themselves as unique criminogenic settings, which implies analysis is required using a limited geographical unit.

Previous literature suggests the importance of passenger flow at bus stops. The seminal study of Levine and Wachs (1986: 20) suggests 'pedestrian crowding appeared to be critical in encouraging thefts'. Overcrowding was a major factor perceived as contributing to bus crime, a factor that was mentioned by victims and witnesses far more often than any other factor. Their findings indicate that, regardless, location factors contributing to crime differ among bus stops, which suggests that bus stops are far from homogenous. For example, during the evening rush hour, when there is disorganization on the sidewalks due to increased numbers of pedestrians given limited sidewalk space, petty thieves (specialized in purse snatching, pickpocketing and jewellery snatching) can operate easily in such a tangled environment.

Crowded bus stops offer crime targets and, in particular, pickpocketing targets if motivated offenders are around and if there is a lack of 'capable guardians' (Cohen and Felson, 1979), persons who, sometimes just by their presence, discourage crime from taking place. Individuals who usually function as capable guardians in their own neighbourhood often have no sense of ownership of bus stops and are thus unwilling to get involved if something happens there (Ceccato and Haining, 2004). Also, few passengers are ready to keep an 'eye on the street' and/or intervene (Jacobs, 1961). Newton (2004) suggests that it is not only crowding at a bus stop that affects vulnerability to crime but also the amount of time passengers have to wait for a bus. Thus, if a bus stop is frequently served, crime opportunities are constantly reset as passengers arrive and leave. However, if buses are infrequent, the bus stops may become crowded at certain times, promoting opportunities for thefts, or they may be constantly empty, allowing other types of criminal activities to occur as nobody is around. In this study, both bus frequency and passenger flow are taken into consideration when assessing the distribution of pickpocketing at bus stops.

Given the importance of the characteristics of bus stops for crime in North American and British cities, this study tests three hypotheses for the Swedish capital city of Stockholm, focusing primarily on the occurrence of pickpocketing at bus stop locations and their immediate vicinities (half a block) represented by cells of 50 by 50 metres:

Hypothesis 1 – Pickpocketing incidents are significantly higher in areas with bus stops than elsewhere in the city.

Hypothesis 2 – The flow of passengers at bus stops explains the variations of pickpocketing; more people, more potential victims and motivated offenders.

Hypothesis 3 – The higher the bus frequency at a bus stop, the lower the level of pickpocketing, as it lessens the passengers' time to wait for a bus.

The study area

The municipality of Stockholm (*Stockholms stad*) has a population of 881,235 (2012), spread over 188 square kilometres, while the Stockholm metropolitan area is home to approximately 22 per cent of Sweden's population (about 9.5 million in 2013). The central parts of the city consist of 14 islands, and a third of the city area is composed of waterways, while another third is made up of parks and green spaces. The whole archipelago (and county) is well connected by roads and an extensive and efficient public transportation system comprised of buses, trams, subway, regional and suburban rail, and archipelago boats. Every weekday, more than 700,000 people travel by public transport in Stockholm. In 2013, there were 2,065 bus stops located within the borders of Stockholm municipality (Figure 5.1). The main public transport interchange is located in the central business district (CBD) area in the central area of the inner city. This interchange, which includes the central station (the main railway station of the capital) also acts as the major hub for both the subway and bus networks, making this area a place through which many travellers and workers pass daily.

Crimes occurring near bus stops are more concentrated relative to the area taken up by the stops. For example, 95 per cent of all offences in Stockholm occur within 300 metres of a bus stop, whereas only 66 per cent of the city's area is within 300 metres of a bus stop. This means that many areas with bus

(a)

Figure 5.1 Continued

(b)

(c)

Figure 5.1 Examples of (a) bus stops located in transfer hubs, (b) along an arterial street and (c) in peripheral outskirts

stops had no crimes. Pickpocketing is concentrated in the inner-city areas, particularly in Södermalm, Norrmalm and Östermalm (a large part of areas shown in Figure 5.4). Police statistics show a total of 7,260 pickpocketing records in 2008, with a sharp increase in 2011. During the summer, police estimate over 50 pickpocketing incidents per day in Stockholm County, and tourists are the thieves' primary targets.

Data and method

In this section, the main three elements of the analysis and their respective methods are briefly presented: (1) number of bus stops, (2) number of crimes committed near bus stops and (3) grid cells that have been overlaid on the study area to count both crimes and bus stops.

Police-recorded statistics of pickpocketing with *x,y* geographical coordinates for 2008 were obtained from the Stockholm Police Headquarters (7,260 incidents). Pickpocketing was mapped using a GIS. Bus stops' locations and their respective attributes were available from the Stockholm Public Transportation Agency (SL).

The dataset contained all bus stops located within Stockholm municipality borders (2,049 stops) along with their respective coordinates and attributes. Passenger flow is expressed as the number of boarding and alighting passengers per bus stop per bus line. Passenger flows fluctuate from day to day and are subject to seasonal variations. In the case of Stockholm, summer is characterized by significantly lower ridership levels. Therefore, the passenger flow is the average number of passengers during weekdays, from 22 August 2011 to 21 June 2012, excluding the summer holiday period. Vehicle flow is expressed as the number of buses serving a stop on a typical weekday (Wednesday). Vehicle flows are aggregated over lines, as bus stops are often served by more than one bus line. It is assumed that vehicle flows are symmetrical for both stop directions at the daily level. In addition to the attributes of bus services, two other variables indicating the activity level are also included in the model. One variable defines transport nodes which serve a high number of passengers as the 'transfer hub'. The other is an ordinal variable indicating the rank of distance to the centre, where activities concentrated. Details of the dataset are found in Appendix 5A.

To compare areas with and without bus stops, a grid pattern of 50 metres was created using GIS, with the boundaries of Stockholm municipality acting as the grid boundary (Figure 5.2). A total of 85,857 cells were created and overlaid with layers of location coordinates of bus stops, bodies of water, forests and parks, major vacant land and coordinates of pickpocketing. By using bus stop and pickpocketing locations as a reference, a selection of cells was performed with the objective of eliminating major areas that did not contribute to the analysis, such as lakes, forests/parks and non-built-up areas, resulting in the deletion of 36 per cent of the original 83,587 cells. The final study area was thereafter composed of 54,802 cells. Using SQL functions in GIS, data on bus stops and pickpocketing were associated with the grid cells to create a topology of pickpocketing by cell.

After data preparation, the study followed a two-stage approach (Figure 5.2). In part one, the objective was to assess whether the location of a bus stop increased the likelihood of having pickpocketing in a cell when the cells were randomly selected across the city. In order to answer this

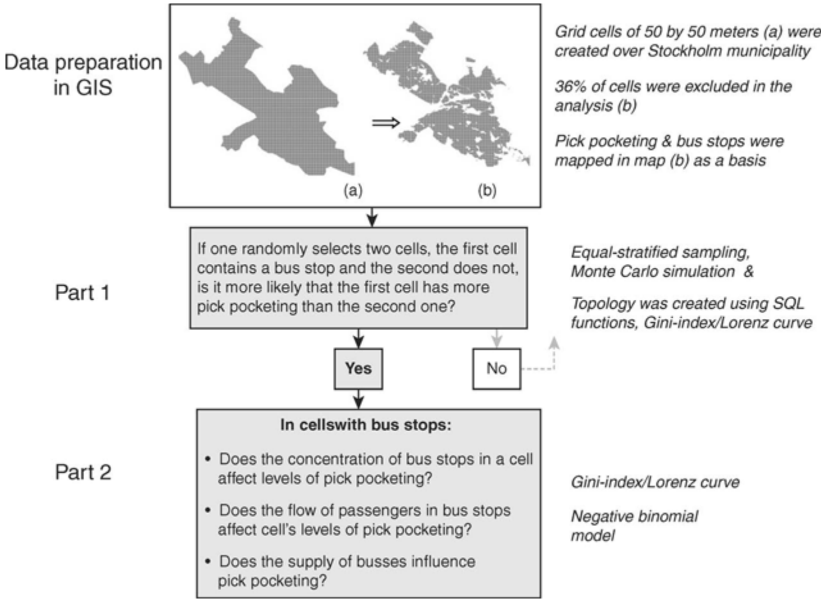


Figure 5.2 The impact of bus stops on the geography of pickpocketing: a two-stage approach

question, equal-stratified sampling, a Monte Carlo simulation and the Gini index are used, as explained in the following section. If the answer to this question was affirmative, then part two had to be performed with both exploratory and confirmatory analyses. Thus, the Gini index and negative binomial modelling would be used to examine whether the number of bus stops and the flows of passengers and buses impact the geography of pickpocketing in cells that have at least one bus stop. The steps taken in the analysis are described in more detail later in this chapter.

Analysis

Part 1: The distribution of pickpocketing and bus stops

Pickpocketing shows a concentrated geography in Stockholm and tends to be associated with the location of bus stops. The analysis shows that all recorded pickpocketing incidents were concentrated in only 2.5 per cent of the cells and that 50 per cent of all pickpocketing incidents occurred in less than 0.001 per cent of the grid cells. This is not unique for Stockholm. As the international literature of crime has long suggested, crime is often concentrated in a limited geographical area (Sherman et al., 1989; Weisburd et al., 2012). In

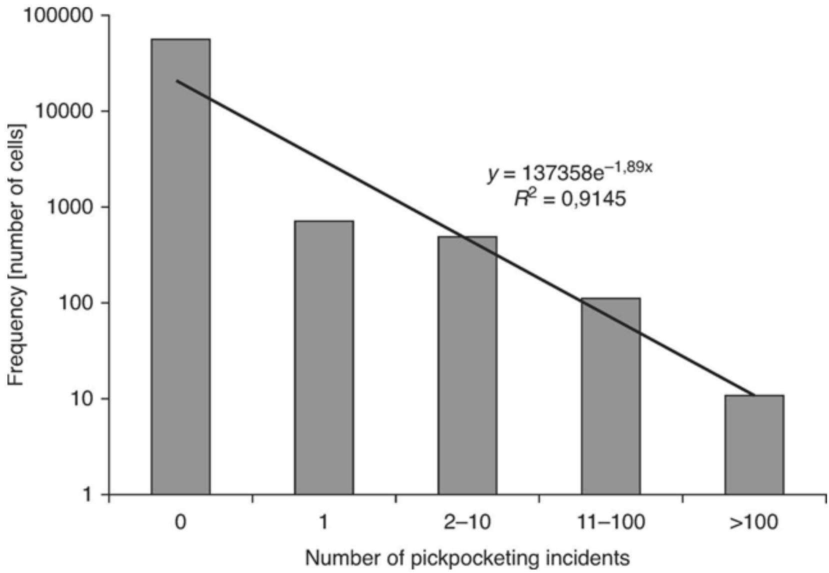


Figure 5.3 Distribution of number of pickpocketing incidents per grid cell

the case of Stockholm, a cell corresponds to a 50 by 50 metres square. This implies that 50 per cent of the incidents are limited to an area smaller than 0.15 square kilometres and that all pickpocketing incidents are constrained to 3.33 square kilometres. Figure 5.3 shows the histogram of pickpocketing incidents by cell. Note that for both axes, the number of incidents as well as the respective number of grid cells is in logarithmic scale. The histogram is characterized by a linear relationship with a high goodness-of-fit ($R^2 = 0.915$). A linear relationship between the logarithmic scales of two variables is the signature of a power law. The power law implies that the relation between the non-transformed variables can be expressed as follows: $f(x) \propto cx^{-\gamma}$, where γ is known as the scale factor, which determines how skewed the distribution is and the length of the tail. The scale factor of pickpocketing frequency in Stockholm is $\gamma = 1.89$ indicating that the vast majority of such incidents are concentrated in a fraction of the geographical cells.

Although the frequency of crime incidents by cell is illustrative of the overall distribution of pickpocketing, it neither says much about the nature of these cells nor why some attract pickpocketing and others do not. In order to assess the chances of having pickpocketing in a cell, cells were classified into two groups: cells that contain at least one bus stop within their boundaries ($N = 1750$), and the majority, those which do not include any bus stop ($N = 54{,}802$). Among the cells that contain at least one bus stop, the average number of stops is 1.18. The summary statistics of pick-pocketing activity for cells with and without bus stops as well as for all

Tables 5.1 Summary statistics of pickpocketing activity by cell type

	N	**Pick-pocketing**	**Pick-pocketing per cell**	**Of which with pick-pocketing**	**Gini index of pick-pocketing**
Bus stop	1750 (3.1%)	1104	0.631	146 (8.3%)	0.977
Non-bus stop	54802 (96.9%)	6030	0.110	1182 (2.2%)	0.994
All	56552	7134	0.126	1328 (2.3%)	0.993

cells combined are presented in Table 5.1. Although most of the pickpocketing incidents (84.5 per cent) took place within non-bus stop cells, the average number of pickpocketing incidents per cell was significantly higher at bus stop cells compared with non-bus stop cells. More interestingly, the share of bus stop cells that had some pickpocketing was almost four times higher than non-bus stop cells – 8.3 per cent and 2.2 per cent, respectively. Note that a large share of the pickpocketing incidents in non-bus stop cells were concentrated within the touristic old town (Gamla Stan) and along the main pedestrian shopping streets (Drottninggatan and its immediate surrounding), in which there are large crowds of tourists and shoppers and no bus stops.

The level of spatial concentration of pickpocketing in cells with bus stops is confirmed by the Gini index, which is computed based on the difference between a perfectly even distribution and a Lorenz curve corresponding to the actual distribution. The Lorenz curve is constructed by matching the cumulative density function of the population with the cumulative density function of the variable of interest. The Gini index would take the value 1 if all pickpocketing incidents were concentrated in a single cell, and the value 0 if the incidents were distributed equally across the study area. The resulting Gini index is 0.993, which indicates an extremely uneven spatial distribution of pickpocketing, with very few cells accounting for the vast majority of incidents. Furthermore, this uneven pattern is observed for cells both with and without bus stops. As much as 90 per cent of the pickpocketing incidents that were committed within boundaries of bus stops cells took place at the top 60 cells regarded as generators/attractors, that is, in only 3.5 per cent of the bus stop cells. Some of the most important attractors are shown in Figure 5.4. The distribution of pickpocketing incidents at non-bus stop cells is even more skewed, with 90 per cent of all these observations attributed to 1 per cent of the cells.

A typology of the prevalence of pickpocketing at bus stops follows from the 60 attractors/generators. They are located in the inner-city areas with very few exceptions, such as cells in Vällingby, Liljeholmen and Älvsjö. The majority of them (46 cells) are composed of cells that have one bus

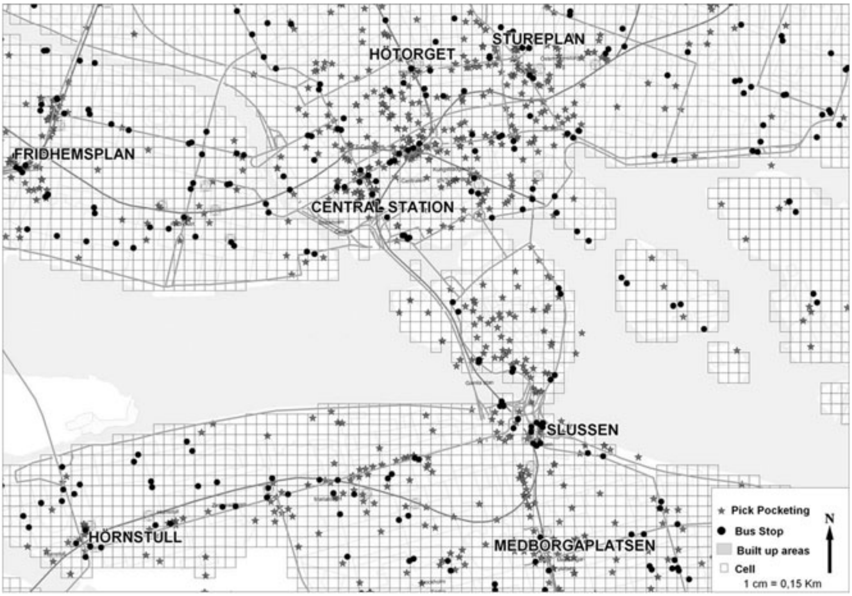


Figure 5.4 Pickpocketing and seven of the most important bus stops and crime generators/attractors

stop, with three or more cases of pickpocketing. Figure 5.4 shows the central area, in which most incidents occur. Examples are those located at Klarabergsvägen (T-centralen and Sergels torg), Linnégatan,, Hötorget, Kunsgatan, Blekholmsterrassen, Odenplan, Folkungatan (Medborgarplatsen), Katarinavägen (Slussen), Ringvägen (Skanstull), Oxtorgatan, Gullmarsplan, and Södertäljesvägen (Liljeholm). The second type are not mutually exclusive types as they are composed of those cells that have several bus stops (at least three) with a concentration of pickpocketing (max. = 111, mean = 17). Examples are those located at Katarinavägen (Slussen), Ringvägen (Skanstull), Central Station, St Eriksgatan/Drottningvägen (Fridhemsplan), Stureplan, Kungsträdsgården, Birger Jarlsgatan (Östermalmstorg), Vallhalavägen (KTH) and in the outskirts, Vällingby (subway station) and Älvsjö. Note that most of them act as transfer hubs providing connections to other types of public transportation such as subway and commuter trains.

In order to test the hypothesis that pickpocketing is more likely to occur in proximity to bus stops than elsewhere, an equal-stratified sampling of grid cells was conducted. This method is more often used in natural sciences and the study of ecological systems, and shows accurate and robust results when compared with similar sampling methods (e.g. see Hirzel and Guisan, 2002). The equal-stratified sampling strategy is systematic and requires a segmentation criterion for clustering the dataset, such as, in this study, the presence of bus stops within cells boundaries. Note that all cells within a certain set, either bus stop cells or non-bus stop cells, had the same probability of being included in the sample without controlling for other factors. In order to perform repeated random sampling of grid cells, the Monte Carlo method was applied. In order to guarantee a robust statistical analysis, ten samples were generated, each consisting of 200 observations. Sample size and the number of samples were selected based on the respective population size (i.e. number of cells per set) and the prevalence and variability of pickpocketing incidents.

Two indicators were calculated for each sample: (a) the share of cells that have at least one pickpocketing incident reported within their boundaries and (b) the total number of pickpocketing incidents occurring within these cells. A one-tailed t-test for two samples with unequal variance was used. The null hypothesis that the pickpocketing rate at bus stop cells is *not* larger than at non-bus stop cells was rejected ($t=3.42$; $p<0.01$). Moreover, the same statistical test also rejected the hypothesis that the share of bus stop cells at which pickpocketing occurred is *not* larger than the corresponding share among non-bus stop cells ($t=8.24$; $p<0.001$).

Both the share of cells with pickpocketing and the number of pickpocketing incidents were found to be significantly higher at bus stop cells than elsewhere, findings that are in line with hypothesis 1. Note that, although this does not imply a causal relationship between bus stop presence and pickpocketing, these findings provide strong evidence for the influence of bus stops on the geography of pickpocketing. First, these cells are relatively small geographical units (equivalent to a half a street block), which should therefore reflect the micro-landscape in which pickpocketing takes place. Second, different types of cells run the same likelihood to be drawn, therefore allowing for other factors, such as differences in land use, to be picked up by the equal-stratified sampling selection.

Part 2: Modelling pickpocketing in cells with bus stops: a grid analysis

In this analysis, the geography of pickpocketing has been associated with proximity to bus stops. Given that bus stops are heterogeneous in terms of flows of passengers and buses, the effects of these two factors on crime are further explored. In detail, does passenger flow at bus stops affect cells' levels of pickpocketing? Does the flow of buses influence pickpocketing?

In order to investigate these issues, a regression analysis is carried out using grid cell data. Original data of flows of passengers and buses are now transformed into numbers by cell. The sum of the attribute value is taken if there is more than one bus stop in a cell. Among 56,039 cells, there are 1,669 cells containing passenger and vehicle flow values.[1] The regression analysis uses these 1,669 observations, of which only 142 cells have a record of pickpocketing incidents. The aim of this regression analysis is not to find the best model, but rather to explore the explanatory power of vehicle and passenger flows with respect to variations in the number of pickpocketing incidents across the urban grid.

Poisson and negative binomial regression are commonly applied in modelling count data. Poisson regression assumes the mean and variance of the dependent variable to be equal, while negative binomial regression, which is used in this study, relaxes this restriction with a dispersion parameter α. The larger αi, the more disperse the variable. Table 5.2 shows that the standard deviation of the number of pickpocketing incidents is 5.6, much higher than its mean of 0.66. In other words, the distribution of the dependent variable is strongly skewed. Thus, it is assumed that the dependent variable follows a negative binomial probability distribution and that the expected value of the number of pickpocketing incidents E[yi] can be modelled as

$$E[y_i] = \lambda_i \, EXP(\beta_0 + \beta_1 * x_i^1 + \beta_2 * x_i^2 + \beta_3 * x_i^3 + \beta_4 * x_i^4 + \epsilon_i),$$

where EXP(ϵ_i) is a gamma-distributed error term with mean equal to 1 and variance α^2 to be estimated.

y_i : The number of pickpocketing incidents in cell *i*

λ_i : The expected number of pickpocketing incidents in cell *i*

x_i^1 : The passenger flow in cell i

x_i^2 : The rate of passenger flow divided by vehicle flow in cell *i*

x_i^3 : A dummy variable, where $x_i^3 = 1$ if cell i contains a transfer hub at which more than 10,000 passengers interchange daily; otherwise, 0.

x_i^4: An ordinal variable indicating the distance di between cell i and the centre cell of *Mälartorg*, which is located in the 'old town' (*Gamla stan*). $x_i^4 = 1 \; if \; d_i < 2 \; km$; $x_i^4 = 2 \; if \; 2 \; km < d_i \leq 4 \; km$; $x_i^4 = 1 \; if \; d_i > 4 \; km$. Therefore, the smaller the d_i, the higher the rank *i* (the highest rank is 1).

Table 5.2 Negative binomial regression, dependent variable (number of pickpocketing incidents), $N = 1669$

	Output	**Parameter**	**Std. error**	***Z* value**	**Pr(>|z|)**
Model A	β_0	1.167	0.337	3.159	0.001
	β_1	0.001	0.000	12.882	0.000
	β_3	2.377	6.046	3.932	0.000
	β_4	–1.529	1.556	–9.825	0.000
	α	13.7741			
	LL(β_0)	–842.648			
	LL(β)	–741.987			
Model B	β_0	1.011	0.392	2.576	0.010
	β_2	0.523	0.056	9.341	0.000
	β_3	2.817	0.615	4.584	0.000
	β_4	–1.497	0.157	–9.533	0.000
	α	15.244			
	LL(β_0)	–842.648			
	LL(β)	–753.117			

Parameter vector $\beta = [\beta_0, \beta_1, \beta_2, \beta_3, \beta_4]$ is the marginal utility of the corresponding variables.

Based on the hypothesis that the congregation of people creates a potential criminogenic effect, two variables, passenger flow x_i^1 and the rate between passenger flow and vehicle flow x_i^2, are respectively included in models A and B (see Table 5.2). The rate x_i^2 is used instead of vehicle flow per se, as the rate indicates the accumulated passengers because of the interval of bus services. The dummy variable x_i^3 for transfer hubs (e.g. a bus stop in the same cell as a subway station) is included for controlling the cells with extra passengers. Inner-city land uses may also be relevant for the geography of pickpocketing (e.g. ATMs, bars, public squares and tourist attractions), and the inclusion of variable x_i^4 reflects how close each cell is to the inner city. Variables x_i^3 and x_i^4 are included in both models A and B (for details, see Appendices 5B and 5C).

Note that, passenger flow varies throughout the day with morning and afternoon peaks. In order to test potential effects of the variations in the number of passengers and buses during the day on pickpocketing, a new set of models looking at peak and off-peak hours was tested. Disaggregated values of passenger and vehicle flows by time windows (peak and off-peak) were tested as explanatory variables, while the dependent variable was the daily count of pickpocketing. The results were inconclusive and will therefore not be included here. The effect of the varying number of passenger and buses is not consistent between morning peak and afternoon peak, or between off-peak windows. One reason could be that only 142 cells have a record of pickpocketing, out of 1,669 cells that contain some level of passenger and vehicle flow. That is, the incidence of pickpocketing is most likely to happen near certain bus stations, for example, stations in the city centre or a transfer hub. This indicates that stops located in the outskirts of the area, which contain a high number of bus passengers in the morning peak times, are not necessarily attracting pickpocketing. Another reason could be that the dependent variable is too aggregated to capture the corresponding time window that the independent variables have.

Parameter vector β is estimated via maximum likelihood using statistics package R. The results of two selected models are reported in Table 5.2, including parameter estimates, standard deviations, Z-values based on normal distribution and two-tailed p-values. All independent variables in the two models are statistically significant, supported by Z-values and p-values. The estimated α indicates how much the variance differs from the mean. The null Log-likelihood ($LL(\beta_0)$) of the model with only the intercept and the final Log-likelihood ($LL(\beta)$) with the explanatory variables are presented. The significance of the added covariates was tested by comparing $LL(\beta_0)$ and $LL(\beta)$.

The difference between the two models is that model A estimates β_1, the marginal value of passenger flow, while model B estimates β_2, the marginal value of rate of passenger flow divided by vehicle flow. Because the effect by the vehicle flow is included in model B, the rate variable is considered a better indication of the bus service. Parameters β_1 and β_2 are significantly different from 0, when controlling for the transfer hub and city centre effects. Positive β_1 in model A implies that the higher the passenger flow, the larger the number of pickpocketing incidents. Positive β_2 in model A indicates that the number of pickpocketing incidents increases with an increased rate of passenger flow divided by vehicle flow.

Positive β_3 suggests that a higher number of pickpocketing incidents happen in the cells with a transfer hub. This is expected because a large number of passengers using an interchange could create high numbers of pickpocketing incidents. It also makes sense that β_4 is negative since the city centre area is a crime attractor. The closer to the city centre, the higher the cell rank and number of pickpocketing incidents.

In summary, cells with both high passenger flow and high passenger rate per bus are associated with more pickpocketing. Overall, this means that cells that are poorly served by buses tend to generate overcrowded bus stops and are therefore more likely to be targeted by pickpockets. However, a deeper inspection of the data indicates that there are special cases to this general pattern of pickpocketing. For instance, incidents of pickpocketing are also concentrated in cells with low rates (passenger flow may be large, but because bus frequency is also high, the rate is low). These exceptions call for a detailed analysis of pickpocketing by passenger flow and rate of passengers per bus, as is explored in the following section.

Figures 5.5(a) and 5.5(b) show scatter plots with a logarithmic scale on the horizontal axis. Figure 5.5(a) depicts the number of pickpocketing incidents against passenger flow. Observations with the number of pickpocketing incidents larger than or equal to 10 are highlighted. The triangles are the cells with passenger flows larger than 1,000, and the squares are the cells with passenger flows less than or equal to 1,000. The observations marked with triangles tend to confirm the results shown in the general regression model A above. A further investigation revealed that these stops are major bus terminals. The observations marked with squares have relatively low passenger flows, yet high numbers of pickpocketing incidents. These cells are found to contain bus stops in proximity to subway stations. It is reasonable to believe that the high numbers of pickpocketing incidents associated with these bus stops is in fact affected by the high passenger flows generated by the nearby subway stations, commuter trains or the land use that characterizes these areas. Thus, pickpocketing by passenger flow is perhaps not a suitable indicator of the criminogenic conditions at these cells as they may only reveal the transportation hierarchy of the city (high pickpocketing and high passenger flows tend to be found in central areas or in the

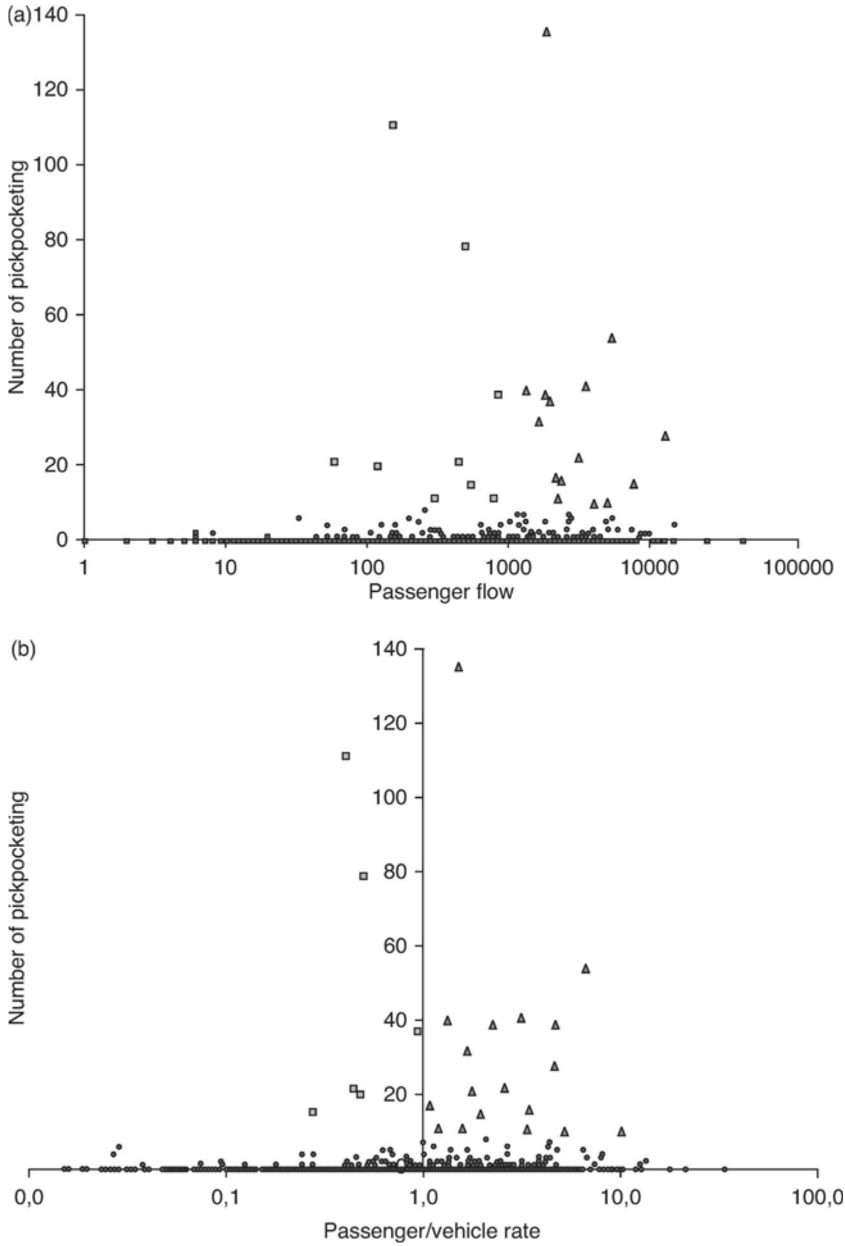


Figure 5.5 Relation between (a) pickpocketing and passenger flow by cell (b) and by rate of passenger by buses by cell

periphery locations) or the dynamics of other transportation modes (subway or commuter trains located nearby).

Figure 5.5(b) depicts the number of pickpocketing incidents against the rate of passengers per buses, where observations with numbers of pickpocketing incidents larger than or equal to 10 are highlighted. The triangles are the cells with vehicle flows less than passenger flows, and the squares are the cells with vehicle flows at least as large as passenger flows. Pickpocketing is more likely to occur in the triangle cells because bus stops are often overcrowded, offering good opportunities for thieves. Typical triangle cells contain areas such as those with bus stops around the central station's exits. In addition, there are 'overserved' cells, marked with squares. Stops in the square cells are characterized by large numbers of buses in relation to the recorded passenger flows because of their strategic locations, such as innercity areas or major intersections of arterial roads connecting different parts of the city. In these areas, the high numbers of pickpocketing incidents could be related to other types of activities in the immediate surroundings.

There is another interesting finding that links the observations with extremely large rates of passenger per bus stop and no pickpocketing. They are mostly the start/end points of some bus lines, located relatively far away from the centre (e.g. Stora Skuggan, Kaknästorg and Minneberg). Although these stops are characterized by low bus frequencies and a comparatively high numbers of passengers, thieves are not attracted to commit pickpocketing in such areas, which are predominately residential. However, this does not mean that these bus stops are not attractors for other types of crime.

Summary and conclusions

This study examines whether pickpocketing is more likely to occur in proximity to bus stops by performing an equal-stratified sampling method on urban cells of 50 by 50 metres for Stockholm, the capital of Sweden. Findings show that both the share of cells with pickpocketing and the number of pickpocketing incidents were significantly higher in cells that contain bus stops than elsewhere, as initially hypothesized. These results are also consistent with previous research in North American and British cities. Moreover, data concerning vehicle and passenger flows were analysed in order to explore the relation between bus stop intensity and pickpocketing incidents. This study corroborates the hypotheses that both the total (boarding and alighting) passenger flow and the number of passengers per bus are significantly associated with higher levels of pickpocketing incidents. The dynamics of pickpocketing may be different based on where the bus stops are located. Some are extra targeted by pickpocketing because they are underserved by buses, while others have a protective effect against pickpocketing because of the high bus frequency.

These findings indicate that the overall passenger flow levels as well as crowding levels at bus stops partially explain the variations in pickpocketing levels by cell. This analysis captures the dynamics of particular settings within a 50-by-50-metre cell – a relatively small geographical area close to bus stops. A way to 'control' for the heterogeneity of these cells was to select areas using equal-stratified sampling in combination with a Monte Carlo simulation. The sampling method was carried out without controlling for variables other than bus stop presence. In future research, the importance of bus stop attributes to explain the geography of pickpocketing has to be reassessed, taking into account other covariates at bus stops (for instance, their design, whether the bus stop is located at street level, elevated or within a terminal) and variables that indicate the complexity of land use and socioeconomic contexts in which bus stops are embedded.

In this study, two variables helped flag for differences in the dynamics of city centre versus peripheral areas (a dummy for city centre and transfer hubs). The flow of passengers (model A) and the rate of passengers per bus (model B) are still significant after controlling for these variables. New modelling strategies could be tested by splitting the dataset into two models (centre and periphery) to test whether the models work differently in the inner areas versus the outer areas. Equally important in future analysis is to consider the temporary population. A measure of tourist and/or shopper distribution over Stockholm would be helpful to better assess the effect of bus stops on pickpocketing at cell level.

The results from this study contribute to the current research on relationships between crime and transport nodes by providing empirical evidence from bus stops in a Scandinavian capital. The analysis also combines different data sources that provide a comprehensive picture of what happens in terms of flows of passengers and buses at stops using grid cells. However, the study shares limitations with other analyses of this type, namely that the data utilized in this study are limited to buses – the presence of bus stops and the corresponding bus and passenger flows. While this enables a concentrated analysis on the impact of bus-related attributes, it also hinders the evaluation of risk. For example, it was found that most of the stops that experience high pickpocketing levels while having low passenger flows are located in direct proximity to subway stations within a common transfer hub. Risk assessment will therefore result in overestimation for passengers using these stops as, in reality, the risk is shared with users of other high-capacity services as well. Moreover, it is plausible that bus stops are likely to be positioned in locations which are characterized by high pedestrian flows (and not necessarily high passenger flows), which could also contribute to higher pickpocketing levels at these cells.

Another limitation is that the analysis is based on a one-year database, which is perhaps too short a time period for drawing final conclusions on the relationship between pickpocketing levels and passenger flows. Future studies should increase the sample size to cover for instance five years of data, or the dimensions of the cells could be increased in order to reduce their number (e.g. using 100-by-100-metre square cells rather than 50 metre). Another alternative is to use a Poisson-lognormal model to avoid the problem of low sample mean (Maher and Summersgill, 1996; Lord, 2006; Ma et al., 2008). Such a model could be tested as an alternative to the current negative binomial model, as it may become unstable with a low sample mean, which was the case in this study.

For future research, one of the main challenges is to elucidate the processes through which other land use and socio-economic variables interact and influence levels of pickpocketing in bus stop cells using a long-term data series, perhaps broken down by time. This study is regarded as only an initial step in identifying what makes bus stops vulnerable to pickpocketing, taking into account passenger and bus flows.

Compared to other analytic approaches, the utilized method avoids limitations imposed by irregular arbitrary administrative zones by creating small cells of 50 by 50 metres over the study area. Data permitting, future analysis should investigate the vulnerability of bus stops during peak and off-peak hours of the day. Although tests were performed in this study, the dataset was not appropriate for creating the same peak and off-peak time windows for both independent and dependent variables. It is important to check the peak and off-peak hours as changes in people's routine activities are expected to affect bus stops differently, for example, eating in different locations, at different hours of the day, the week and seasonally.

What are the implications of the results of this study for transport planners and safety experts?

For transport planners, the results suggest that bus stops with high volumes of waiting passengers and with high rates of waiting passengers per bus are especially prone to pickpocketing. Bus stops are often used by several bus lines, which provide greater transfer and connection possibilities, but which also may result in greater crowding among passengers waiting for different bus lines. An alternative is that bus lines could be split between several bus stops along the road segment in order to mitigate pickpocketing. However, in some cases, this solution goes against standards of public transport level of service. This is particularly true in cases in which the lines serving the bus stop have a considerable overlap between their downstream destinations, as many passengers will board the first arriving vehicle. Another alternative is the division of passenger flows, particularly at bus stops at transfer hubs, by creating queues using barriers. Queues may make crowding look less chaotic and also make passengers aware of what is happening when an individual behaves differently from everyone else, for instance, by walking in the wrong direction.

For safety experts, findings support the saying that 'pickpocketing needs a crowd'. Thus, an increase in the number of buses per passenger may not only improve level of service but also promote passengers' transit safety. Putting strategies into practice requires tight cooperation between public transportation authorities, police, security companies, other stakeholders and passengers themselves. Increased security should be focused in the places and time windows where and when most thefts take place. In these buses, the presence of service hosts, security guards or police raise the offender's risk of arrest. There is also a need to create opportunities for passengers and transients to strengthen the natural surveillance of bus stops. Moreover, it is important to advise passengers to be aware and keep track of their belongings along the trip. Simple warning messages are one of the easy solutions that make it more difficult for thieves to act. This is particularly relevant for Stockholm during the summertime, when the city attracts tourists who may be unfamiliar with the public transportation settings, and may be easy targets for thieves.

In this study, police-recorded data on pickpocketing do not reveal whether the offence happened inside the bus (when the bus was parked at the bus stop), at the bus stop or on the way to/from the bus stop (a few metres from the bus stop). This uncertainty in the exact location of crime calls for a shared responsibility for safety between transportation agencies and municipal authorities. Adopting 'a whole journey approach' to safety requires clearer roles in cooperation between transportation agencies, municipalities, police and other actors. Transportation agencies often dismiss any responsibility for passengers' safety at or near a bus stop. The municipal authorities may not feel responsible for what happens around bus stops either. Instead of putting the burden on only one actor, it would be better to adopt a model of shared responsibility for safety. This fits the picture of the city of tomorrow – a city that offers a safe public transportation system and also a more sustainable one.

Appendices 5A The Dataset

Data	Definition	Source
Pickpocketing incidents	Pickpocketing (*fickstöld*), 2008	Stockholm Police Authority
Bus stop	The location of bus stops, 2013	Stockholm Public Transportation Agency (SL)
Passenger flow	Average daily number of alighting and boarding passenger, 2013	Stockholm Public Transportation Agency (SL)
Vehicle flow	Bus frequency on a weekday, 2013	Stockholm Public Transportation Agency (SL)

Appendix 5B Variables of models A and B

Model A

y_i: The number of pickpocketing incidents in cell *i*
x_i^1: The passenger flow in cell *i*
x_i^3: A dummy variable. x_i^3, If cell *i* owns a transfer hub at which more than 10,000 passengers interchange yearly; otherwise 0
x_i^4: An ordinal variable indicating the distance d_i between cell *i* and the centre cell of *Mälartorg*, which is located at the old town (*Gamla stan*). $x_i^4 = 1$ *if* $d_i < 2km$; $x_i^4 = 2$ *if* $4km < d_i \leq 2km$; $x_i^4 = 3$ *if* $d_i > 4km$. So the smaller d_i is, the higher rank *i* is.

Model B

y_i: The number of pickpocketing incidents in cell *i*
x_i^2: The rate of passenger flow divided by vehicle flow in cell *i*
x_i^3: A dummy variable. $x_i^3 = 1$, if cell *i* owns a transfer hub at which more than 10,000 passengers interchange yearly; otherwise, 0.
x_i^4: An ordinal variable indicating the distance d_i between cell *i* and the centre cell of *Mälartorg*, which is located at the old town (*Gamla stan*). $x_i^4 = 1$ *if* $d_i < 2km$; $x_i^4 = 2$ *if* $4km < d_i \leq 2km$; $x_i^4 = 3$ *if* $d_i > 4km$. So the smaller d_i is, the higher rank *i* is.

Appendix 5c Pickpocketing, flow of passengers and passengers by buses by cell

	Variable	Maximum	Mean	Std. deviation
Dependent variable	Pickpocketing incidents	136	0.66	5.64
Independent variables	Passenger flow	41101	653.36	1703.02
	Vehicle flow	22128	451.48	931.04
	Passenger\vehicle rate	33.65	1.33	1.84
	Transfer hub dummy	1	0.026	0.004
	City centre	3	2.463	0.018

Acknowledgements

We thank the Transport Administration of Stockholm County Council (SLL) and Stockholm Police Authorities for providing data for this study and for the support of the Centre for Transport Studies (CTS) at the School of Architecture and the Built Environment at the Royal Institute of Technology (KTH). We are also grateful to Marcus Felson and Ned Levine for reading a first version of this manuscript.

Note

1. An articulated bus, common in Stockholm, is about 18 metres long; thus, two articulated buses cover almost one side of the cell, half a street block in Stockholm. Another innovative aspect of this study is the use of negative binomial regression models, instead of traditional ordinary least square models, to assess the importance of passenger flow and rate of passengers per bus stop to explain the variation in pickpocketing counts by grid cell.

References

Brantingham, P. L. and Brantingham, P. J. (1995) Criminality of Place: Crime Generators and Crime Attractors. *European Journal on Criminal Policy and Research, 3*(3): 1–26.

Ceccato, V. (2013) *Moving Safely: Crime and Safety in Stockholm's Subway Stations*. Lanham, MD: Lexington Books.

Ceccato, V. and Haining, R. (2004) Crime in Border Regions: The Scandinavian Case of Öresund, 1998–2001. *Annals of the Association of American Geographers, 94*(4):807–826.

Ceccato, V. and Uittenbogaard, A. C. (2014) Space-time Dynamics of Crime in Transport Nodes. *Annals of the Association of American Geographers, 104*,131–150.

Cohen, L. E and Felson, M. (1979) Social Change and Crime Rate Trends: A Routine Activity approach. *American Sociological Review, 44*, 588–608.

Hart, T. C. and Miethe, T. D. (2015) Public Bus Stops and the Meso Environment: Understanding the Situational Context of Street Robberies. In: Ceccato, V. and Newton, A. (eds) *Safety and Security in Transit Environments: An Interdisciplinary Approach*. Basingstoke: Palgrave Macmillan.

Hirzel A. and Guisan A. (2002) Which Is the Optimal Sampling Strategy for Habitat Suitability Modelling. *Ecological Modelling, 157*(2–3), 331–341.

Jacobs, J. (1961) *The Death and Life of Great American Cities*. New York: Vintage Books.

Kooi, B. R. (2013) Assessing the Correlation between Bus Stop Densities and Residential Crime Typologies. *Crime Prevention and Community Safety, 15*(2), 81–105.

La Vigne, N. G. (1997) *Visibility and Vigilance: Metro's Situational Approach to Preventing Subway Crime*. National Institute of Justice-Research in Brief. Washington, DC: US Department of Justice.

Lemieux, A. M. and Felson, M. (2012) Risk of Violent Crime Victimization during Major Daily Activities. *Violence and Victims, 27*(5),635–655.

Levine, N. and Wachs. M. (1986) Bus Crime in Los Angeles: Measuring the Incidence. *Transportation Research A, 20*(4), 273–84.

Levine, N, Wachs, M. and Shirazi, E. (1986) Crime at Bus Stops: A Study of Environmental Factors. *Journal of Architectural and Planning Research, 3*(4), 339–361.

Lord, D. (2006). Modeling Motor Vehicle Crashes using Poisson-Gamma Models: Examining the Effects of Low Sample Mean Values and Small Sample Size on the Estimation of the Fixed Dispersion Parameter. *Accident Analysis and Prevention, 38*(4), 751–766.

Loukaitou-Sideris A. (1999) Hot Spots of Bus Stop Crime: The Importance of Environmental Attributes. *Journal of American Planning Association, 65*(4), 395–411.

Loukaitou-Sideris, A., Liggett, R. and Iseki, H. (2002) The Geography of Transit Crime: Documentation and Evaluation of Crime Incidence on and around Green Line Stations in Los Angeles. *Journal of Planning Education and Research, 22*(2), 135–151.

Loukaitou-Sideris, A, Liggett, R., Iseki, H., and Thurlow, W. (2001) Measuring the Effects of Built Environment on Bus Stop Crime. *Environment and Planning B*, *28*, 255–280.

Ma, J., Kockelman, K. M. and Damien, P. (2008) A Multivariate Poisson-Lognormal Regression Model for Prediction of Crash Counts by Severity, using Bayesian Methods. *Accident Analysis & Prevention*, *40*(3), 964–975.

Maher M. J. and Summersgill, I. (1996) A Comprehensive Methodology for the Fitting of Predictive Accident Models. *Accident Analysis & Prevention*, *28*(3), 281–296.

Newton, A. (2004) Crime on Public Transport: 'Static' and 'Non-static' (Moving) Crime Events. *Western Criminology Review*, *5*, 25–42.

Newton, A. (2008) A Study of Bus Route Crime Risk in Urban Areas: The Changing Environs of a Bus Journal. *Built Environment, 34*(1), 88–103.

Newton, A. and Bowers, K. (2007) The Geography of Bus Shelter Damage: The Influence of Crime, Neighbourhood Characteristics and Land-Use. *The Internet Journal of Criminology*. Accessed 15 February 2013, http://www.internetjournalofcriminology.com.

Sherman, L. W., Gartin, P. R. and Buerger, M. E. (1989) Hot Spots of Predatory Crime: Routine Activities and the Criminology of Place. *Criminology*, *27*(1), 27–56.

Smith, M. J. and Cornish, D. B. (2006) *Secure and Tranquil Travel: Preventing Crime and Disorder on Public Transport*. London: UCL Jill Dando Institute of Crime Science.

Tsai, L. C-F., Zhang, Y. and Hoover, L. T. (2011) Distribution of Street Robberies in Relation to Bus Stops in Houston. Paper presented 68th Annual Meeting of the American Association of Criminology, Washington, DC.

Uittenbogaard, A. C. (2015) The Nature of Guardianship Opportunities in Underground Stations. In: Ceccato, V. and Newton, A. (eds) *Safety and Security in Transit Environments: An Interdisciplinary Approach*. Basingstoke: Palgrave Macmillan.

Weisburd, D., Groff, E. R. and Yang, S. M. (2012) *The Criminology of Place: Street Segments and Our Understanding of the Crime Problem*. New York: Oxford University Press.

Yu, S. V. (2009) Bus stops and crime: Do bus stops increase crime opportunities in local neighborhoods? Doctoral dissertation. Newark, NJ: Rutgers University.

6

In and Around: Identifying Predictors of Theft within and Near to Major Mass Underground Transit Systems

Andrew Newton, Henry Partridge and Andy Gill

Introduction

This study analyses theft of personal property offences on the London Underground (LU). This major mass transit system carries over 1,000 million passenger per year, and experienced 5,063 theft offences in financial year 2011/2012 (BTP, 2013). Whilst this represents a rate of only four thefts per million passenger journeys, theft is a key offence type on the LU. Indeed, as a proportion of all offences, over half were for theft. This chapter examines a specific type of theft offence, what Smith (2008) termed stealth crimes, for example, pickpocketing. It excludes snatching and other theft types. For these stealth offences, victims are often unaware items are stolen, only discovering them missing at a later date, on transit journeys usually somewhere else on the transit line. As the location of many of these thefts is unknown, an innovative methodology is used to better estimate the locations of theft on transit stations. This is termed Interstitial Crime Analysis (ICA) and is described in detail by Newton et al. (2014).

This research builds on the Newton et al. (2014) study of the spatial patterns of theft on the LU that found the following: theft was concentrated at a small number of stations; positive correlations existed between theft at three settings, 'below ground', 'at' stations, and, in 'nearby' surroundings of stations; and these correlations were most prominent at peak travel times. A key question that arose in the previous study, which this chapter attempts to address is, what are the explanations for these patterns of theft observed on the LU?

This chapter aims to identify predictor variables of theft on the LU at two distinct settings: within underground rail stations and in the nearby surroundings of stations. The key questions are, what predictor variables influence theft on the LU, and is there any evidence of a transmission of theft risk between these internal and external settings? Theoretical explanations and previous studies (for overviews, see Smith and Clarke, 2000;

Smith and Cornish, 2006; Newton, 2014) suggest three possible interrelated explanations for theft on transit systems: the presence of transit systems are themselves a system cause of theft; stations act as generators/attractors of theft; and stations serve as a type of 'risky facility'.

Theoretical background

The presence of transit systems may help shape the crime patterns of urban areas (Piza and Kennedy, 2003). Stations act as a focal point, the entrances and exit to the system, and the interchanges connecting different journeys. During peak travel times they concentrate a number of persons together in small spaces, while at other times stations are isolated with fewer users. The presence of a transit station may create opportunities for offending at particular locations at certain times of the day. Therefore, the first question is whether the transit system itself creates opportunities for theft, driven by passenger movement and passenger journeys.

Attractors and generators

Stations may serve as attractors or generators of crime (Brantingham and Brantingham, 1995). Crime attractors are places offenders visit due to known expected opportunities for crime, for example, liquor stores, pawn brokers, drug treatment centres, homeless shelters, and liquor clubs (Rengert et al., 2005; McCord et al., 2007). Generators are settings whereby a number of persons are channelled together, resulting in unplanned but favourable conditions for crime, for example, high schools, football stadiums and parks (Groff and McCord 2012). Kurland et al. (2014) states that football stadiums (although this could equally apply to underground stations) may act as mostly a crime attractor, mostly a crime generator, or simultaneously as a crime generator/crime attractor. However, attractors and generators are difficult to quantify, a point returned to later in this chapter. The second question to be explored is therefore whether stations act as an attractor or generator of theft, or both?

Stations may also act as 'risky facilities', a term used to describe similar land features such as bars or hospitals, or in this case underground rail stations, whereby most of the crime at these facilities occurs at only a minority of them (Eck et al., 2007). Explanations for the presence of risky facilities are centred on the mobility of urban areas, determined by the geometry and patterns of crime (Brantingham and Brantingham, 1993). Offenders and victims have daily movement patterns termed routine activities (Felson and Cohen, 1980), and movement is concentrated at favourite activity nodes, for example, based on work, leisure, or recreation activities. Risky facilities are often located at these activity nodes. Travel between nodes occurs along distinct routes (paths) constrained by obstacles (barriers) to movement, and offenders increase their knowledge of suitable opportunities to offend during their routine activities. On transit systems there may be certain nodes (stations) and paths (railway lines) that users favour. It is suggested that the presence or absence of certain features along these paths and at these nodes may encourage or deter offenders. A third question is therefore, what characteristics of stations and their nearby surroundings influence opportunities for theft?

All three theoretical standpoints propose that high-crime stations will be located in high-crime areas, and low-crime stations in low-crime areas. This suggests crime is a product of its wider environment, and Block and Block (2000) usefully term these nearby surroundings the 'environs' of rapid transit. However, the research evidence here is unclear. Not all stations in high-crime areas experience high levels of crime. Some studies suggest a well-designed transit station can insulate itself from crime in the wider environment (Clarke et al., 1996; La Vigne 1996), while others argue high-crime stations are situated in high-crime areas (Block and Block, 2000; Loukaitou-Sideris et al., 2002; Ceccato et al., 2013, Newton et al., 2014). Few studies have examined this relationship between crime in a station and near to a station, explicitly for theft. La Vigne's (1996) study found Part I offences (including the subcategory of theft) were not correlated with their external environment. However, theft could not be isolated here from other Part I crimes, and thus findings here for theft alone may be skewed by other crime types.

Bowers (2013) examined whether crime risk transfers between the internal and external settings of risky facilities, and hypothesized risky facilities may act as radiators of crime, as the primary driver of risk radiating risk to the nearby surroundings, or as absorbers of crime, soaking up crime from the surrounding environment. The study found risky facilities were more likely to act as radiators, although it did not include transit facilities in the analysis. Underground stations are a unique type of risky facility, a 'true' radiator, connected by underground lines (pipes) that can be entered and exited from their external environs, or underground via a different station. A final research question is therefore whether there is a transfer of theft risk between the internal settings of underground stations and their surrounding environs, and vice versa. The following research questions were devised for this study:

1. What are the predictor variables of theft on the LU?
2. Is theft on the LU influenced by both internal design characteristics (within stations) and the external settings near to stations (external features)?
3. Is there evidence of a transmission of theft risk between the internal settings of underground rail stations and their nearby external environs?

Theft on transit systems

Theft on underground stations has been shown to be non-uniform in time and space, concentrated at particular stations and peak times of the day (Loukaitou-Sideris et al., 2002; Ceccato et al., 2013; Newton, 2014). Theft concentrates at busy stations during the early morning and afternoon rush hour periods. However, high passenger numbers and nearby high theft levels alone do not provide a sufficient explanation of theft. Additional predictor variables present both inside stations (internal characteristics) and in their nearby surroundings (external features) are required to better explain theft levels on underground transit systems, and previous literature on potential mechanisms of theft on transit systems identified a number of possible predictor variables of theft.

Newton et al. (2014) summarized a number of mechanisms that may act as predictor variables for theft at transit stations. For this study, these are grouped into the following classifications: high densities of people clustered together in small spaces; a lack of user knowledge about the system; the ease of passenger distraction; the accessibility and ease of access to and exit from stations; anonymity of offenders; barriers to movement between and within stations; and staffing, protection and guardianship. These are not mutually exclusive. For example, high passenger density offers natural anonymity and reduced likelihood of detection. Moreover, individual predictor variables such as paid control gates, better lighting or the presence of closed-circuit television (CCTV) may impact on more than one of the above classifications.

Stations may act as a crime generator or attractor, although few have attempted to quantify the differences between these. Perhaps a useful starting point here is offered by Clarke and Eck (2003): crime generators are defined as having a high count of crime but a low rate per population, and crime attractors as experiencing a high count and rate of crime, a point returned to later in this chapter.

This is further complicated as additional features near to a station may also be a crime attractor or generator. Whilst some studies have examined attractors and generators near to risky facilities (Groff et al., 2010), few have examined this specifically for transit stations. Bernasco and Block (2011) investigated the influence of crime generators, crime attractors and offender anchor points on robbery near to rail stations and found that pull factors such as crime generators increased the transient population of an area and therefore increased risk; that blocks with attractors/generators of crime elevated crime risk in adjacent blocks; and that push factors such as the presence and proximity of a motivated offender's anchor point increased risk. Again, the authors did not distinguish between features that served as crime attractors and those that were crime generators.

Groff and McCord (2012) examined generators around parks and found that elevated levels of crime near to parks increased risk inside parks; that both the internal and external settings of parks influenced risk; and that features serving as activity generators inside parks reduced crime. Parks with more activity generators, generally the larger parks, had more legitimate users, more capable guardians and therefore less crime. However, not all activity generators increase legitimate users. At transit stations more activity generators may not reduce theft. Increased numbers of users may actually increase targets but also disguise offenders. Loukaitou-Sideris et al. (2002) term this a second level population density: as passenger levels increase, a certain density (first level) may be reached that encourages some violent crimes; beyond this, even higher passenger densities (second level) may actually promote some lower level crimes such as pickpocketing.

Outside of parks, Groff and McCord found increased levels of mixed land use near parks reduced crime levels by increasing 'eyes on the street', consistent with the work of Jacobs (1961). However, as discussed by Browning et al. (2010), mixed land use may also increase crime prevalence due to territorial impacts, reducing informal levels of social control, consistent with Newman (1973). For this chapter, land use near to stations will be tested as an external predictor variable of theft, as this may serve to increase or potentially reduce theft levels.

Data and methodology

This study uses data from a range of sources, including data on theft within and near to stations, and possible predictor variables of theft, both inside stations (internal characteristics) and near to stations (the external environment).

Crime data

On the LU, stations are policed by the British Transport Police (BTP) and their external environs by the Metropolitan Police Service (MPS) and City of London Police (CoLP). Data was obtained from all three organizations for the 12-month period 1 April 2011 to 31 March 2012 for the following codes: Home Office (HO) codes shoplifting (HO classification 46), theft person (HO classification 39) and theft other (HO Classification 49); and BTP codes theft luggage (J02), theft personal property (J03), theft from the person (J04) and shoplifting (J22).

Theft data was captured for the internal setting, within stations, and the external environs near to stations. For theft at stations, the BTP theft data was separated into thefts 'at' stations with a known location, and theft that happens as part of a transit journey (with an unknown location). The latter was measured using the ICA measure to estimate likely locations of underground theft during transit journeys. A 400m buffer zone around stations was used for the external environs near to stations, a distance shown from previous studies to be appropriate (Newton et al., 2014). Additional crime data for other crime types which may influence theft levels were captured at census ward level as they were not available within the 400m buffer for this study.

Interstitial Crime Analysis (ICA)

A difficulty in analysing pickpocketing offences is that time and location are often unknown: theft may have occurred at or between several stations traversed during a transit journey. The innovative ICA technique (Newton et al., 2014) generates probability estimates of the likely locations of theft on underground journeys using the following procedure.

Taking a hypothetical model, if pickpocketed passenger 'X' travels from station A to station C, and changed at station B, then there are five 'sections' of this journey at which theft may have occurred (station A; segment A to B; station B; segment B to C; and station C). The risk at each of the five sections is assigned a value of 0.2. If a second victimized passenger 'Y' travels from station A to C and did not change at B, the risk is 0.25 at each section of the journey (station A; segment A to B; segment B to C; station C). If passenger 'Z' travels from station A to B, the risk at each section is 0.33 (station A; segment A to B; and station B). The ICA then generates a cumulative risk for each station and for each segment, based on the possible pickpocketing offences for passengers X, Y and Z combined. For this chapter an ICA score was calculated for each station and station segment using 5,063 theft offences on the LU. An ICA score for each station was generated. This was further standardized as a rate (ICA adj*), by dividing the ICA score by the number of annual passenger journeys at each station.

Predictor variables

A range of station features were selected as potential 'internal' predictor variables of theft, including station age and depth, gates and validators, ticket machines, lifts and escalators, amenities, staffing levels and number of platform (Table 6.1). An OLS regression model revealed these variables were highly correlated with each other, and therefore some variables were removed to avoid multi-collinearity errors (Table 6.1). A second OLS regression model confirmed those selected for further analysis were within acceptable statistical levels (VIF< 3.5, Tolerance >0.25).

A range of potential 'external' predictor variables for theft were identified from the environs of stations, including socio-demographic data, accessibility measures based on roads and paths, nearby crime levels, and local land use (Table 6.2). An OLS regression model was again used to remove any highly correlated variables. As a final stage, a third OLS model combining both the internal and external predictor variables was generated, and any

Table 6.1 Potential predictor variables of theft – internal station settings

Predictor	Influence	Selection
Supplied by TfL		
Passenger journey (per million passengers)	CD	Offset variable
N electric gates (new version)	BM	Y
N pneumatic gates	BM	NMC
N electric gates (old version)	BM	NMC
N manual gates	BM	NMC
N manual gates (1 off type)	BM	Y
N wide aisle gates	BM	NMC
N passenger validators	BM	Y
N ticket halls	FCG	Y
N waiting rooms	FCG	Y
N cash machines	FCG	Y
N shop rentals	FCG	Y
N kiosk rentals	FCG	Y
Station age (years)	FCG	Y
Cycle racks (Y/N)	FCG	Y
Control room visible to passengers (Y/N)	FCG	Y
Toilets (Y/N)	FCG	NNS
N lifts where primary access	CA	Y
N lifts where secondary access	A	Y
N non-station lifts	A	NNS
N stair lifts	A	NMC
N escalators	A	Yes
N passenger conveyors	A	NMC
Station depth: average platform depth (m)	A	Y
N tube platforms	CA	NMC
N surface platforms	CA	Y
N sub-surface platforms	CA	Y
N island platforms	CA	NMC
Estimated staffing levels (number)	D	Y
Supplied by BTP		
At station theft personal property: J04	OA	Y
At station shoplifting: J03	OA	Y
At station theft other: J22	OA	Y

Predictor: N = Number of Influence: CD = Congestion/Detection; BM = Barrier to Movement; FCG = Facilities/Congestion/Guardianship; CA = Congestion/Accessibility; A = Accessibility; DG = Detection/Guardianship; OA = Offender Activity.

Selection: Y = Yes; NNS = No, not significant, NMC = no, multi-collinearity.

Table 6.2 Potential predictor variables of theft – external nearby settings

Predictor	Source	Influence	Selection
Crime	GLUD unless stated		
Nearby station shoplifting (<400m)	MPS/CoLP	OA	Y
Nearby station other theft (<400m)	MPS/CoLP	OA	Y
Theft and handling rate (census ward)		OA	NNS
Robbery rate (census ward)		OA	NNS
VAP rate (census ward)		OA	Y
SES characteristics (census ward)			
Population density		DC	NNS
Average house prices		SES	NNS
Index of Multiple Deprivation Score	ONS	FCG	NNS
LU- % domestic buildings		FCG	Y
LU- % domestic gardens		FCG	NMC
LU-% non-domestic buildings		FCG	NMC
LU- % green space		FCG	NMC
LU-% roads		A	Y
LU- % rail		A	NMC
LU- % paths		A	Y
LU – % other land use		FCG	Y
% claiming incapacity benefits		FCG	NMC
% claiming income support		FCG	Y
% of unauthorized school absence		FCG	Y
% of young persons (<16)		M	Y
% working persons		M	NMC
% old		M	Y

Predictor: LU = Land Use

Source: MPS = Metropolitan Police Service; CoLP = City of London Police; GLUD = Generalized Land Use Database; ONS = Office National Statistics

Influence: CD = Congestion/Detection; BM = Barrier to Movement; FCG = Facilities/Congestion/Guardianship; CA = Congestion/Accessibility; A = Accessibility; DG = Detection/Guardianship; OA = Offender Activity

Selection: Y = Yes; NNS = No, not significant, NMC= no, multi-collinearity

highly correlated variables were removed before further analysis. The variance inflation factor and tolerance scores revealed variables selected for further modelling were appropriate.

A third possible theft predictor variable of theft, in addition to the internal and external predictor variables is 'station type', and this was captured and classified using three methods. The first was based on fare zone ranging from zone 1 to zone 6; stations in zone 1 are in the centre of the LU network, those in zone 6 on the outskirts. The second was a TfL classification of primary usage and location, namely, 'City'; 'Inner Suburb'; 'Outer Suburb'; 'Shopping'; 'Terminus'; and 'Tourist'. The third method was an attractor/generator index (AGI) developed specifically for this chapter.

Preliminary analysis found considerable variation when comparing stations which experienced high counts of theft, and those stations which had high rates of theft (per million passenger journeys). Only ten stations were in the top twenty of all LU stations for both theft counts and theft rates. Furthermore, there was also considerable spatial variation in high-risk stations by time of the day. Therefore the AGI was developed to separate stations into possible crime attractors (with high counts and rates of theft) and potential crime generators (with high counts of theft only). These were also subdivided further by those that experienced high rates of theft at all times of the day; high theft rates but only at certain times of the day; and, low theft rates.

Theft offences were broken down into six time periods: early (02.00–06:59); morning peak (07.00–09:59); inter-peak (10.00–15:59); afternoon peak (16.00–18:59); evening (19.00–21:59); and late (22.00–01:59). For all stations, ICA and ICA adj* scores were calculated, across each of the six time periods. The AGI score devised was then used to classify stations into six types: AGI_1, high theft counts at all time periods; AGI_2, high theft rates at all time periods; AGI_3, high theft counts and high theft rates at all time periods; AGI_4, intermittently high theft counts and rates (at some but not all times of the day; AGI_5, intermittent medium theft rates and counts; and AGI_6, low risk of theft counts and rates.

Modelling

A series of negative binomial Poisson regression models was constructed. The dependent variable was theft at stations measured using the ICA, and this was regressed against a series of potential internal and external predictor variables. Preliminary analysis of the distribution of the ICA scores based on cumulative count data revealed this was highly skewed and over dispersed. Therefore negative binomial Poisson regression models were deemed appropriate (Hilbe, 2011) as used in a number of studies (Osgood, 2000; MacDonald and Lattimer, 2010; Bernasco and Block, 2011).

Six models were constructed: model 1 considered internal characteristics, model 2 external features and model 3 combined internal and external variables. Three additional models were generated (4–6) to incorporate station type into the analysis, using fare zone, TfL classification and the AGI score.

The negative binomial Poisson models use theft counts rather than rates. The population at risk is accounted for through the use of an exposure measure, the offset variable. In this analysis, annual per million passenger journey counts at each station were used as the offset variable. Therefore passenger levels which may influence theft levels (Ceccato et al., 2013; Newton et al. 2014) are included in the model but not as a direct predictor variable. The procedure for generating each model was the following: enter each predictor variable one at a time, significant variables are kept, and none significant variables are removed at each iteration stage. This was repeated for all predictor variables. At the end of this procedure, none significant variables are re-entered into the model to check whether they influence the final model and are re-included if significant.

Results and discussion

Model 1 examined internal predictors of theft (Table 6.3), and variables found to have a statistically significant positive relationship with theft were the number of lifts that are primary means of access to platforms and the number of waiting rooms. Negative relationships were found for station depth, the number of electronic gates, and the number of platforms. In model 2 (Table 6.3) external variables found to positively influence theft were the percentage of roads and paths near to stations, and high levels of theft nearby. Negative relationships were found between theft and more domestic buildings nearby, and high levels of violence against the person near to stations. The log likelihood, BIC and AIC values in models 1 and 2, showed they were both better predictors of theft than the baseline model 0 (stations offset by passenger numbers with no predictor variables).

Model 3 combined both internal and external predictor variables of theft into a single model (Table 6.3). The log likelihood, AIC and BIC scores, revealed model 3 was a better predictor of theft than models 1 and 2. There were some differences in identified predictor variables. In model 3, variables found to have a negative correlation with theft included station depth; the number of personal validators; staffing levels; the number of platforms; and more domestic buildings nearby. Variables shown to significantly increase theft were the number of lifts which are primary access to platforms; waiting rooms; the percentage of roads and paths in nearby environs; and increased theft levels in the surrounding area.

Models 4 to 6 incorporated station classification into the analysis. Fare zone was found to be none significant and removed. Model 4 analysed the TfL classification of station type, and model 5 examined the AGI values. Model 6 combined TfL classification and AGI values (Table 6.4). In model 4 a significant positive relationship was found between theft and stations classed as 'tourist', and a negative relationship with 'terminus' stations. In model 5 a positive relationship was found between theft and AGI_3 stations (possible crime attractors), and a slightly negative relationship with AGI_5 stations (with intermittent medium levels of theft only at some times of the day). AGI_1 stations (possible crime generators) were also slightly positively correlated with theft. The final model (6) combined all three measures, the internal and the external predictor variables and station typology. The log likelihood, ACI and BCI scores revealed model 6 was a better predictor of theft than all previous models.

From model 6 it was evident that predictor variables that reduce the risk of theft are higher numbers of staff, personal validators, platforms, and shop rentals; more domestic buildings nearby; and stations classified as terminus

Table 6.3 Regression analysis: internal and external characteristics of stations and theft

	Model 1: Internal Only			Model 2: External			Model 3: Internal and External		
Predictor variable	**B**	**SE**	**Sig**	**B**	**SE**	**Sig**	**B**	**SE**	**Sig**
Approximate age	0	0.002					–	–	
Station depth	–0.01	0.003	***				–0.006	0.003	**
Electronic gates	–0.036	0.009	***				–	–	
Manual gates	–1.53	0.844	*				–1.14	0.793	
Personal validators	–0.031	0.018	*				–0.036	0.017	**
Lifts (primary access)	0.118	0.049	**				0.111	0.045	**
Lifts (secondary access)	0.063	0.042					0.04	0.036	
Staff levels (estimated)	–0.008	0.007					–0.016	0.005	***
Sub–surface platforms	–0.168	0.06	***				–0.107	0.054	**
Surface platforms	–0.167	0.049	***				–0.136	0.046	***
Ticket halls	–0.054	0.13					–	–	
Waiting rooms	0.151	0.08	*				0.141	0.079	*
Shop rentals	–0.005	0.011					–0.013	0.011	
Kiosk rentals	–0.054	0.062					–	–	
Cycle racks	–0.192	0.107	*				–	–	
Control room	–0.127	0.104					–	–	
At station thefts	–0.005	0.007					0.001	0.006	
Domestic buildings				–0.047	0.015	***	–0.031	0.012	***
Road				0.043	0.014	***	0.039	0.012	***
Path				0.22	0.062	***	0.247	0.055	***
Other land uses				–0.017	0.012		–0.011	0.011	
Children				0.003	0.017		0.013	0.014	
Elderly				0.008	0.023		0.028	0.019	
% Claim income support				–0.034	0.032		–0.026	0.025	
% Unauthorized school Absence				–0.037	0.187		–	–	
Violence rate				–0.002	0.001	**	–	–	
Shoplifting < 250m				–0.009	0.009		–0.007	0.008	
Theft person < 250m				0.013	0.007	**	0.011	0.006	*
Other theft < 250m				0.002	0.01		–0.006	0.008	
Constant	1.125	0.373		–0.968	0.59		–0.607	0.632	
minus 2*LOG(lh)	1024.97			1023.42			944.258		
AIC	1170.532			1120.520			1031.237		
AICC	1173.313			1122.213			1036.149		
BIC	1172.56			1165.158			1106.779		

Note: ***99% significance; **95% significance, * 90% significance.

Table 6.4 Regression analysis: internal and external characteristics of stations, station classification and theft

	Model 4			Model 5			Model 6		
Predictor variable	**B**	**SE**	**Sig**	**B**	**SE**	**Sig**	**B**	**SE**	**Sig**
Station depth	–0.003	0.003		–0.005	0.003	*	–0.003	0.003	
Manual gates	–1.218	0.766		–1.002	0.771		–1.107	0.753	
Personal validators	–0.025	0.016		–0.035	0.016	**	–0.027	0.015	*
Lifts (primary access)	0.103	0.041	**	0.084	0.044	*	0.07	0.04	*
Staff levels	–0.018	0.005	***	–0.013	0.004	***	–0.016	0.004	***
Sub-surface platforms	–0.109	0.056	**	–0.147	0.052	***	–0.094	0.053	**
Surface platforms	–0.101	0.044	**	–0.111	0.045	**	–0.087	0.043	**
Waiting rooms	0.128	0.075	**	0.139	0.077	*	0.13	0.074	*
Shop rentals	–0.011	0.009		–0.027	0.01	***	–0.02	0.009	**
At station thefts	–0.001	0.005		0.017	0.007	**	0.012	0.006	**
Domestic buildings	0.033	0.016	**	–0.028	0.012	**	–0.018	0.01	*
Roads	0.014	0.011		0.033	0.012	***	0.021	0.011	**
Paths	0.138	0.052	***	0.217	0.052	***	0.131	0.049	***
Other land uses	–0.005	0.01		–0.016	0.011		–0.009	0.011	
Children	0.007	0.011		0.016	0.011		–0.011	0.011	
Elderly	–0.008	0.011		0.257	0.183		0.023	0.019	
Shoplifting <250m	–0.014	0.008	**	–0.004	0.008		–0.009	0.007	
Theft Person < 250m	0.012	0.005	***	0.009	0.006		0.01	0.005	**
Other Theft < 250m	–0.007	0.007		–0.012	0.008		–0.013	0.007	*
AGI1	0.304	0.181	*	–	–		0.207	0.174	
AGI2	0.066	0.174		–	–		0.064	0.169	
AGI3	0.91	0.151	***	–	–		0.811	0.147	***
AGI4	0.083	0.14		–	–		0.079	0.134	
AGI5	–0.219	0.118	*	–	–		–0.21	0.117	*
Tourist				0.246	0.181		0.351	0.163	**
Shopping				0.021	0.203		0.088	0.181	
Inner suburb				0.027	0.196		0.271	0.18	
Outer suburb				–0.286	0.23		–0.001	0.22	
Terminus				–0.955	0.297	***	–0.55	0.276	**
Constant	–0.855	0.602	–1.42	–0.689	0.636		0.057	1.125	0.050
minus 2*LOG(lh)		893.594			919.17			868.13	
AIC		964.9068526			989.283			947.472	
BIC		1050.749903			1075.126			1050.484	

Note: ***99% significance; **95% significance, * 90% significance.

stations. Potential explanations here are the following: validators may reduce offender anonymity; increased staffing levels may increase possible detection and reduce anonymity of offenders; more platforms at stations may disperse passengers throughout the station and therefore victims are less concentrated; and, nearby domestic buildings might encourage more guardianship, or users may be familiar with the station and use it regularly thus be more aware of suspicious offender activity.

Factors that increased the risk of theft below ground included the number of lifts which are primary means of access to platforms; the number of waiting rooms; theft 'at' stations; the percentage of roads and paths in the nearby environs; nearby levels of theft; and stations identified as crime attractors. Potential explanations here are that lifts and waiting rooms may concentrate persons in confined spaces; more roads and paths may increase accessibility and/or increase the movement of persons to and away from an area; and high levels of theft nearby, consistent with Newton et al. (2014), indicate a likely transmission of risk from inside a station to its external environs, and vice versa. Moreover, model 6, which incorporated internal characteristics, external variables and station typology, was a better predictor of theft than other models, suggesting there is an interaction between the internal and external features that influence theft, and, therefore, it is argued that a transmission of theft risk does exist between underground stations and their nearby environs.

There are a number of potential limitations with this analysis. The ICA technique may not accurately estimate likely locations of risk as it assumes that the risk at a segment between two stations, and the risk at a station are equal. Suggestions for future refinement of the ICA method are provided by Newton et al., (2014). The AGI index could also be further refined and tested. The predictor variables used may not include all relevant variables, and external predictors are aggregated using census wards, which may not be representative of station environs. Recorded crime data is subject to under-reporting, although it is contended under-reporting of theft is likely to be a universal problem across the entire LU, not skewing the ICA scores by individual stations. The analysis is based on the LU network, and there may be errors due to spatial auto-correlation. However, although the ICA scores are subject to a high degree of spatial auto-correlation, an examination of the ICA adj* (standardized per million passenger journeys) did not find such errors. The negative binomial Poisson regression models are offset by the passenger data, and thus it is not thought spatial auto-correlation errors are present.

Conclusion

This chapter examined potential predictor variables of theft selected from the 'internal' settings of stations and their nearby 'external' environs. It combined the use of the innovative ICA measure for predicting underground theft at unknown locations and times, with negative binomial Poisson regression models to identify predictor variables of theft on the LU. Factors found to increase risk of theft were those that may encourage congestion of passengers within stations (lifts and waiting rooms), and those that increase levels of accessibility and access to stations (more paths and roads nearby). In contrast, those that reduce theft were those likely to decrease anonymity and increase potential guardianship and offender detection (higher levels of staffing, personal validators, shop rentals, and more domestic buildings nearby), and those that disperse passengers throughout the station and avoid congestion (more platforms). Stations with higher theft levels in their surrounding environs, those identified as crime attractors (high theft counts and high theft rates) and stations with high levels of tourist use were at greater risk. Terminus stations were at lower risk.

Policy implications and future research avenues

The evidence presented in this chapter suggests offenders operate both inside the LU and near to underground stations. Indeed, even if different offenders are in operation at these two settings, at peak travel times this elevated risk occurs both within and near to high-risk stations, thus deployment of resources, joint operations and shared intelligence between BTP, MPS and CoLP should be encouraged. The ICA technique can assist in identifying the location and times of high-risk stations, and deployment at these times and places should focus on both settings, within stations and in their nearby environs, as both are subject to elevated risk levels.

This chapter presents evidence of a transmission of theft risk between the internal and external environments and vice versa, and therefore it is likely that barriers to movement between these settings (for example, paid access gates) are perhaps not effective at deterring pickpocketing offenders. An explanation offered by Newton et al. (2014) is that offenders are able to travel 'unregistered' on the LU using Oyster cards (plastic prepaid travel cards) and all-day travel cards, which can be bought with cash at automated machines. These travel cards are inexpensive for all-day travel, and the price of travel may be small compared to the potential rewards of successful and undetected theft activity.

The findings of this chapter present a range of potential design solutions. For example, increased accessibility outside stations and increased congestion within stations increases theft risk. However, any design alterations such as restricting accessibility may increase other crime types on the LU, or indeed impact negatively on the user's experience and feelings of safety. Moreover, features that increase or reduce theft risk are present both within the internal settings and in the nearby environs of stations, and thus measures that address only internal or only external risk factors in isolation may not be effective in reducing theft.

Further avenues for research

The ICA technique should be further refined to better assign risk at stations and segments, for example, based on journey time, platform length, carriage capacity or other possible weightings of risk. A number of additional variables not currently captured could be incorporated into the model, for example, line of sight, visibility, lighting and CCTV. Better measures of nearby predictor variables could also be captured, for example, within

250m of a station as opposed to entire census ward areas. Accessibility and congestion could be modelled using CCTV data, for example, to compare high- and low-risk stations for theft by different times of the day. The AGI index should also be refined, to develop better measures of crime attractors and crime generators for studies that examine crime at risky facilities.

The ICA technique allows identification of stations that experience high and low levels of theft. This could be used to identify stations for further fieldwork, capturing information on the individual settings within a station, for example, on platforms, on stairwells and escalators, to advance knowledge of which sections within a station are more at risk, and at which time of the day or the day of the week. The ICA technique could also be used to evaluate the impact of prevention activity, for example, deployment of plain-clothed and uniformed officers could be monitored and compared. The analysis presented here considers two settings, inside and near to stations. Stations could be further subdivided. For example, Ceccato et al. (2013) identified the following: the immediate vicinity; exits and entrances; lounges; transition areas; and platforms, and Newton et al. (2014) identified four alternative settings: near to but outside a station; inside a station but before the paid barrier control; within a station inside the paid barrier control, including platforms, escalators and lounges; and on carriages themselves. It may be useful to examine theft against these more detailed settings in a refined model.

Finally, this study does not consider the items stolen. It may be useful to study theft offences by the type of property, as the increasing use of mobile technology and smartphones may be attractive to offenders, as a primary or secondary target, as opposed to wallets, purses and their contents. There may be different patterns observed by type of product stolen. Additionally changes to the network may impact on theft. For example, current proposals on the LU to close three out of four ticket offices, extend services to 24 hours and increase Wi-Fi coverage on the network may actually impact on theft and/or other crime levels. Careful consideration should be given to the management of stations if such changes are introduced.

References

Bernasco, W. and Block, R. (2011) Robberies in Chicago: A Block-Level Analysis of the Influence of Crime Generators, Crime Attractors, and Offender Anchor Points. *Journal of Research in Crime and Delinquency*, *48*(1), 33–57.

Block, R. and Block, C. (2000) The Bronx and Chicago: Street Robbery in the Environs of Rapid Transit Stations. In: Goldsmith, V., McGuire, P., Mollenkopf, J., and Ross, T. (eds) *Analyzing Crime Patterns; Frontiers of Practice*. Thousand Oaks, CA: Sage Publications: 137–152.

Bowers, K. (2013) Risky Facilities: Crime Radiators or Crime Absorbers? A Comparison of Internal and External Levels of Theft. *Journal of Quantitative Criminology*. Advance Access September 2013 . DOI 10.1007/s10940–013–9208-z.

Brantigham, P. and Brantingham, P. (1993) Environment, Routine and Situation: Toward a Pattern Theory of Crime. In: Clarke, R. and Felson, M (eds). *Routine Activity and Rational Choice. Advances in Criminological Theory* Vol. 5. New Brunswick, NJ: Transaction Publishers, 259–294.

Brantigham, P. and Brantingham, P. (1995) Criminality of Place: Crime Generators and Crime Attractors. *European Journal on Criminal Policy and Research*, *3*(3), 5–26.

British Transport Police. (2013) Statistical Bulletin 2012/13 http://www.btp.police.uk/pdf/Statistical-Bulletin-2013.pdf, accessed 4 August 2013.

Browning, C., Byron, R. Calder, C., Krivo, L. Kwan, M, Lee, J, and Peterson, R. (2010) Commercial Density, Residential Concentration, and Crime: Land Use Patterns and Violence in Neighborhood Context. *Journal of Research in Crime and Delinquency*, *47*(3), 329–335.

Ceccato, V., Uittenbogaard, A. and Bamzar, R. (2013) Security in Stockholm's Underground Stations: The Importance of Environmental Attributes and Context. *Security Journal*, *26*, 33–59.

Clarke, R., Belanger, M. and Eastman, J. (1996) Where Angels Fear to Tread: A Test in the New York City Subway of the Robbery/Density Hypothesis. In: Clarke, R. (ed.), *Preventing Mass Transit Crime*. Crime Prevention Studies, Vol. 6, Monsey, NY: Willow Tree Press, 217–236.

Clarke, R. V. G. and Eck, J. E. (2003) *Become a Problem Solving Crime Analyst in 55 Small Steps*. London, UK: Jill Dando Institute, University College London.

Eck J. E., Clarke R. V. and Guerette, R. T. (2007) Risky Facilities: Crime Concentration in Homogeneous Sets of Establishments and Facilities. In: Farrell, G., Bowers, K., Johnson, S. D. and Townsley, M. (eds) *Crime Prevention Studies*, Vol 21, Monsey NY: Criminal Justice Press, 225–264.

Felson, M. and Cohen. L. (1980) Human Ecology and Crime. A Routine Activity Approach. *Human Ecology*, *8*(4), 389–406.

Groff, E. and McCord, E. (2012) The Role of Neighborhood Parks as Crime Generators. *Security Journal*, *25*(1), 1–24.

Groff, E., Weisburd, D. and Yang, S. (2010) Is It Important to Examine Crime Trends at a Local Micro Level? A Longitudinal Analysis of Street to Street Variability in Crime Trajectories. *Journal of Quantitative Criminology*, *26*(1), 7–32.

Hilbe, J. M. (2011) *Negative Binomial Regression*. Cambridge: Cambridge University Press.

Jacobs, J. (1961) *The Death and Life of Great American Cities*. New York: Vintage Books.

Kurland, J. Johnson, S. and Tilley, N. (2014) Offenses around Stadiums: A Natural Experiment on Crime Attraction and Generation. *Journal of Research in Crime and Delinquency*, *51*(1), 5–28.

La Vigne, N. (1996) Safe Transport: Security by Design on the Washington Metro. In: Clarke, R. V. (ed.), *Preventing Mass Transit Crime*. Monsey, NY: Criminal Justice Press, 163–197.

Loukaitou-Sideris, A., Liggett, R. and Hiseki, I. (2002) The Geography of Transit Crime: Documentation and Evaluation of Crime Incidence on and around the Green line Stations in Los Angeles, *Journal of Planning Education and Research*, *22*(2), 135–151.

McCord, E., Ratcliffe, J., Garcia, R. and Taylor, R. (2007) Non Residential Crime Attractors and Generators Elevate Perceived Neighborhood Crime and Incivilities. *Journal of Research in Crime and Delinquency*, 44(3), 295–320.

MacDonald, J. and Lattimore, K. (2010) Count Models in Criminology. In: Piquero, A. and Weisburd, D. (eds) *Handbook of Quantitative Criminology*. New York: Springer.

Newton, A. (2014) Crime and Public Transport. In: Weisburd, D. and Bruinsma, G. (eds) *Encyclopedia of Criminology and Criminal Justice*. New York: Springer-Verlag, 709–720.

Newton, A., Partridge, H. and Gill, A. (2014) Above and Below: Measuring Crime Risk in and around Underground Mass Transit Systems. *Crime Science*, *3*(1) 1–14.

Newman, O. (1973) *Defensible Space People and Design in the Violent City*. London: Architectural Press.

Osgood, D. (2000) Poisson-Based Regression Analysis of Aggregate Crime Rates. *Journal of Quantitative Criminology*, 38(1), 81–116.

Piza, E. and Kennedy, D. (2003) Transit stops, Robbery, and Routine Activities: Examining Street Robbery in Newark, NJ Subway Environment. http://proceedings.esri.com/library/userconf/proc04/docs/pap1303.pdf. Accessed 1 August 2013.

Rengert, G., Ratcliffe, J. and Chakravorty, S. (2005) *Policing Illegal Drug Markets: Mapping the Socio-Economic Environments of Drug Dealing*. New York: Criminal Justice Press.

Smith, M. (2008) Addressing the Security Needs of Women Passengers on Public Transport. *Security Journal, 21*(1–2), 117–133.

Smith, M. and Clarke, R. (2000) Crime and Public Transport, *Crime and Justice*: *A Review of the Research*, 27, 169–233.

Smith, M. and Cornish, B. (2006) *Secure and Tranquil Travel: Preventing Crime and Disorder on Public Transport*. London: UCL Jill Dando Institute of Crime Science.

Part III

On the Move: The Transit Journey

7

'Wolves to the Door' or 'Lambs to the Slaughter?' Crime Opportunity Searches on a New Public Transport System

Christopher M. Sedelmaier

Introduction

The prospect of increased crime helps fuel the 'not in my backyard' (NIMBY) attitude that individuals may display when facing the introduction of a new transport system in their neighbourhood (see Wattrick, 2011). Some believe that new systems introduce crime by facilitating access between crime-prone areas (e.g. certain inner-city neighbourhoods) and relatively low-crime areas (e.g. certain residential neighbourhoods) (e.g. Garrison, 2008). This is not transport crime, per se, as that term generally connotes offenses committed on the system. Rather, this is transport-related crime – offenses near the stations. Transport-related crime is important to consider in the 'whole-trip' context. Regardless of actual victimization risk, the perceived risk experienced by public transport users at or near stations is a real component of trips (Wiebe et al., 2014; Loukaitou-Sideris, 2012). The thought that the system will bring offense and offender to the doorstep can have a detrimental effect upon perceived safety and, subsequently, may affect use, enjoyment and property values alike.

Given such concerns, it is reasonable to ask whether such an 'offender importation' scenario is realistic. Assume that the station introduction coincides with increased offending in a neighbourhood, unrelated to citywide crime patterns. While this may well be indicative of an influx of offenders from distant neighbourhoods, this could *also* be an indicator that *local* offenders are capitalizing on new opportunities to offend provided by the new system's presence. Knowing whether offenders are 'travellers' or 'locals' may help law enforcement conduct investigations and craft more effective crime prevention strategies – but this requires offender residence information absent from most transit studies.

This study examines arrestee addresses connected to offenses committed near transit stops. The focus of this study, the Hudson-Bergen Light Rail (HBLR), faced NIMBY opposition, particularly in one relatively affluent Jersey City neighbourhood, in which residents feared declining home values, nuisances and crime that the system might bring (Chen, 1996). This study uses station area arrest data to test the hypothesis that system introduction led to increased crime trips along the system. Following system introduction, the finding of large proportions of arrestees living within station areas *other than* the offence site may suggest public transport use to reach the offence site.

Literature review

A widely accepted finding in the journey-to-crime literature is that crime trips tend to be short distance (Townsley and Sidebottom, 2010). Distance-decay, or the finding that offenders tend to choose targets close to an anchor point (typically the offender's home, place of work, etc.), has held fairly consistently across varying property (Bernasco, 2010; Snook, 2004; Rengert and Wasilchick, 2000; Wiles and Costello, 2000) and violent offenses (Groff and McEwen, 2005; Rossmo et al., 2004; van Koppen and Jansen, 1997; Capone and Nichols, 1976). The idea that offenders would choose closer targets over distant targets makes sense when viewed through a 'least effort' lens (Zipf, 1965). Townsley and Sidebottom suggest that the distance-decay finding may be true primarily for the most prolific offenders, and that less active offenders may display this pattern less consistently at the individual level (2010).

Studying criminal commutes on the New York City subway, Belanger (1999) found that most repeat offenders committed crimes within ten stops of their home, suggesting that travel time can be as important as distance in the journey-to-crime on public transport. Furthermore, Clare and associates (2009) examined the effects of barriers (e.g. rivers) and connectors (e.g. public transport linkages) between residential neighbourhoods upon residential burglars' target choices in Perth, Australia. Their findings indicated that connectivity significantly impacted target choice, as burglars living in neighbourhoods with rail stations were twice as likely to choose targets in neighbourhoods located along that system (Clare et al., 2009). While not explicitly stating that offenders used the system to reach the point of offence, the results are highly suggestive that the transport system influenced the offenders' awareness spaces. HBLR's size makes it an interesting case. A timetable from the time of the system's introduction indicates that it was possible to travel the length of Jersey City (approximately five miles from Danforth Avenue Station to Newport Station) in 23 minutes (New Jersey Transit, 2001). Given the short distances and travel times that HBLR covers, and the connectivity that it provides, it seems plausible that the system could contribute to crime trips and expand potential offenders' awareness spaces.

There are several ways in which public transport systems might influence crime in station areas. Cohen and Felson's (1979) routine activity posits that crime opportunities occur when three situational criteria converge: (1) presence of a motivated offender; (2) presence of a suitable target; and (3) absence of a capable guardian (Cohen and Felson 1979). Public transport systems create such conditions by assembling people at the stations. Block and Block (2000) found that robbery and assault concentrated in 'rings' around subway stations in Chicago, Illinois and the Bronx, New York. In both cases, offending appeared to be most likely to occur approximately one-and-one-half blocks from the station (Block and Block 2000). The authors contend that this supports Angel's (1968) 'critical intensity zone' hypothesis. At the distance at which most offences occurred, the concentration of targets reaches the optimal balance for offending that Angel suggests – enough to make hunting productive, but too few to afford potential victims the safety of numbers.

Crime pattern theory describes offender search behaviour and offending in relation to an offender's *awareness space*, a term meant to convey both mental and physical familiarity with an area. Brantingham and Brantingham (1991) describe the components of awareness space in terms of three socio-geographic features: nodes, paths and edges.

Nodes are discrete locations, such as transport stations, in which activities occur. At the station, targets and offenders cluster, awaiting the vehicle. As offenders become more familiar with the station area, they add it to their awareness space. As familiarity increases, offenders may take advantage of opportunities presenting themselves.

Paths play an integral role in shaping offenders' knowledge concerning available crime opportunities. Areas adjacent to travel paths tend to experience more crime than areas more distant from these routes. For example, Beavon et al. (1994) link residential burglary levels to street networks, finding that residences near major thoroughfares experience higher levels of property crime than residences located off of main roadways as they fall within the awareness space of more potential offenders. Public transport influences offenders' awareness space along paths; the view from the bus or streetcar provides offenders a window to new opportunities. Transport systems may be particularly useful to young offenders and those lacking automobiles. Wikström (1995) found that youths from suburban areas used public transport to reach offending areas within the central business district, affording them access to areas otherwise beyond their reach.

Edges are 'places where there is enough distinctiveness from one part to another that the change is noticeable' (Brantingham and Brantingham, 1993: 17). Within cohesive neighbourhoods, residents may recognize neighbours and other people who 'belong' in those neighbourhoods, but along the edges of a neighbourhood, it may be less clear who 'belongs' and who does not. Here, informal social control may be weaker, emboldening potential offenders. Block and Block's (2000) aforementioned study may support this concept. The 'critical intensity zone' may represent a perceptual edge, the outer bounds of guardianship that the station may provide. Additionally, Newton et al. (2014) suggest that victimization risk is transmissible between system, station and outer environs, and vice versa. Stations located in edge areas may be especially at risk.

Finally, transport crime research also supports the rational choice perspective (Clarke and Cornish, 1985). Beller et al. (1980) concluded that the crowded, anonymous setting of the New York City subway is ideal for 'minor' sexual offenders (e.g. fondlers and exhibitionists). Comparing 1977 New York Transit Police statistics to citywide statistics, the authors found that almost 75 per cent of the city's *total* sex abuse arrests occurred within the subway system (1980: 51). Similarly, Loukaitou-Sideris (1999) found that minor offences clustered at crowded Los Angeles bus stops. Pickpockets and low-level sex offenders benefit from the jostling contact natural to crowded conditions. Here, offenders can also linger without arousing suspicion as loitering is expected at transport stops.

The body of research examining the relationship between transport system expansion and its impact upon journeys to crime is surprisingly small, and generally lacks information about offender points of origin. Plano (1993) analysed crime patterns in the neighbourhoods surrounding three new Baltimore light rail stations over a six-year period. Two of the stations were located in predominantly residential neighbourhoods, and the third served a large shopping centre. Each station was also near a large parking facility. Plano found erratic increases in Uniform Crime Report Part I offences in each neighbourhood, but these mirrored countywide trends. Plano's study was hampered by the nature of the available data, aggregated at the level of 'Crime Reporting Areas' described as 'neighborhood-sized areas (smaller than census tracts) defined generally by natural and man-made geographic edges such as stream valleys and roadways' (1993: 60).

Poister (1996) studied transport system expansion and crime in Atlanta. In June 1993, the Metropolitan Atlanta Rapid Transit Authority's east-west rail line expanded eastward to include two new stops in Atlanta's suburbs: one mixed-use area (Kensington) and one residential neighbourhood (Indian Creek), separated geographically by an interstate highway (1996). Poister's 'impact areas' included neighbourhoods within ten to fifteen minutes' walking distance from each of the new stations (1996). Poister bettered Plano's analysis by including several 'quality-of-life' offences, such as vagrancy, criminal damage, drug offences and disturbing the peace (1996). These 'minor' offences may greatly influence feelings of safety in station neighbourhoods.

Time-series analysis of address-level incident data from DeKalb County's Department of Public Safety from January 1990 through September 1994 revealed stable long-term crime trends in the impact areas. Overall, Kensington's crime levels were higher than those in Indian Creek. This was expected, as daily activity was higher in Kensington than in the primarily residential Indian Creek. The station openings had little effect in either area. For some crime types – larceny, motor vehicle theft, robbery and vagrancy in Kensington, and burglary in Indian Creek – there was a short-lived increase when the stations first opened followed by regression to previous levels. Poister theorized that offending increased as offenders integrated the impact areas into their awareness spaces, but dropped after offenders found fewer attractive opportunities for crime than anticipated.

Liggett et al. (2003) sought journey-to-crime contributions on the Green Line light rail system in Los Angeles. Their study included time-series and hot spot analyses of a variety of offences (Type 1 Non-Auto, Type 1 Auto-related and Type 2) occurring within a half-mile radius of the line's downtown stations and suburban termini for five years preceding Green Line operation and the line's first five years of service. Consistent with the aforementioned studies, Liggett and associates found little evidence that the Green Line contributed to crime trips, particularly in more affluent suburbs, where in most cases crime remained stable or decreased.

The current study builds upon the literature by including offenders' last known home addresses to attempt to ascertain how new transport connections and new target opportunities may affect the offender distribution. Do new systems introduce distant offenders to station areas, bringing 'wolves to the door', or do they provide new targets for active local offenders, bringing 'lambs to the slaughter?' One might expect different scenarios depending upon station area characteristics. For example, in residential areas, it seems unlikely that a major influx of distant offenders would occur *just* because of increased accessibility. Rather, one might expect to see local offenders taking advantage of new target streams (e.g. cars parked near the stations by commuters). Conversely, if the system connects to commercial areas, then this may provide access for more distant offenders.

Study area

Located in Hudson and Bergen Counties in New Jersey, HBLR served primarily Jersey City at the time of its introduction in 2000. Jersey City was the second most populous city in New Jersey (240,055 people in 2000) (US Census Bureau, 2013a) and occupies a scant 14.8 square miles of land area (US Census Bureau, 2013b) directly across the Hudson River from lower Manhattan. In the late 1990s, Jersey City was probably best known for its questionable title as the 'Car Theft Capital of the US' (Boca Raton News, 7 April 1998, p. 4A) and the presence of several Wall Street firms in the

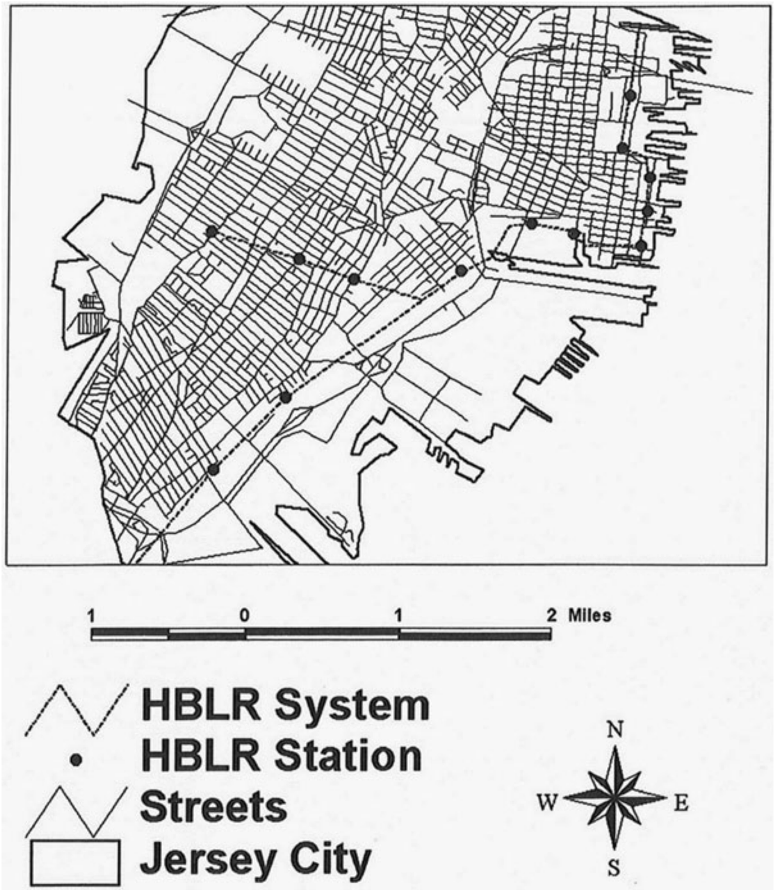


Figure 7.1 The Hudson-Bergen light rail system in Jersey City, NJ, April 2000 – November 2001

Source: Originally published in Sedelmaier, C. M. (2014) Offender-target redistribution on a new public transport system. *Security Journal,* 27(2), 164–179, reproduced with permission.

Exchange Place area on the city's waterfront. Jersey City is also a driving gateway to lower Manhattan via the Holland Tunnel. Heavy traffic volume on workdays created concerns that new public transportation options were necessary for the area's future development and viability (Kerr, 1989; Hoff 1989). HBLR (Figure 7.1) runs the eastern edge of Jersey City between developed areas and the waterfront, often sharing right of way with road vehicles, with a grade-separated spur line extending westward into the city's interior. With the exception of Newport service zone stations, the system entered service on 15 April 2000, while Newport service zone stations entered service on 18 November 2000.

Applying the 'ten-minute walk' standard (Poister, 1996; Plano, 1993) to HBLR stations results in overlapping service areas on parts of the system. Fortunately, most stations are clustered in ways that group them naturally into similar neighbourhoods. Four 'service zones' were created based on the stations' proximity to one another and characteristics of each station's outlying neighbourhood (Figure 7.2).

A mix of multifamily residential buildings and commercial establishments characterizes the area surrounding Midtown service zone's three stations, with West Side Avenue station serving as one of two 'park-and-ride' facilities. This grade-separated spur runs through a relatively run-down low-income section of the city. According to 2000 US Census figures, 1999 per capita income for the block groups in which these stations are located fell in a range between $7,283 and $16,717 (2002).

Southside service zone also includes three stations. With two stations located walking distance from public housing, this service zone is more residential than Midtown. Liberty State Park station is HBLR's second 'park-and-ride' facility in Jersey City. Richard Street and Danforth Avenue stations are located along the eastern edge of residential development in this portion of Jersey City. These stations are primarily reached by foot. One block west from both stations is a major north-south arterial road served by New Jersey Transit and city buses. To the south, HBLR extends into the city of Bayonne.

Paulus Hook service zone includes four stations. When HBLR entered service, the westernmost stations were in a developing area, and there was a rapid transition of land use to the more developed eastern stations. The two easternmost stations serve a relatively affluent neighbourhood – the 1999 per capita income for residents of this area was between $41,612 and $67,435 (US Census Bureau, 2002). This area in particular was the focal point for NIMBY activism against the system's route: a resident group sought a court order to block construction, as the route would 'discriminate against low-income people who are entitled to better transit' (Chen, 1996: 13NJ-6). Paulus Hook is also home to Exchange Place, a major commuter destination containing several Wall Street firm offices and, prior to 11 September 2001, HBLR's closest link to the Port Authority Trans-Hudson (PATH) rail system. PATH service there was suspended following the World Trade Center attack.

Entering service on 18 November 2000, Newport service zone was the second segment of HBLR to be completed. Newport's three stations completed HBLR's link to Jersey City's waterfront and an important shopping destination. Two of these stations serve Metro Plaza shopping centre and Newport Centre Mall, respectively. This area was a known crime generator and attractor well before HBLR was built, as shoplifting and theft from motor vehicles in parking structures were both notable issues at Newport Centre Mall. HBLR's Newport station provides connection to PATH's Pavonia/Newport station and was HBLR's northern terminus until September 2002, when the system expanded northward to Hoboken.

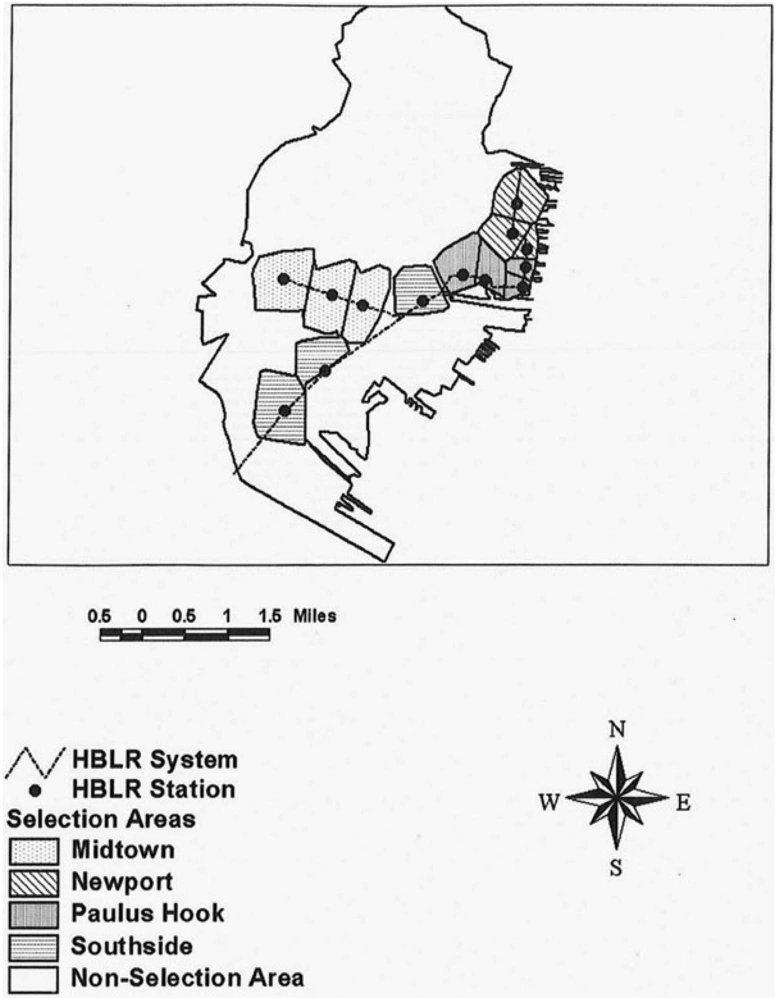


Figure 7.2 Service zones based on 0.5 mile street distances

Note: Street network removed for clarity.

Source: Originally published in Sedelmaier, C. M (2014) Offender-target redistribution on a new public transport system. *Security Journal*, 27(2), 164–179, reproduced with permission.

Data and methods

Jersey City Police Department adult offender arrest data was analysed using ArcGIS and SPSS. Mapping software was used to select offences committed within light rail station areas, and then to categorize those cases based upon the distance of the arrestees' last known address from the nearest station. Chi-square tests were used to examine the proportion of 'local' and increasingly 'distant' arrestees connected with crimes committed within each service zone. The analyses divided offenders into the following categories:

1. resided, offended within same service zone;
2. resided within one service zone, offended within another;
3. resided within one-half mile of any service zone;
4. resided within Jersey City more than one-half mile from any service zone;
5. resided outside Jersey City.

Following service introduction, a finding that an increased proportion of arrests for crimes committed within service zones are connected to arrestees residing within *different* service zones (e.g. offended in Newport, lives in Midtown) may support the hypothesis that arrestees used the system to reach non-local offending areas. A finding that an increased proportion of arrests for crimes committed within the service zones are connected to arrestees living within that *same* service zone may indicate that local offenders are taking advantage of new targets delivered by the light rail system.

A major caveat must be noted: the data in this study represent adult offenders only, as only adult arrest data included the arrestee's last-known address. This was a stipulation of being granted access to the data and is an admitted limitation, as public transport may be especially attractive to potential offenders below legal driving age (Wikström, 1995).

Arrest data from 1 January 1998 through 14 October 2001 were provided for this study. Each record included incident location, arrest location and arrestee's last known address. In several instances a single arrest accounted for multiple offences (e.g. a burglary and an assault). To address this, existing crime types were regrouped into four categories: Violent Offences (homicide, assault, sexual assault, robbery), Property Offences (burglary, theft, auto theft), Morals/Narcotics Offences (drug-related or low-level sex offences), and Other Offences (criminal mischief, disorderly conduct, weapons possession). This allowed within-type duplicate removal while retaining separate charges for given arrestees (e.g. if an arrestee is arrested and charged with one count of robbery and two counts of drug possession, the robbery charge and one drug charge were retained). While this precludes analysis of the *overall* arrest data set per service zone, as occasionally one arrestee provides more than one arrest type, it preserves relevant minor offence types that would likely have been underrepresented if only the most 'serious' charge was used for each case. Duplicate records were removed based on arrest time, arrest date, offence date, offence type and arrestee address. While some cases that should have been retained may have been lost (e.g. co-offenders sharing an address who were arrested at the same time), this risk seemed small. For this reason, the data cannot be analysed *across* offence type.

Half-mile street network selection buffers were created around each station, based on the findings of a residential development study conducted for Chicago's Metro System. Rider surveys revealed that 80 per cent of transit users live within one-half mile of a station walk to that station (Sööt et al. 2000, 1). This distance encompasses an area within which riders seem likely to walk to and from stations, providing crime opportunities.

Results

Midtown Service Zone: Chi-square analyses (Table 7.1) found no significant changes to the proportions of arrestees residing in each address category when comparing the pre-service period to the post-introduction period. This was true across offence categories. Moreover, in each case the proportion of arrestees residing within other service zones declined in the post-introduction period. There is little evidence to suggest that HBLR has delivered a disproportionate number of 'outside' offenders to Midtown. Rather, these results suggest that offending within Midtown is primarily the work of local residents. This is not unexpected: the Midtown area is relatively poor and offers little 'draw' for distant offenders, with perhaps the exception of known drug areas. Even though there were more drug arrests for 'locals' in the post-HBLR period than predicted, the difference was not significant.

Southside Service Zone: Southside is similar to Midtown in that 'Moral/Drug Offences' is the leading offence type category, followed by 'Violent Offences'. This reflects patterns in the call for service data, as within that dataset most drug activity also appeared to be concentrated within

Table 7.1 HBLR Midtown service zone observed (expected), arrests by arrestee address category

	arrestee address							
	Midtown SZ	**Other SZ**	**< 0.5 Mile From SZ**	**> 0.5 Mile From SZ**	**Outside JC**	***df***	**χ^2**	***p.***
Offence Type								
Violent								
Pre-HBLR	376 (381.4)	76 (74.1)	143 (144.9)	36 (33.0)	49 (46.5)	4	1.69	.79
Post-HBLR	190 (184.6)	34 (35.9)	72 (70.1)	13 (16)	20 (22.5)			
Property								
Pre-HBLR	124 (131.8)	63 (53.1)	84 (84.7)	23 (25.0)	28 (27.4)	4	6.20	.19
Post-HBLR	97 (89.2)	26 (35.9)	58 (57.3)	19 (17.0)	18 (18.6)			
Moral/Drug								
Pre-HBLR	1334 (1353.0)	402 (393.0)	822 (822.7)	259 (260.3)	288 (276.0)	4	2.90	.58
Post-HBLR	735 (716.0)	199 (208.0)	436 (435.3)	139 (137.7)	134 (146.0)			
Other								
Pre-HBLR	204 (208.2)	55 (50.4)	96 (93.4)	21 (21.5)	29 (31.6)	4	2.45	.65
Post-HBLR	106 (101.8)	20 (24.6)	43 (45.6)	11 (10.5)	18 (15.4)			

the southern portion of the city (Sedelmaier, 2003). Southside arrest data analyses revealed no significant changes in arrestee address proportions following HBLR service introduction (Table 7.2). With the exception of 'Other Offence Arrests', the proportion of 'Other Service Zone' arrestees declined following service introduction in each case. It seems unlikely that the additional access to the area that HBLR provides has induced non-local offenders into exploring Southside. As was true in Midtown, there are few 'draws' in this area. Offending in Southside neighbourhoods appears to be mostly the work of locals involved in drug sales.

Paulus Hook Service Zone: The majority of arrests in Paulus Hook involve either violent offences or property offences. The Drug and Morals categories are not nearly as dominant within Paulus Hook as they were in Midtown and Southside neighbourhoods. Paulus Hook also differs from the previous two areas in that no station has major off-street parking capacity. However, Paulus Hook includes Exchange Place station, which serves the heart of the financial district and provided connection to the larger Port Authority Trans-Hudson (PATH) rail system until the World Trade Center attacks. Because Exchange Place is a major employment destination, Paulus Hook seems a likely candidate to draw a disproportionate number of 'outsiders'.

While Paulus Hook arrest data analyses also discovered no statistically significant changes in arrestee address proportions following HBLR service introduction (Table 7.3), it is interesting to note differences between Paulus Hook distributions and those of Midtown and Southside. Looking at the

Table 7.2 HBLR Southside service zone observed (expected), arrests by arrestee address category

	arrestee address							
	Southside SZ	**Other SZ**	**< 0.5 Mile From SZ**	**> 0.5 Mile From SZ**	**Outside JC**	***df***	**χ^2**	***p.***
Offence Type								
Violent								
Pre-HBLR	236 (239.9)	38 (37.7)	86 (79.3)	12 (13.0)	22 (24.1)	4	2.52	.64
Post-HBLR	133 (129.1)	20 (20.3)	36 (42.7)	8 (7.0)	15 (12.9)			
Property								
Pre-HBLR	57 (58.1)	36 (34.1)	58 (57.4)	13 (10.7)	11 (14.7)	4	4.72	.32
Post-HBLR	30 (28.9)	15 (16.9)	28 (28.6)	3 (5.3)	11 (7.3)			
Moral/Drug								
Pre-HBLR	402 (406.4)	165 (155.6)	335 (342.2)	59 (58.6)	109 (107.1)	4	2.15	.71
Post-HBLR	243 (238.6)	82 (91.4)	208 (200.8)	34 (34.4)	61 (62.9)			
Other[a]								
Pre-HBLR	122 (115.5)	13 (16.0)	43 (43.4)	5 (6.0)	10 (12.0)	4	4.36	.36
Post-HBLR	51 (57.5)	11 (8.0)	22 (21.6)	4 (3.0)	8 (6.0)			

Note: [a]1 cell (10%) has an expected count of less than 5.

Table 7.3 HBLR Paulus Hook service zone observed (expected), arrests by arrestee address category

	arrestee address							
	Paulus Hook SZ	**Other SZ**	**< 0.5 Mile From SZ**	**> 0.5 Mile From SZ**	**Outside JC**	***df***	**χ^2**	***p.***
Offence Type								
Violent								
Pre-HBLR	80 (78.4)	34 (32.2)	42 (39.5)	20 (18.1)	19 (26.8)	4	8.38	.08
Post-HBLR	37 (38.6)	14 (15.8)	17 (19.5)	7 (8.9)	21 (13.2)			
Property								
Pre-HBLR	30 (29.5)	42 (39.2)	61 (59.7)	18 (18.6)	25 (28.9)	4	2.20	.70
Post-HBLR	16 (16.5)	19 (21.8)	32 (33.3)	11 (10.4)	20 (16.1)			
Moral/Drug								
Pre-HBLR	42 (44.9)	25 (24.1)	33 (34.2)	16 (14.7)	24 (22.1)	4	1.60	.81
Post-HBLR	25 (22.1)	11 (11.9)	18 (16.8)	6 (7.3)	9 (10.9)			
Other[a]								
Pre-HBLR	35 (32.4)	18 (19.4)	35 (33.1)	11 (8.6)	22 (27.4)	4	7.56	.11
Post-HBLR	10 (12.6)	9 (7.6)	11 (12.9)	1 (3.4)	16 (10.6)			

Note: [a]1 cell (10%) has an expected count of less than 5.

'Violent Offence' and 'Other Offence' categories, the relative frequencies of non-Jersey City resident arrestees are considerably higher in Paulus Hook service zone than in the Midtown and Southside service zones. This would seem directly attributable to the waterfront financial district. Midtown and Southside service zones both lack large employment centres and the accompanying retinue of commercial establishments. Regardless, there is little statistical evidence that HBLR has impacted the Paulus Hook offender pool.

Newport Service Zone: Light rail service began here on 18 November 2000 – roughly seven months after the other three service zones. The most striking difference between Newport service zone and the others is the dominance of arrests for property offences. This is attributable to the Newport Centre Mall and the Metro Plaza Shopping Center. Adjacent to one another, these two locations combine to form one large shopping destination. Furthermore, Newport service zone is also home to waterfront office buildings and upscale apartment complexes. Finally, Newport service zone is also connected to the PATH system via Pavonia/Newport station.

Again, no statistically significant differences are evident between pre-service introduction and post-service introduction arrestee address distributions (Table 7.4). This is especially important to note, as stations in Newport service zone exert ostensibly more 'pull' than any other area in the system. If any service zone might be expected to experience an outsider offender

Table 7.4 HBLR Newport service zone observed (expected), arrests by arrestee address category

	arrestee address							
	Newport SZ	**Other SZ**	**< 0.5 Mile From SZ**	**> 0.5 Mile From SZ**	**Outside JC**	***df***	**χ^2**	***p.***
Offence Type								
Violent								
Pre-HBLR	33 (35.8)	33 (28.1)	33 (33.5)	22 (19.5)	45 (49.1)	4	8.03	.09
Post-HBLR	13 (10.2)	3 (7.9)	10 (9.5)	3 (5.5)	18 (13.9)			
Property								
Pre-HBLR	31 (33.7)	215 (218.4)	255 (245.5)	163 (170.0)	470 (466.4)	4	5.28	.26
Post-HBLR	10 (7.3)	51 (47.6)	44 (53.5)	44 (37.0)	98 (101.6)			
Moral/Drug[a]								
Pre-HBLR	6 (7.6)	8 (9.2)	15 (15.1)	7 (5.9)	11 (9.2)	N/A	N/A	N/A
Post-HBLR	3 (1.4)	3 (1.8)	3 (29)	0 (1.1)	0 (1.8)			
Other[b]								
Pre-HBLR	13 (11.4)	17 (14.7)	28 (27.7)	16 (16.3)	19 (22.8)	N/A	N/A	N/A
Post-HBLR	1 (2.6)	1 (3.3)	6 (6.3)	4 (3.7)	9 (5.2)			

Note: [a]4 cells (40%) have an expected count of less than 5. Test results non-applicable.
[b]3 cells (30%) have an expected count of less than 5. Test results non-applicable.

influx, it would most likely be Newport as HBLR service introduced a quick, direct connection linking this locally important shopping area to higher crime areas of Jersey City. In the 'Violent Offences' category, it is interesting to note the number of arrestees reporting addresses outside Jersey City in the post-service introduction period. Of 18 arrests, 12 involved arrestees reporting Newark addresses. The 'outside Jersey City' arrestee address dispersion is far greater for 'Property Offences', but even in this offence category Newark addresses are among the most frequently reported. This suggests that if public transport access to Newport service zone *is* a factor in introducing offenders to the area, then the PATH system is more likely to be an important contributor than is HBLR as the PATH provides direct linkage between Newark and this area.

Discussion

There is little evidence that HBLR has been a catalyst for introducing distant offenders to new offending areas. Improved access to new areas is apparently only part of the journey-to-crime equation. Perceived availability of suitable targets is at least equally important. In the case of HBLR, only Newport service zone is both easily accessible and provides a broad spectrum of attractive hunting grounds and opportunities. The other areas had far less to offer in comparison. Furthermore, it seems likely that the majority of potential offenders were already aware of the opportunities available in the

Newport area. As such, the time necessary for the Newport neighbourhoods to become integrated into offenders' awareness spaces was likely minimal.

Unfortunately, these data did not include offenders below the age of 17. This is a major limitation to this study, as it precludes the ability to determine whether young people might have been using the system to reach new areas. While access to the data in this case was contingent upon discounting juvenile offenders, this hampered the ability to include a critically important segment of the population, as the young seem especially good candidates for using public transport to reach otherwise unreachable areas. Although HBLR may have had little impact for adult offenders, it may have been more important for juveniles without cars. Future studies of this type should make every effort to include young offenders if at all possible.

In most cases, local residents appeared to comprise the bulk of arrestees, but this was also the case prior to service introduction. Only in Newport service zone do instances appear in which 'outsider' arrests formed a majority, and these were primarily for property crimes committed at the Newport Centre Mall. Furthermore, the lack of statistically significant shifts in the proportions of arrestees from different address categories following HBLR service introduction suggests that offenders had not incorporated the system into their opportunity searches, nor had local offenders availed themselves of any new targets that the system may have provided. This would appear to underscore the general preference for choosing nearby crime opportunities that the journey-to-crime literature has found in the past (Bernasco, 2010).

There is some evidence, however, that larger, well-established transport systems may deliver offenders to criminal opportunities – particularly in Newport service zone. Many of the arrestee addresses falling outside of Jersey City in this area were located in Newark, Manhattan and Brooklyn, NY. Newport service zone may be easily reached from these areas via the PATH system. While the arrest data did not provide any information detailing how arrestees reached the area, it seems reasonable to believe that many of these arrestees could have used the PATH system to reach the shopping centre; it terminates in Newark to the west and Manhattan to the east, where it connects with several New York City Subway routes.

At its inception, HBLR was primarily a small-scale commuter system. Based on ticket validation data, most trips made were toward the central business district and PATH connections at Newport and Exchange Place in the morning, and vice versa during the evening rush. With the bulk of the system's trips work commute-related, its contribution to local crime patterns might be expected to be minimal. A larger-scale, 24-hour system such as PATH serves more commercial and recreational destinations and carries more passengers to those destinations during off-peak hours than was the case on HBLR. With the exception of Newport's shopping centres and Paulus Hook's connection to work destinations and PATH, there were very few stops on the system that one might consider 'destinations' in and of themselves – Southside is primarily low-income residential, and Midtown is a low-income, mixed-use area. The residential nature of these neighbourhoods may, in fact, help increase guardianship and have a preventive effect on crime both at and near the stations (Newton et al., 2014). Add the fact that many journeys were likely to have been between a rider's 'home' station and one of the aforementioned 'destination' stations as part of a work commute, and it seems that HBLR may have done little to expand most potential offenders' awareness spaces (Brantingham and Brantingham, 1991). Although in theory it made reaching new hunting grounds easier, there is little reason to embark upon even a short trip to a new hunting ground when there is little expectation of finding attractive opportunities. Even in Newport service zone, where the Newport Centre Mall provided known criminal opportunities, there was little evidence to suggest that offenders were using HBLR to reach those opportunities.

Revisiting HBLR today would provide an interesting follow-up study. Since 2001, the system has expanded to include more municipalities. It would be instructive to determine how ridership patterns – and exposure to potential targets – have changed with the system's growth. It could be that the system's ability to influence offender awareness spaces or the opportunity structure had simply not reached maturity in the year-and-a-half following its introduction, even though the findings here were consistent with studies that had access to longer-term data (Liggett et al., 2003). Years on, the stations themselves may have further encouraged changes in local land use that might bring new offence opportunities, such as development of new businesses in the station neighbourhoods in western Paulus Hook.

Policy implications

The immediate good news for transport planners and law enforcement alike is that the current findings reinforce past studies' conclusions that transport expansion will not necessarily have a criminogenic effect on the neighbourhoods served. That said, knowing whether or not offenders – or victims – had used a transport system to reach the station area would benefit investigative, crime prevention and academic endeavours by providing a more accurate accounting for that system's contributions. Accomplishing this goal requires improved data collection practices. The arrest data used in this study were admirably thorough, but they were not collected with the study of transport-related crime in mind. The included offence types, locations, dates and times are the norm for transport-related crime studies, but a more complete understanding could be achieved through the inclusion of more contextual information. Considering that the theories generally applied in such studies underscore the importance of situational variables, their inclusion is imperative. Collecting contextual data is generally regarded to be too burdensome to be incorporated into routine police practices, although it might be gathered through offender-specific interviews as well as through organized environmental inventories conducted by either the police or the transport authority. The discovery of patterns within this data may help law enforcement officials and transport planners prevent future offences by allowing them to more effectively collaborate in crafting appropriate responses to developing offence trends. Increased data sharing and collaboration between local law enforcement and transport authorities could underpin data improvements beneficial to all parties involved.

References

Angel, S. (1968) Discouraging Crime Through City Planning (Working Paper No. 75) Berkeley: University of California Berkeley, Center for Planning and Development Research.

Beavon, D., Brantingham, P. L., and Brantingham, P. J. (1994) The Influence of Street Networks on the Patterning of Property Offenses. In: Clarke, R. (ed.) *Crime Prevention Studies*. Vol. 2. Monsey, NY: Criminal Justice Press.

Belanger, M. (1999) Crime Mobility and Public Transport: The Case of the New York City Subway. Doctoral dissertation. Rutgers – The State University of New Jersey, School of Criminal Justice.

Beller, A., Garelik, S. and Cooper, S. (1980) Sex Crimes in the Subway. *Criminology, 18*(1), 35–52.

Bernasco, W. (2010) Modeling Micro-Level Crime Location Choice: Application of the Discrete Choice Framework to Crime at Places. *Journal of Quantitative Criminology, 26*(1), 113–138.

Block, R., and Block, C. (2000) The Bronx and Chicago: Street Robbery in the Environs of Rapid Transit Stations. In: Goldsmith, V., McGuire, P., Mollenkopf, J., and Ross, T. (eds) (2000) *Analyzing Crime Patterns: Frontiers of Practice*. Thousand Oaks, CA: Sage Publications.

Boca Raton News. (1998) Jersey City Becomes Nation's Car Theft Capital. (1997) *Boca Raton News*, 7 April, p. 4A.

Brantingham, P. J., and Brantingham, P. L. (1993) Nodes, Paths and Edges: Considerations on the Complexity of Crime and the Physical Environment. *Journal of Environmental Psychology*, *13*(1), 3–28.

Brantingham, P. L., and Brantingham, P. J. (1991) *Environmental Criminology,* second edition. Prospect Heights, IL: Waveland.

Capone, D. L., and Nichols, Jr., W. W. (1976) Urban Structure and Criminal Mobility. *American Behavioral* Scientist, *20*(2), 199–213.

Chen, D. (1996, April 21) Neighborhood Fears a Trolley Could Change Everything. *New York Times*, Section 13NJ, p. 6.

Clare, J., Fernández, J. and Morgan, F. (2009) Formal Evaluation of the Impact of Barriers and Connectors on Residential Burglars' Macro-Level Offending Location Choices. *Australian and New Zealand Journal of Criminology*, *42*(2), 139–158.

Clarke, R., and Cornish, D. (1985). Modeling Offenders' Decisions: A Framework for Research and Policy. In: Tonry, M., and Morris, N. (eds) *Crime and Justice: An Annual Review of Research*, Volume 6. Chicago: University of Chicago Press.

Cohen, R., and Felson, M. (1979) Social Change and Crime Rate Trends: A Routine Activity Approach. *American Sociological Review*, *44*(4), 588–608.

Garrison, C. (2008, August 20) Out-of-control Shoplifting at the St. Louis Galleria. Violent Attacks in the Delmar Loop. Is Metrolink a Vehicle for Crime? Retrieved from http://www.riverfronttimes.com/2008–08–20/news/out-of-control-shoplifting-at-the-st-louis-galleria-violent-attacks-in-the-delmar-loop-is-metrolink-a-vehicle-for-crime/, accessed 15 July 2013.

Groff, E.R., and McEwen, T. (2005) Disaggregating the Journey to Homicide. In: *Geographic Information Systems and Crime Analysis* Wang, F. (ed.) Hershey, PA: Idea Group.

Hoff, J. (1989) Waterfront Transit Plan Questioned. *New York Times*, [online] 23 July. Available at: http://www.nytimes.com/1989/07/23/nyregion/waterfront-transit-plan-questioned.html?pagewanted=all&src=pm, accessed 20 November 2013.

Kerr, P. (1989) Kean Proposes Transit Plan for Waterfront. *New York Times*, [online] 27 June. Available at: http://www.nytimes.com/1989/06/27/nyregion/kean-proposes-transit-plan-for-waterfront.html, accessed 20 November 2013.

Liggett, R., Loukaitou-Sideris, A. and Iseki, H. (2003) Journeys to Crime: Assessing the Effects of a Light Rail Line on Crime in the Neighborhoods. *Journal of Public Transportation*, *6*(3), 85–115

Loukaitou-Sideris, A. (1999) Hot Spots of Bus Stop Crime: The Importance of Environmental Attributes. *Journal of The American Planning Association*, *65*(4), 395–411.

Loukaitou-Sideris, A. (2012) Safe on the Move: The Importance of the Built Environment. In: Ceccato V. (ed.) *The Urban Fabric of Crime and Fear*. New York: Springer.

New Jersey Transit. (2001) *Hudson-Bergen Light Rail Schedule*, pamphlet, New Jersey Transit, Newark, NJ.

Newton, A. D., Partridge, H. and Gill, A. (2014) In and Around: Identifying Predictors of Theft within and near to Major Mass Underground Transit Systems. *Security Journal*, *27*(2), 132–146.

Plano, S. L. (1993) Transit-Generated Crime: Perception versus Reality – a Sociogeographic Study of Neighborhoods Adjacent to Section B of Baltimore Metro. *Transportation Research Record*, *1402*(1), 59–62.

Poister, T. H. (1996) Transit-Related crime in Suburban Areas. *Journal of Urban Affairs*, *18*(1), 63–75.

Rengert, G. F., and Wasilchick, J. (2000) *Suburban Burglary*. Springfield, IL: Charles Thomas.

Rossmo, D. K., Davies, A., and Patrick, M. (2004) Exploring the Geo-Demographic and Distance Relationships between Stranger Rapists and Their Offences. Special Interest Series: Paper 16. London, UK: Research, Development and Statistics Directorate.

Sedelmaier, C. M. (2003) 'Railroaded: The Effects of a New Public Transport System upon Local Crime Patterns', Doctoral dissertation, Rutgers University, Newark, NJ.

Snook, B. (2004) Individual Differences in Distance Traveled by Serial Burglars. *Journal of Investigative Psychology and Offender Profiling, 1*(1), 53–66.

Sööt, S., S.B. Friedman & Company, Vlecides-Schroeder Associates, Inc., and Nancy Seeger Associates, Ltd. (2000) Metra Rail Service and Residential Development Study: Summary of Findings. Chicago, IL: S.B. Friedman and Company.

Townsley, M., and Sidebottom, A. (2010) All Offenders Are Equal, But Some Are More Equal Than Others: Variation in Journeys to Crime between Offenders. *Criminology*, *48*(3), 897–917.

United States Census Bureau. (2002) US Census 2000: Summary File 3. http://factfinder.census.gov/servlet/DTGeoSearchByListServlet?ds_name=DEC_2000_SF3_U&_lang=en&_ts=64671230532, accessed 7 February 2003.

United States Census Bureau. (2013a) Profile of General Demographic Characteristics: Census 2000 Summary File 1 100-Pct Data for Jersey City, Hudson County, New Jersey http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk, accessed 20 November 2013.

United States Census Bureau. (2013b) *Gazetteer of New Jersey Places*. [online] Available at: http://www.census.gov/geo/maps-data/data/docs/gazetteer/county_sub_list_34.txt, accessed 20 November 2013.

van Koppen, P. J., and Jansen, R. W. J. (1997) The Road to the Robbery: Travel Patterns in Commercial Robberies. *The British Journal of Criminology*, *38*(2): 230–246.

Wattrick, J. (2011) 'The Troy Transit Center, a Georgetown DC Metro Stop and Why Transit-Crime Fears Are Hokum', blog, 20 December, MLive http://www.mlive.com/news/detroit/index.ssf/2011/12/the_troy_transit_center_a_geor.html, accessed 15 July 2013.

Wiebe, D., Richmond, T., Poster, J., Guo, W., Allison, P. and Branas, C. (2014) Adolescents' Fears of Violence in Transit Environments. *Security Journal*, *27*(2), 226–241.

Wikström, P. (1995) Preventing City-Center Street Crimes. In: *Building a Safer Society: Strategic Approaches to Crime Prevention,* Tonry, M., and Farrington, D. (eds) Vol. 19 of *Crime and Justice: A Review of Research*, Tonry, M. (ed.). Chicago, IL: University of Chicago Press.

Wiles, P., and Costello, A. (2000) *The 'Road to Nowhere': The Evidence for Traveling Criminals*. Home Office Research Study 207. London: Research, Development and Statistics Directorate.

Zipf, G. K. (1965) *Human Behavior and the Principle of Least Effort: An Introduction to Human Ecology*. New York: Hafner.

8

Adolescents' Fears of Violence in Transit Environments during Daily Activities

Douglas Wiebe, Therese Richmond, Jed Poster, Wensheng Guo, Paul Allison and Charles Branas

Introduction

Of the studies that have been dedicated to understanding how often violence and fear of violence occur in transportation environments, characteristics of the offenders and the victims, and the nature and circumstances of the events, few studies have specifically focused on experiences of youth. Further, these studies have explored fear of violence by asking youth subjects global questions about their past experiences, rather than questions directly focused on the locations and times when youth were using a given mode of transportation. Such global approaches can produce data that do not accurately represent the topic of interest and are subject to considerable recall bias. Our motivation was to improve our understanding of fear of violence among youth. Doing so may help identify opportunities for preventing the circumstances that lead youth to feel unsafe and circumstances that put youth at risk of being the victims of violence.

To address this gap in the literature, the objective of our study was to use a geographic information system-assisted (GIS) interview to anchor participants' responses to specific places and times, in order to study children's perceived safety from the risk of being assaulted while they were in different transportation modes over the course of daily activities. First, we provide an introduction to the topic and summarize findings from past research that has investigated young people's perceptions of their safety in the context of transportation environments. We then describe the setting of the present study, the recruitment process for its subjects, its data collection methods and the statistical analysis. We then report our findings on perceived safety and its relationship with subject characteristics and modes of transportation over the course of subjects' daily activities. We conclude by comparing our findings to those of past research and listing recommended next steps for research and practice.

Background

Public transportation provides mobility and travel possibilities to individuals from every walk of life worldwide. In the United States, people took 10.4 billion rides on public transportation in 2011 (American Public Transportation Association, 2013). While most riders are adults, public transportation is used commonly by children and adolescents. Many municipalities, community organizations and transportation agencies host education programs to teach children how to utilize public transportation safely (Los Angeles County Metropolitan Transportation Authority, no date).

The use of public transportation does not come without risks. For adults and children alike, unintentional injuries can result from being struck by traffic while boarding or alighting a bus, for example, and from losing balance on a bus or subway during abrupt starts and stops. In addition to the risks that are associated explicitly with the act of accessing and riding public transportation, the use of public transportation also exposes individuals to violence that occurs in these environments. The risk of being assaulted and the risk of being fearful about the potential to be assaulted are therefore two aspects of transportation that warrant particular attention.

The studies that have focused on youth and their perceived safety in the context of transportation environments, although limited in number, have produced several important findings. As early as 1976, Lalli and Savitz (1976) conducted interviews with youth in Philadelphia, Pennsylvania, USA, to assess their impressions of their neighbourhoods and the perceived implications for their safety. A key finding was that over half of the 532 youth (55 per cent) thought that streets they had to travel between their home and their school were dangerous and made them feel unsafe. Then in 1977, Savitz et al. (1977) found that male students in Philadelphia considered the risk of being assaulted or robbed to be greater while walking to and from school than while in schoolyards, hallways or classrooms. Over the three decades that followed, a number of studies investigated whether youth experience fear while travelling between home and school. Alvarez and Bachman analysed data from a national survey conducted in the United States in 1989 and found that fear of being attacked while travelling between home and school was common among the over 10,000 junior high and high school students who participated (Alvarez and Bachman, 1997). Similarly, Bachman, Randolph and Brown examined responses to the 2005 National Crime Victimization Survey in the United States in which perceptions of fear were studied. Approximately, 19 per cent of high school student respondents were fearful about violence while they were at school, and 11 per cent of respondents were fearful of violence as they travelled to or from school (Bachman et al., 2011). These large national studies suggest that travel between home and school may be a key setting for fear of violence, but vary in their estimates of how commonly such fear occurs.

Fear arising from youths' daily commutes to and from school has been studied by researchers outside the United States as well. Johansson, Hasselberg and Laflamme's study of 13- and 14-year-old children in Stockholm, Sweden, during the 2005/2006 school year found that children's mobility and their choice of transportation mode in commuting to school were linked to fears associated with conditions in their neighbourhoods (Johansson et al., 2010). This group of researchers subsequently administered a web-based survey to 1,008 13-year-olds and found additional evidence that fear of neighbourhood conditions is common and impacts the mobility of children living in Stockholm (Johansson et al., 2009). In 2011, Orion reviewed the international literature on transportation to school and found fear of crime to be among the issues that most commonly influenced children's choice of active transportation modes (e.g. walking or cycling) in commuting to school (Stewart, 2011).

None of these studies, even though they reveal that safety from violence is a salient concern for many youth, investigated the specific issue of whether children's concerns about safety vary as they use different modes of transportation. At least two studies, however, did investigate adolescents' perceived safety in the context of transportation environments explicitly. In 1991, Pearson and Toby (1991) analysed responses from the School Crime Supplement to the 1989 National Crime Survey administered by the US Bureau of Justice Statistics. Conducting cross-tabulations of the data revealed that travelling to school by car was associated with the lowest fear of assault, while travelling by public transportation was associated with a higher fear of assault.

The second study was commissioned in 1998 by the Mobility Unit of the United Kingdom Department of the Environment, Transport and the Regions (Crime Concern, 1999). The *Crime Concern* project collected a large amount of primary data from 10- to 24-year-olds in order to study experiences and perceptions of personal security (i.e. perceived safety) and crime among children, adolescents and young adults in the context of public transportation (Crime Concern, 1999). Data were collected through a blend of quantitative and qualitative methods that included focus groups and questionnaires tailored to the target population. The questionnaires were distributed to schools and colleges located in inner-city, suburban and rural areas across the United Kingdom, and completed by a total of 582 student respondents. Focus groups with male and female children and adolescents were used to explore in depth their experiences and perceptions of how their perceived personal security impacted their use of public transportation. The study revealed that it was more common for respondents to be afraid of crime after dark than during the day. One-third of male respondents felt uneasy or very unsafe when waiting at a bus stop after dark, and over half of male respondents felt uneasy or very unsafe at a train station after dark. Female respondents reported greater fear in transportation environments than their male counterparts, and particular settings in which fear was elevated included being alone, being bullied, being in the presence of people who were intoxicated and being in environments with graffiti. Being with friends or a family member was associated with feeling safer.

The findings of these studies provide insight that it is not uncommon for youth to experience fear while travelling to and from school in public transportation environments. Further, the level of this fear varies based on the mode of transportation used. While a considerable body of research has established that fear during daily activities is a highly prevalent concern for adults, only a relatively small portion of the literature has investigated the prevalence of fear in transportation environments specifically (Doran and Burgess, 2012a; Loukaitou-Sideris, 2012). Accordingly, our goal was to investigate more closely the nature of youth's activities as they travel from location to location using a range of transportation modes. Our work using GIS-assisted interviews in Philadelphia found that children's levels of perceived safety varied as a function of their companions and their mode of transportation as they travelled to school (Wiebe et al., 2013). In particular, fear of being assaulted was elevated during the portion of their commute that involved taking public transportation. The current investigation examines whether and how adolescents' fear of being assaulted varies over the entire span of their daily activities, between waking up in the morning and going home at the end of the day, and investigates whether fear in transportation environments differs during daytime hours versus at night.

Methods

Design

We used interview data to study the minute-to-minute experiences of youth over the course of their daily activities.

Sample recruitment and subjects

We analysed a subset of the data from the Space-Time Adolescent Risk Study (STARS) of violence. The STARS is set in Philadelphia, Pennsylvania, USA, and uses a case-control design. The case subjects are 10- to 24-year-olds who were assaulted and treated in a hospital emergency department. Household random-digit dialing (Waksberg, 1978) was used to recruit 10- to 24-year-olds from the general population as control subjects. Because the STARS matches controls to cases by race and sex – and because almost all the case subjects were African American and male – almost all of the controls were African American and male. Remuneration was $50 for minors and $100 for 18-year-olds. Other design issues were described previously (Basta et al, 2010). The subjects used in the present analysis are 10- to 18-year-old control subjects, all of whom are African American and male. Case subjects were not used, given that their reporting period included the time when they were assaulted, and activity path data were collected for only the time leading up to the assault. Using controls therefore enabled the study of individuals who reported on an entire day of activities.

Technique for collecting activity paths and perceived safety

The interview included administering a questionnaire about the subjects and their neighbourhoods. One of the scales on the questionnaire was the 18-item Neighbourhood Environment Scale (NES), which provides a measure of perceived neighbourhood conditions including civil incivilities and structural decay. Items include 'I feel safe when I walk around my neighbourhood by myself'; 'There are plenty of safe places to walk or play outdoors in my neighbourhood'; 'Every few weeks, a kid in my neighbourhood gets beat-up or mugged'; 'In my neighbourhood, the people with the most money are drug dealers'; and 'I feel safe when I walk around my neighbourhood by myself'. The items use true-false responses, and results can range from 0 to 18, with higher values indicating a greater degree of neighbourhood disadvantage. The NES has been found to have good internal consistency (Kuder-Richardson 20 reliability = 0.85) (Crum et al., 1996).

Next, the subject and interviewer viewed a tablet computer running a customized version of ArcEngine software (ESRI, Inc., Redlands, California) that showed a street map of the subject's residential area and, when zoomed out, the entire city of Philadelphia. The subject was asked to sequentially report his daily activities by location and time, starting from the moment he woke up in the morning and concluding with his return home at night. Using a stylus to draw points on the map, the interviewer created a minute-by-minute record of how, when, where and with whom the subject spent time as he walked or otherwise travelled from location to location and activity to activity.

Subjects were asked to report their activities on one of the three days immediately preceding the interview, determined at random. Each subject was asked to report his status on several elements throughout his travel, including transportation mode, whether he was alone or with companions, and how safe he felt in terms of his risk of being assaulted. Companions were represented in the data using a nominal variable to indicate whether, at a given time, the subject was alone, with an adult (and possibly other people, including children), with a child (or multiple children, but no adults), or with another type of person or people (called 'other'). Perceived safety was reported on a scale from 1 (very unsafe) to 10 (very safe). To encourage reporting repeatedly for each instance of a perceived change in safety, subjects were handed a cue card showing a 24-hour timeline with graphics representing response options for each item of interest. The perceived safety item was a horizontal visual-analogue scale numbered from 10 at the left to 1 at the right, with a smiling face symbol at the left and a frowning face symbol at the right end. The scale was captioned, 'How safe you did feel?', and it was explained to each subject that 'safe' referred to safety from being 'beaten up or hurt by other people'. Subjects were asked to report their perceived safety starting with the first point of their day and report any change and the time at which it occurred. Each time the subject reported a change in safety level or a change in transportation mode or companion type, a new path point was placed on the map. Afterward, the data were processed to represent minute-by-minute travel, in which each minute was coded with the perceived safety level. Thus the working dataset had one row for each minute of each subject's activities.

Environment factors

We accessed data for Philadelphia at the tract and block group level for characteristics associated with violence (Basta et al., 2010; Branas et al., 2009; LaGrange et al., 1992; Rapp et al., 2000) that we hypothesized could be associated with perceived safety among youth (Crime Concern, 1999; Tseloni and Zarafonitou, 2008). These items included median household income, per cent of the population that is African American and per cent of the population that is Hispanic, per cent of adults with college education, per cent of the population comprised of 15- to 24-year-olds, the prevalence of alcohol outlets and violent crime per capita (measured as Part 1 crimes defined by the Federal Bureau of Investigation). Because of collinearity among the variables, we used only two of these variables as potential confounders in the analysis: per capita violent crime and the prevalence of alcohol outlets. Data from the National Ocean and Atmospheric Administration were accessed to determine times of sunrise and sunset on the dates to which the subjects referred during their interviews. We linked each variable to each path point for each subject by latitude and longitude. The sunlight data provided an approximation of whether there was daylight or whether it was dark outside for each point of each subject's activity path.

Analysis

We examined subjects' perceived safety for the portion of their reporting periods that spanned from the moment they exited their home in the morning to the moment they returned home in the evening. Any time spent indoors during that period was omitted from the analysis. Time that was spent outdoors and on foot and in motion (e.g. walking to a destination) was not distinguished from time spent outdoors and on foot but stationary (e.g. sitting on a corner; standing on a corner). The analysis involved descriptive statistics to summarize characteristics of subjects and the locations of their residences. The Kuder-Richardson 20 was used to evaluate the internal consistency of the NES.

We analysed the path point data with ordinal logistic regression in generalized linear models with random intercepts to estimate perceived safety level based on characteristics of subjects' travel. Perceived safety was modelled after recoding it to a four-level variable representing safety levels of 10, 9, 8 and 7 or less. This was done for parsimony because most (88 per cent) path points had a safety level greater than 6. We analysed safety levels by transportation mode for subjects' travel periods after stratifying the data by a time-of-day variable – daylight or night-time hours – given evidence that people may be more afraid after dark (Mayhew and White, 1997; Mirrlees-Black and Allen, 1998). Each regression model included neighbourhood context variables to control for confounding. We report the regression coefficients for each variable, as well as the results of post-estimation tests to compare the coefficients of categories of the nominal variables (i.e. transportation mode; companion type) and test for differences in magnitude. Coefficients for the cut points, which are returned when using ordinal logistic regression, are also reported. We used the cut point coefficients to calculate the marginal, cumulative predicted probability that subjects reported specific perceived safety levels based on transportation mode, age group and whether they were travelling alone or with companions. The predicted probabilities are plotted in graphs as a way to communicate these key findings. The modelling used the GLLAMM (Generalized linear latent and mixed models) suite of programs, with random intercepts to account for variability between subjects with respect to their 'baseline' level of perceived safety, clustering by subject, robust standard errors and conventional diagnostics (Rabe-Hesketh and Skrondal, 2012).

The software used for data management and analysis was ArcMap version 10.1 (ESRI, Inc., Redlands, California) and Stata version 12 (StataCorp, College Station, Texas). The study was approved by the relevant institutional review boards.

Results

One hundred fifty three (153) subjects between 10 and 18 years of age were included in the analysis. Table 8.1 reports characteristics of the subjects and their activities. All were male and were African American. Approximately one in ten subjects (9.2 per cent) reported being a member of a gang. Reponses on the NES ranged from 1–16 (median = 9). The internal consistency of the NES in this sample was good (Kuder-Richardson 20 = 0.60).

Table 8.2 reports perceived safety levels for the subjects overall. One-quarter of subjects (24.2 per cent) reported a minimum level of safety of 10 out of 10, meaning that they felt 'very safe' from the risk of being assaulted for their entire reporting period. Conversely then, three-quarters of the subjects (75.8 per cent) felt some fear of being assaulted at some point during their daily outdoor activities.

The activity path data consist of a total of 5,541 minutes of activity time, and thus the working dataset had 5,541 observations. The median distance

Table 8.1 Characteristics of 153 children and their travel during daily activities

	Per cent or median (IQR)	**Range**
Subject		
Age, median (IQR)	16 (17, 17)	
Male, %	100	
African American, %	100	
Gang member, %	9.2	
Neighbourhood Environmental Scale, median (IQR)	9 (7, 11)	
Travel		
Distance (miles), median (IQR)	2.7 (0.6, 10.9)	0.1, 18.6
Transportation mode		
Foot, %*	100	
Car, %*	27.5	
Bus, %*	29.4	
Subway, %*	18.3	
Modes of transportation, median (IQR)	2 (1, 2)	1, 4
Foot only, %	44.4	
Travel time**		
Foot (minutes), median (IQR)	79 (60, 96)	9, 135
Car (minutes), median (IQR)	18 (9,26)	1, 70
Bus (minutes), median (IQR)	13 (4, 20)	1, 57
Subway (minutes), median (IQR)	12 (3, 18)	1, 33

Note: * Indicates per cent who used a particular mode of transportation; subjects may have used more than one mode of transportation; ** Indicates travel time only among subjects who used each particular transportation mode.
IQR: interquartile range.
Subway includes travel on a subway, trolley or train.

Table 8.2 Perceived safety during daily activities

Minimum safety level reported (scale from 1–10), %	**Per cent**
10	24.2
9	15.0
8	14.4
7	15.0
6	10.5
5	10.5
4	4.6
3	2.6
2	2.0
1	1.3

(Euclidian) travelled by the subjects was 2.7 miles. Four modes of transportation were observed: walking, bus (public bus or school bus), car and subway (including trolley and elevated train). All subjects walked at some point (100 per cent), 29.4 per cent travelled by bus, 27.5 per cent travelled by car and 18.3 per cent travelled by subway (Table 8.1).

Table 8.3 reports the ordinal logistic regression modelling based on travel during daytime hours. The results show that subjects' safety levels did not vary as a function of the incidence of crime or the prevalence of alcohol outlets in the locations in which subjects travelled. However, subjects' safety levels were higher among younger subjects (p<0.001), lower among subjects who reported being in a gang (p<0.001), and varied significantly based on

Table 8.3 Perceived safety level among 10- to 18-year-olds in Philadelphia during daily activities by transportation environment, age and companion status during daytime hours

Day time	**Coef.**	**SE**	**P**	**95% CI**
Car	–0.67	0.51	0.190	–1.85, –0.98
Bus	–0.72	0.45	0.115	–1.60, 0.17
Subway	–1.00	0.48	0.036	–1.93, –0.07
Foot (reference)	-ref-			
10–15 years	3.58	0.29	<0.001	3.01, 4.15
16–18 years (reference)	-ref-			
Adult	0.69	0.26	0.008	0.18, 1.20
Child	2.10	0.36	<0.001	1.40, 2.81
Other	0.04	0.34	0.900	–0.63, 0.71
Alone (reference)	-ref-			
Gang member	–1.42	0.22	<0.001	–1.85, –0.98
Crime	0.09	0.29	0.405	–0.12, 0.30
Alcohol outlets	–0.03	0.12	0.781	–0.20, 0.26
_cut 1	–1.57	0.24	<0.001	–2.04, –1.10
_cut 2	0.45	0.33	0.130	–0.13, 1.03
_cut 3	2.38	0.41	<0.001	1.58, 3.18

	Safety level based on transportation mode		
Predicted cumulative probabilities	**>7**	**>8**	**>9**
Car	0.84	0.69	0.51
Bus	0.85	0.70	0.52
Subway	0.69	0.50	0.32
Foot	0.80	0.64	0.46
Adult	0.84	0.69	0.51
Child	0.87	0.74	0.57
Other	0.77	0.60	0.41
Alone	0.70	0.50	0.31
10–15 years	0.93	0.82	0.65
16–18 years	0.69	0.48	0.28

Results based on ordinal logistic regression using generalized linear models.
Higher values on outcome variable correspond to higher safety level.
Outcome variable coded 10, 9, 8 and ≤ 7.
Coef.: coefficient; SE: standard error; CI: confidence interval.
The 'cut' variables report thresholds associated with the outcome variable.
The predicted cumulative probabilities of safety levels are plotted in Figure 8.1.

whom subjects were with. Comparisons among these categories, conducted with post-estimation tests comparing regression coefficients, revealed that safety levels were lowest when children were alone, higher when subjects were with an adult and highest when subjects were with another child. Significance levels of the post-estimation tests and the predicted cumulative probabilities of feeling different levels of safety are reported in Table 8.3 and Figure 8.1. Regarding companions, the probability of reporting a safety level of >8, for example, during daytime hours was 0.50 when travelling

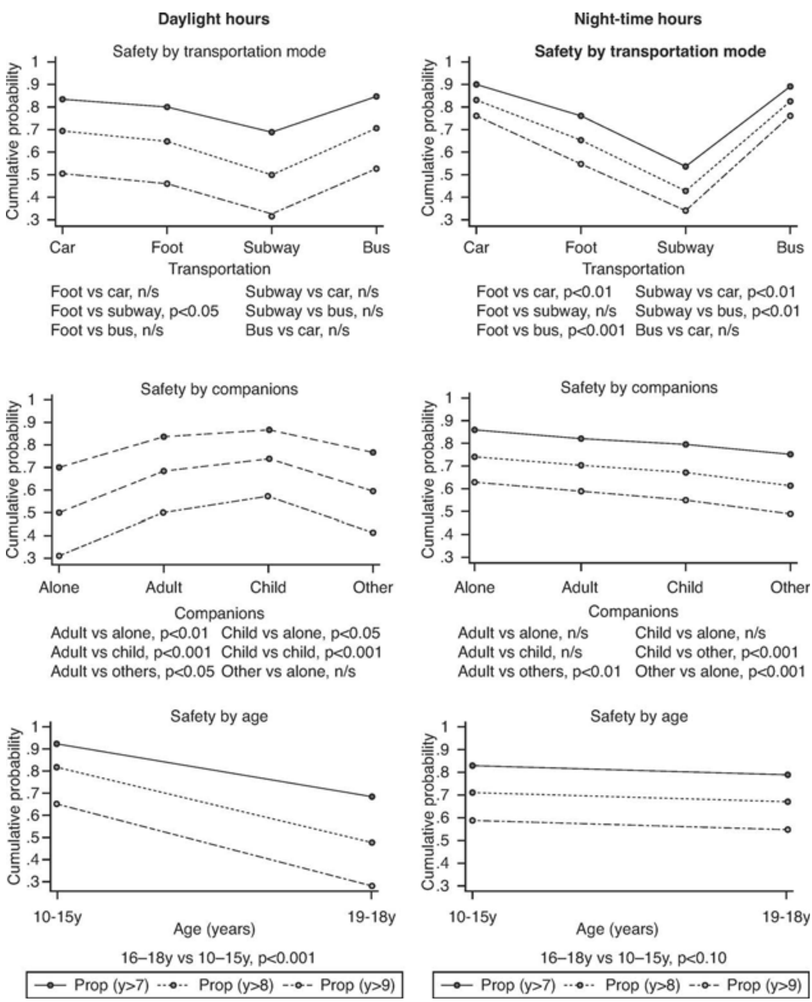


Figure 8.1 Cumulative predicted probabilities of perceived safety levels of above 7, above 8 and above 9

Note: Based on transportation mode and companion status during daylight hours (left) and after-dark hours (right) based on the regression models in Tables 8.3 and 8.4.

alone, 0.69 when with an adult, 0.74 when with a child and 0.60 when with another type of companion. After controlling for these factors, we found transportation mode variation with respect to subways only. Specifically, travelling on a subway was associated with lower perceived safety compared to travelling by foot ($p<0.05$). For example, the probability of reporting a safety of >8 was 0.50 on a subway as compared to 0.64 while on foot. That is, the likelihood that subjects' perceived safety was >8 on the scale of 1 to 10 (i.e. safety was 9 or 10 out of 10) was relatively low during the time they spent on a subway (50 per cent) and higher (64 per cent) during the time they spent on foot.

Table 8.4 reports the ordinal logistic regression modelling based on travel that occurred during night-time hours. The results show that after dark, subjects' safety levels were higher among younger children ($p<0.10$) and lower among subjects who reported being a member of a gang ($p<0.001$). Safety levels also varied significantly depending on subjects' companions and safety levels were lower in locations in which the prevalence of alcohol outlets was disproportionately high. After controlling for these factors, safety levels varied significantly by mode of transportation and were highest while subjects were in a car or riding a bus and lowest while riding a subway. Comparisons among these categories, conducted with post-estimation tests, revealed that safety levels were significantly lower when travelling on foot compared to being in a car ($p<0.01$) or travelling in a bus ($p<0.001$), and

Table 8.4 Perceived safety level among 10- to 18-year-olds in Philadelphia during daily activities by transportation environment, age and companion status during night-time hours

Night-time	Coef.	SE	P	95% CI
Car	3.02	0.93	0.001	–3.11, 1.51
Bus	2.13	0.50	<0.001	1.15, 3.11
Subway	–1.09	1.04	0.296	–3.14, 0.96
Foot (reference)	-ref-			
10–15 years	0.66	0.37	0.075	0.07, 1.38
16–18 years (reference)	-ref-			
Adult	–0.28	0.55	0.612	–1.36, 0.80
Child	–0.48	0.35	0.167	–1.17, 0.20
Other	–1.94	0.47	<0.001	–0.07, 1.38
Alone (reference)	-ref-			
Gang member	–2.31	0.10	<0.001	–3.11, –1.51
Crime	–0.03	0.18	0.865	–0.38, 0.32
Alcohol outlets	–1.34	0.43	0.002	–2.18, –0.50
_cut 1	–4.56	0.64	<0.001	–5.82, –3.31
_cut 2	–2.63	0.44	<0.001	–3.50, –1.76
_cut 3	–1.04	0.38	0.006	–1.78, –0.29

(*Continued*)

Table 8.4 Continued

Predicted cumulative probabilities	**Safety level based on transportation mode**		
	>7	**>8**	**>9**
Car	0.92	0.84	0.76
Bus	0.91	0.84	0.75
Subway	0.53	0.40	0.31
Foot	0.79	0.66	0.54
Adult	0.82	0.70	0.59
Child	0.80	0.67	0.55
Other	0.75	0.61	0.48
Alone	0.85	0.74	0.63
10–15 years	0.83	0.72	0.60
16–18 years	0.79	0.67	0.55

Results based on ordinal logistic regression using generalized linear models.
Higher values on outcome variable correspond to higher safety level.
Outcome variable coded 10, 9, 8 and ≤ 7.
Coef.: coefficient. SE: standard error. CI: confidence interval.The 'cut' variables report thresholds associated with the outcome variable.The predicted cumulative probabilities of safety levels are plotted in Figure 8.1.

lower when on a subway compared to when riding in a car ($p<0.01$) or travelling by bus ($p<0.01$). Significance levels of the post-estimation tests and predicted cumulative probabilities of feeling different levels of safety are reported in Table 8.4 and Figure 8.1. These values indicate the probability of reporting a safety of >8 after dark, for example, was 0.84 while in a car and 0.84 when riding a bus, but was 0.66 while walking and 0.40 while riding a subway. The probability of reporting a safety of >9 was 0.76 while in a car and 0.75 while on a bus, but was 0.54 while on foot and 0.31 while riding a subway. That is, after dark the likelihood that subjects' perceived safety was >9 on the scale of 1 to 10 (i.e. safety was 10 out of 10) was high during the time they spent in a car (76 per cent) or riding a bus (75 per cent), but was 54 per cent during the time they spent on foot and 31 per cent during the time they spent on a subway.

Discussion

This study produced novel insights into the perspectives of children and their perceived safety from violence as they travelled in different transportation environments during their daily activities. By our asking children to rate their safety repeatedly while recounting the span of their activities on a recent day, several key findings about the prevalence and nature of safety emerged. It was common for children – 75.8 per cent – to report feeling less than very safe at some point while travelling from place to place during the course of their activities. Also, after controlling for age, subjects' companions, gang membership and the context of the urban environment, children's feelings of safety varied little across transportation environments as they travelled during the hours when the sun was up. After dark, however, feelings of safety varied considerably and were highest while children were travelling in a car or on a bus, were lower while they were travelling on foot and were lowest while they were travelling on a subway.

We also found that, at night, subjects felt less safe in areas in which alcohol outlets were disproportionately common. This finding, and the finding that fear was elevated after dark, is consistent with the findings from children and adolescents in the United Kingdom, in which perceived safety was lower after dark and negatively associated with the presence of people who were intoxicated (Crime Concern, 1999). We also found that perceived safety was lower among gang members, and that perceptions of safety were lower among older compared to younger children. The risk of being the victim of violence (including homicide) in urban America is higher for teenagers as compared to younger children. Hence our finding may be an indication that older children perceive this risk. Gang members' involvement in risky activities unrelated to their mode of transportation may have some influence on their self-reported feeling safe. It is unclear why perceived safety after dark was distinctly lower during the times that subjects were riding a subway, but was not lower while riding a bus or travelling in a car. In fact, travelling on a bus was associated with higher perceived safety than was travelling by foot. In the Crime Concern findings based on youth in the United Kingdom, it was more common for youth to feel unsafe on a train than to feel unsafe on a bus. In our findings, it may be that the act of going underground to ride a train, trolley or subway is what raised subjects' concerns, perhaps because responsible adults who could provide informal guardianship were not present, lines of sight were diminished and lighting was poor. Each of these features of the social and built environment was associated with elevated fear among the youth in the United Kingdom (Crime Concern, 1999). It may also be the case that during the instances in which subjects in our study were riding a bus, something about their situation improved their safety, such as being accompanied by an adult. Although we controlled for this and other factors that are independently associated with perceived safety, we did not examine effect modification due to limits of the sample size. Investigating how combinations of risk and protective factors relate to perceived safety would be interesting to pursue in future research.

It was interesting to find that perceived safety from the risk of assault was not associated with the incidence of violent crime in locations in which subjects spent time. It may be the case that the subjects were familiar with the locations in which they spent time and felt that the underlying level of crime did not compromise their safety. It is also possible that subjects had an inaccurate perception of their safety with respect to the likelihood of crime in an area. Additionally, it may be that using administrative data to represent the underlying level of crime in an area does not accurately reflect the risk that a young person in that area will be assaulted. Research that is conducted with qualitative methodologies, including focus groups, would help us understand this issue and help interpret the results of the present study. Whereas our study provides novel insight into what factors appear to impact perceptions of safety, our approach does not lend itself to understanding why.

A key requirement for being able to address fear of crime as a public health problem is understanding where and when people are afraid (Doran and Burgess, 2012b). As Doran and Burgess (2012b) point out, traditional survey tools are not well suited for this because they lack a reference to geography. Moreover, there are challenges associated with asking people to provide ratings of their fear. Global measures that ask people to rate their fear can be problematic because the question wording may be ambiguous (Rountree and Land, 1996). Alternatively, asking people if they are 'afraid' may be unrealistically foreboding (LaGrange and Ferraro, 1989). Given these concerns, Nassar (1998) called for new analytic approaches that leverage GIS as a way to increase accuracy in mapping individuals' perceptions of safety and fear. More recently, Samuels and Judd called for using a spatio-dynamic approach to measuring fear, in particular because it has the possibility of interpreting social indicators of fear in their epidemiologic context (Samuels and Judd, 2002). Consistent with this rationale, we used a scale to ask subjects to rate their perception of their safety, as opposed to fear, on a continuous scale, and we embedded that scale in a GIS interface. Our use of a GIS to learn about the locations of children's activities, and to anchor children's recall not only in terms of geography but in terms of timing as well, enabled us to capture information that provides the novel insight into perceived safety that is reported here.

In one of the relatively few studies of fear in transportation environments that was conducted among adults, Loukaitou-Sideris (2012) found that adults reported elevated levels of fear when waiting at transit stops in Los Angeles. The Crime Concern report also found that fear was common among youth in the United Kingdom as they waited at bus stops and train stations (Crime Concern, 1999). In the data we have reported above, there were few instances in which subjects noted that they were waiting for a bus or for a subway at a given time, and thus we could not investigate children's fear while waiting at transit stops specifically. In addition to this lack of specificity, our study has several limitations. Ultimately, the validity of our results depends on how well our perceived safety question performed. One indication that our safety question yielded accurate information is seen in a number of the findings that are reasonable and intuitive, such as safety being lower after dark and safety being highest when a subject was travelling in a car. Reported safety was also relatively high at times in which subjects were in the presence of an adult, which is reasonable given the guardianship that could be conferred. In these ways we see evidence of face validity, yet we ultimately do not have a direct way of gauging the criterion validity of the method we used to measure perceived safety. Reporting bias is a potential limitation as well. Participants, child and adolescent-age males in Philadelphia, may have been reluctant to report being fearful of violence (Farrall et al, 1997).

Thus, our results may overestimate how safe participants truly felt. Also, a scenario that makes one child feel a little unsafe may make another child feel very unsafe. Modelling perceived safety as a variable with a range of response options helped protect against any measurement error these issues could introduce, as did using a random intercept model, which allowed for each subject to be compared to himself as his safety levels changed over the course of the day. Note that while reporting bias may exist, the study took steps to prevent it, including establishing rapport during the recruitment process, interviewing in private and ensuring confidentiality. Also, as found by Wikström et al., young people's activities and modes of transportation vary by day of the week (Wikström et al., 2012). Controlling for day of week, or examining perceived safety by day of week explicitly, may be an interesting avenue to pursue. A more general issue is that our results are based on a homogeneous sample, comprised of urban African American children who were male. There is evidence from past research that experiencing fear from neighbourhood conditions may be more common among girls than boys, and that types and determinants of fear may be gender specific (Johansson et al., 2009). But given that we lack direct evidence of how perceived safety in transportation environments functions among females and children of other races who live in urban settings, it would be helpful to conduct similar studies in other populations so that our results could be compared.

As noted above, in comparison to the large body of research that has focused on crime and assault as the outcome, considerably less research has focused on understanding fear of crime specifically as the outcome of interest (Doran and Burgess, 2012a). Whereas it is relatively rare to be the victim of crime, being afraid of being victimized common (Doran and Burgess, 2012c). This perspective stems from understanding that fear is not restricted in time and space in the same way in which crime is restricted (Perkins and Taylor, 1996; Smith, 1987). Unlike crime, which requires a convergence in time and space of an offender and victim (Cohen and Felson, 1979), fear requires only the victim (Doran and Burgess, 2012a). While the outcome of violence can be discrete and measurable – with an evident treatment strategy – the outcome of fear of violence is more abstract and can be more difficult to diagnose and treat. The perception of crime risk may not manifest itself with a predictable symptomatology, but instead result in altered patterns of behaviour that have deleterious effects on adolescent lifestyle and development. Fear of crime can lead children (and their parents) to pursue avoidant behaviours that constrain both mobility and participation in activities that take place in the public realm. In the context of transportation to and from school, fear might lead a student to choose an inefficient route to school in order to avoid areas that cause him or her undue fear of violence. Such a detour might cause excessive tardiness – or, conversely, insufficient sleep. Avoidant behaviours like this can result in suboptimal educational outcomes, particularly for students of lower socio-economic status, who are substantially more likely to rely on public transportation to get to and from school (Mota et al., 2007).

Implications for research and practice

As seen in the Crime Concern research from the United Kingdom, transit stops were the site of frequent physical incivilities, including graffiti, which elicited fear among children and adolescents (Crime Concern, 1999). One focus group participant stated gang sign tagging in particular as a cause for concern. Strategies including removing graffiti may therefore help improve perceived safety, as may additional changes to the built environment such as increasing lighting and improving lines of sight at bus stops and train stations (Wang and Taylor, 2006). Of course, increasing safety, in addition to perceived safety, is a more fundamental public health goal.

There are opportunities to introduce strategic interventions that target social environments as a way to accomplish both objectives. An example is common in the United States, in which creating 'safe routes to school' has become a nationwide phenomenon (Safe Routes to School National Partnership, 2010). Examples include Flagstaff, Arizona, and Austin, Texas, in which parent-supervised Walking School Bus programs were introduced in high-crime areas in attempts to ensure students' safety on the way to school (Institute for Youth, Education, and Families, 2011; Safe Routes to School National Partnership, 2010). Ultimately, as such efforts may be unsustainable, it is warranted to seek more upstream approaches to creating defensible space in neighbourhoods and more generally making neighbourhoods and transportation environments safer to prevent situations that threaten adolescents' sense of safety (Orion, 2011). Other opportunities to learn about how interventions may impact behaviours to make specific environments safer could be achieved by using experimental designs like the one described by Solymosi et al. (Chapter 9 of this volume).

With so little research in this area, our results provide helpful insight revealing that adolescents' perceptions of their safety are dynamic over the course of their daily activities, and are distinctly low in range of situations. We hope the methods and findings motivate future research that uses both qualitative and quantitative approaches to better understand the mechanisms by which transportation environments impact children's perceptions of their safety, and to find ways to make children feel safer.

Acknowledgements

Funded by grants R01AA014944 and K02AA017974 from the National Institute on Alcohol Abuse and Alcoholism and the Eunice Kennedy Shriver National Institute of Child Health and Human Development.

References

Alvarez, A., and Bachman, R. (1997) Predicting the Fear of Assault at School and While Going to and From School in an Adolescent Population. *Violence and Victims*, *12*(1), 69–86.

American Public Transportation Association. (2013) Facts. Available at http://www.apta.com/mediacenter/ptbenefits/Pages/FactSheet.aspx, accessed 4 August 2013.

Bachman, R. Randolph, A., Brown, B. L (2011) Predicting Perceptions of Fear at School and Going to and From School for African American and White Students: The Effects of School Security Measures. *Youth & Society*, *43*(2), 705–726. doi: 10.1177/0044118x10366674.

Basta, L. A.et al. (2010) Neighborhoods, Daily Activities, and Measuring Health Risks Experienced in Urban Environments. *Social Science and Med*, *71*(11), 1943–1950.

Branas, C. C. et al. (2009) Alcohol Consumption, Alcohol Outlets, and the Risk of Being Assaulted with a Gun. *Alcoholism: Clinical and Experimental Research*, *11*(4), 1–10.

Cohen, L. E., and Felson, M. (1979) Social Change and Crime Rate Trends: A Routine Activities Approach. *American Sociological Review*, *44*(4), 588–608.

Crime Concern. (1999). *Young People and Crime on Public Transport*. Department of the Environment, Transportation and the Regions, UK.

Crum, C. R. et al. (1996) Neighborhood Environment and Opportunity to Use Cocaine and Other Drugs in Late Childhood and Early Adolescence. *Drug and Alcohol Dependence*, *43*(3), 155–161.

Doran, B. J., and Burgess, M. B. (2012a) The Emergence of Fear of Crime as an Area of Research (chapter 1). *Putting Fear of Crime on the Map: Investigating Perceptions of Crime Using Geographic Information Systems* (pp. 1–4). New York: Springer.

Doran, B. J., and Burgess, M. B. (2012b) Future Avenues for Fear Mapping: Potential Applications and Improvements (chapter 8). *Putting Fear of Crime on the Map: Investigating Perceptions of Crime Using Geographic Information Systems* (pp. 251–261). New York: Springer.

Doran, B. J., and Burgess, M. B. (2012c) What Causes Fear of Crime? (chapter 3). *Putting Fear of Crime on the Map: Investigating Perceptions of Crime Using Geographic Information Systems* (pp. 25–50). New York: Springer.

Farrall, S. et al. (1997) Questioning the Measurement of the Fear of Crime: Findings from a Major Methodological Study. *British Journal of Criminology*, *37*(4), 658–679.

Institute for Youth, Education, and Families. (2011) The California Cities Gang Prevention Network, Bulletin 21, In: N. L. o. Cities (ed.). Oakland, CA. (February 2011). Accessed 15 July 2011. Available at: http://www.ccgpn.org/.

Johansson, K. et al. (2009) Exploring the Neighborhood: A Web-Based Survey on the Prevalence and Determinants of Fear among Young Adolescent Girls and Boys. [Research Support, Non-US Government]. *International Journal of Adolescent Medicine and Health*, *21*(3), 347–359.

Johansson, K. et al. (2010) Young Adolescents' Independent Mobility, Related Factors and Association with Transport to School. A Cross-Sectional Study.

[Research Support, Non-US Government]. *BMC Public Health 10*, 635. doi: 10.1186/1471–2458–10–635.

LaGrange, R. L., and Ferraro, K. F. (1989) Assessing Age and Gender Differences in Perceived Risk and Fear of Crime. *Criminology, 27*(4), 697–720.

LaGrange, R. L. et al. (1992) Perceived Risk and Fear of Crime: Role of Social and Physical Incivilities. *Journal of Research in Crime and Delinquency, 29*(3), 311–334. doi: 10.1177/0022427892029003004.

Lalli, M., and Savitz, L. D. (1976) The Fear of Crime in the School Enterprise and Its Consequences. *Education and Urban Society, 8*(4), 401–416.

Los Angeles County Metropolitan Transportation Authority (No date) Transit Safety programs. Available at http://www.metro.net/about/transit-safety/, accessed 4 August 2013.

Loukaitou-Sideris, A. (2012) Safe on the Move: The Importance of the Build Environment. In: V. Ceccato (ed.), *The Urban Fabric of Crime and Fear* (pp. 85–110). New York: Springer, 85–110.

Mayhew, P., and White, P. (1997) *Home Office Research and Statistics Directorate Findings no. 57: The 1996 International Crime Victimisation Survey.* From http://www.homeoffice.gov.uk/rds//pdfs/r57.pdf.

Mirrlees-Black, C., and Allen, J. (1998) *Concerns about Crime: Findings from the 1998 British Crime Survey. Research Findings No. 83.* London: Home Office Research, Development and Statistics Directorate.

Mota, J. et al. (2007) Active versus Passive Transportation to School: Differences in Screen Time, Socio-Economic Position and Perceived Environmental Characteristics in Adolescent Girls. [Research Support, Non-US Government]. *Annals of Human Biology, 34*(3), 273–282. doi: 10.1080/03014460701308615.

Nassar, J. L. (1998) *The Evaluative Image of the City.* Thousand Oaks CA: Sage.

Orion, S. (2011) Findings from Research on Active Transportation to School and Implications for Safe Routes to School Programs. *Journal of Planning Literature, 26*(2), 127–150.

Pearson, F. S., and Toby, J. (1991) Fear of School-Related Predatory Crime. *Sociology and Social Research 75*(3), 117–125.

Perkins, D. D., and Taylor, R. B. (1996) Ecological Assessments of Community Disorder: Their Relationship to Fear of Crime and Theoretical Implications. *American Journal of Community Psychology, 24*(1), 63–107.

Rabe-Hesketh, S., and Skrondal, A. (2012) *Multilevel and Longitudinal Modeling Using Stata. Volume II: Categorical Responses, Counts, and Survival*, third edition. College Station, TX: Stata Press.

Rapp Paglicci, L. A., and Wodarski, J. S. (2000) Antecedent Behaviors of Male Youth Victimization: An Exploratory Study. *Deviant Behavior, 21*(6), 519–536.

Rountree, P. W., and Land, K. C. (1996) Perceived Risk versus Fear of Crime: Empirical Evidence of Conceptually Distinct Reactions in Survey Data. *Social Forces, 74*(4), 1353–1377.

Safe Routes to School National Partnership (2010) Implementing Safe Routes to School in Low-Income Schools and Communities: A Resource Guide for Volunteers and Professionals. Available at: http://www.saferoutespartnership.org/resourcecenter/publications/low-income-guide, accessed 20 May 2012.

Samuels, R., and Judd, B. (2002) *Public Housing Estate Renewal: Interventions and the Epidemiology of Victimisation.* Paper presented at the Housing, crime and stronger communities conference, Melbourne, Australian Institute of Criminology & Australian Housing and Urban Research Institute.

Savitz, L. M. et al. (1977) *City Life and Delinquency*. Washington, DC. US Department of Justice.
Smith, S. J. (1987) Fear of Crime: Beyond a Geography of Deviance. *Progress in Human Geography*, *11*, 1–23.
Stewart, O. (2011) Findings from Research on Active Transportation to School and Implications for Safe Routes to School Programs. *Journal of Planning Literature,* 26(2), 127–150. doi: 10.1177/0885412210385911.
Tseloni, A., and Zarafonitou, C. (2008) Fear of Crime and Victimization: A Multivariate Multilevel Analysis of Competing Measurements. *European Journal of Criminology, 5*(4), 387–409. doi: 10.1177/1477370808095123.
Waksberg, J. (1978) Sampling Methods for Random Digit Dialing. *Journal of the American Statistical Association*, *73*, 40–46.
Wang, K., and Taylor, R. B. (2006) Simulated Walks through Dangerous Alleys: Impacts of Features and Progress on Fear. *Journal of Environmental Psychology*, *26*(4), 269–283.
Wiebe, D. J. et al. (2013) Fears of Violence during Morning Travel to School. *Journal of Adolescent Health* 53, 54–61.
Wikström, P. H. et al. (2012) *Breaking Rules: The Social and Situational Dynamics of Young People's Urban Crime*. Oxford: Oxford University Press.

OPEN

9

Crowd Spatial Patterns at Bus Stops: Security Implications and Effects of Warning Messages

Réka Solymosi, Hervé Borrion and Taku Fujiyama

Introduction

As demonstrated throughout this book, the risk of certain types of crime can increase in congested spaces. Contact crimes, crimes which require the offender to make physical contact with the victim, are especially common in more crowded transport networks and can discourage many would-be passengers (Brand and Price, 2000). Pickpocketing makes up a substantial portion of this, accounting for around 50 per cent of all crime on London's transport network (Transport for London, 2012). Other chapters in this volume have emphasized the link between pickpocketing and bus stops, and this chapter will delve deeper into the mechanics of crowding at bus stops, and implications for pickpocketing and risk.

The aim of this chapter is to investigate crowding at bus stops by measuring micro-level spatial patterns of movements of individuals and consider implications for crime. Safety on the move is being approached on various scales in this book, and many meso- and macro-level studies reveal that risks are not equally or randomly distributed. This chapter takes a micro-scale approach, but replicates the findings from the above frameworks, to demonstrate that by observing the microlevel, detailed insight into where risks can occur could be generated.

To achieve new insight the chapter presents a novel approach of using a laboratory experiment as a method to study crime in a transport setting. This approach is used to measure fine details about interpersonal interactions at a crowded bus stop, and examine implications for interventions such as audio warning messages. The overall objective is to use insight into crowding gained by these experiments to make suggestions as to where future interventions should focus, and whether auditory warning messages provide a promising option, as well as to illustrate the potential benefits of this methodology for crime and transport research.

This article firstly reviews relevant literature on crowding and transport crime, pedestrian motion analysis and warning messages. It then presents the research questions that arose from the reviewed literature. The experimental methodology is then presented in detail, followed by the results and discussion of the implications of the findings.

Theoretical background and hypotheses

Transport crowding and theft

Transport systems in large cities experience passenger volumes that test the higher end of their capacity. For example, in London, approximately 24.8 million total trips are made daily, using public transport (Transport for London, 2011). A peak time increase in ridership results in overcrowding, creating a criminogenic environment unique to transport environments (Smith and Clarke, 2000). In a crowded environment, contact crime, that is, crime that thrives where people come into close contact with one another, can present a significant problem. Crowding is a precondition of contact crime (Smith and Clarke, 2000), and typical offences include theft (Kabundi and Normandeau, 1987) and sexual assaults (Beller et al., 1980). Indeed many of the chapters in this book focus on the relationship between crowding, including increase in theft risk with congestion, and the impact of passenger flow on pickpocketing at bus stops.

At the meso- and the macro-levels, observational studies have demonstrated how crowding specifically at stations and stops has been associated with high rates of crime and fear of crime (Shellow et al., 1974; Kenney 1986). Pickpocketing in particular occurs at overcrowded stops at which offenders can take advantage of the high densities of people who are close together (Loukaitou-Sideris and Liggett, 2000, Loukaitou-Sideris, 1999, Liggett et al., 2001; Loukaitou-Sideris, 2012; Loukaitou-Sideris et al., 2001). Additional studies which examine information from police files, revisit sites and interview offenders and victims suggest that the specific act of pickpocketing frequently takes place during boarding, when people are getting on the bus, and are crowding around the bus door, rather than while waiting or after boarding the bus (Poyner, 1986). While singling out a specific element of the entire process of crowding at bus stops may help target interventions, there is not enough insight into the mechanisms of crowding to justify this. Therefore this chapter will study the spatial patterns of crowding in more detail, to attain further insight into what happens while people are boarding a bus.

Bottlenecks

Research on pedestrian motion analysis has found that often, in crowded environments problems emerge due to bottlenecks (Helbing et al., 2005). Bottlenecks are areas in which there is a significant capacity drop in pedestrian movement, such as a narrow doorway in a corridor, where jamming occurs when the incoming flow exceeds the capacity of the bottleneck (Seyfried et al., 2009). Hoogendoorn and Daamen (2005) observed that during such a jam, pedestrians form layers, and while trying to navigate through a door one metre wide, the width of these layers will become less than the effective width of a pedestrian, causing them to overlap. Effectively, when passing through a bottleneck, people come in close proximity, effectively moving into each other's personal space, which enables close contact such as getting within arm's reach of one another.

Assuming that the bus door causes capacity to drop and forces people to come within close distances of one another while boarding, this would create many opportunities for one person to reach into the pocket of another. If the bottleneck at the bus door has such an effect on the crowd's movement, we should see people coming closer to one another, and doing so more frequently. Identifying the bus door as a bottleneck that produces such an effect can help shift focus to that specific element of crowding at bus stops and inform better planning interventions to reduce this. Laboratory experiments are a common methodology for examining pedestrian behaviour in bottlenecks. They have the advantage of creating a controlled environment in which variables related to spatial patterns can be measured. Studying micro-level interactions in a laboratory setting results in many findings and real-world applications (for an example see Helbing et al., 2005), for crime prevention practitioners, as well as academics working on meso- and macro-scale models, or academics from other disciplines interested in using pedestrian motion analysis to study social phenomena.

The self-organizational behaviour of crowds

Routine activity theory states that crime occurs given the intersection of a likely offender, a suitable target and the absence of a capable guardian (Felson and Cohen, 1979). To prevent and control crime, we can attempt to manipulate one of more of these three variables. This chapter will focus on how crowding can produce suitable targets, and will assume the presence of a motivated other. Crowding is affected by density (the number of people using the bus) and by the width of the bottleneck (bus door). However, reducing the number of people using the transport system or widening all bus doors is an unrealistic solution. Alternatively, other factors also influence crowding in a bottleneck, such as the behaviour of passengers passing through (Hoogendoorn and Daamen 2005). People's behaviour is influenced by their environment (Evans 2009). For example, similar to crowding at bus stops, crowding at nightclubs has been associated with increased crime rates (Macintyre and Ross, 1996). Yet Macintyre and Ross (1996) established a difference between 'good' crowding and 'bad' crowding, independent of density, suggesting better design standards for nightclubs, shifting focus from crowd control and capacity management approaches to the layout and design of clubs. Similarly, an intervention that would encourage pedestrians to adopt self-protective behaviour while boarding a bus could help reduce crime at bus stops.

To observe self-organizational behaviour, this project focuses on the micro-level interactions between persons in a crowd. Pedestrians' movements are affected by interactions with other pedestrians (Helbing et al., 2001). The term 'micro-level interaction' refers to local interactions, from which collective behaviour emerges (Moussaïd et al., 2009). Goffman (1971) found that pedestrians react only to those other pedestrians who are in a small circle around them, neglecting others who are one or two persons away. Therefore, to study the micro-level interactions in a crowded setting, it is important to focus on those persons immediately surrounding the individual, and the relationship between them, as those individuals further away (more than two persons away) will not affect their actions. Thus the study will focus on the micro-level interactions within the context of crowding at bus stops.

Warning messages

Warning messages are an example of an intervention currently in use, aimed at encouraging passengers to adopt self-protective behaviours (Metropolitan Police 2011; British Transport Police 2011). The purpose of a warning is to alert people to potential hazards (Stewart and Martin 1994) and to encourage modification of behaviour to protect against them (Wogalter and Laughery 1985). However, often they are informative rather than persuasive, and can be ignored, reducing their impact as a preventive measure (Jacoby et al., 1998). Even if attended to, warning messages may have unintended consequences, like serving as a tool for pickpockets; posters can be used to pinpoint valuables when people walking by them tap their pockets to check if they still have their belongings (see Ekblom, 1995). During a passenger journey on public transport, the primary goal is to reach one's destination. To ensure a message is observed can be especially challenging in this context, and the extent to which passengers' behaviour can be altered is furthermore restricted by features of the environment. Applying methods from crowd dynamics, mentioned earlier, may serve to answer questions about the feasibility of using warning messages to encourage change in behaviour in restricting environments.

Research questions

The research questions were devised to be feasible within the simplified context of a laboratory setting, yet still produce meaningful insight into crowding behaviour relevant to a bus stop. Based on the identification of the boarding component of the bus journey, as the phase in which pickpocketing takes place (Poyner, 1896), and on literature on pedestrian motion analysis, discussed above, it can be speculated that the creation of a bottleneck at the entrance of the bus amplifies the crowding situation. To determine whether this is the case, research question one asks, *is there* *a difference in the distance passengers keep from those immediately around them between when they are waiting, boarding and being on a bus?*

H1: There is a difference in the distance people keep from one another at the different phases of the transit journey (waiting at the stop, boarding the vehicle and being on a bus)

The above literature summary also suggests that altering passenger behaviour within a crowded environment may reduce 'bad crowding'. Question two will seek to determine *whether people are capable of altering their behaviour in terms of distance from those immediately around them, when exposed to auditory warning messages about the presence of a pickpocket, despite having to carry out their primary goal of completing a bus journey.*

H2: There is a difference in the distances people keep from one another between control, warning and pickpocket scenarios.

Answering these questions will identify what specific phase of crowding is 'bad crowding' (when people come close enough to be able to reach one another), and whether spatial behaviour on the micro-scale can be changed

Method

Most literature on crowding, bus stops and pickpocketing relies on field observations, providing valuable and detailed insight into contact crime in transport environments from this angle. To gain new insight, a laboratory experiment was chosen for this study, to address field studies' difficulty in measuring concepts and altering or controlling variables (Eck and Liu, 2008). The simplification of context allows for measurement of micro-level interactions that make up crowding by observing interpersonal distances during the process of waiting for, boarding and finding a place on a bus. This choice of methodology serves to introduce something new into research on contact crimes in transport environments. Further, the direct relation of the research questions to the simplified context makes the laboratory experiment a useful tool for observing rules and patterns of pedestrian behaviour and group self-organization (Helbing et al., 2005; Daamen et al., 2008). Practical reasons such as the ability to precisely measure positional data and run replicable scenarios that are not available or difficult to observe in normal conditions (Hoogendoorn and Daamen, 2005) are a further benefit of choosing a laboratory experiment as the method for this study.

The experiment was carried out at University College London's (UCLs) Pedestrian Accessibility Movement Environment Laboratory (PAMELA). PAMELA has been used to study how pedestrians navigate urban spaces (Cepolina and Tyler, 2005; Fernándezet et al., 2010; Fujiyama and Childs, 2005). A mock-up bus shelter and bus were constructed in PAMELA to replicate the study environment. Measurements for the shelter were initially determined by consulting guidance manuals (Transport for London, 2006), but were later adjusted based on measurements of actual bus shelters in North London, to ensure real-world parameters. A full scale 'mock-up' of the front section of a New Bus for London (NBfL) bus was built to correspond with the exact parameters of NBfL. Only the front section was constructed to ensure that the crowding level (see Participants section) was maintained throughout the experiment. It is assumed that the bus is so crowded that participants can only fit into the front section of the bus.

Ambient traffic noise and sounds representing a bus pulling up to a stop and opening its doors were played over phase array speakers in PAMELA to provide an appropriate background (Childs et al., 2005). A range of environmental factors were included, such as vertical and horizontal gaps, door width and internal arrangement of space, to replicate those of a real bus, in order to recreate the type of bottleneck effect that would occur during boarding in the real world. Appendix 9A shows the final parameters and set-up of the experiment.

To measure distances between individuals, participants' movements were tracked by motion-tracking devices and studied in relation to one another. The motion trackers consist of small wireless markers (Appendix 9B) that record Cartesian coordinates of their location in reference to a coordinate grid set out by sensors (Appendix 9C) with which they communicate using radio frequency, at a frequency of 47Hz (recording data 47 times per second). The markers were placed on hard hats, which participants were instructed to wear (Appendix 9D). The sensors were set-up around the experiment environment (Appendix 9E).

The distance between markers was obtained using the following equation:

$$d = \sqrt{(X_B - X_A)^2 + (Y_B - Y_A)^2 + (Z_B - Z_A)^2}$$

The above procedure was used to find the distances between all marker pairs for the full duration of each run of the experiment. All three coordinates were considered in order to get the absolute distance between markers. If any shift in the coordinate grid occurred due to participants' accidentally bumping into the infrastructure, the distances measured between markers would still remain consistent, allowing for comparability between all the scenarios and experiment runs.

A total of 16 participants were recruited with a mean age of 25.4 years, with the youngest at 19 and the oldest 40 years old. There were 10 male and 6 female participants. Most participants were strangers to each other, although there was one group of three who were friends who moved together as a group. To create a more diverse range of boarding behaviour, participants were assigned roles which they were instructed to perform during the course of the entire experiment. Roles were assigned to participants randomly, and contained information such as the urgency with which they needed a seat (*passenger who wants a seat on the bus, elderly passenger, passenger in a hurry* and *normal passenger*) to replicate the competition for space that takes place in a real bus environment. Participants were also asked to keep their roles secret from each other. Enough participants were recruited to recreate crowding in this portion of the bus and at the mock-up bus shelter. This number was achieved based on findings from behavioural experiments on personal space preferences. Minimum desirable occupancies range from five to ten square feet per person, and the experimental set-up provided significantly less than that, to achieve crowding (Fruin, 1992).

Experiment procedure

For the experiment, participants were asked to wait at the mock-up bus shelter for about one minute, after which they were prompted to board the bus and situate themselves on it. This was repeated nine times. After the every third repeat, the warning scenario condition was changed. The three different scenarios will be referred to as control, warning and pickpocket. The *control* scenario consisted of participants waiting at the bus stop and boarding the bus when indicated. The *warning* scenario was the same as the control, except alongside the noise of traffic and the bus, a standard station announcement, recorded from a UK station, was played over the sound system (automated voice) while the participants waited at the bus stop. The recorded message said, 'May I have your attention please: would customers please note that pickpockets operate on this station. Please do not leave any item of luggage unattended at any time. Please make sure your personal items are secure'.

In the *pickpocket* scenario, the participants were informed by the experimenter, that one of them has been given the role of pickpocket. It was verbally explained by the experimenter (human voice) that the pickpocket's task was to place a playing card on the person of a fellow participant. In reality, *none of the participants were actually given this role*. The aim was to encourage vigilance amongst participants, providing the most serious warning condition. Participants were told to aim to avoid becoming the victim of the 'pickpocket'. This scenario is much like the popular game 'assassin', in which players have to come close to one another undetected to place an object on the other person (for example, a sticker or a playing card). As it was not possible to hire a professional pickpocket, or for the participants to believe one of them was an actual pickpocket, this was a believable alternative which the participants understood as a credible threat. For every run of the experiment, participants spent roughly the same amount of time waiting at the bus stop before they would board the bus. Data recording was stopped after all participants had boarded and found a place on the bus.

In order to measure only micro-level interactions between participants, and to focus on those who came 'close enough' for a pickpocket to physically be able to operate, people's peripersonal space was considered. This is the space immediately surrounding a person, within which objects can be reached without the person's moving (Holmes and Spence, 2004). To operationalize this measure, a study of arm-reach carried out to inform fighter-jet design was consulted (King, 1948), which found this threshold distance to be 26.7 in (67.8 cm). The following sections will detail the results of the experiment, analyse them in terms of the research questions and present a discussion of the findings.

Results

Initially, the x and y coordinates of participants were plotted to show their trajectories for the first run of the experiment (Figure 9.1).

As individual trajectories describe where participants went in space, but not much about their relation to one another, this data was further analysed

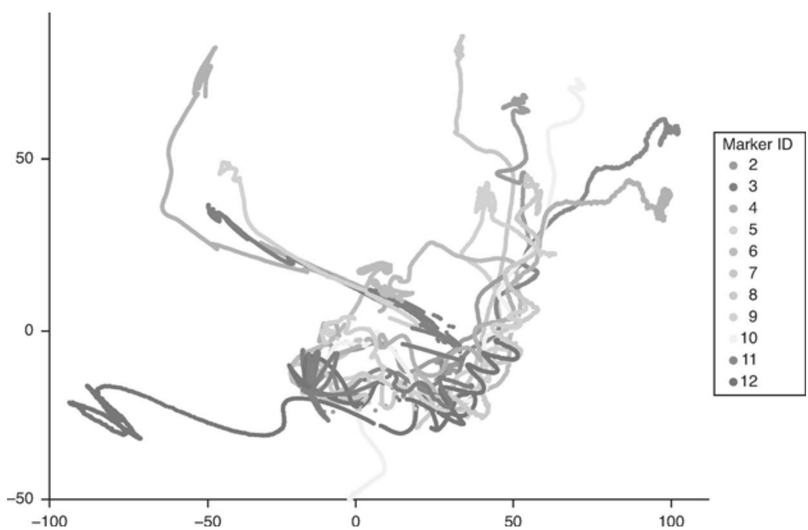


Figure 9.1 Trajectories of participants in one run of the experiment showing their movement while waiting for boarding and dispersing from the mock-up bus

to calculate the distances between people. Firstly, the smallest distance between people during each phase (waiting, boarding, on bus) of each run (control, warning and pickpocket) was considered. Figure 9.2 shows a frequency distribution of minimum distances. Each smallest distance per marker pair was plotted on a histogram, in which the x axis shows distance in inches, grouped into categories (those that fall between 0 to 10.0 in, 10.1 to 20.0 in, etc.), and the height of each bar represents the number of values that fall within each group. This data is normalized for the number of valid measurements collected. Therefore, the data presented is the proportion of the valid samples that fell within each distance category.

During boarding, the closest people came to one another was most frequently between 0 and 20 inches. This is very different from the waiting and on the bus phases, in which a more even distribution is present. More people come very close to one another during the stage of boarding than the other phases of 'waiting' and 'on the bus'. Indeed, looking at all nearest distances between pairs, on average people maintained a minimum distance over twice as large while 'waiting', or 'on the bus', than what they managed to keep during 'boarding'.

As this data does not follow a normal distribution, a Wilcoxon signed rank test is used (Baguley, 2012) to determine that this difference in minimum distances kept is significant between the waiting, boarding and

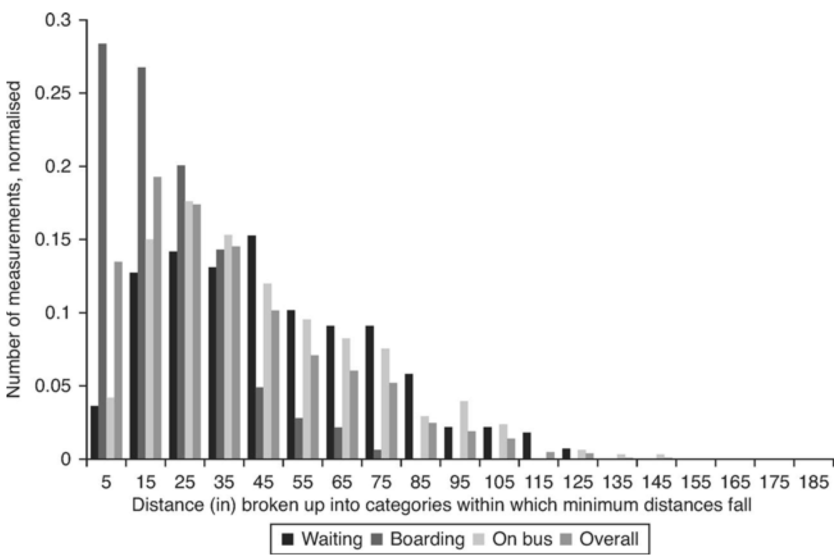


Figure 9.2 Distribution of the smallest distances between people broken down by phase

on the bus phases ($p < 0.05$). The bus door does indeed create a bottleneck in which people are forced significantly closer to one another. Looking back at people's trajectories within the experiment space, Figure 9.3 shows participants coming together and then moving apart during boarding.

To determine opportunities in which participants would be able to reach each other's pockets, we refer back to the measure of peripersonal space. Figure 9.4 shows how many times two people came within arm's reach of one another (normalized for number of valid measurements). Of all the phases, it was while boarding that two people were most likely to come close enough to one another that one could reach the other's pockets. The bottleneck effect created when passengers board the bus clearly forces people closer together, more often than other stages of crowding at bus stops. This indicates that 'bad crowding', when people come close enough to be able to reach another, is most likely to occur when people are boarding the bus.

However, time spent within arm's reach is another important factor to consider. If two people move within each other's peripersonal space (threshold distance), but merely bump into one another and move away from this immediately, a person may not have been exposed to any threats such as pickpocketing because this act may require a longer time frame. A further element of people's behaviour in terms of interpersonal distance is the length of time they spend within another's peripersonal space. As the length of time each experiment took was varied, due to the versatile nature of a large group of people boarding a bus, measurements of time were normalized for comparability. Therefore, the following time data are presented not in seconds, but in seconds per minute. So, for example, if the phase lasted precisely one minute, the seconds per minute would give the exact number of seconds spent within threshold.

To see where measurements fall, a graph similar to those used for distance measurements was plotted. Figure 9.5 shows how long participants who came within arm's reach of one another stayed there before moving away. Bar height represents how many measurements fall into any of these categories. Bars represent the three phases of waiting, boarding and on the bus. When two people never came within threshold distance to one another, this would obviously result in '0' seconds, and these were excluded from this analysis.

Boarding and on the bus measurements fall most frequently into categories in which people move away from each other between 0 and 30 seconds per minute after initially coming within arm's reach. However, the majority of those who came within threshold distance of one another during waiting phase fall into the 55–60 second category. This means that those who stood within arm's reach of one another while waiting for the bus stayed there for up to the entire duration of the phase. The difference between how long

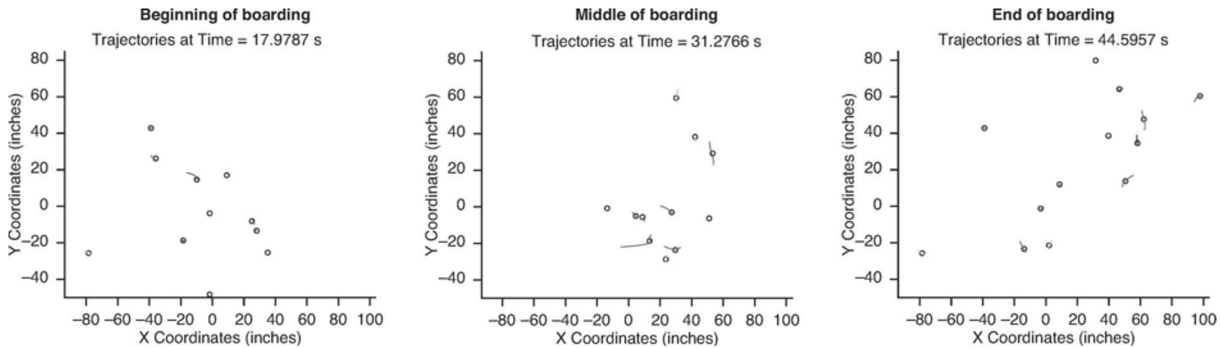


Figure 9.3 Trajectories of people during boarding at different intervals during boarding phase

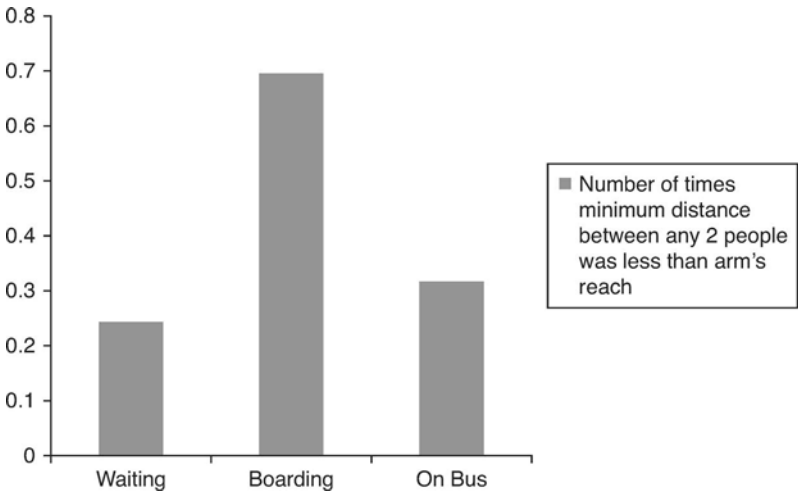


Figure 9.4 Number of times minimum distances between people were less than threshold per phase

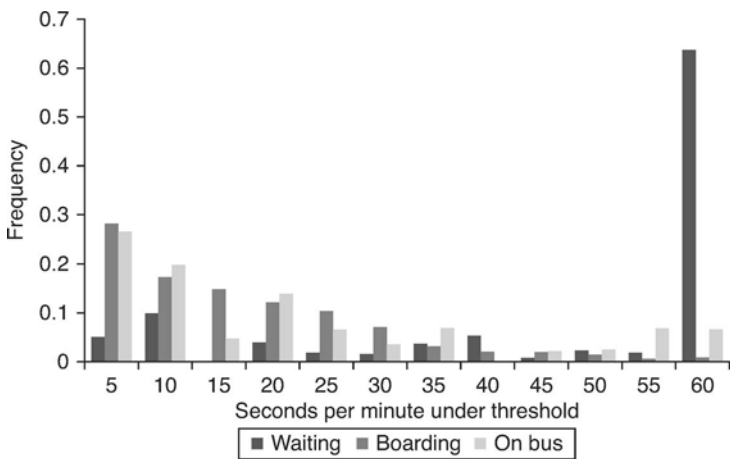


Figure 9.5 How much time people spent within threshold distance of another, by phase

people spent within threshold during warning and the other two phases is statistically significant (Table 9.1)

The amount of time spent close to others also shows a noticeable difference during the waiting phase. Findings show that if we consider length of time spent within arm's-reach of another as an important factor as well as the

Table 9.1 Wilcoxon signed rank test for difference between duration of time people spend within arm's reach distance per phase of experiment

	board – wait	**on bus – wait**	**on bus – board**
2-tailed significance	.000	.002	.773

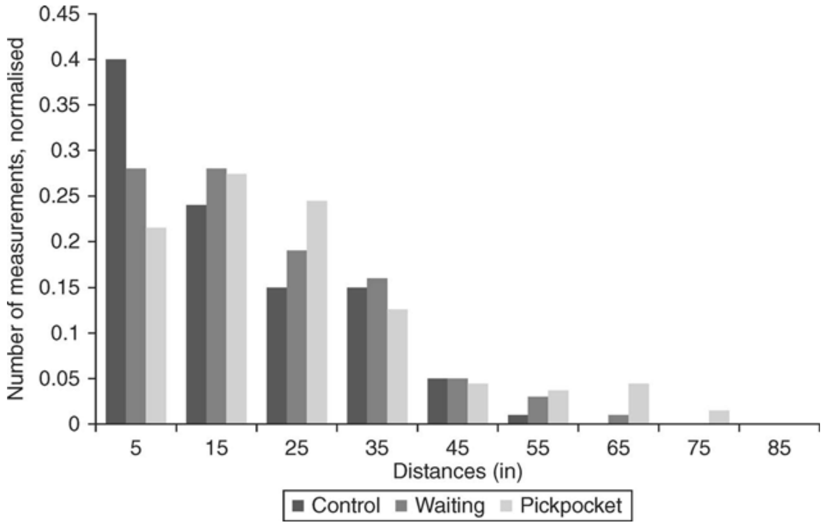


Figure 9.6 Minimum distances (in) by warning scenario, during boarding

number of times a person can be reached, waiting at the bus shelter might provide opportunities for contact crimes as well as the boarding phase.

Given the micro-level spatial interactions in which people come within arm's reach of one another in the context of waiting for and boarding a bus, if motivated by audio warning messages, can they alter the distance they keep from fellow passengers? To answer this question, minimum distances during boarding were considered for each warning condition. In a similar graph to Figure 9.2, distribution of smallest distances was plotted for all three scenarios (Figure 9.6).

Figure 9.6 shows that minimum distances fall mostly into the smallest category during the control scenario, and shift slightly towards the larger distance categories in both the waiting and the pickpocket scenario. It is also in the pickpocket scenario (most serious warning condition) that the largest minimum distance is observed.

The Wilcoxon signed rank test reveals that there is a significant difference between control and pickpocket scenarios in the closest distances that people got to one another at a $p < 0.05$ level Table 9.2.

Plotted in Figures 9.7, 9.8 and 9.9 are the cumulative distribution functions, $F_T(t)$, of the time (t) spent within threshold distance, to show the proportion of measurements that fall below the threshold. This illustrates that during waiting, in the pickpocketing condition there is a higher probability of people spending less time within threshold distance of one another

Table 9.2 Wilcoxon signed rank test statistic for minimum distances while boarding

	warning – control	**pickpocket – control**	**pickpocket – warning**
significance	.158	.000	.001

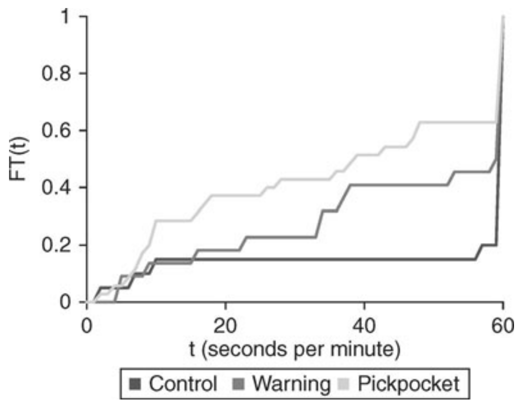


Figure 9.7 Cumulative distribution of the time under the threshold for waiting

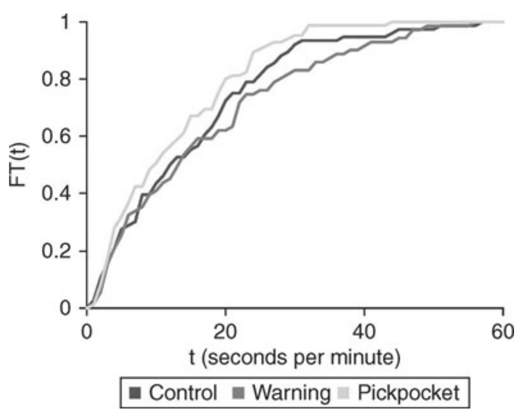


Figure 9.8 Cumulative distribution of the time under the threshold for boarding

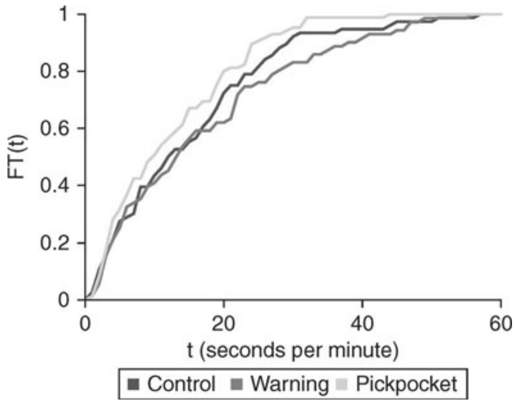


Figure 9.9 Cumulative distribution of the time under the threshold on bus

than in warning or control conditions. However, these differences are not statistically significant.

Discussion

Results from this experiment indicate that a bottleneck is created when people board the bus, in which they come much closer to one another than before (waiting) or after (on bus) (Figure 9.2) and come within arm's reach with many more passengers than they do while waiting for the bus or when aboard the bus (Figure 9.4). Considering a passenger's coming close enough to another person for him or her to be able to reach that passenger's pocket as creating an opportunity, this finding supports previous theories that pickpocketing opportunities are provided when individuals are boarding the bus (Poyner, 1986). This has practical implications for prevention to shift focus onto boarding.

For example, closed-circuit television (CCTV) cameras on buses tend to focus on the inside of the bus, so directing some to cover the area in which people board the bus may be a possible intervention to consider. Other situational crime prevention measures aimed at reducing the bottleneck effect could be developed through future research that experiments with different queue marshalling barriers (Poyner, 1986) or design techniques which influence jams at bottlenecks (Helbing et al., 2005). These could also address other proximity-related crime such as groping. Furthermore, the finding that the jam caused by boarding the bus exhibits similar crowd movement patterns to other unilateral bottlenecks, implies that findings from pedestrian motion analysis could inspire future research on crime related to crowding at bus stops.

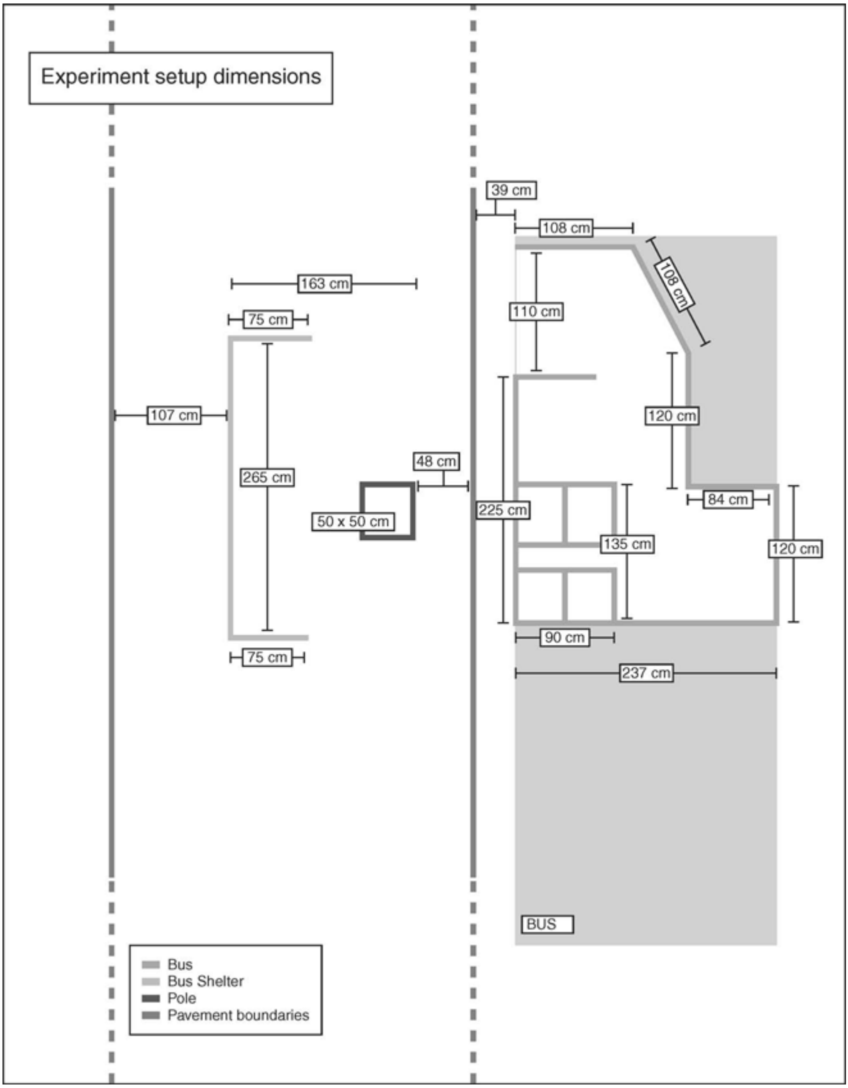
However, it is important to note that even though a bottleneck phenomenon during boarding may cause more people to come closer to each other than during other phases, this may not be the only variable to consider. Looking at the time that people spend within arm's reach of at least one other passenger reveals that while people come closer together more frequently during boarding, they do not spend a lot of time within this threshold. This may be due to the nature of the activity of boarding a bus; people are constantly moving trying to get on the bus. During the waiting period, people do not move as much. If two passengers are near one another, they will remain so until there is a reason for them to move. Further research should look into a time threshold for pickpocketing, and determine whether increased time spent close to one another during the waiting phase increase exposure to potential pickpockets, and also whether the time spent very close to one another while boarding is long enough for a contact crime to occur.

Findings also indicate that people are capable of modifying and willing to modify their behaviour within the crowded environment in light of audible warning messages. People showed a tendency to keep larger distances from one another within the bottleneck environment when hearing the most relevant and credible warning message of the experiment (Figure 9.5). This may have positive implications for the use of audio warning messages at stations to warn passengers. Contents of warning messages was not a topic of this research, and future research might focus on the feasibility of creating a credible and attention grabbing warning, applicable to real-world environments. Additionally, the finding that people do not move around while waiting for the bus can have implications for anomaly detection surveillance programs. If this pattern is found to be consistent with real-life observations, this could inform CCTV pattern analysis, used in a variety of security applications such as counterterrorism strategies (Davies and Velastin, 2005).

Additionally, results that pertain to individuals' micro-level behaviour and interactions with one another and their environment can inform models used in pedestrian simulation related to security and crowd control. Modelling provides a useful methodological tool for attaining rigorous results from large datasets (Antonini et al., 2004; Scholl 2001; Teknomo 2002; Wijermans et al., 2007; Yavuz et al., 2007). Agent-based models (ABMs) look at the global consequences of local interactions by using agents, which are assigned a small set of rules which govern their behaviour (Scholl 2001) and are used in a variety of academic disciplines. ABMs have many components, one of the most important of which is the rules given to the agents by which to act (Macal and North, 2010). This experiment can help calibrate and validate such models by adding to the empirical evidence based on real people's actual behaviour, which may inform rules assigned to agents (Helbing and Balietti, 2011).

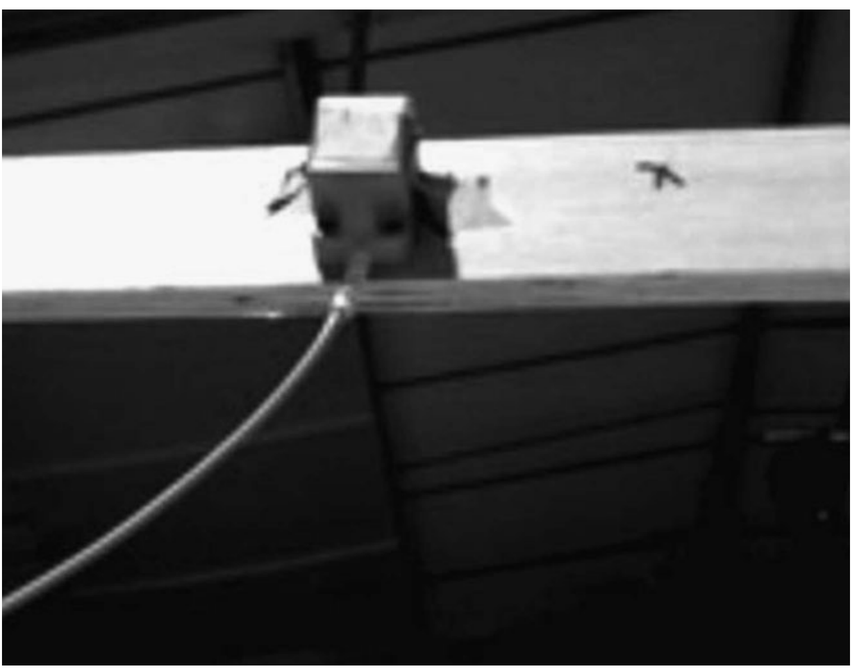
This chapter has demonstrated the use of data collected in a laboratory experiment to gain further insight into measurable variables related to a criminological problem. While the benefits, including the ability to control and manipulate variables, and produce repeated measurements have been illustrated throughout this chapter, there are some important limitations to mention. The homogeneity and size of the participant group may not accurately represent all passenger characteristics. While this was addressed by assigning roles to participants to diversify their behaviour, a repeat of the study with a more heterogeneous group may provide more generalizable findings. Additionally, the effect of order bias (Landon, 1971) may have had an influence on differences in measurement as the experiment progressed. Additionally, while participants filled the experiment space to a crowded level as defined by Fruin (1992), levels of crowding can be intensified by external variables such as punctuality of the bus, or if a bus is running late. Future research might look into more intense levels of crowding as well as other variables present in a real-life setting, such as distractions caused by headphones, and how these might affect the observed behaviours. In this experiment the recording equipment was constrained by the availability of markers (there were only 11 active markers to be used at one time). However, the data analysis took into account this limitation and consisted of comparing data on distances between recorded participants within immediate range of one another. If all participants were recorded, additional analysis could have been achieved, for example, density calculations. However, in the absence of this it is unknown whether non-measured people would have an effect. Finally, the laboratory offered a risk-free environment for participants which may have affected their perception of the credibility of warning messages. To address this, the pickpocket scenario was developed to be believable and relevant within this context.

Evidently there are limitations associated with such a laboratory experiment; however, 'basic research in a controlled laboratory environment is a necessary first step to identifying effects that subsequently can be tested in a field context' (Schultz and Tabanico, 2009: 1205). This chapter attempts to demonstrate a way to draw in knowledge and techniques from other research areas to the topic of crime and transport, and broaden the range of this topic by providing a stepping stone to achieving such results and offering an additional lens through which further insight can be gained.



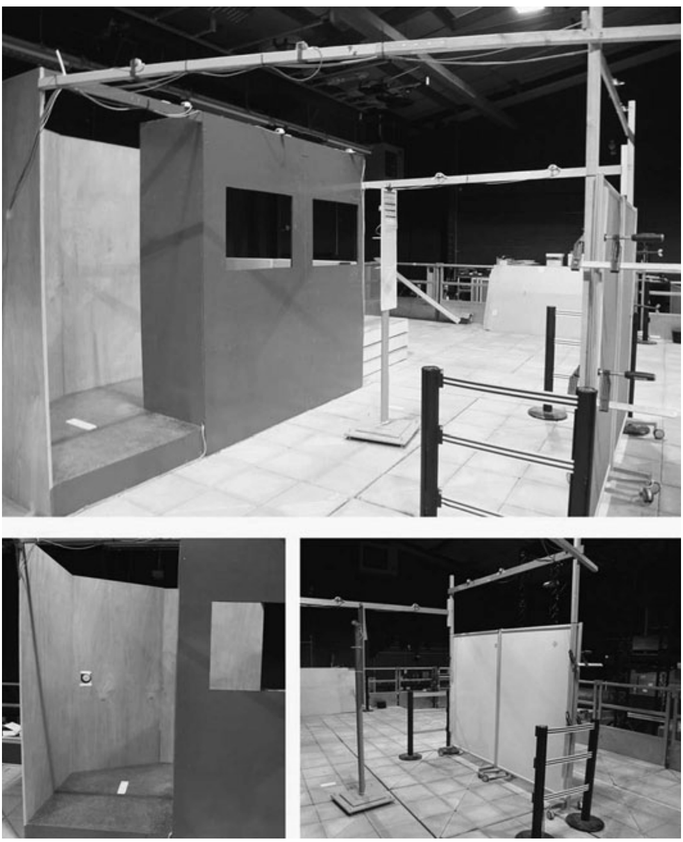
Appendix 9A Dimensions of the recreated bus waiting area and bus environment

Appendix 9B Wireless marker



Appendix 9C Sensor-defining grid

Appendix 9D Participants wearing motion trackers on hard hats



Appendix 9E Markers defining coordinate grids, within which motion trackers' positions are recorded are set-up around the experimental environments

Acknowledgements

The author would like to thank Nick Calvert for help with the data analysis, and the UCL Accessibility Research Group for help with the experiment, as well as all participants who took part. Funding for this project was provided by the Engineering and Physical Sciences Research Council Grant no: EP/G037264/1 as part of UCL's Security Science Doctoral Training Centre.

References

Antonini, G., Venegas, S., Thiran, J., Bierlaire, M. (2004) A Discrete Choice Pedestrian Behavior Model for Pedestrian Detection in Visual Tracking Systems. RO 2004 09 09, proceeding; TRANSP-OR-REPORT-2004–001.

Baguley, T. (2012) *Serious Stats: A Guide to Advanced Statistics for the Behavioral Sciences*. Basingstoke: Palgrave Macmillan.

Beller, A., Garelik, S. and Cooper, S. (1980) Sex Crimes in the Subway. *Criminology, 18*(1), 35–52.

Brand, S., and Price, R. (2000) *The Economic and Social Costs of Crime*. London, Home Office Online Report 30/05.

British Transport Police (2011) Give Them an Inch and They'll Take All They Can. *http://www.btp.police.uk*. Available at: http://www.btp.police.uk/pickpockets/, accessed 7 August 2012.

Cepolina, E., and Tyler, N. (2005) Understanding Capacity Drop for Designing Pedestrian Environments. Available at: http://discovery.ucl.ac.uk/1412/1/Cepolina_Tyler_paper_Walk21.pdf, accessed August 30, 2013.

Davies, A. C., and Velastin, S. A. (2005) A Progress Review of Intelligent CCTV Surveillance Systems. In: IEEE Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications; 05–07 Sept 2005, Sofia, Bulgaria. Eck, J. E., and Liu, L. (2008) Contrasting Simulated and Empirical Experiments in Crime Prevention. *Journal of Experimental Criminology*, *4*(3), 195–213.

Ekblom, P. (1995) Less Crime, by Design. *Annals of the American Academy of Political and Social Science*, *539*(1), 114–129.

Evans, G. (2009) Accessibility, Urban Design and the Whole Journey Environment. *Built Environment*, *35*(3), 366–385.

Felson, M., and Cohen, E. L. (1979) Social Change and Crime Rate Trends: A Routine Activity Approach. *American Sociological Review*, *44*(4), 588–608.

Fernández, Rodrigo, Pablo Zegers, Gustavo Weber, and Nick Tyler (2010) Influence of Platform Height, Door Width, and Fare Collection on Bus Dwell Time. *Transportation Research Record: Journal of the Transportation Research Board*, *2143*(1), 59–66.

Fruin, J. (1992) Designing for Pedestrians. *Public Transportation*. United States. Available online [http://ntl.bts.gov/DOCS/11877/Chapter_8.html].

Fujiyama, T., Childs, C. R., Boampomg, D. and Tyler, N. (2005) Investigation of Lighting Levels for Pedestrians: Some questions about Lighting Levels of Current Lighting Standards. Walk 21-VI, Everyday Walking Culture, The 6th International Conference on Walking in the 21st Century, 22–23 September 2005, Zurich, Switzerland.

Helbing, D., Molnar, P., Farkas, I. J., and Bolay, K. (2001) Self-Organizing Pedestrian Movement. *Environment and Planning B: Planning and Design*, *28*(3), 361–383.

Helbing, D. et al. (2005) Self-Organized Pedestrian Crowd Dynamics: Experiments, Simulations, and Design Solutions. *Transportation Science*, *39*(1), 1–24.

Helbing, D., and Balietti, S. (2011) How to Do Agent-Based Simulations in the Future: From Modeling Social mechanisms to Emergent Phenomena and Interactive Systems Design. SFI Working Paper: 11–06–024; Available online http://www.santafe.edu/media/workingpapers/11–06–024.pdf.

Holmes, N. P., and Spence, C. (2004) The Body Schema and the Multisensory Representation(s) of Peripersonal Space. *Cognitive processing*, *5*(2), 94–105.

Hoogendoorn, S. P., and Daamen, W. (2005) Pedestrian Behavior at Bottlenecks. *Transportation Science*, 39(2), pp.147–159.

Jacoby, J., Johar, G. and Morrin, M. (1998) Consumer Behavior: A Quadrennium. *Annual Review of Psychology, 49*(1), 319–344.

Kabundi, M., and Normandeau, A. (1987) Crime in the Montreal Subway. *International Criminal Police Review*, *42*(406), 24–27.

Kenney, D. J. (1986) Crime on the Subways: Measuring the Effectiveness of the Guardian Angels. *Justice Quarterly*, *3*(4), 481–496.

King, B. G. (1948) Measurements of Man for Making Machinery. *American Journal of Physical Anthropology*, *6*(3), 341–351.

Landon, E. (1971) Order Bias, the Ideal Rating, and the Semantic Differential. *Journal of Marketing Research*, *8*(3), 375–378.

Liggett, R., Loukaitou-Sideris, A. and Isekl, H. (2001) Bus Stop-Environmental Connection: Do Characteristics of the Built Environment Correlate with Bus Stop Crime ? *Transportation Research Record*, Paper No. 0(613), 20–27.

Loukaitou-Sideris, A. (1999) Hot Spots of Bus Stop Crime: The Importance of Environmental Attributes. *Journal of the American Planning Association*, *65*(4), 395–411.

Loukaitou-Sideris, A. (2012) Safe on the Move: The Importance of the Built Environment In: Ceccato, V. (ed) *The Urban Fabric of Crime and Fear*. New York, Dordrecht, London: Springer, 85–110.

Loukaitou-Sideris, A. and Liggett, R. (2000) On Bus-Stop Crime. *ACCESS*, 16, 18–21.

Loukaitou-Sideris, A. et al. (2001) Measuring the Effects of Built Environment on Bus Stop Crime. *Environment and Planning B: Planning and Design*, *28*(2), 255–280.

Macal, C. M., and North, M. J. (2010) Tutorial on Agent-Based Modelling and Simulation. *Journal of Simulation*, *4*(3), 151–162. Available at: http://www.palgrave-journals.com/doifinder/10.1057/jos.2010.3, accessed 12 July 2012.

Macintyre, S., and Ross, H. (1996) Danger on the Dance Floor: A Study of the Interior Design, Crowding and Aggression in Nightclubs. In: Ross, H. (ed.) *Policing for Prevention: Reducing Crime, Public Intoxication, and Injury. In Crime Prevention Studies,* Vol. 7. Monsey, NY: Criminal Justice Press: Criminal Justice Press.

Metropolitan Police (2011) Pickpockets Targeted in Transport Crackdown. Available at: http://content.met.police.uk/News/Pickpockets-targeted-in-transport-crackdown/1400004504624/1257246745756, accessed 5 August 2012.

Moussaïd, M. et al. (2009) Experimental Study of the Behavioural Mechanisms Underlying Self-Organization in Human Crowds. *Proceedings. Biological Sciences/ The Royal Society*, 276(1668), 2755–2762.

Scholl, H. J. J. (2001) Agent-Based and System Dynamics Modeling: A Call for Cross Study and Joint Research, Proceeding HICSS '01: Proceedings of the 34th Annual Hawaii International Conference on System Sciences (HICSS-34)-Volume 3 – Volume 3 Page 3003 IEEE Computer Society Washington, DC, USA.

Schultz, P. W., and Tabanico, J. J. (2009) Criminal Beware: A Social Norms Perspective on Posting Public Warning Signs. *Criminology, 47*(4), 1201–1222.

Seyfried, A. et al. (2009) New Insight into Pedestrian Flow through Bottlenecks. *Transportation Science*, *43*(3), 395–406.

Shellow, R., Romualdi, J. P. and Bartel, E. W. (1974) Crime in Rapid Transit Systems: An Analysis and a Recommended Security and Surveillance System. *Transportation Research Record*, 487, 1–12.

Smith, M. J., and Clarke, R. V. (2000) Crime and Public Transport. *Crime and Justice*, 27, 169–233.

Stewart, D. W., and Martin, I. M. (1994) Intended and Unintended Consequences of Warning Messages: A Review and Synthesis of Empirical Research. *Journal of Public Policy and Marketing*, *13*(1), 1–19.

Teknomo, K. (2002) *Microscopic Pedestrian Flow Characteristics: Development of an Image Processing Data Collection and Simulation Model*. Doctoral Dissertation. Tohoku University.

Transport for London (2006) Accessible Bus Stop Design Guidance (January), 1–64. Available at: http://www.tfl.gov.uk/cdn/static/cms/documents/accessibile-bus-stop-design-guidance.pdf [Accessed 31st March 2015).

Transport for London (2011) Travel in London: Report 4. Available at: http://www.tfl.gov.uk/assets/downloads/corporate/travel-in-london-report-4.pdf, accessed 14 August 2012.

Transport for London (2012) 2011/2012 Crime Statistics Bulletin. Available at: http://www.tfl.gov.uk/assets/downloads/corporate/crime-statistic-bulletin-201112.pdf, accessed 24 July 2012.

Wijermans, N. et al. (2007) Modelling Crowd Dynamics: Influence Factors Related to the Probability of a Riot. In: *Proceedings of the Fourth European Social Simulation Association Conference (ESSA)*, Toulouse University of Social Sciences 531–541.

Wogalter, M. S., and Laughery, K. R. (1985) Behavioural Effectiveness of Warnings. In: *Proceedings of the Human Factors Society 29th Annual Meeting, Santa Monica, CA Human Factors and Ergonomics Society,* 679–683.

Yavuz, N., Welch, E.W. and Sriraj, P. S. (2007) Individual and Neighborhood Determinants of Perceptions of Bus and Train Safety in Chicago, Illinois: Application of Hierarchical Linear Modeling. *Transportation Research Record*, *2034*(1), 19–26.

Part IV

Transit Systems and the Wider Urban Environment: Meso and Macro Settings

10
Crime, Transportation and Malignant Mixes

Ward Adams, Christopher R. Herrmann and Marcus Felson

Introduction

Crime sometimes concentrates in or near transit nodes, such as train stations. Yet it is a mistake to think that public transit is necessarily criminogenic. Nancy LaVigne's (1996) classic dissertation on security in the Washington, DC, metro system documented a fundamental principle – that public transit systems need not be dangerous. Her study found the downtown nodes to be relatively safe; the greatest risk in that system was in the parking areas of suburban stations in which automobiles remained unattended during the daily commute. That finding helps raise a more general question: do transit facilities produce extra crime in combination with another type of facility, beyond what either facility would have produced alone? Even more generally, can different land uses interact to form malignant mixes, defined in this study as land uses or activities that, in combination, engender greater risk of crime?

Geographers move up and down a cone of resolution to study phenomena at varying levels of analysis, from macro-level studies to micro-level investigations (Brantingham et al., 1976). Each level of the cone provides unique and important perspectives about the phenomena under study. The present study, located at the macro level near the top of the cone, considers how transit stations and centres interact with other facilities to generate assaultive violence. This city-level study provides a distinctive vantage point, which complements the meso- and micro-level studies found in this volume. Considered together, they offer a comprehensive, multilevel overview of transit crime.

The main purpose of the current chapter is exploratory, and focuses on the conceptualization of malignant mixes. First, we develop the conceptual groundwork of malignant mixes using ideas and examples from environmental criminology, and studies of transit crime. Second, we present two case studies to illustrate those concepts empirically. The first case study identifies spatial and temporal patterns of robbery near transit stations in the Bronx, New York. The second case study involves aggravated assault in and around neighbourhood parks and transit centres in Houston, Texas.

These cities are very different in their composition. The former, located in the northeast United States, is a small, but densely populated place with an extensive public transportation system. The latter location is a geographically diffuse metropolitan area in the southern United States, with a relatively low population density and a modest public transit system. Finding support at such disparate locations demonstrates that the concept of mixing may be replicable in a variety of situations beyond those of the study sites.

Conceptualizing Malignant Mixes

One should not assume, however, that all combinations of facilities would create a criminogenic environment. In Jane Jacobs (1961) classic book, *Death and Life of Great American Cities*, Jacobs argues *for* mixing land uses in order to put eyes on the street at different times. Indeed, mixed land uses are an essential feature of the new urbanism that traces to Jacobs work. Crowe and Zahm (1994) elaborate upon that idea by explaining that some mixing can produce more crime, while other combined uses produce less. They offer an interesting synthesis, suggesting that planners locate safe activities in unsafe places and unsafe activities in safe places. Thus, a parking lot should be placed in a visible spot where robbers would be reluctant to attack.

In contrast, a trash collection activity can be located on a side street, since it offers no significant crime target. This general principle helps explain why schools should not be near malls, or drug rehabilitation clinics placed near nightlife areas in which crime opportunities are abundant. The importance of connectivity and access to transportation has long been an important topic in crime analysis (Brantingham and Brantingham, 1984a, 1984b) We are not brushing connectivity aside, but are suggesting that land use combinations are also important, something of which the Brantinghams were clearly well aware.

Some studies have documented the relationship between crime and land use using ideas from social disorganization. For example, Stucky and Ottensmann (2009) demonstrated that not only does land use directly influence the level of crime but also interacts with socioeconomic disadvantage, an important precursor of social disorganization, to engender more crime. In a related study, Taylor et al. (1995) found that higher levels of non-residential land use are predictive of the physical condition of street blocks, which adds weight to Stucky and Ottensmann's findings. Browning et al. (2010) examined the relationship between land use and aggravated assault, homicide and robbery. They concluded that land use is predictive of violent crime, although the process is different for robbery.

Brantingham et al. (1991) identified the significance of malignant mixing when they described how Vancouver's elevated monorail, Skytrain, generated crime problems at a particular station very close to a shopping mall. Those going from the transit station to the mall or back traversed a parking structure, inviting thefts from and vandalism of cars parked there. The malignant mix of activities was the main problem, especially the combination of a transit station and a parking structure.

Transit systems contribute to crime because they contribute to connectivity within a community, but that is not their only criminogenic role. This is illustrated through consideration of a natural experiment in Montreal. The metro system here includes two nearly parallel downtown transit loops (Normandeau, 1987). One of these transit loops traverses the shopping district, in which many people are carrying cash. The other downtown line passes though the financial and banking district. Sutton (1976) argues offenders may have robbed banks because that is where the money is, but bankers do not have much cash in their pockets when going to and from work. Indeed, research found most metro-linked robbers preferred the line near shopping, not banking. Holding connectivity constant, we still have a malignant mix on one line but not the other. Thus, crime emerges more from some land use combinations, but not from others. Although any pair of land uses can combine to generate more crime, we focus here on combinations involving transportation, combined with another land use. A transportation facility, station or stop can play a criminogenic role in such combinations.

Identifying potentially volatile combinations of facilities is important for the safety of all transit system users. Certain transit user groups, however, perhaps have a heightened vulnerability that makes them especially good targets. For example, Weibe et al., in this volume, present a study of young males' fear of violence by several modes of transportation, finding that children felt the least safe on subways when travelling in darkness. Sochor, again in this volume, explores the use of Information and Computing Technology (ICT) to enhance the public transportation experiences of the visually impaired. Identifying and addressing malignant mixes along transit lines could conceivably reduce the fear of public transportation and its adverse effects on the health outcomes of young people. Increased safety through the reduction of malignant mixes may enhance the positive effects of ICT, thus increasing independence of the visually impaired.

In the following sections, the concept of malignant mixes is operationalized in two case studies. The first section presents an empirical example that involves hot spots, or places of high criminal activity, that shift between locations near transit stops in the Bronx, New York, based on time of day and school year.

First case study: transit crime in the Bronx

Data and method

The Bronx is one of the five boroughs of New York City, covering 42 square miles (109 sq. km), some 14 per cent of New York City's total geographic area. A quarter of the land area in the Bronx is for either industrial use or uninhabited open space. The remaining residential portion is the third most densely populated county in the United States after Manhattan and Brooklyn. This analysis began with 10,781 street segments and information on 89,211 property lots gathered from three city agencies. The incident data for this study come from the New York Police Department (NYPD) Office of Management Analysis and Planning (OMAP). This study is based on 22,674 robberies that occurred from 2006 to 2010. According to the US Census, the Bronx is one of the smallest counties in a geographical area, one of the highest in population density and has a high level of ethnic/racial diversity. The Bronx also experiences a substantial amount of violent crime relative to the other New York boroughs. Robbery is the most prevalent type of violent crime in the study area (Herrmann, 2012).

Robbery hot spots in Bronx County were identified using the nearest neighbour hierarchical clustering (Nnh) algorithm. The Nnh clustering technique is widely used in the detection and analysis of incidents that are in proximity, or near, one another (Herrmann, 2012). The routine constructs a hierarchy of hot spots, beginning with first order and then progressing to higher orders, based on a criterion such as the number of points within a specified area. Much like Russian dolls, the smaller orders are contained within higher orders. Incidents must fall within the specified search area and belong to a cluster with the minimum required number of incidents before they are included in the first-order clusters. This study is concerned with the spatial and temporal processes occurring at the micro-level – street segments, property lots and particular types of land uses. Therefore, only first-order clusters are considered (Herrmann, 2012).

Figure 10.1 compares hotspots for street robbery occurring in two different time periods: (a) the hour after school on school days (3:00pm–3:59pm), and (b) 1:00am–1:59am on non-school days. When comparing these two times, it is evident that the hot spots at these times are in entirely different places. Robbery from 3:00 to 3:59pm on school days concentrates *between transit stations of the New York City Subway, and the nearby high school*. Robbery from 1:00 to 1:59am concentrates *between the transit stations and the Bronx's cluster of barrooms*.

Table 10.1 Violent crime in the Bronx, New York, 2006–2010

Offense	**2006**	**2007**	**2008**	**2009**	**2010**	**Total**
Murder	143	122	125	109	124	623
Rape	335	281	249	250	234	1349
Robbery	4,842	4,525	4,747	4,041	4,519	22,674
Assault	4,205	4,205	3,895	4,147	4,277	20,729
Shootings	591	562	538	556	543	2,791
Total	10,116	9,695	9,554	9,103	9,697	48,166

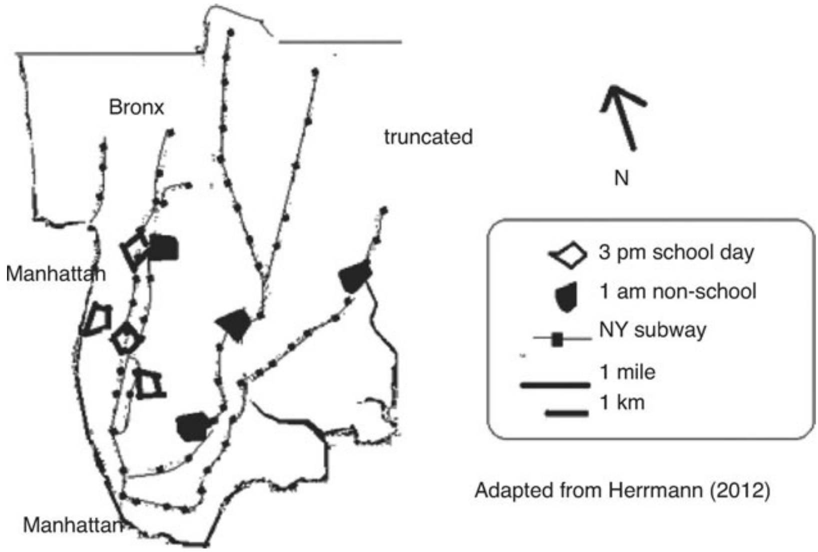


Figure 10.1 Shifting robbery hot spots, the Bronx, New York City
Source: Adapted from Hermann (2012).

The findings clearly demonstrate that there are two distinct mixes associated with Bronx transit centre crime. During the school year, there are 70,000 Bronx high school students, and it is likely they play an integral role in mid-afternoon robberies near Bronx subway stations. However, on non-school days (especially weekends), there is a considerably different and escalated night-time robbery pattern occurring between 11pm and 1am. These violent hot spots also occur near transit stations, but here schools are not present. Instead, a different mix of facilities occurs around transit stations, as the hot spots are located near drinking establishments. This presents an example of possible malignant mixes around transit stations in Bronx Country, New York. The next example in this chapter considers a malignant mix of parks and transit centres and aggravated assault in Houston, Texas.

Second case study: parks and assaultive violence in Houston, Texas

Literature

Parks contribute to a better quality of life in the community in a number of ways (Ceccato and Hansson, 2013; Loukaitou-Sideris, 1995) Neighbourhood parks provide easy access to green space in which urban dwellers can take refuge from the 24-hour-a-day environment of urban living. Parks provide opportunities for outdoor rest and relaxation, and offer a variety of amenities, such as facilities for team sports, hiking and biking trails, playgrounds for young children and covered locations for special events. Naturally, users expect their parks to be safe and secure. Unfortunately, parks are not always safe harbours. Criminal activity in and around parks can cause community residents to stop using them for fear of victimization (Ceccato and Hansson, 2013; Knutsson, 1997; Weiss, et al., 2011). The consequences of unsafe parklands for community quality of life are the motivation for this case study. This section explores the potentially malignant mix of transit centres and neighbourhood parks, and aggravated assault in Houston, Texas.

The role of transit centres, bus stops and other transit system settings in generating crime and fear of crime at the location is well documented (see, for example, Loukaitou-Sideris [1999]; Loukaitou-Sideris et al. [2002]; LaVigne [1996]; and Ceccato and Uittenbogaard [2013]). Other research has explored how certain facilities influence criminal activity in the larger area around them. Bowers (2014), for example, theorized that certain risky places might transmit criminogenic properties to external sites, thereby creating additional criminogenic facilities. Bowers (2014) found that theft from the person which occurs within facilities is strongly related to levels of theft in external areas that contain high concentrations of risky facilities, which also experience high levels of theft. Similarly, Newton and Bowers (2007) found that certain land uses (parks, children's play areas and schools) directly affected damage to bus stop shelters, while adult-themed facilities such as pubs were inversely related to shelter damage.

Crime opportunities theories suggest that such a synergistic effect is plausible. Transportation nodes have the capacity to bring large numbers of people together. Many riders regularly use public transit, and consequently become familiar with the area surrounding their activity spaces, which is referred to as awareness spaces (Brantingham and Brantingham, 1984a). Some, but not all, riders are potential offenders, and notice opportunities for criminal behaviour near their transit centres during their daily travails. Essentially, transit centres, in addition to generating crime on-site, may increase criminal behaviour at other facilities, such as parks. In support of that argument, Block and Block (2000) found that transit stations played a role in generating robbery at off-site locations.

Transit centres are just one of several competing factors with the potential to influence crime in and around parks. This study does not claim to provide an exhaustive list of the predictors of park crime. Instead, we control for the effects of several key facility types that have been associated with generating crime in facility environs. Such facilities may also form malignant mixes with parks, and could explain the hypothesized association of parks and transit centres. Houston, Texas, has a modest public metro system, but like most American cities, its inhabitants rely substantially on automotive travel and very extensive road systems. Public transportation usage in the United States has been on the rise since 2004, if certain metrics are considered

(Public Transportation Use, 2014), but usage remains low, with about five per cent of the US population using means other than automobiles for daily commuting (United States Census Bureau, 2014). Crime pattern theory states that road systems are the arterial network of cities, which act to channel and direct movement throughout an area (Brantingham and Brantingham 1984a). Criminal activity can concentrate along roads, especially at street intersections.

Schools represent another risky type of facility that has been linked to crime in the surrounding area. Roncek and LoBosco (1983) found that residential blocks near public high schools experienced higher levels of burglary and car theft. Roncek and Faggiani (1985) replicated the findings of Roncek and LoBosco (1983) using data from a different state and city. An extensive body of research has established that alcohol outlets, such as bars or pubs, are also associated with violence in surrounding areas (Day et al., 2012; Green and Plant, 2007; Ratcliffe, 2012; Roncek and Pravatiner, 1989; Scott and Dedel, 2001). Research has also shown that parks can generate crime. For example, Groff and McCord (2012) found that neighbourhood parks in residential or primarily residential settings were associated with higher violent, property and disorder crime. Crewe (2001) found that homes near linear parks produced more calls for service. Based on this literature and in addition to the primary aim, the following hypotheses were tested:

1. Proximity to schools, drinking establishments, other neighbourhood parks and major road intersections will increase crime counts within 150 meters of neighbourhood parks.
2. Higher park capacity, as measured by the number of park amenities, will result in more instances of assaultive violence.
3. Transit centres, in synergy with neighbourhood parks, will engender more violence in and around those parks than would otherwise be present.

Data and method

Houston, Texas, is the fourth-largest city in the United States, with a population of 2.1 million, spread out over 1,554 square kilometres. Houston is home to a diverse population. The city has higher percentages of Latinos, Asians, African Americans and persons of two or more races than the state of Texas. Data for this case study come from several sources (see Appendix 10.A for a complete list of data sources). There are 362 parks in Houston, and there is a range of types of park present, ranging from very large regional parks of several thousand hectares, to very small pocket parks of one hectare or less (Houston Parks and Recreation, 2014). This study uses a similar premise to that of Groff and McCord (2012) and uses a subset of 177 neighbourhood parks from the total number of parks as the unit of analysis. Limiting the study to neighbourhood parks helps standardize parks in terms of size, amenities and user characteristics, thus creating a more homogeneous study population.

The recorded crime data used were aggravated assaults occurring from 1 January 2000 to 31 December 31 2009, supplied by the Houston Police Department. Incident addresses were geocoded using ArcGIS, version 9.3. The Houston Planning and Development Department provided the neighbourhood park boundaries, school locations and street intersections. Alcohol outlet data for the City of Houston were obtained from the Texas Alcoholic Beverage Commission (TABC). The number of aggravated assaults occurring within 500 feet (152 meters) of the park boundary is the dependent variable, a buffer distance selected as appropriate as used in prior research (Groff and McCord, 2012). A total of 2,039 aggravated assaults occurred within the buffer areas of the neighbourhood parks. Ordinary least squares (OLS) regression is an inappropriate statistical method, since the dependent variable is a count of aggravated assaults. To that end, a negative binomial regression procedure is used, a statistical technique that is widely used to model over-dispersed count data (Osgood, 2000; Osgood and Chambers, 2000).

Houston has 20 bus transit centres that serve as hubs, which provide access to multiple routes and destinations for its ridership (Metro Transit Authority of Harris County, Houston Texas, 2013). The transit centre independent variable is operationalized as the distance in miles between parks and the closest transit centre. One mile equals approximately 1,610 meters.

Schools, drinking establishments and major road intersections were operationalized as the natural log of the distance in miles from each park to the nearest of each type of facility. The distance data are highly skewed, hence the transformation of the data to better reflect a normal distribution. Distance to parks was not transformed because of several zero values, indicating that the border of a park touched the border of another. Log transformation requires positive values. Rather than losing observations, distance to the nearest park was kept in its original metric. The number of park amenities, or features, such as swimming pools, basketball courts and playgrounds, is included as a proxy measure of park capacity.

Descriptive and bivariate statistics

The number of assaults ranges from zero to 66 assaults per neighbourhood park, averaging approximately 11 assaults per park buffer. Parks contain two amenities on average, ranging from no amenities to five or more. On average, all facilities are within relatively short distances from parks, with the exception of transit centres, which are typically within 2.21 miles of the closest neighbourhood park. There is also considerable spread in distance from neighbourhood parks to transit centres, ranging from less than a mile to 8.44 miles to the nearest neighbourhood park on the high end. Several of the independent variables are moderately correlated, with the highest correlation, .327, occurring between distance to bars and intersections (Appendixes 10B and 10C).

Analysis

The regression results show that most of the independent variables are associated with higher crime counts, with the exceptions of the natural log of distance to the nearest school and parks with two amenities. Parks with fewer amenities appear to be associated with more crime, while parks with three or more amenities seem to dampen incidents of assaultive violence. Previous research has demonstrated similar outcomes (Groff and McCord, 2012). A possible explanation is that parks with more amenities experience higher volumes of pedestrian activity, and consequently more guardians, which may explain the lower levels of violence. Parks with fewer amenities have fewer potential guardians, and thus there may be more opportunities for violent crime.

The proximity to schools variable appears to have no effect on the level of violent crime near parks. Distance to the nearest drinking establishment performs as hypothesized. Parks located closer to bars experience more assaultive violence. Contrary to expectations, proximity to major intersections results in lower assault counts in and around parks. Major road systems in Houston often involve large multi-lane freeways or other large roads that do not promote non-automotive travel, which provide fewer potential targets for would-be offenders. There is also a relationship by distance to the nearest park, and as the distance between neighbourhood parks closes, neighbourhood parks experience higher levels of assaultive violence. In the midst of multiple competing effects, transit centres remain statistically associated with higher assaultive violence. After controlling for the influence of other known criminogenic facilities, it is found that neighbourhood parks located near transit centres are more violent. To summarize, the results suggest that the safest parks are those that provide multiple activities, and are located further away from transit centres and bars.

Conclusions and recommendations

This chapter is not a definitive study, but rather an exploration of the concept of malignant mixes using two case studies. An important limitation to this study, as it is a limitation in many studies, is that modelling all important relationships and interdependencies in a complex, urban environment is a formidable challenge (Wilcox and Eck, 2011). Omitted variable bias, and therefore a misspecified model, is always a concern in observational studies. The *preliminary* results do show, however, that the malignant mixing of facilities is an idea worthy of further research. The first case study illustrated the spatial-temporal pattern of robberies. For transit stations found in proximity to schools, more robberies occurred in the afternoon hours during

Table 10.2 Negative binomial regression of number of assaults on selected independent variables, Houston, Texas, 2000–2009

	Independent variable	Coefficient	Chi-square	Odds Ratio
	(Intercept)	−8.30	60.56*	.00
Number of park amenities	Five or more	−0.68	6.34*	.51
	Four	−0.93	9.11*	.39
	Three	−0.79	6.00*	.45
	Two	0.16	0.36	1.18
	One	0.80	8.14*	2.23
Log Distance to:	Closest school	0.01	0.01	.99
	Closest public transit centre	−0.86	22.56*	.48
	Closest bar	−1.51	27.16*	.53
	Closest major intersection	0.31	14.28*	1.39
	Closest park (**)	−1.08	11.98*	.34

Note: (*) Significant at 0.01 level or better. (**) Not logged.

the school year. More robberies were observed in the late evening hours at stations near drinking establishments. The second case study demonstrated that there is more assaultive violence around parks located near transit centres, after controlling for several known crime generators.

The concept of malignant mixing can be extended beyond the current study to include any number of facilities, such as malls and parking garages. Accordingly, we suggest that future research consider not just one land use or activity, nor one hot spot pattern for the year under study. Rather, we think that studying combined activities and land uses will produce greater clarity. We especially advise the future study of crime and security in terms of both public and private transportation, both vehicle and pedestrian movement. We suggest that certain combinations of activities and access may serve to multiply crime risks of one sort or another. We can imagine that variations among schools and parks and entertainment districts will partly reflect their proximity to one another and the ease of transit between them. However, malignant mixes will not prove very useful until details are gathered across a variety of settings and activities. This study raises several questions that should be addressed through further research.

Which combinations of facilities produce more crime and which produce less? Some mixes of facilities may prove to be benign, while other mixes may prove to be especially malignant. For example, the synergistic effects of alcohol outlets in proximity to street intersections known for drug-related criminal activity may produce more violent crime than the combinations of high-use, high-visibility parks near exposed bus stops. High schools may only be a problem if they are located near shopping malls, or skate parks.

Are activities only dangerous in certain combinations with other activities? This question is closely related to the previous question, but considers specific behaviour within facilities. The entertainment district of a college town may experience a significant increase in crime during sporting events involving rival teams at the university sports stadium. Friction between supporters of each team creates opportunities for assault when fans frequent the same alcohol outlets. That mix may dissipate when the stadium is used for non-sporting events.

How do arrangements in space and time affect mixing? The routine activities approach is based on the convergence of three criteria in space and time (Cohen and Felson, 1979). The nature of spatial relationships has received extensive attention in the literature, but the temporal component has received relatively little. It does not make sense to expect high schools to create crime at shopping malls during the late evening hours long after schools have closed. Bus stops and alcohol outlets most likely create a mix during the evening hours after the end of the workday, rather than during the morning hours, when bars are closed. Timing is important: aligning night-time activities with night-time crime, and doing the same for daytime hours may produce sharper estimates and stronger predictive models (Allen and Felson, 2012).

How do malignant mixes relate to crime generators and crime attractors? Crime generators and attractors are a key feature of environmental criminology. Crime generators are locations that bring large numbers of people together and generate criminal activity through the presence of motivated offenders (Brantingham and Brantingham, 1998). Crime attractors are locations of known criminal activity visited by offenders expressly for the purposes of breaking the law (Brantingham and Brantingham, 1998). The crime-producing potential of crime generators may vary depending on the proximity of other types of facilities. Conversely, an apparently malignant mix may not consist of criminogenic locations, but locations that bring large number of targets and offenders together. The crime generator concept implies a degree of persistence in space and time. Whether malignant mixes are influenced by consistent criminal activity at a nearby crime generator should be carefully examined. Similarly, Wilcox and Eck (2011) state that particular types of facilities may not matter as much as more general features, such as the number of people they bring together. It is possible that only heavily used parks in proximity to high-use transit stops generate malignant mixes, while sparsely utilized or populated combinations of facilities are no more criminogenic than the average facility.

Do experimental designs provide a better methodology to study malignant mixes? Observational studies rarely address the methodological elephant in the room: misspecified statistical models. Even if all the relevant factors in a non-experimental study can be identified, controlling for all of them is virtually impossible. More often than not, one can never be sure that all of the important predictors have been accounted for. Consequently, biased results are a major concern (Weisburd, 2003). The appeal of experimental designs is that by randomly assigning subjects to treatment and control groups, bias is spread across those groups, and the need for complex multivariate analyses is eliminated. Simple tests of significance are often the only statistical tools necessary. However, experimental designs are often very costly, pose formidable logistical challenges, are unfeasible in certain scenarios and may present ethical concerns (Clarke and Cornish, 1972). A benefit of non-experimental studies is that the phenomenon under study is observed as it occurs in the real world, which fosters a better understanding of the relationship among theoretical components (Reynald, 2011)

Does Crime Prevention Through Environmental Design (CPTED) present effective strategies to reduce crime associated with mixing? The central argument of CPTED, generally, is that appropriate construction of the built environment can reduce opportunities for offending (Ekblom, 2011). CPTED is a multidimensional approach, which incorporates principles such as natural surveillance and target hardening. While the efficacy of CPTED has received some debate over the years, there appears to be a burgeoning body of work demonstrating its efficacy (see, for example, Armitage et al., 2011; Cozens et al., 2005; Reynald, 2011). Additionally, Ekblom (2011) has redefined CPTED to upgrade its ability to reduce criminal activity.

The principles of CPTED would seem to be especially useful in addressing the problem of malignant mixes. In these case studies, the results show that transit centres and stations located close to neighbourhood parks create more assaultive violence than would normally be present. Transportation planners, cognizant to that tendency, may search for future transit centre or station locations with a high degree of guardianship or that are further away from parks to minimize the interaction of the facilities. For existing facilities, planners should conduct on-site inspections and look for specific opportunities to reduce assault by implementing ideas from Situational Crime Prevention (SCP).

Appendix 10A Data sources used to construct the datasets

Data	**Definition**	**Source**
Robbery incidents	Robbery offenses	New York Police Department Office of Management and Planning
Parks	Neighbourhood boundaries	Houston, Texas, Planning and Development Department
Aggravated Assault Incidents	Aggravated assaults	Houston Police Department
Alcohol outlets	Drinking establishments	Texas Alcoholic Beverage Commission
Schools	Houston, Texas, schools points	Houston, Texas, Planning and Development Department
Major intersections	Intersections of major roads	Houston, Texas Planning and Development Department

Appendix 10B Descriptive statistics of dependent and independent variables, Houston, Texas, United States, January 2000–2009

Variables	**Minimum**	**Maximum**	**Mean**	**Standard Deviation**
Number of assaults within 150 meters of park	0	66	11.39	11.64
Number of park amenities	0.00	5.00	2.36	1.81
Distance to closest park	0.00	1.77	0.44	0.34
Distance to closest bar	0.00	3.07	0.37	0.40
Distance to closest transit centre	0.17	8.44	2.21	1.64
Distance to closest school	0.07	4.69	1.23	0.87
Distance to closest major street intersection	0.01	1.38	0.30	0.24

Note: BASE N = 177

Appendix 10C Pearson correlations between independent variables

	Distance to nearest school	**Distance to transit centre**	**Distance to bar**	**Distance to major intersection**
Distance to nearest school	1			
Distance to transit centre	.150*	1		
Distance to bar	0.102	.244**	1	
Distance to major intersection	−0.030	.291**	.327**	1

Note: All distances are logged, with the exception of distance to school. * Correlation is significant at the .05 level. ** Correlation is significant at the .01 level.

References

Allen, J. L., and Felson, M. (2012) Crime Risk, Day and Night. Paper presented at the annual meeting of the American Society of Criminology, November, Chicago, IL.

Armitage, R., Monchuk, L., and Rogerson, M. (2011) It Looks Good, But What Is It Like to Live There? Exploring the Impact of Innovative Housing Design on Crime. *European Journal on Criminal Policy and Research, 17*(1), 29–54.

Block, R., and Block, C. (2000) The Bronx and Chicago: Street Robbery in the Environs of Rapid Transit Stations. In: Goldsmith, V., McGuire, P., Mollenkopf, J. and Ross, T. (eds) *Analyzing Crime Patterns: Frontiers of Practice*. Thousand Oaks, CA: SAGE Publications, 137–153.

Bowers, K. (2014) Risky Facilities: Crime Radiators or Crime Absorbers? A Comparison of Internal and External Levels of Theft. *Journal of Quantitative Criminology 30*(3), 389–414.

Brantingham, P. J., and Brantingham, P. L. (1984b) *Patterns in Crime*. New York: Macmillan.

Brantingham, P. J., Brantingham, P. L. and Wong, P. S. (1991) How Public Transit Feeds Private Crime: Notes on the Vancouver 'Sky Train' Experience. *Security Journal, 2*, 91–94.

Brantingham, P. J., Dyreson, D. A., and Brantingham, P. L. (1976) Crime Seen through a Cone of Resolution. *American Behavioral Scientist, 20*(2), 261–273.

Brantingham, P. L., and Brantingham, P. J. (1984a) Mobility, Notoriety, and Crime: A Study in Crime Patterns of Urban Nodal Points. *Journal of Environmental Systems 11*(1), 89–99.

Brantingham, P. L., and Brantingham, P. J. (1995) Criminality of Place: Crime Generators and Crime Attractors. *European Journal on Criminal Policy and Research 3*(3), 1–26.

Brantingham, P. L., and Brantingham, P. J. (1998) Mapping Crime for Analytic Purposes: Location Quotients, Counts, and Rates. *Crime Mapping and Crime Prevention, 8*, 263–288.

Browning, C. R., Byron, R. A., Calder, C. A., Krivo, L. J., Kwan, M. P., Lee, J. Y. and Peterson, R. D. (2010) Commercial Density, Residential Concentration, and Crime: Land Use Patterns and Violence in Neighbourhood Context. *Journal of Research in Crime and Delinquency*, *47*(3), 329–357.

Ceccato, V., and Hansson, M. (2013) Experiences from Assessing Safety in Vingis Park, Vilnius, Lithuania. *Review of European Studies*, *5*(5), 1–17.

Ceccato, V., and Uittenbogaard, A. C. (2013) Space-Time Dynamics of Crime in Transport Nodes. *Annals of the Association of American Geographers,104*(1), 131–150.

Clarke, R., and Cornish, D. (1972) The Controlled Trial in Institutional Research: Paradigm or Pitfall for Penal Evaluators? London: HMSO.

Cohen, L. E., and Felson, M. (1979) Social Change and Crime Rate Trends: A Routine Activity Approach. *American Sociological Review*, *44*(4), 588–608.

Cozens, P. M., Saville, G. and Hillier, D. (2005) Crime Prevention through Environmental Design (CPTED): A Review and Modern Bibliography. *Property Management*, *23*(5), 328–356.

Crowe, T., and Zahm, D. (1994) Crime Prevention through Environmental Design. *Land Development* Fall, 22–27. http://www.popcentre.org, accessed 9 August 2013.

Day, P., Breetzke, G., Kingham, S. and Campbell, M. (2012) Close Proximity to Alcohol Outlets Is Associated with Increased Serious Violent Crime in New Zealand. *Australian and New Zealand Journal of Public Health, 36*(1), 48–54.

Green, J., and Plant, M. A. (2007) Bad Bars: A Review of Risk Factors. *Journal of Substance Use*, *12*(3), 157–189.

Groff, E., and McCord, E. S. (2012) The Role of Neighbourhood Parks as Crime Generators. *Security Journal*, *25*(1), 1–24.

Herrmann, Christopher R. (2012) Risky Businesses: A Micro-Level Spatiotemporal Analysis of Crime, Place, and Business Establishment Type. Doctoral dissertation, The Graduate Centre–City University of New York.

Houston Parks and Recreation Department. *Our Parks*. http://www.houstontx.gov/parks/ourparks/index.html, accessed on 24 April 2014.

Jacobs, Jane (1961) *Death and Life of Great American Cities*. New York: Random House.

Knutsson, J. (1997) Restoring Public Order in a City Park. *Policing for Prevention: Reducing Crime, Public Intoxication, and Injury*, *7*, 133–151.

LaVigne, N. G. (1996) Safe Transport: Security by Design on the Washington Metro, in Clarke, R.V. (ed.) *Preventing Mass transit Crime*. Monsey, NY: Criminal Justice Press, 163–197.

Loukaitou-Sideris, A. (1995) Urban Form and Social Context: Cultural Differentiation in the Uses of Urban Parks. *Journal of Planning Education and Research*, *14*(2), 89–102.

Loukaitou-Sideris, A. (1999) Hot Spots of Bus Stop Crime: The Importance of Environmental Attributes. *Journal of the American Planning Association 65*(4), 395–411.

Loukaitou-Sideris, A., Ligget, R. and Hiseki, Hiroyuki (2002) The Geography of Transit Crime: Documentation and Evaluation of Crime Incidence on and around the Green Line Stations in Los Angeles. *Journal of Planning Education and Research*, *22*(2), 135–151.

Metro Transit Authority of Harris County, Houston, Texas. (2013) Schedules and Maps: Transit Centre Locations. http://www.ridemetro.org/SchedulesMaps/TransitCentre.aspx, accessed 24 October 2013.

Newton, A., and Bowers, K. J. (2007) The Geography of Bus Shelter Damage: The Influence of Crime, Neighbourhood Characteristics, and Land-Use. *Internet Journal of Criminology*. Available at http://eprints.hud.ac.uk/474/1/NewtonGeography.pdf, accessed 31 March 2015.

Normandeau, A. (1987) Crime on the Montreal Metro. *Sociology and Social Research, 71*(4), 289–292.

Osgood, D. Wayne (2000) Poisson-Based Regression Analysis of Aggregate Crime Rates. *Journal of Quantitative Criminology 16*(1*)*, 21–43.

Osgood, D. Wayne, and Chambers, Jeff M. (2000) Social Disorganization outside the Metropolis: An Analysis of Rural Youth Violence. *Criminology*, *38*(1), 81–115.

Public Transportation Use Is Growing – Here Are the Facts (2014) *Media Centre*. Available at http://www.apta.com/mediacentre/ptbenefits/Pages/Public-Transportation-Use-is-Growing-.aspx, accessed 31 March 2015.

Ratcliffe, J. H. (2012) The Spatial Extent of Criminogenic Places: A Change Point Regression of Violence around Bars. *Geographical Analysis*, *44*(4), 302–320.

Reynald, D. M. (2011) Translating CPTED into Crime Preventive Action: A Critical Examination of CPTED as a Tool for Active Guardianship. *European Journal on Criminal Policy and Research, 17*(1), 69–81.

Roncek, D. W., and Faggiani, D. (1985) High Schools and Crime: A Replication. *The Sociological Quarterly, 26*(4), 491–505.

Roncek, D. W., and LoBosco, A. (1983) The Effects of High Schools on Crime in Their Neighbourhoods. *Social Science Quarterly*, *64*(3), 598–613.

Roncek, D. W., and Pravatiner, M. A. (1989) Additional Evidence That Taverns Enhance nearby Crime. *Sociology and Social Research*, *73*(4), 185–188.

Scott, M. S., and Dedel, K. (2001) *Assaults in and around Bars*. Washington, DC: US Department of Justice, Office of Community Oriented Policing Services.

Stucky, T. D., and Ottensmann, J. R. (2009) Land Use and Violent Crime. *Criminology*, *47*(4), 1223–1264.

Sutton, W. (1976) *Where the Money Was: The Memoirs of a Bank Robber*. New York, Viking.

United States Bureau of the Census (2014) *Means of Transportation to Work by Selected Characteristics, 2008 –2012, American Community Survey Five-Year Estimates*. Available at http://www.census.gov/acs/www/ accessed 31 March 2015.

Weisburd, D. (2003) Ethical Practice and Evaluation of Interventions in Crime and Justice: The Moral Imperative for Randomized Trials. *Evaluation Review, 27*(3), 336–354.

Weiss, C. C., Purciel, M., Bader, M., Quinn, J. W., Lovasi, G., Neckerman, K. M., and Rundle, A. G. (2011) Reconsidering Access: Park Facilities and Neighbourhood Disamenities in New York City. *Journal of Urban Health*, *88*(2), 297–310.

Wilcox, P., and Eck, J. E. (2011) Criminology of the Unpopular. *Criminology and Public Policy,10*(2), 473–482.

11

Public Bus Stops and the Meso Environment: Understanding the Situational Context of Street Robberies

Timothy C. Hart and Terance D. Miethe

Introduction

The concentration of crime in close proximity to bus stop locations has been the focus of increased scholarly attention. From an environmental criminology perspective, public bus stops are often viewed as crime generators because they represent specific areas within communities that are exceptionally busy (Brantingham and Brantingham, 1995). If public bus stops are located within particular parts of communities that lack adequate protection, they may be characterized as crime attractors (Brantingham and Brantingham, 1995). Regardless of whether bus stops are viewed as crime generators or attractors, past research suggests that criminal victimization, including violent victimization such as robbery, tends to cluster in close proximity to them (Levine and Wachs, 1985; Levine, Wachs and Shirazi, 1986; Loukaitou-Sideris, 1999; Newton, 2008).

In the broader meso environment, bus stops are just one of several types of activity nodes that are spatially related to crime (Eck et al., 2007). Check cashing outlets and automated teller machines (ATMs) (Holt and Spencer 2005), pawnshops and bars (Roncek and Maier, 1991), and schools (Bowers, Hirschfield and Johnson, 1998) are all among other types of 'risky facilities' around which crime has been shown to concentrate. However, little research to date has empirically documented the extent to which the combined presence of bus stops along with other activity nodes in the meso environment enhances or reduces victimization risk within these environs.

The current study uses a matched sample of known robbery incidents and robbery-free locations to explore several questions about the physical backcloth of street robbery. After identifying activity nodes that are most often found in the proximate environment of robbery events, we assess the relative risks attributed to bus stops across each event profile, which is defined by empirically observed combinations of activity nodes within the proximate environment. Results of this study are then discussed in terms of their implications for future research and public policy about bus stops, other activity nodes and crime prevention.

Literature review

A robust and growing field of scientific inquiry exists in the study of crime, place and space. Using various units of analysis and methodological approaches, previous studies have explored the extent and nature of crime on buses and at transit stops, developed theoretical explanations for the spatial/temporal location of these crimes, and has more generally examined the characteristics of particular places and human activity within them that enable or constrain criminal opportunities.

Criminal and public transit

Despite buses being the most popular mode of public transportation, few scientific investigations have focused specifically on transit bus passenger victimization. Studies conducted in Los Angeles during the 1980s and 1990s are noteworthy exceptions. For example, Levine and Wachs (1985, 1986a) found that bus-crime victims occupied one out of every five West Central Los Angeles households, and Loukaitou-Sideris (1999) demonstrated that 31 per cent of inner-city transit bus passengers reported being victimized at least once during the five years prior to her survey. These studies also report that riders are more likely to be victimized at or around a public bus stop than while actually riding a bus, that robbery and personal theft are among the types of crimes experienced most often by transit passengers, and that passengers who are frequent bus riders, older, female, Hispanic and who have lower incomes are at increased risk of personal victimization.

Within the transit crime literature, spatio-temporal analysis of transit nodes has also been conducted to identify crime hot spots. For example, Yu (2009) found that many types of property crimes (e.g. motor vehicle theft, theft from autos and residential burglary) and violent crimes (e.g. robbery and aggravated assault) are strongly influenced by the spatial concentration of public bus stops. Similarly, Kooi (2013) found that census block groups with higher concentrations of bus stops were associated with increases in public-order offenses. Finally, Newton (2008) demonstrated that risk of victimization while riding a bus was highest in high-crime areas, but that the risk was especially elevated when there was a high concentration of bus stop locations along a bus route.

Existing research also suggests that mass transit crime 'clusters' during different times of the day. For example, Block and Davis (1996) found that street robberies outside rapid transit stations in Chicago occurred most often in the late evening and early morning hours (i.e. between 11pm and midnight and also around 2am). Moreover, Adams, Herrmann and Felson (Chapter 10 in this volume) found that robbery hot spots cluster near subway stations in the Bronx (NY) differently, depending on whether school is in session. Finally, studies focused specifically on bus-related crime suggest that the late afternoon and evening hours are the most dangerous times to travel (Levine and Wachs, 1985, 1986b; Loukaitou-Sideris, 1999). Combined, this scholarship suggests that crime concentrates both in space and in time near bus stops and that certain bus stops are more dangerous than others.

Opportunity-based theories of crime

Criminologists have developed various theories to identify the wider social forces and situational factors that enhance and constrain the opportunity for crime. Within the field of environmental criminology, the most popular of these opportunity-based theories are routine activity theory (Cohen and Felson, 1979) and crime pattern theory (Brantingham and Brantingham, 1984). These theories offer explanations for macro-level changes in crime's spatio-temporal occurrence and its concentration within particular environmental contexts.

According to routine activity theory, criminal opportunities are produced by the ordinary legitimate activities of everyday life. The social ecology of daily activity increases crime rates and the individual's risks of victimization when they increase one's exposure to motivated offenders, increase target attractiveness and/or reduce the availability of capable guardians (Cohen and Felson, 1979). Subsequent revisions of this theory add the notions of 'handlers' (i.e. persons who keep motivated offenders out of trouble) and 'place managers' (i.e. persons who maintain the functioning of a place) as other types of controllers of criminal opportunities (Felson and Santos, 2009).

The spatial distribution of crime around bus stops is easily explained by routine activity theory's major concepts and general ecological framework. From this perspective, bus stops have a social ecology (i.e. a tempo, pace and rhythm of human activity) that enhances criminal opportunities in the following ways. First, bus stops are public places that afford motivated offenders with greater opportunity to engage in predatory crimes without the crime-inhibiting effect provided by their handlers. Second, passenger flow around bus stops increases the supply of visible and accessible crime targets for offenders. Third, other transit passengers may provide some guardianship against victimization while on the bus, but the availability of capable guardians diminishes as potential crime victims move outward in the proximate environment of the transit stop. Fourth, with the possible exception of transfer stations, security agents and other place managers are not usually present near and around most bus stops. Given these conditions, many bus stops exhibit the three necessary conditions for predatory victimization under routine activity theory: (1) exposure to motivated offenders, (2) the availability of suitable targets and (3) the absence of capable guardians (Cohen and Felson, 1979).

As its name implies, crime pattern theory contends that crime is highly patterned and occurs in predictable locations. Its predictability is based on the intersection of crime opportunities and an offender's awareness space (Brantingham and Brantingham, 1984). From this perspective, crime is disproportionately clustered in a few locations because these places serve as crime attractors (i.e. they bring motivated offenders into the area due to their reputation for ease of committing crime) and crime generators (i.e. they draw many potential victims to these locations due to the numerous legitimate activities nearby).

Three principal components of crime pattern theory (i.e. nodes, paths and edges) provide the basis for expecting high levels of crime around particular bus stops (see also Newton, 2004). In particular, many bus stops are susceptible to crime because they are 'paths' for transporting a wide supply of potential offenders and victims to and from major 'nodes' of human activity (e.g. work, school, shopping, entertainment areas) and are often located on the 'edges' of mixed land use (e.g. commercial, residential). Bus stops on these edges are especially vulnerable locations for crime because they (1) are transitional areas involving strangers and temporary visitors who may be less willing to provide guardianship for others and (2) lack place managers who are assigned to regulate conduct within them.

Facilitating places within the proximate environment of bus stop locations

Bus stops are physical locations that are situated in a wider environmental context. Different terms have been used in previous research to describe this wider context (e.g. environmental 'backcloth', 'meso-environment' etc.). However, what is important about the environment in the immediate vicinity of bus stops is that the other physical features and activity nodes within it dictate its potential risk for crime. In other words, public transit nodes like bus stops may represent places in which risk of criminal victimization is increased, but it is important to acknowledge that they are 'only part of a milieu of risky places' (Block and Davis, 1996: 252).

Eck et al. (2007) define 'risky places' as a small subset of a homogenous group of public or private facilities that account for the majority of crimes experienced by the entire group. Prior research has documented the kind of patterns described by Eck and colleagues at a variety of activity nodes, each with particular features that enhance criminal opportunity and facilitate the commission of crimes within them. Among these types of human activity nodes, existing research suggests that some bus stops are riskier places than others. For example, Levine and Wachs (1985, 1986b) found that 22 per cent of all recorded bus stop crime in West Central Los Angeles occurred at only eight locations. Similarly, Loukaitou-Sideris (1999) found that 18 per cent of crime at inner-city Los Angeles bus stops was associated with only ten unique hot spots. Finally, Newton (2004) found that 70 per cent of all incidents of bus-shelter vandalism in Liverpool (United Kingdom) occurred at 25 per cent of all shelters throughout the city.

Studies of bus stop locations also suggest that they are part of a meso environment that attracts and/or generates criminal activity (Brantingham and Brantingham, 1984, 1995). For example, Loukaitou-Sideris (1999) found that high-crime bus stops typically had greater numbers of liquor stores/bars, pawnshops/check cashing facilities, and in some cases more adult bookstores than matched bus stops with relatively less crime. Similarly, based on field observations of the most dangerous bus stops in West Central Los Angeles, Levine and Wachs (1985) and Levine et al. (1986) concluded that liquor stores, adult bookshops, parking lots and residential hotels were often in close proximity to high-risk bus stops.

The existing research described above provides important information about the spatio-temporal concentration of crime at public bus stops and the particular kinds of 'risky places' that are within their proximate environment. However, these studies have not fully informed our understanding of the relationship between bus stops, other activity nodes within their immediate environment and risk of criminal victimization. Specifically, it is unclear how victimization risk is influenced by the particular combination of activity nodes that are located within these contexts. Identifying the nature and magnitude of these context-specific differences in the victimization risk around public bus stops is the primary focus of the current study.

Current study

Research within the field of environmental criminology has expanded the use of a place-based approach to crime pattern analysis (see, for example, Weisburd Groff and Yang, 2012). Similar to findings about crime in other places, previous research indicates that victimization risk at public bus stops is highly clustered and not uniform across locations. However, less is known about how the prevalence of crime associated with public bus stop locations compares to other 'risky places' and how particular activity nodes around bus stops influence the risk of crime.

Building upon previous research, the current study examines street robberies and the relative risk of criminal victimization associated with bus stop locations and other activity nodes within the meso environment. Using data from a matched sample of 453 street robberies in Henderson,[1] Nevada, three research questions are addressed. First, what type and combination of activity nodes are most commonly found in the proximate environment of street robberies? Second, what is the likelihood that a public bus stop is part of this proximate environment? And third, what is the relative risk of robbery victimization across different environmental contexts that are defined by the combination of activity nodes when public bus stops are also present/absent?

Data and methods

Event profiles, defined by the unique combination of activity nodes present or absent in the proximate environment of a street robbery (and robbery-free locations), were constructed using conjunctive analysis (see 'Conjunctive analysis of case configurations' section). These profiles are used in the current case study as a place-based unit of analysis. Crime incident data, information about activity nodes located within the proximate environment of robbery (and robbery-free) locations, and zoning district information for legal properties within the study area were used to create each profile.

Crime incident data

Crime data were obtained from the Henderson (Nevada) Police Department and consist of known robbery incidents that occurred between 1 January 1 2007 and 31 December 2009 (n = 453) and that conform to the FBI's Uniform Crime Reporting (UCR) Program definition of a robbery: taking or attempting to take anything of value from the care, custody, or control of a person or persons by force or threat of force or violence and/or by putting the victim in fear (FBI, 2011). All robbery incidents were successfully georeferenced to the city's street centreline network, which is an approach that has been shown to produce complete and accurate geocoded crime data (Hart and Zandbergen, 2013).

Activity nodes and the proximate environment

Event profiles for all robbery and matched robbery-free locations were created based on the proximate physical environment. Environs for each location were defined by the presence (1) or absence (0) of eight different activity nodes that previous research suggests may attract/generate crime. Specific activity nodes used in the current study include *ATMs, bars/taverns, (public) bus stops, check cashing stores, fast food restaurants, gas stations, shopping plazas* and *smoke* shops.[2]

An activity node was considered 'present' in the proximate environment if it was within 1,000 feet of a robbery/robbery-free location. This distance used to define the proximate environment represents a balance between existing micro-environment criminological scholarship, which suggests that the spatial influence of the physical environment on crime is best defined by a single block or two[3] (e.g. Weisburd et al., 2012) and the urban planning literature, which suggests that the maximum distance a person may be willing to travel for public transportation – and thereby be exposed to risk of victimization – is approximately one-quarter mile (e.g. Calthrope, 1993). Since Euclidean distance (i.e. straight-line distance) does not consider physical barriers that occur in the natural environment that may restrict movement, the current study used street distance or service area distance to measure proximity.

In terms of activity nodes considered in the current study, Figure 11.1 depicts a robbery location in Henderson in which only a public bus stop is part of the proximate environment. Figure 11.2 shows a robbery location in which multiple activity nodes (e.g. ATM, bus stop, check cashing store and shopping plaza) are present in the proximate environment.

Zoning and land use data

Zoning and future land use information was obtained from the City of Henderson's Community Development Department. A total of 31 different zones are used by the city to classify properties, which can be grouped into two general categories: non-residential/mixed-use and residential. Nearly two-thirds of all robbery incidents described in the previous section occurred in non-residential/mixed-use areas. Since the spatial distribution of the particular activity nodes considered in the current study is a function of land use,[4] the specific zoning district for each robbery incident was determined so that a matched sample of robbery-free locations, stratified by zone, could

Figure 11.1 A robbery location in Henderson, NV. A public bus stop location is the only activity node examined in the current study that is present in the proximate environment

Source: Copyright 2013 by Jeremy Waller. Reprinted with permission.

Figure 11.2 Another robbery location in Henderson, NV. Multiple activity nodes considered in the current study (e.g. ATM, bus stop, check cashing store and shopping plaza) make up the proximate environment of this incident location

be randomly selected from a master list of all address locations within the city (n = 453). Event profiles for both the robbery and the matched sample of robbery-free locations were created using conjunctive analysis.

Conjunctive analysis of case configurations

Miethe, Hart and Regoeczi (2008) recently offered a new analytic approach for exploring crime data, which they describe as conjunctive analysis of case configurations. The technique is similar to qualitative comparative analysis (QCA) methods developed by Ragin (1987) and can be summarized in three steps. First, a 'truth table' or data matrix is constructed from focal variables that are measured at the nominal or ordinal level and that are contained in a dataset. For example, a conjunctive analysis involving two dichotomous variables and two variables with three categories would yield a composite table with 36 rows ($2 \times 2 \times 3 \times 3 = 36$). Collectively, rows in this table represent all unique combinations of variable attributes considered simultaneously and that *could be observed* in the dataset. Second, each case in the sample is classified into one of the rows that make up the table. Once all cases are distributed, the third step involves applying decision rules[5] for defining rare and commonly observed profiles. After these rules are applied, the resulting table contains one row for each of the *dominant profiles* that are *empirically observed* in the data. The columns in this table represent each focal variable used in the analysis.

In the current study, this method of conjunctive analysis was used to construct three separate composite tables. The first table (see Table 11.1) consists of robbery event profiles that were created by combining the eight dichotomous measures used to indicate whether an activity node was presence or absence from the proximate environment of a robbery incident (i.e., $2^8 = 256$ possible profiles). Data for each crime event contained in the sample were then allocated to each profile, and analysis of the resulting table provided an answer to our first research question: *What type and combination of activity nodes are most commonly found in the proximate environment of street robberies?*

The second composite table consists of robbery event profiles that were created by combining seven of the eight activity node measures (see Table 11.2). The bus stop measure was excluded from this table and used instead as the outcome measure. Robbery data were allocated to each profile so that the probability of a public bus stop's being part of the proximate environment of a crime could be calculated. Differences in the overall rank-order of dominant situational profiles were assessed using the Friedman two-way analysis of variance (ANOVA) test, and the Wilcoxon signed rank test was used to identify differences between specific pairs of profiles. Analysis of this second composite table enabled us to answer our second research question: *What is the likelihood that a public bus stop is part of this proximate environment?*

The final composite table (see Table 11.3) was constructed in the same way as the second table. For this third table, however, data from the *robbery-free locations* sample were allocated to each profile so that the probability of a public bus stop's being part of the proximate robbery-free environment could be determined. Profiles from the third table were matched to identical profiles from the second table in order to calculate the relative risk of victimization. The Wilcoxon signed rank test was used to determine whether the likelihood a bus stop was present among the dominant situational profiles for the robbery sample was different from the matched robbery-free profiles. Analysis of the third table offered insight into our final research question: *What is the relative risk of robbery victimization across different environmental contexts that are defined by the combination of activity nodes when public bus stops are also present/absent?*

Results

The three research questions underlying this study were examined through a conjunctive analysis of the distinct combination of activity nodes in close proximity to street robberies.

Our initial research question focuses on the specific combinations of activity nodes that are most commonly found in the proximate environment of street robberies. The results of our conjunctive analysis for this research question are presented in Table 11.1 and reveal three distinct patterns.

First, all robberies in this study (n = 453) cluster within a smaller group of situational profiles (n = 76) that define a crime's proximate environment. That is to say, given the number of dichotomous variables used to create the composite table of activity nodes, we would have expected to observe 256 distinct situational profiles if robbery was contextually invariant. However, only 76 unique combinations of activity nodes were empirically observed in our sample data (see the profile summaries at the bottom of Table 11.1). This suggests that robbery clusters within a relatively small set of environmental contexts that involve specific combinations of activity nodes.

Second, situational clustering in this study was not uniform across each of the 76 profiles. In fact, among all 76 profiles empirically observed in the data, the majority of robberies occurred in environments characterized by only nine *dominant situational profiles* (i.e. composite profiles of activity nodes with ten or more robbery incidents). These findings are consistent with both previous studies of bus stop crime that suggest a few 'hot spots' account for most crime (Levine and Wachs, 1985, 1986b; Loukaitou-Sideris, 1999) and the 'risky places' literature in general which suggest that a small subset of places within a larger homogenous group account for most crime (Eck et al., 2007).

Finally, within the nine dominant situational profiles of risky places that define the proximate environment of a robbery, a bus stop was part of the profile on all but two occasions. None of the other types of activity nodes in this study demonstrated a stronger pattern across the dominant situational

Table 11.1 Dominant situational profiles of robberies

	Activity nodes										
Profile ID#	**ATM**	**Bar**	**Bus stop**	**Check cashing**	**Fast food**	**Gas station**	**Shopping plaza**	**Smoke shop**	**n**	**Pct.**	**Cum. pct.**
1	No	No	No	No	No	No	No	No	80	17.7	17.7
2	No	No	Yes	No	No	No	No	No	49	10.8	28.5
3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	18	4.0	32.5
4	Yes	Yes	Yes	No	Yes	No	Yes	Yes	18	4.0	36.4
5	Yes	Yes	Yes	No	Yes	Yes	Yes	No	18	4.0	40.4
6	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	17	3.8	44.2
7	No	No	Yes	Yes	Yes	Yes	Yes	No	12	2.6	46.8
8	Yes	No	Yes	No	No	No	No	No	12	2.6	49.4
9	Yes	No	No	Yes	Yes	Yes	Yes	Yes	12	2.6	52.1
				9 dominant situational profiles:					236	52.1	
				67 other situational profiles:					217	47.9	
				76 total observed situational profiles:					453	100.0	

Note: Profiles listed in Table 11.1 were created by combining the *eight* dichotomous measures used to indicate whether an activity node was presence or absence from the proximate environment of a robbery. Therefore, Profile ID numbers listed in Table 11.1 are not comparable to the Profile ID numbers listed in Tables 11.2 and 11.3, as only *seven* of the eight activity nodes were used to construct those tables. The presence or absence of a bus stop was used in Tables 11.2 and 11.3 as the outcome measure.

profiles (e.g. only four profiles with bars were in the dominant proximate environment of robbery). These findings suggest that the opportunity to commit a robbery may be strongly influenced by the presence or absence of a public bus stop, which is part of the larger proximate environment that influences human behaviour in and around these particular locations.

Our second research question focuses more closely on the presence or absence of bus stops at robbery locations, given the patterns observed among dominant situational profiles that were associated with this particular activity node. We created a second composite table using conjunctive analysis to determine the likelihood that a bus stop was part of the proximate environment of a robbery (Table 11.2). Results of the Friedman two-way ANOVA test showed significant differences between the overall rank-order of dominant situational profiles ($\chi^2 = 65.0$; $p \leq .001$), and pairwise comparisons using the Wilcoxon signed rank test showed significant differences between Profile ID #11 and Profile ID #1 to #8 (z = 3.34, $p \leq .05$).

Findings indicate that the likelihood of a public bus stop's being part of the robbery environ varies widely across contexts that are defined by the specific combination of other activity nodes. For example, a bus stop was *always* part of a robbery's proximate environment when an ATM, bar, fast food restaurant, gas station, shopping plaza and smoke shop were all also present (see Profile ID #1 in Table 11.2). Conversely, a bus stop was part of the proximate environment of a robbery only 10 per cent of the time when a

Table 11.2 Likelihood a bus stop is among other activity nodes that define the dominant situational profiles of robbery events

	Activity nodes								
Profile ID#	**ATM**	**Bar**	**Check cashing**	**Fast food**	**Gas station**	**Shopping plaza**	**Smoke shop**	**Likelihood a bus stop is near***	**n**
1	Yes	Yes	No	Yes	Yes	Yes	Yes	1.00	17
2	Yes	Yes	No	Yes	Yes	Yes	No	0.95	19
3	No	No	Yes	Yes	Yes	Yes	No	0.92	13
4	Yes	Yes	No	Yes	No	Yes	Yes	0.86	21
5	Yes	Yes	Yes	Yes	Yes	Yes	Yes	0.82	22
6	Yes	No	No	No	No	No	No	0.71	17
7	Yes	Yes	No	No	Yes	Yes	No	0.70	10
8	No	No	No	No	No	No	No	0.38	129
9	Yes	No	Yes	Yes	Yes	Yes	Yes	0.37	19
10	Yes	No	No	Yes	Yes	No	No	0.27	11
11	No	Yes	No	No	No	No	No	0.10	10

Note: Profile ID numbers are unique identifiers that can be used to match profiles presented in Table 11.3.

*Friedman two-way ANOVA ($\chi^2 = 65.0$; $p \leq .001$); Wilcoxon signed rank test $p \leq .05$ for differences between Profile ID #11 and Profile IDs #1-#8.

bar was the only other type of activity node in close proximity to the crime incident (see Profile ID #11 in Table 11.2). Collectively, our findings that most robberies occur within a few dominant situational profiles and that variability exists in the likelihood that a bus stop is part of these proximate environments suggests that the robbery risks could also be strongly influenced by the specific contextual combinations of activity nodes.

Our third and final research question focuses on the relationship between victimization risk and the particular combinations of dominant activity nodes in the surrounding environment. Using a matched sample of robbery-free locations, a third composite table – also predicting the likelihood that a bus stop was part of the proximate environment – was constructed using conjunctive analysis. Event profiles from this third composite table were matched with identical profiles from the second composite table in order to calculate a relative risk score (Table 11.3). The risk score represents a ratio of the likelihood that a bus stop is present at a robbery event to the likelihood that a bus stop with the identical environmental backcloth is present at a robbery-free location. Results from Wilcoxon's signed rank test showed that the likelihood a bus stop was present among the dominant situational profiles for the robbery sample (Md = 0.71) differed significantly from the matched robbery-free profiles (Md = 2.00) ($z = -2.31$, $p \leq .05$).

Table 11.3 Relative risk of robbery for dominant situational profiles of activity nodes that define the proximate environment

	Activity nodes							
Profile ID#	**ATM**	**Bar**	**Check cashing**	**Fast food**	**Gas station**	**Shopping plaza**	**Smoke shop**	**Relative risk***
6	Yes	No	No	No	No	No	No	7.10
8	No	No	No	No	No	No	No	1.52
2	Yes	Yes	No	Yes	Yes	Yes	No	1.42
1	Yes	Yes	No	Yes	Yes	Yes	Yes	1.27
5	Yes	Yes	Yes	Yes	Yes	Yes	Yes	0.95
3	No	No	Yes	Yes	Yes	Yes	No	0.92
4	Yes	Yes	No	Yes	No	Yes	Yes	0.86
7	Yes	Yes	No	No	Yes	Yes	No	0.70
9	Yes	No	Yes	Yes	Yes	Yes	Yes	0.49
11	No	Yes	No	No	No	No	No	0.30
10	Yes	No	No	Yes	Yes	No	No	0.27

Note: Profile ID numbers in Table 11.3 correspond to the profile ID numbers in Table 11.2. Profiles are ranked from highest to lowest in terms of relative risk of victimization. The relative risk value represents the likelihood that a bus stop is part of the proximate environment divided by the likelihood that it is absent.

*Results of the Wilcoxon signed rank test showed that the likelihood a bus stop was present among the dominant situational profiles for the robbery sample (Md = 0.71) differed significantly from the matched robbery-free profiles (Md = 2.00) ($z = -2.31$, $p \leq .05$).

As shown in the last column of Table 11.3, the relative risks of robbery victimization vary widely depending on the specific combinations of activity nodes that define the environmental context. For example, the risk of robbery victimization is 7.1 times greater when the proximate environment consists of only an ATM and a bus stop than when it consists of only an ATM (see Profile ID #6 in Table 11.3). In other situations, however, the presence of a bus stop is actually associated with a reduced likelihood of robbery victimization. For example, the risk of robbery victimization is more than three times *less* when the proximate environment consists of only a bar and a bus stop than when it consists of only a bar (see Profile ID #11 in Table 11.3). Combined, these findings suggest that the risk of robbery victimization is strongly dependent on the presence or absence of a bus stop *in conjunction with* certain combinations of other types of activity nodes that also serve as crime generators and/or attractors.

Discussion and conclusion

Drawing upon the previous research in environmental criminology, the current study examined the physical backcloth of robbery incidents in order to (1) empirically identify the particular combinations of activity nodes that are found within the proximate environment of robberies; (2) determine the likelihood of a bus stop being part of the proximate environment for these crimes; and (3) assess the relative risk of robbery victimization across the dominant situational profiles when public bus stops are also present/absent.

Analyses of the composite profiles of activity nodes near robbery incidents provide answers to the three research questions underlying this case study. First, consistent with previous research using individuals and places as the unit of analysis, street robberies are highly clustered within a relatively small number of environmental contexts that are defined by specific combinations of activity nodes that may generate/attract criminal activity. In particular, over half of the robbery incidents occurred within only nine unique profiles of activity nodes. Second, as a crime generator/attractor, bus stops are more likely than any other activity node to be found across dominant situational profiles of robbery. Third, the relative risk of robbery associated with the presence/absence of bus stops varies widely on the basis of specific combinations of other activity nodes. The presence of a bus stop *increases* by over seven times the risk of robbery for a particular combination of activity nodes, but it *decreases* the risk by a factor of three in other contexts. The implications and limitations of this study are summarized below.

Implications

In her assessment of two transit system studies within the Washington, DC, region, La Vigne (Chapter 14 in this volume) suggests that effective crime prevention efforts could be highly contextual. Furthermore, she demonstrates how similar crime reduction strategies, implemented under different circumstances, can produce inconsistent outcomes. Findings from the current study support and extend previous research. Moreover, they offer guidance for answering questions like those raised by LeVigne and others by identifying the nature and magnitude of situational clustering of street robberies and the distinct combinations of activity nodes that make up their meso environment. The greater risk of robbery victimization in proximity to bus stops, however, is highly contextual, depending upon the particular combination of other activity nodes within its wider environ.

This lack of invariance in the associative effects of bus stops on the risks of robbery across contexts suggests an important qualifier on statements about the risk or the dangerousness of these physical locations. This conditional statement is that bus stop locations are neither a necessary nor sufficient condition for street robbery. Instead, its role as a crime generator or attractor depends entirely on the particular combination of other activity nodes that make up the physical backcloth of its proximate environment.

The current study of the situational risks of robbery around bus stops has been guided by the principles of environmental criminology, an interdisciplinary approach that draws from rational choice theories of offending and human ecology. However, this approach for studying crime events is also relevant to a more general assortment of disciplinary traditions (e.g. economics, engineering, geography, psychology, sociology). For example, for geographers and engineers working with city and urban planners, our findings about the nature and magnitude of situational clustering of street robberies provides an empirical foundation for proactive interventions and policies that derive from the principles of environmental design and situational crime prevention (e.g. increased responsibility for place managers, greater surveillance and target hardening around the meso environment of high-risk locations). Through a more complete multidisciplinary integration of the fields of urban design, technology (e.g. use of unmanned aerial devices [drones] for visual surveillance), and environmental criminology, future empirical studies of risky places around bus stops may serve as a basis for enhancing the effectiveness of crime prevention efforts within these particular locations.

Compared to other analytic approaches, the method of conjunctive analysis used in this study appears to be ideally suited for exploring how the complex interplay of various physical attributes of places influence their relative risks of crime. In the current study, conjunctive analysis used a series of composite tables – representing combinations of all possible activity nodes – to provide a descriptive summary of the relative prevalence of distinct situational contexts for robbery and the impact of particular activity nodes within them. This analytic approach also revealed patterns of differential risks across contexts that are not easily recognized in traditional quantitative analyses of crime data. By providing a descriptive approach for contextual analysis, conjunctive analysis offers a relatively simple and straightforward method for looking systematically at the type of data that is often the focus of environmental criminology.

For crime prevention efforts that emphasize crime generators and attractors, the current results suggest that particular profiles of risky places can be empirically identified. In the case of bus stops, our conjunctive analysis clearly identifies 'dangerous places' and thus provides the basis for further investigation of their particular risk-enhancing properties. When coupled with ethnographic studies of these 'high-risk' bus stops and comparing them with those places with a similar backdrop, future research may be better able to identify the particular mechanisms that contribute to these differential risks for similar types of environments.

Limitations and conclusions

The current study uses police data on street robbery incidents and various secondary data to construct a series of composite tables that define robbery environments. Although the limitations of police data are well known, police reports of street robberies were the best available data source for the current study. Incidents of street robbery during criminal transactions (e.g. drug dealing or prostitution) or among known parties (e.g. family or acquaintances) are underreported in official crime data. In addition, time was not included in the situational profiles created in the current study, but time has been shown to strongly influence crime around public transportation nodes. And finally, given that most studies of the criminogenic effect of bus stops are conducted in large urban areas (e.g. New York, Los Angeles, Chicago), the use of a sample from a relatively smaller city also may limit the applicability of the current findings to other settings. Due to these limitations, some caution is required in making substantive and policy inferences from the current findings.

The conclusions from this study are easily summarized. Consistent with past research, street robbery is highly concentrated within particular situational contexts that are defined by the combination of specific activity nodes that generate and attract criminal activity. Bus stops are strongly and consistently associated with street robbery, but the relative risk of these places also varies widely on the basis of other activity nodes that define their proximate environment. Based on these findings, the influence of bus stops and other place attributes on robbery risks is best viewed as highly contextual, depending on the presence or absence of other activity nodes within their particular locations.

Notes

1. Henderson is located in Clark County, Nevada. It is part of the Las Vegas metropolitan area. It is the second-largest city in Nevada, and in 2012, its estimated population was 265,679.

2. A total of 16 activities nodes were originally considered: adult stores or entertainment sites, ATMs, bars/taverns, (public) bus stops, check cashing centres, fast food restaurants, gas stations, liquor stores, (public) parking garages, pawnshops, (public) recreation centres or parks, (public or private) schools, shopping malls, shopping plazas, smoke shops, and (public) storage facilities. This number was reduced to eight and represents those activity nodes that are frequently observed in robbery environs. Including the remaining nodes that are rarely in the proximate environment of a robbery would significantly increase the number of situational profiles that made up the original truth table (e.g. 16 dichotomous variables or 2^{16} would yield a truth table with 65,536 situational profiles). More importantly, over 99 per cent of the profiles contained in the truth table would be unobserved (i.e. the particular combination of attributes would have a '0' observed frequency in the sample). Consequently, our analysis is based on eight of the 16 original activity nodes.
3. The average block in Henderson, Nevada, based on street segments, is 482 feet.
4. For example, public bus stops and parks can be located within residential district zones, but bars, pawnshops and other commercial properties must be located in non-residential zones. Therefore, the presence or absence of a specific activity node is defined, in part, by city land use.
5. In conjunctive analysis, dominant situational profiles are defined based on the application of minimum cell frequency rules. Following the recommendations of Miethe et al. (2008), a minimum cell frequency of 10 is used in the current study to define a dominant situational profile.

References

Block, R., and Davis, S. (1996) The Environs of Rapid Transit Stations: A Focus for Street Crime or Just Another Risky Place? In: Clarke, R. V. (ed.) *Preventing Mass Transit Crime*, Monsey, NY: Criminal Justice Press, 237–257.

Bowers, K., Hirschfield, A. and Johnson, S. (1998) Victimization Revisited: A Case Study of Non-residential Repeat Burglary in Merseyside. *British Journal of Criminology, 38*(3), 429–452.

Brantingham, P. J., and Brantingham, P. L. (1984) *Patterns in Crime*. New York: Prentice Hall.

Brantingham, P. L., and Brantingham, P. J. (1995) Criminality of Place: Crime Generators and Crime Attractors. *European Journal on Criminal Policy and Research, 3*, 1–26.

Calthrope, P. (1993) *The Next American Metropolis: Ecology, Community and the American Dream*. New York: Princeton Architectural Press.

Cohen, L. E., and Felson, M. (1979) Social Change and Crime Rate Trends: A Routine Activity Approach. *American Sociological Review, 44*, 588–608.

Eck, J. E., Clarke, R. V. and Guerette, R. T. (2007) Risky Facilities: Crime Concentration in Homogeneous Sets of Establishments and Facilities. *Crime Prevention Studies, 21*, 225–264.

Federal Bureau of Investigation (FBI). (2011) *Crime in the United States, 2010*, US Department of Justice, Washington, DC.

Felson, M., and Santos, R. B. (2009) *Crime and Everyday Life*, Fourth edition, Thousand Oaks, CA: Sage.

Hart, T. C., and Zandbergen, P. A. (2013) Reference Data and Geocoding Quality: Examining Completeness and Positional Accuracy of Street Geocoded Crime

Incidents. *Policing: An International Journal of Police Strategies and Management*, *36*(2), 263–294.

Holt, T., and Spencer, J. (2005) A Little Yellow Box: The Targeting of Automatic Teller Machines as a Strategy in Reducing Street Robbery. *Crime Prevention and Community Safety*, *7*, 15–28.

Kooi, B. R. (2013) Assessing the Correlation between Bus Stop Densities and Residential Crime Typologies. *Crime Prevention and Community Safety*, *15*(2), 81–105.

Levine, N., and Wachs, M. (1985) *Factors Affecting the Incidence of Bus Crime in Los Angeles*, Vols. 1 and 2 (Report No. CA-06–0195), US Department of Transportation, Washington, DC.

Levine N., and Wachs, M. (1986a) Bus Crime in Los Angeles: I – Measuring the incidence. *Transportation Research A*, *20*(4), 273–284.

Levine, N., and Wachs, M. (1986b) Bus crime in Los Angeles: II – Victims and public impact. *Transportation Research A*, *20*(4), 285–293.

Levine, N., Wachs, M. and Shirazi, E. (1986) Crime at Bus Stops: A Study of Environmental Factors. *Journal of Architectural and Planning Research*, *3*(4), 393–362.

Loukaitou-Sideris, A. (1999) Hot Spots of Bus Stop Crime: The Importance of Environmental Attributes. *Journal of the American Planning Association*, *65*(4), 395–411.

Loukaitou-Sideris, A. (2009) *How to Ease Women's Fear of Transportation Environments: Case Studies and Best Practices* (Report No. 09–01). San Jose, CA: Mineta Transportation Institute.

Miethe, T. D., Hart, T. C. and Regoeczi, W. C. (2008) The Conjunctive Analysis of Case Configurations: An Exploratory Method for Discrete Multivariate Analyses of Crime Data. *Journal of Quantitative Criminology*, *24*(2), 227–241.

Newton, A. (2004) Crime on Public Transport: 'Static' and Non-static (Moving) Crime Events. *Western Criminological Review*, *5*(3), 25–42.

Newton, A. (2008) A Study of Bus Route Crime Risk in Urban Areas: The Changing Environs of a Bus Journal. *Built Environment*, *34*(1), 88–103.

Ragin, C. C. (1987) *The Comparative Method*. Berkeley: University of California Press.

Roncek, D. W., and Maier, P. A. (1991) Bars, Blocks, and Crimes Revisited: Linking the Theory of Routine Activities to the Empiricism of 'Hot Spots'. *Criminology*, *29*, 725–753.

Weisburd, D., Groff, E. R. and Yang, S. M. (2012) *The Criminology of Place: Street Segments and Our Understanding of the Crime Problem*, Oxford: Oxford University Press.

Yu, S. V. (2009) *Bus Stops and Crime: Do Bus Stops Increase Crime Opportunities in Local Neighborhoods?* Unpublished doctoral dissertation, Rutgers University, Newark, NJ.

12

Areas Where Vulnerable Public Transit Commuters Reside: A Method for Targeting Crime Prevention and Other Resources to Address Local Area Problems

Sung-suk Violet Yu and Martha J. Smith

Introduction

Hart and Miethe (Chapter 11 in this volume) focused on where street robberies occur, taking proximate environments into account. In this chapter, we shift the focus from crime events and features of places to potential victims and the areas around their residences. We identify areas in which groups previously found to be vulnerable to crime victimization or fear of crime on public transit cluster in the New York City context. Reaching these vulnerable populations can be expensive if local area planners or agencies have to do all of the research by themselves, but it is easier, and less expensive, if agencies can build on existing research. One such publicly available set of information about US residents is the American Community Survey (ACS). The main purpose of the ACS is to inform policymakers about how to distribute federal and state funding to various local and state governments for infrastructure and services (USCB, 2013). Transit operators who want to provide more secure travel for passengers most in need may use the ACS to identify where commuters reside.

In this study, we identify those most in need of crime-prevention resources in terms of crime-target 'vulnerability' within the context of public transit use. Specifically, we define vulnerability in terms of (1) crime victimization, (2) fear of crime and (3) ability to use or access other modes of travel. We focus on demographic factors – such as gender, age, race and ethnicity, and income level – that have been shown in past research to be correlated with vulnerability. The chapter first presents the theoretical basis for the study, followed by methods and analysis. Results and discussion are then presented with a focus on the policy implications.

Theoretical background

Examining services in terms of area of residence makes good sense because the decision to use public transport is influenced by the perceived security along the prospective rider's 'whole journey' from home to transport stop, along the transit system to destination, and then back to transport stop and home again (e.g. Maxson et al., 2001). Crime, or fear of crime, encountered in this journey is one of the main reasons given for not using public transport (Department for Transport, 2012) and, unlike the South African context (Smit et al., Chapter 13 in this volume), most US neighbourhoods have open access, and much local crime is committed by those who do not live far away from their victims (Wiles and Costello, 2000; Bernasco and Nieuwbeerta, 2005; Bernasco and Block, 2009).

While some transit professionals may see this focus on vulnerable passengers along the whole travel route as beyond their remit (Loukaitou-Sideris and Fink, 2009), there are good pragmatic and social welfare (Knepper, 2009) reasons for this focus. The importance of pragmatic considerations is easily understood by looking at the effects of fear of crime on ridership. For example, a study of public transport in the United Kingdom estimated that reducing fear of crime might increase ridership by three to ten per cent (Department for Transport, 1999). Moreover, many single crime-prevention initiatives (Clarke, 1992), and whole policing approaches (Goldstein, 1979), are focused on where, or against whom, crime is likely to occur. In terms of social welfare concerns, (a) public transport can provide wide access across all types of persons to amenities available within the areas served, perhaps decreasing the social exclusion of marginal groups, (b) public transport access might be seen as a right, or (c) 'vulnerability' might be viewed as a fundamental aspect of the human condition and a means of examining society's obligations to its citizens (Fineman, 2008). It is not necessary to choose among these different types of considerations, but it is important to note that each can be used to justify this approach.

Transit rider vulnerability in an opportunity-theory context

Routine activity theory (Cohen and Felson, 1979) has sensitized us to the utility of perceiving crime events as occurring when motivated offenders converge in time and space with suitable targets when capable guardians are not present, and to looking at target characteristics such as value, accessibility, visibility and inertia. Later work by Felson (1987) stressed the importance of the design and layout of urban places in crime convergence. Crime pattern theory (Brantingham and Brantingham, 2008) encourages us to examine the movement patterns of offenders and victims, providing a language for discussing how the environment plays a large role in crime events and their prevention. Felson (1986) and Eck (1995) have expanded the view of crime-control roles beyond the lone target guardian, and described linkages with offenders and places, by adding offender 'handlers' and place 'managers', respectively. Increasing the presence and effects of these 'controllers' and designing movement patterns to limit convergences are just some of the ways in which these concepts can be used to help prevent crime events. Using the terminology of the rational choice perspective (Cornish and Clarke, 2008), those in control of environments need to increase the risks and the efforts related to crime while reducing potential rewards, and focus on the choice-structuring properties of crime. These approaches to target vulnerability suggest looking at transit-rider vulnerability in terms of both theory and empirical research.

Transit-rider vulnerabilities

In keeping with Clarke and Cornish (1985), we adopt a 'good enough' or working definition of 'vulnerability' to guide our efforts. We have identified four aspects of victim vulnerability that transit operators should consider when targeting crime-prevention resources: (1) patterns of past victimization; (2) perceptions of vulnerability as one dimension of fear of crime; (3) the limited travel alternatives of the so-called 'transit captive;'[1] and (4) other types of vulnerabilities (such as lack of access to education and employment opportunities). Although this last type of vulnerability is beyond the scope of the present chapter, it is included to remind transit operators and policymakers that crime and public transit do not exist in a cultural vacuum. They form part of the 'backcloth' of crime opportunities (Brantingham and Brantingham, 2008) that can affect victimization, and should be considered.

Past patterns of vulnerability (victimization) on public transport

Research on victimization on public transport shows variability by type of crime, mode of travel, situational context (such as passenger density), and location in, around and on the way to the system (see Smith and Cornish, 2006). In the United Kingdom, Crime Concern (2004) noted that ethnic minority groups reported higher levels of harassment than whites. Levine and Wachs (1986b) found that, among heavy bus users, the elderly, women, Hispanics and low-income people were most likely to report having been victimized by a bus or bus-related crime (primarily larceny and robbery). It is important to stress that both men and women are victimized on public transport.

Perceptions of vulnerability and fear of crime

In general, women, the elderly, members of ethnic minority groups and those who are disadvantaged report higher levels of fear of crime than others. For example, studies have shown that gender is one of the strongest factors influencing concerns for personal security in mass transit environments (Department for Transport, 2002). In the study noted above by Levine and Wachs (1986b), women, the elderly, Hispanics and those with low incomes also reported being fearful when riding buses in Los Angeles. Patterson (1985) supports this finding of fear among elderly transit users. Research also indicates that one dimension of fear of crime appears to be related to the respondent's perceived likelihood of victimization (e.g. Roundtree and Land, 1996). And perceived vulnerability can be related to signs of crime or disorder, and to possible limitations in one's ability to thwart personal victimization.

Fear of crime has been found to be high for some journeys to and from public transport (Ferrell et al., 2012; Crime Concern, 2004). The fear-inducing aspects of walking to and from public transport are important to consider since three out of five riders walk to transit stations or stops (APTA, 2007). Considering conditions along travel routes fits with the 'whole journey' approach (Maxson et al., 2001), which suggests that the most important factor in travel decisions may be how dangerous or fear-inducing one or more parts of the journey are.

Potential vulnerability due to lack of modal choice – the transit captive

Those who have no means of getting from one place to another, other than by public transportation, are considered to be 'transit captive'. Women (TTC et al., 1989), the elderly (Bailey, 2004) and those with low incomes often are dependent upon public transit for their transportation needs. Transit captives may represent, on average across the Unite States, roughly one in five (APTA, 2007). This figure was not based on lack of vehicle ownership alone, but on not having an alternative mode of travel if public transportation were not available. Others with very limited means of travel may find themselves captive at certain times or in particular situations.

Captive transport users may have special needs in relation to their lack of travel choices. Specifically, they may be more likely to be the actual victims of crime, particularly if they live in areas with high levels of crime, since they cannot decide to use another, potentially safer, mode of travel.

Why not just look at crime location?

Much recent criminological research focuses on places in which past crimes have occurred, and on increasingly smaller 'micro' areas, such as block faces (e.g. Groff, Weisburd and Yang, 2010). While this approach is useful, it does not always address the concerns of public transit policymakers, particularly where place of occurrence is only one of the important factors that needs to be considered. For example, information on crime location may not indicate whether the victim of the crime was a public transit user or a potential user, or whether the victim was on his or her way to or from a public transport station or stop (Levine and Wachs, 1986a).

Transit operators may, therefore, have good reasons to focus some of their crime prevention efforts on identifying factors related to transit riders as potential crime victims. Gathering this information is expensive, so starting from scratch may not be an option for many systems. Using an existing dataset with information about where public transport users live can, therefore, give transit operators a head start in deciding where to gather additional information or where to focus their prevention resources. If operators also have crime data available – at an area level (informative), at a compatible area level (preferred) or at the street address level (ideal) – they can combine it with information about public transit users' areas of residence to assist micro-level crime-prevention planning.

Methods and analysis

Study site

New York City (NYC) was chosen as the study site to examine the spatial concentration of vulnerable transit commuters (VTCs). It is a densely populated major US city with a high number of public transit users and a heterogeneous population in terms of the vulnerability characteristics identified previously. NYC's Metropolitan Transportation Authority (MTA) operates 24 hours a day. Its subway system is the seventh-largest in the world by annual subway ridership (MTA, n.d.*b*). On an average weekday, over 8.4 million trips are made on NYC subways (APTA, 2012). An additional 2.6 million trips are made on buses in NYC. The City is served by ferries and other rail services also. While not all of the five boroughs (or counties) that make up NYC have all of these systems, each has access to a public transportation system. In 2012 there were 468 subway stations with over 20 subway lines. NYC also had 235 local bus routes, 64 express bus routes and five Select Bus Services (MTA, n.d.*a*).

Data

The current study utilizes two area-level datasets: the ACS 2006–2010, a five-year average dataset (USCB, 2011), aggregated by census tract, and New York Police Department (NYPD) Compstat crime data for 2010, by precinct. Since the ACS is a part of the Census, selected respondents are required to participate in the survey. The response rate is above 95 per cent for all years (USCB, n.d.). No individual-level data are released to the public, to protect the confidentiality of respondents. To obtain population estimates through the ACS, the respondents are weighted at person and housing-unit levels. The current study focuses on information on commuters[2] aged 16 and older in NYC. To provide a backcloth for looking at areas with VTCs, NYPD crime data were also examined. NYPD crime data are only available by the police precinct (N=76). We focus our analysis on 'index crime' – murder, rape, robbery, felonious assault, burglary, grand larceny and grand larceny automobile – all defined using the NY Penal Code.

Analysis

The analysis included three steps. First, using the ACS dataset, we examined profiles of commuters by means of travel. The next step involved carrying out an exploratory Principal Component Analysis (PCA) in SPSS 20 to obtain the neighbourhood concentration of VTCs. PCA is frequently used to obtain an index of neighbourhood concentration in the public health field (Byrne et al., 2013) as well as in criminology (e.g. Yu et al., 2014; Regoeczi and Jarvis, 2011). Having obtained the PCA results, we also examined their relationship to variables related to the time respondents left for work and to occupation category.

The NYPD crime data were combined into two crime types – violent index crimes (murder, rape, robbery and felonious assault) and property index crimes (burglary, grand larceny and grand larceny automobile). While the current chapter relies on visual comparisons of index crime and neighbourhood concentrations of VTCs, it should be noted that we considered – and rejected – two types of more sophisticated statistical analyses (areal weighting and hierarchical linear modelling [HLM]) of the data.[3]

Results

Profiles of transit commuters

According to the ACS, there were over 3.6 million commuters aged 16 or older in NYC. The commuter population includes those who work from home. Table 12.1 sets out the profiles of NYC commuters by means of travel. Note that these data are based on reported frequencies and do not imply that we had access to individual-level information. The majority of the NYC commuters (55.3 per cent) reported that they used public transportation to commute to work. Use of a private vehicle, including being in a carpool (28.4 per cent), was the second most common means used to get to work. Female commuters were more likely to rely on public transit than males (59.3 per cent compared to 51.3 per cent). Nearly 50 per cent of non-Hispanic white commuters reported using public transit compared to over 60 per cent of black and Hispanic commuters. Younger commuters were more likely to take public transit than older commuters. Specifically, 63.9 per cent of commuters aged 16 to 24 took public transit to work, while just under half of commuters aged 55 and older (48.3 per cent) used this mode.

Table 12.1 Profile of commuters by means of travel to work in NYC

		PER CENT				
	Number	**Public transit**	**Private vehicle***	**Walking****	**Home Office**	**Taxi**
Commuters	3,627,850	55.3	28.4	10.0	3.8	2.3
Demographic information:						
Female	1,763,954	59.3	24.0	11.2	3.8	1.7
Male	1,877,451	51.3	32.5	10.5	1.8	3.9
White, non-Hispanic	1,360,007	48.3	29.8	13.0	5.5	3.5
Black	842,756	60.7	30.0	5.5	2.5	1.4
Hispanic	935,175	60.6	24.5	9.7	3.2	2.1
Asian	488,963	55.2	28.8	11.4	2.7	1.9
Age: 16 to 24	400,548	63.9	18.2	13.8	2.1	2.1
Age: 25 to 44	1,861,633	57.4	26.9	9.8	2.5	3.4
Age: 45 to 54	1,064,849	50.4	33.7	9.1	2.4	4.4
Age: 55 and older	608,042	48.3	32.8	10.4	2.6	4.6
Native: Citizen	1,962,574	53.7	28.5	10.8	2.7	4.3
Foreign born: Naturalized	867,930	52.5	34.9	7.8	1.6	3.1
Foreign born: Not naturalized	810,901	61.6	21.1	11.2	3.4	2.6
Economic Information:						
Below poverty	522,416	59.4	19.1	13.8	5.3	2.3
Income: Under $25,000	1,235,131	57.8	22.4	12.7	4.9	2.2
Income: $25,001 – $49,999	1,126,346	56.6	30.6	8.0	3.1	1.8
Income: $50,000 – $74,999	616,029	52.5	34.7	7.9	3.1	1.8
Income: $75,000 and more	663,571	50.3	30.0	11.3	3.9	4.5
Other Information:						
Own a vehicle	1,994,685	41.3	46.7	6.6	1.8	3.6
No vehicle available	1,624,005	72.3	6.1	14.3	4.1	3.2
Renter	2,273,876	61.8	19.9	12.0	3.7	2.6

Note: *'Private vehicle' includes carpool; ** 'Walking' includes about 0.7 per cent of commuters (N = 23,986) who biked to work.

Source: American Crime Survey, Five-year average from 2006–2010.

Since NYC has high populations of immigrants, we examined mode of travel by citizenship status. Similar percentages of native-born citizens (53.7 per cent) and naturalized citizens (52.5 per cent) took public transit to work compared to 61.6 per cent of non-naturalized immigrants. We also examined mode of travel by income. Almost 60 per cent of commuters with incomes below the poverty level commuted to work by public transit. Use of public transit seemed to decrease as income level increased: 57.8 per cent of commuters earning less than $25,000 a year used public transit as opposed to 50.3 per cent of those earning $75,000 or more. Lastly, 72.3 per cent of those without a vehicle relied on public transit compared to 41.3 per cent of those who had a vehicle available.

Neighbourhoods with VTCs

To discover the spatial distribution patterns of VTCs in NYC, we conducted a PCA[4] including only those using public transit to go to work. Based on theory and empirical research we selected potentially relevant variables from the 21 variables shown in Table 12.1. For example, we included female transit commuters since female patrons are usually linked to higher levels of fear of crime than male patrons. Of the four age groups, we retained the oldest group. For the income variable, we retained the lowest income-range group. Three ethnicity variables (non-Hispanic white, black and Asian) displayed low correlations with the remaining variables and were dropped from the PCA. 'Renters' was also dropped because it was related to more than one component. In the final stage of the PCA, two components, which explained 88 per cent of the seven remaining variables, were extracted at the census-tract level.

The PCA results showed there were largely two types of neighbourhoods characterized by different vulnerability among transit commuters. Some census tracts (i.e. neighbourhoods) had concentrations of transit commuters with the following characteristics: (1) aged 55 and older (.998), female (.905) and no vehicle available (.745) (OWNV), which explained 17.5 per cent of total variance, and (2) foreign-born immigrants (.865), low income (.902), Hispanic (.972) and below poverty (.925) (FBPH), which explained 70.6 per cent of total variance. It should be noted that some of the census tracts (N = 102) had high concentrations of both FBPH and OWNV transit commuters. These neighbourhoods are described separately in the analyses of commuting patterns and in the policy implications section. It is important to interpret carefully what these components signify. For example, the neighbourhoods with high OWNV do not include only older women transit commuters without access to a vehicle; instead, these census tracts tend to have clusters of transit commuters who are aged 55 and older, who are women, or who do not have a vehicle available. This latter group is likely to be transit captive to the extent that they also have limited access to a car pool or to the use of taxis.

Figure 12.1 presents the spatial distribution of all public transit commuters (Figure 12.1a) and the neighbourhood concentration of VTCs (Figure 12.1b OWNV and Figure 12.1c FBPH).[5] For ease of comparison among three variables, we displayed census tracts with concentrations of the target population defined as being above one standard deviation from the mean. Neighbourhoods with high concentrations of public transit commuters, in general, were found in parts of Manhattan, and some parts of the Bronx, Brooklyn and Queens (Figure 12.1a). Two patterns are apparent from Figures 12.1b and 12.1c. First, high-OWNV and high-FBPH areas were generally located in different parts of NYC. Concentrations of OWNV were found in Manhattan, whereas FBPH clustered in the lower

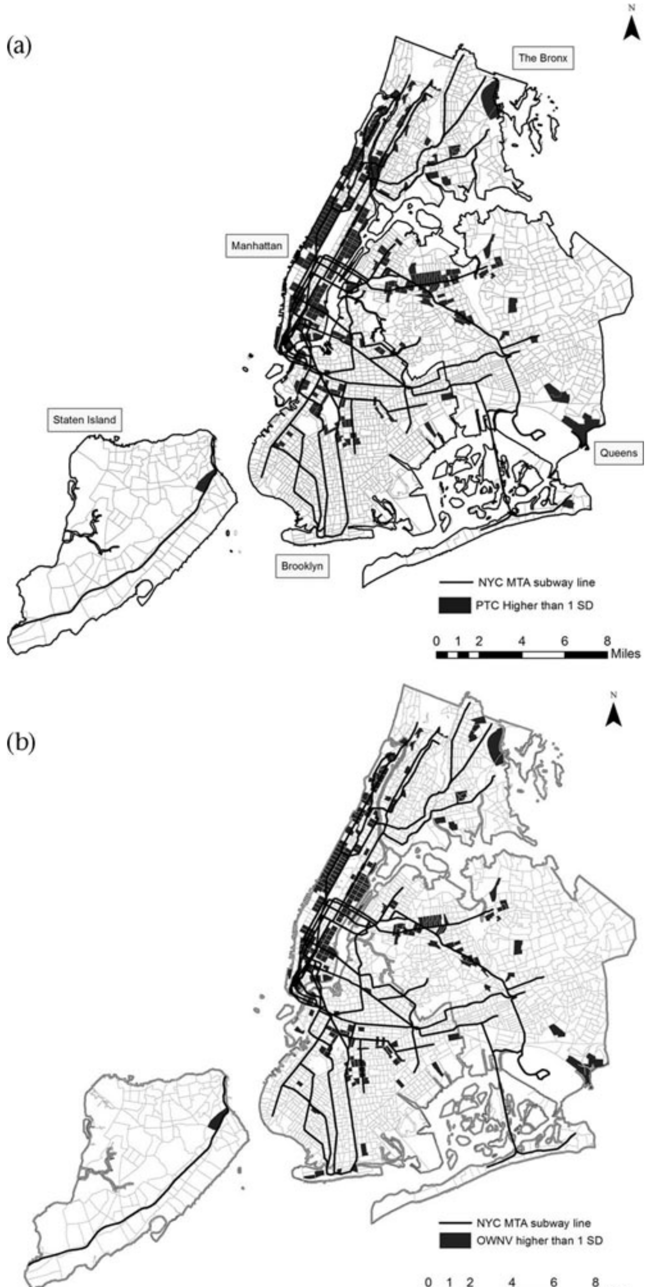


Figure 12.1 Continued

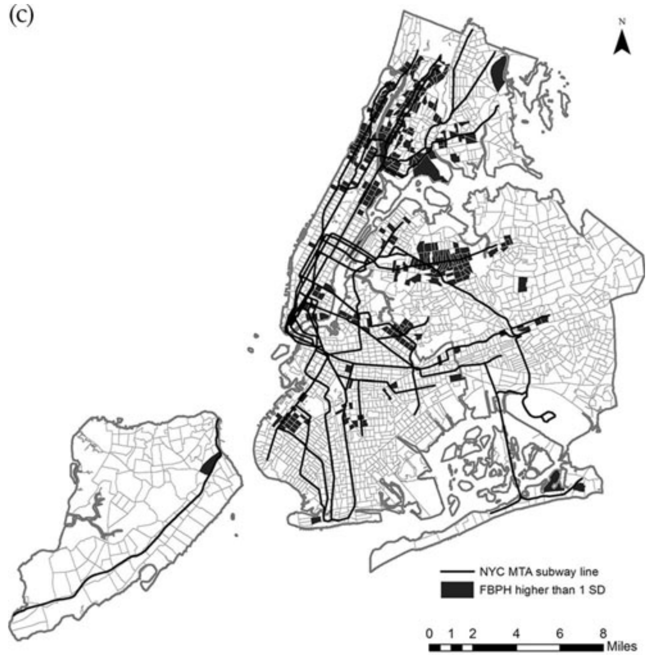


Figure 12.1 Spatial distribution of public transit commuters in NYC

Source: Based on ACS 2010: Five-year average by census track; (a) Spatial distribution of public transit commuters in NYC; (b) Spatial distribution of older, women and those with no vehicle available (OWNV) transit commuters in NYC; (c) Spatial distribution of foreign-born, poor and Hispanic (FBPH) transit commuters in NYC.

Bronx, parts of Brooklyn and the northern part of Queens. Both types of areas were found in upper Manhattan areas as well. Second, high-OWNV areas display somewhat similar patterns to spatial patterns of transit commuters as a whole: they were concentrated in mid- and upper-Manhattan areas, along with some smaller areas with high concentrations in the Bronx, Brooklyn and Queens. Some of the neighbourhoods with high FBPH in the north part of Queens overlapped with areas of high public transit commuters, in general.

Commuting patterns in neighbourhoods with VTCs

We also examined time leaving for work in areas with high concentrations of VTCs because it is a good indication of the environment these commuters encounter along the first part of their whole journey. Using the MTA's rush-hour schedule, we grouped time left for work into four categories (see Table 12.2) – midnight to 6:00am, 6:00am to 10:00am, 10:00am to 4:00pm, and 4:00pm to midnight. This information is separated by mode of commuting and by census tracts with high OWNV only (N=141), high FBPH only (N=181) or both high OWNV and FBPH components (N=102). Two things are apparent from Table 12.2. First, commuters in areas with high FBPH only, high OWNV only and combined high FBPH and OWNV were more likely to utilize public transit to get to work. In areas without high concentrations of VTCs (N=1,742), only 52 per cent of commuters used public transit to travel to work. However, for the census tracts with high FBPH or high OWNV, 62.9 per cent to 69 per cent of commuters relied on public transit to get to work. Second, transit commuters in areas with high FBPH only were more likely to leave for work from 4:00pm to midnight (6.8 per cent) and from midnight to 6:00am (9.8 per cent) when compared to areas with high OWNV only (3.0 per cent and 3.5 per cent, respectively). These findings suggest that neighbourhoods with high FBPH were more likely to have people leaving for work during non-conventional commuting times.[6]

We then examined occupation category by concentration of VTCs (see Table 12.3). There were big differences in occupation category by mode of travel. While 37 per cent of transit commuters in census tracts with high FBPH were employed in the service industry, only 28.5 per cent of commuters using private cars or taxis in the same neighbourhood were

Table 12.2 Time left for work by mode of travel by census tract in NYC (N = 2,166)

	Total (N)	**%**	**Midnight to 6am**	**6am to 10am**	**10am to 4pm**	**4pm to midnight**
Commuters	3,501,635	100.0	7.8	74.7	12.1	5.5
Public Transit Commuters (PTC)	1,697,466	57.4	7.1	76.5	11.5	4.9
Other Means of Commuting (OMC)	1,804,169	42.6	8.7	72.3	12.9	6.2
High FBPH* (N=181)						
PTC	164,963	67.9	9.8	68.2	15.2	6.8
OMC	219,695	32.1	11.5	65.9	14.8	7.9
High OWNV** (N=141)						
PTC	262,422	62.9	3.5	84.3	9.2	3.0
OMC	242,422	37.1	4.9	78.3	12.2	4.6
High FBPH* & OWNV** (N=102)						
PTC	181,072	68.9	7.6	73.3	13.2	6.0
OMC	193,341	31.1	9.3	66.9	17.4	6.4
Remaining census tracts (N = 1,742)						
PTC	1,089,009	52.4	7.4	77.0	10.8	4.8
OMC	1,148,711	47.6	8.9	72.5	12.3	6.3

Note: * 'FBPH' refers to the foreign-born, poor and Hispanic component; ** 'OWNV' refers to the older, female and non-vehicle owner component.

Source: American Crime Survey, Five-year average from 2006–2010.

Table 12.3 Occupation category by census tract in NYC (N = 2,166)

	Total	Management, business, science, and arts	Service	Sales and office	Natural resources, construction, and maintenance	Production, transportation and material moving
All census tracts (N=2,166)	100.0	37.7	21.8	24.6	6.6	9.2
Public Transit Commuters (PTC)	55.2	36.3	24.6	25.9	5.7	7.5
Other Means of Commuting (OMC)	44.8	39.3	18.5	23.1	7.7	11.3
High FBPH* (N=181)						
PTC	65.9	16.6	37.0	23.5	10.0	12.8
OMC	34.1	19.2	28.5	20.8	10.3	21.2
High OWNV** (N=141)						
PTC	59.3	60.4	11.7	23.2	1.9	2.9
OMC	40.7	61.6	10.8	20.4	2.6	4.6
High FBPH* & OWNV** (N=102)						
PTC	66.4	30.5	30.4	25.1	5.7	8.2
OMC	33.6	33.1	24.7	20.5	6.6	15.1
Remaining census tracts (N=1,742)						
PTC	50.5	35.5	24.0	27.3	5.8	7.4
OMC	49.5	38.2	18.1	24.2	8.5	11.0

Note: * 'FBPH' refers to the foreign-born, poor and Hispanic component; ** 'OWNV' refers to the older, female and non-vehicle owner component.

Source: American Crime Survey, Five-year average from 2006–2010.

employed in the service industry. A similar pattern was observed in areas in which both FBPH and OWNV were high (30.4 per cent compared to 24.7 per cent, respectively). On the other hand, areas with high OWNV had a majority of commuters in management, business, science and arts, with only around 11 per cent employed in the service industry regardless of their mode of commuting.

The distributions of crime incidents

The spatial distributions for index crimes in 2010 in NYC are presented in Figures 12.2 and 12.3. For ease of visual comparison, we overlaid census tracts with high concentrations of VTCs and police precincts with high index crime, defined by above 1.0 standard deviation.[7] The high violent index crimes were observed in the middle portion of the Bronx and for the east-central part of Brooklyn. Property index crimes show a different distribution pattern across precincts, with the highest concentrations found in

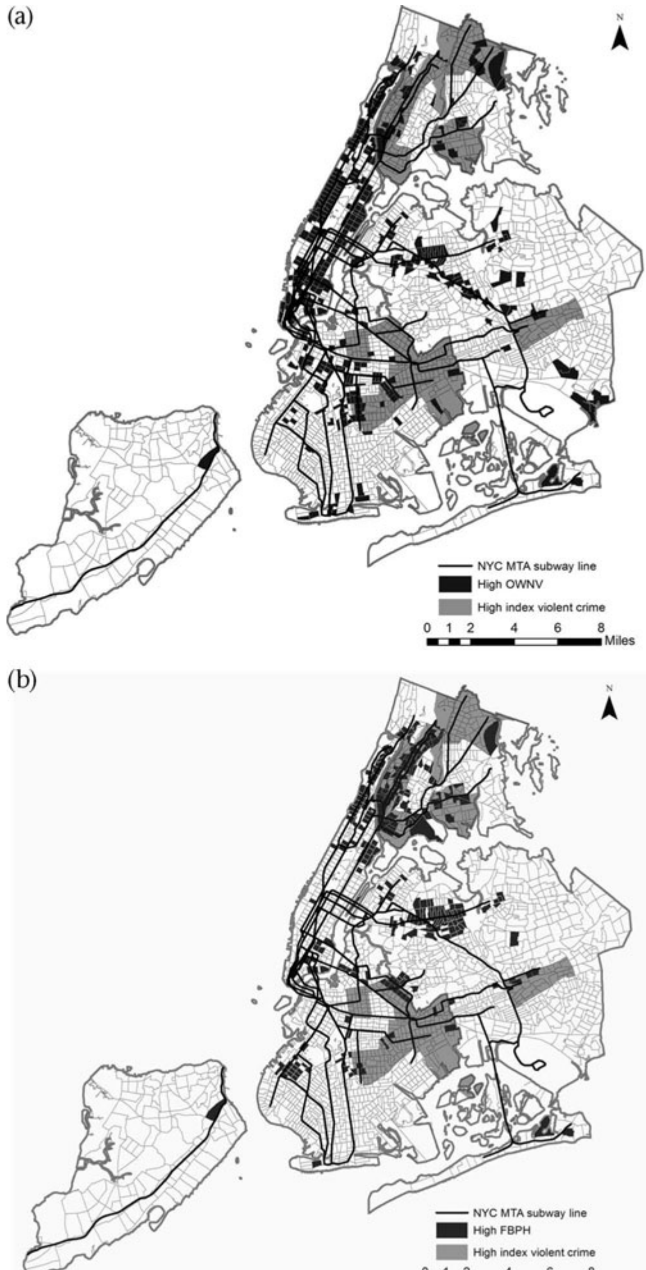


Figure 12.2 Spatial distribution of violent index crime and vulnerable transit riders in NYC

Source: Based on ACS 2010: Five-year average by census track; (a) Spatial distribution of violent index crime and OWNV in NYC, 2010; (b) Spatial distribution of violent index crime and FBPH in NYC, 2010.

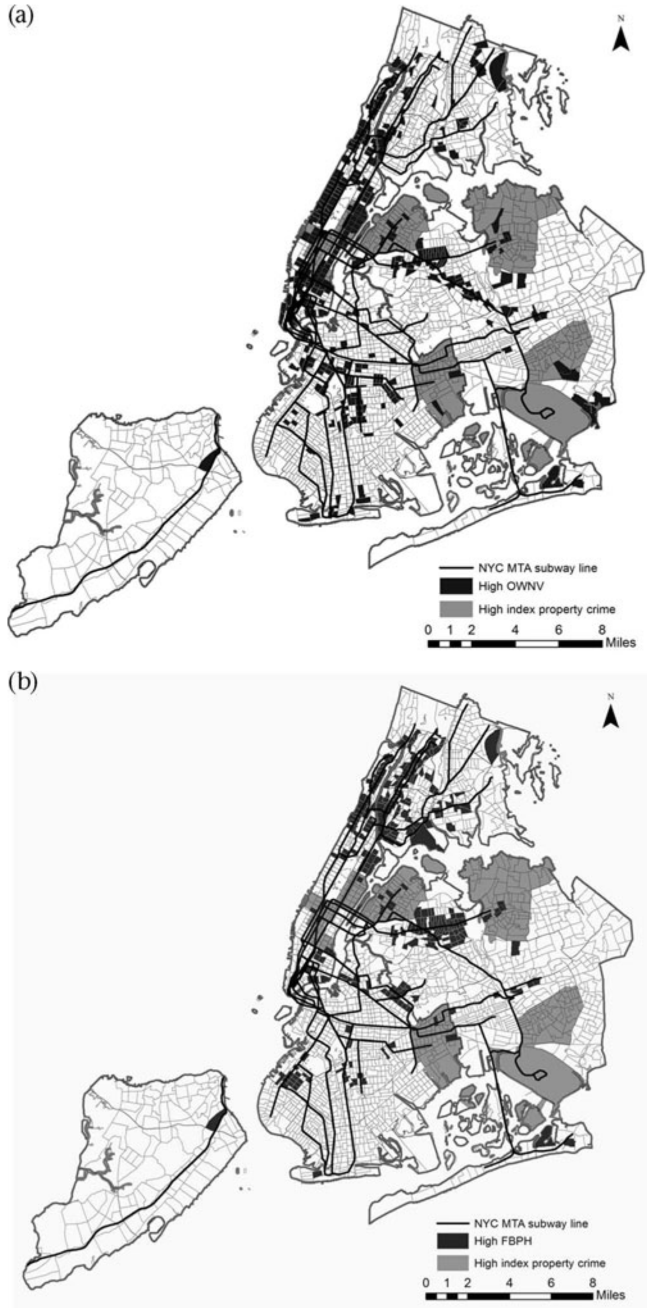


Figure 12.3 Spatial distribution of property index crime and vulnerable transit riders in NYC

Source: Based on ACS 2010: Five-year average by census track; (a) Spatial distribution of property index crime and OWNV in NYC, 2010; (b) Spatial distribution of property index crime and FBPH in NYC, 2010.

mid- and lower Manhattan, eastern Brooklyn, and both the northern and southern portions of Queens.

It is impossible to speculate about the crime level in any given census tract based on police-precinct crime level. Nevertheless, we can make some general observations about spatial overlap. The areas with high OWNV showed little spatial overlap with precincts with high concentrations of violent index crimes, although there was some overlap with precincts with high property index crime. The situation seems different for high-FBPH areas. In the Bronx, many neighbourhoods with high FBPH overlap with precincts with high violent index crimes, while in Queens and Brooklyn, only a few areas with high FBPH show this pattern. A few high FBPH were found in precincts with high property index crime.

Discussion of the results

This study found that VTCs are not a homogeneous group and they do not reside in the same areas of NYC, although some overlap was found. Of the two groups identified, high OWNVs were generally concentrated in the same areas in which other transit users live. Some of these areas – such as parts of Manhattan – have precincts with high levels of property index crime. The other group, high FBPHs, were concentrated in some of the high violent crime areas. Given that areas with different vulnerability roughly overlap with different types of crimes, it is probable that commuters in high-FBPH areas have a high probability directly or indirectly of encountering violent crime, with commuters in high-OWNV areas more likely to encounter property crime.

The areas with high concentrations of VTCs also showed different occupation patterns, as well as commuting-to-work times. For example, neighbourhoods with high OWNV reported higher levels of residents with management, business, science and arts jobs than were found in high-FBPH areas, in which service jobs were the most commonly reported occupation. In addition to this high percentage of service jobs, areas with high FBPH were more likely to have residents who commuted by any means during non-conventional commuting times. This suggests that commuters in these areas may face more personal security challenges than those in other areas since these areas overlap with high violent crime precincts; however, there is a need to analyse when and where crimes occur in these areas.

Although the ACS did not ask respondents how they get to their local transit stops or stations, it is likely that many walk since they may not own cars and there are numerous bus stops (over 15,000 [MTA, n.d.*a*]) and subway stations in NYC. Previous research (Ferrell et al., 2012) found that the people in the high-crime areas of greater San Francisco were less likely to walk to public transport than those in less crime-ridden areas. In terms of NYC, however, only further research can find out specific information about whether or how local crime conditions are related to transit use.

Policy implications of using ACS data

This research has demonstrated that ACS data can be effectively used to identify areas that warrant further analysis in terms of transit-commuter vulnerability, both in terms of crime and other social concerns. Areas identified in this study have high concentrations of public-transit-commuting residents with characteristics related to personal-security vulnerability, the primary focus of this study. Two main types of further research are needed in these areas: (1) site surveys (see Felson et al., 1990; Ceccato et al., 2013) – often referred to as safety audits if used to focus on gender-related concerns (see Smith, 2008); and (2) surveys of riders, nonusers and community leaders (see Boyle and Ouderkirk, 1993). Both of these can be used to examine these areas in more detail and assist transit operators in planning for security upgrades, specifically making physical changes to increase guardianship possibilities. Care must be used, however, since both theory and practice in situational crime prevention suggest the need for a crime-specific approach (Cornish and Clarke, 2008).

The PCA identified areas according to two main groupings (OWNV and FBPH), which, in their highest concentrations, were often not in the same census tracts – or even the same types of areas. This suggests that the security needs of transit commuters in these areas may be different from each other. In addition, the high-OWNV-only tracts often overlapped with areas with high levels of public transport use in general, while high-FBPH-only tracts tended only to overlap with this group in some parts of Manhattan and in northern Queens. These areal overlaps indicate that these VTCs may be less vulnerable than they might otherwise be. This could occur if areas with high usage are less risky for individual commuters either due to the relatively higher levels of guardianship provided by other transit commuters, or if transit operators provide more security in areas with a high volume of riders. Surveys in these areas should examine this possibility and concentrate crime prevention resources accordingly.

When focusing on the areas with high FBPH, it is important to consider the overall vulnerability characteristics of this group. For example, the FBPH clustering represents some of the most vulnerable groups in NYC – foreign born, the poor and Hispanic. While respondents in these areas are working, the areas do not tend to overlap geographically with high transit-use areas as a whole, except in parts of Manhattan and northern Queens. This geographic separation may be a reflection of, or a causal factor for, their social or even cultural isolation, factors that are beyond the scope of the present study. Transit surveys may not normally cover these types of issues, but questions about social isolation and barriers to the use of public transport (Department for Transport, 2012) can be added to see if residents in these high-FBPH areas are in fact more isolated than those in high-OWNV areas and to help determine whether this social isolation affects their use of public transit.

The findings on times leaving for work suggest that policymakers should note the different commuting patterns in the areas with high concentrations of VTCs. The focused ridership surveys could gather information about where off-hours commuting workers live and what routes they take to bus and subway stops. Special services might be made available for those who commute after dark when there are fewer people to act as natural guardians. The nonuser surveys should attempt to identify those who do not work due to local area crime levels or fear of crime victimization. The possibility that there may be increased revenues for public transit if more people were to use it could be an incentive for increasing security patrols or paratransit services, even though these can be costly. If ridership increased, so might feelings of safety in the local areas (Newton, 2004), perhaps due to the increased guardianship.

In addition to its application to factors related to area-resident vulnerability, the ACS may also be used for planning and assessing other transit services, such as the DASH bus services in Los Angeles that cost riders $0.50 or less.[8] These buses serve local neighbourhoods, providing service to the downtown area and regional transport links, and are designed to provide 'frequent, inexpensive, and convenient bus service' (LADOT, n.d.).

Limitations of the data

It is useful to note some of the limitations of the data used in this study. For example, the ACS provided some indications of who may be transit captive (i.e. who has no alternative means of travel); however, the ACS data did not provide information about past victimization or fear of crime among public transit commuters. Further studies in the identified areas are needed to gather these types of information. Also, the data do not permit an analysis of other vulnerable individuals who do not work. Transit operators concerned about increasing ridership would likely be interested in learning more about those who do not commute to work using public transit. The available crime figures for NYC had limited utility for comparisons with ACS data because the aggregation level of Compstat data was the precinct rather than the census tract or census block. Nevertheless, transport providers in other cities may be able to obtain crime data on a more micro level that will allow in-depth comparisons of crime and use of public transit.

NYC is different from other cities in terms of its residential density and the high number of commuters taking public transit. This study is not seeking necessarily to produce conclusions that can be generalized to other cities. Rather, the study was designed to explore how researchers and transit operators may be able to use existing data sources (the ACS and serious crimes reported to the police), gathered for their municipality, to explore the characteristics of VTCs in their city and determine how best to address local security concerns. Understanding the characteristics of VTCs and where they live is a first step in devising safety measures to improve the travel experiences of these commuters. Future studies should look at ways to understand this heterogeneous population and address their concerns in the most useful way.

Acknowledgements

We thank Vania Ceccato, Paul Ekblom, Nancy LaVigne, Anastasia Loukaitou-Sideris, Andrew Newton, Chris Sedelmaier, Jana Sochor and the other participants in the 'Safety in Transit Environments' seminar, Hailee LaBeth, and the three anonymous reviewers for their very helpful comments and advice. This research was supported in part by PSC CUNY Grant Category A, John Jay College of Criminal Justice.

Notes

1. 'Transit dependent' also describes this group (Levine and Wachs, 1986b), although 'captivity' may, in fact, connote the feelings these travellers sometimes experience.
2. Although commuters do not represent all transit users in NYC, they are an important group to study because of their relatively stable patterns of public transit use.
3. An often-used method – areal weighting – is particularly unsuitable for the current study given the size of police precincts and rapidly changing neighbourhood characteristics of NYC. Additionally, the sizes of census tracts are not uniform, and a small census tract does not mean that less crime has occurred there. Some census tracts with non-residential areas may be larger in size (e.g. a census tract with a park in it), yet have fewer residents. Another alternative for analysing information at both the census-tract and the police-precinct levels would be to use a family of multilevel modelling methods, e.g. using police precinct as level 2 and census tract as level 1 in a hierarchical linear model. This requires that there be a theoretical reason for seeing police precinct as an important grouping factor for census tracts in relation to transit commuters. We found no such theoretical support for this method.
4. Factor analysis was conducted using the extraction method of PCA with rotation of Oblimin with Kaiser Normalization in SPSS 20.
5. Subway routes are also shown on all maps.
6. The ACS data provide a population estimate, so no statistical analyses of differences are needed. Nevertheless, upon request, we conducted ANOVA tests that showed statistically significant differences by census tract groups on time left for work and occupation (with findings from these analyses available upon request from the authors).
7. We also looked at the spatial distribution patterns of robbery, felony assault and grand larceny separately in relation to VTCs. We found few differences in the

areas overlapping with the FBPH and OWNV areas when compared to the overall high index crime patterns. Maps of overall NYC crime patterns by crime type are available in Castelvecchi (2011).

8. We are grateful to Anastasia Loukaitou-Sideris for suggesting this potential use of the ACS.

References

American Public Transportation Association (APTA) (2007) *A Profile of Public Transportation Passenger Demographics and Travel Characteristics Reported in On-Board Surveys*. Washington, DC: APTA.

American Public Transportation Association (APTA). (2012) *Transit Ridership Report: Second Quarter 2012*. Washington, DC: APTA.

Bailey, L. (2004) *Aging Americans: Stranded Without Options*. Surface Transportation Policy Project. Washington, DC: American Public Transportation Association.

Bernasco, W. and Block, R. (2009) Where Offenders Choose to Attack: A Discrete Choice Model of Robberies in Chicago. *Criminology*, *47*(1), 93–130.

Bernasco, W. and Nieuwbeerta, P. (2005) How Do Residential Burglars Select Target Areas? A New Approach to the Analysis of Criminal Location Choice. *British Journal of Criminology*, *44*(3), 296–315.

Boyle, D. K. and Ouderkirk, P. E. (1993) Strategic Planning for Transit Agencies in Small Urbanized Areas. *Transportation Research Record*, *1402*, 25–27.

Brantingham, P. and Brantingham, P. (2008) Crime Pattern Theory. In: Wortley, R. and Mazerolle, L. (eds), *Environmental Criminology and Crime Analysis*. Cullompton, UK: Willan, 78–93.

Byrne, T., Prvu Bettger, J., Brusilovskiy, E., Wong, Y.-L., Metraux, S. and Salzer, M. S. (2013) Comparing Neighbourhoods of Adults with Serious Mental Illness and of the General Population: Research Implications. *Psychiatric Services*, *64*(8), 782–788.

Castelvecchi, D. (2011) New York City's 20 years of Declining Crime: Two Decades of New York Police Department Crime Statistics Mapped Precinct by Precinct. *Scientific American*, 4 August. http://www.scientificamerican.com/article.cfm?id=crime-new-york-city-20-years-declining-stats-maps, accessed 6 November 2013.

Ceccato, V. Uittenbogaard, A. and Bamzar, R. (2013) Security in Stockholm's Underground Stations: The Importance of Environmental Attributes and Context. *Security Journal*, *26*(1), 33–59.

Clarke, R. V. (ed.) (1992) *Situational Crime Prevention: Successful Case Studies*. Guilderland, NY: Harrow and Heston.

Clarke, R. V. and Cornish, D. B. (1985) Modeling Offenders' Decisions: A Framework for Research and Policy. In: Tonry, M. and Morris, N. (eds) *Crime and Justice: An Annual Review of Research*, Vol. 6. Chicago, IL: University of Chicago Press, 147–185.

Cohen, L. E. and Felson, M. (1979) Social Change and Crime Rates: A Routine Activity Approach. *American Sociological Review*, *44*(4), 588–608.

Cornish, D. B. and Clarke, R. V. (2008) The Rational Choice Perspective. In: Wortley, R. and Mazerolle, L. (eds), *Environmental Criminology and Crime Analysis*. Cullompton, UK: Willan, 21–47.

Crime Concern. (2004) *People's Perceptions of Personal Security and Their Concerns About Crime on Public Transport: Literature Review*. London, UK: Crime Concern and Department for Transport.

Department for Transport. (1999) *Personal Security Issues in Pedestrian Journeys*. London, UK: Department for Transport.

Department for Transport. (2002) *A Bulletin of Public Transport Statistics: Great Britain 2002*. London, UK: Department for Public Transport.
Department for Transport. (2012) *Understanding the Travel Needs of London's Diverse Communities: A Summary of Existing Research*. London, UK: Transport for London.
Eck, J. E. (1995) Examining Routine Activity Theory: A Review of Two Books. *Justice Quarterly*, *12*(4), 783–797.
Felson, M. (1986) Linking Criminal Choices, Routine Activities, Informal Control, and Criminal Outcomes. In: Cornish, D. B. and Clarke, R. V. (eds), *The Reasoning Criminal: Rational Choice Perspectives on Offending*. New York: Springer-Verlag, 117–128.
Felson, M. (1987) Routine Activity and Crime Prevention in the Developing Metropolis. *Criminology*, *25*(4), 911–931.
Felson, M., Dickman, D. E., Glenn, D. E., Kelly, L. M., Lambard, G. A., Maher, L., Nelson-Green, L. L., Ortega, C. S., Preiser, T. J., Rajendran, A., Ross, T. E., Tous, L. and Veil, J. M. (1990) Preventing Crime at Newark Subway Stations. *Security Journal*, *1*(3), 137–142.
Ferrell, C. E., Mathur, S., Meek, J. and Piven, M. (2012) *Neighbourhood Crime and Travel Behavior: An Investigation of the Influence of Neighbourhood Crime Rates on Mode Choice – Phase II*. San Jose, CA: Mineta Transportation Institute.
Fineman, M. A. (2008) The Vulnerable Subject: Anchoring Equality in the Human Condition. *Yale Journal of Law and Feminism*, *20*, 1–23.
Goldstein, H. (1979) Improving Policing: A Problem-Oriented Approach. *Crime and Delinquency*, *25*(2), 236–258.
Groff, E. R., Weisburd, D. and Yang, S.-M. (2010) Is It Important to Examine Crime Trends at a Local 'Micro' Level?: A Longitudinal Analysis of Street to Street Variability in Crime Trajectories. *Journal of Quantitative Criminology*, *26*(1), 7–32.
Knepper, P. (2009) How Situational Crime Prevention Contributes to Social Welfare. *Liverpool Law Review*, *30*(1), 57–75.
Levine, N. and Wachs, M. (1986a) Bus Crime in Los Angeles: I – Measuring the Incidence. *Transportation Research A*, *20*(4), 273–284.
Levine, N. and Wachs, M. (1986b) Bus Crime in Los Angeles: II – Victims and Public Impact. *Transportation Research A*, *20A*(4), 285–293.
Los Angeles Department of Transportation (LADOT) (n.d.) *LADOT Transit Services*. http://www.ladottransit.com/dash/, accessed 7 November 2013.
Loukaitou-Sideris, A. and Fink, C. (2009) Addressing Women's Fear of Victimisation in Transportation Settings: A Survey of U.S. Target Agencies. *Urban Affairs Review*, *44*(4), 554–587.
Maxson, P., Browne, C., Conway, R., Mather, A. and Ridgway, J. (2001) *Secure Transport Route-Manchester (Victoria) to Clitheroe Pilot*. London, UK: Department of the Environment, Transport and the Regions and Crime Concern.
Metropolitan Transportation Authority (n.d.*a*) *MTA.Info – Subway and Bus Ridership*. http://web.mta.info/nyct/facts/ridership/index.htm, accessed 30 July 2013.
Metropolitan Transportation Authority (n.d.b) *MTA.Info – Subways*. http://www.mta.info/nyct/facts/ffsubway.htm, accessed 6 October 2013.
Newton, A. D. (2004) *Crime and Disorder on Buses: Toward an Evidence Base for Effective Crime Prevention,* Doctoral dissertation. University of Liverpool, Liverpool, UK.
Patterson, A. H. (1985) Fear of Crime and Other Barriers to the Use of Public Transit by the Elderly. *Journal of Architectural Planning and Research*, *2*(4), 277–288.
Regoeczi, W. C. and Jarvis, J. P. (2011) Beyond the Social Production of Homicide Rates: Extending Social Disorganization Theory to Explain Homicide Case Outcomes. *Justice Quarterly*, *30*(6), 983–1014.

Roundtree, P. W. and Land, K. C. (1996) Perceived Risk versus Fear of Crime: Empirical Evidence of Conceptually Distinct Reactions in Survey Data. *Social Forces*, *74*(4), 1353–1376.

Smith, M. J. (2008) Addressing the Security Needs of Women Passengers on Public Transport. *Security Journal*, *21*(1–2), 117–133.

Smith, M. J. and Cornish, D. B. (eds) (2006) *Secure and Tranquil Travel: Preventing Crime and Disorder on Public Transport*. London: UCL – Jill Dando Institute of Crime Science.

Toronto Travel Commission (TTC), Metro Action Committee on Public Violence against Women and Children (METRAC), and Metro Toronto Police Force (MTPF) (1989) *Moving Forward: Making Transit Safer for Women*. Toronto, CAN: TTC, METRAC, and MTPF.

US Census Bureau (USCB) (2011) *2006–2010 American Community Survey*. http://www.census.gov/acs/www/about_the_survey/american_community_survey/, accessed 6 October 2013.

US Census Bureau (USCB) (2013) *American Community Survey: Information Guide*. Washington, DC: US Census Bureau. http://www.census.gov/acs/www/about_the_survey/acs_information_guide/, accessed 2 May 2014.

US Census Bureau (USCB) (n.d.) *Helping Your Make Informed Decisions*. Washington, DC: US Census Bureau. http://www.census.gov/acs/www/Downloads/QbyQfact/Housing09.pdf, accessed 6 October 2013.

Wiles, P. and Costello, A. (2000) *The 'Road to Nowhere': The Evidence for Traveling Criminals*. Home Office Research Study 207. London: Home Office.

Yu, D., Fang, C., Xue, D. and Yin, J. (2014) Assessing Urban Public Safety via Indicator-Based Evaluating Method: A Systemic View of Shanghai. *Social Indicators Research*, *117*(1), 89–104.

13

The Impact of Crime and Neighbourhood Enclosures on Travel Behaviour and Transport Patterns in South Africa

Trudi Smit, Karina Landman and Christoffel Venter

Introduction

On a macro level in South Africa, transit systems take on a complex role, as the relatively high crime rates and fear of crime in the country directly influence travel choices. This may translate to not only the avoidance of using certain transport modes but could also lead to an alteration of the physical environment of a neighbourhood, which can ultimately change transit systems at a meso-scale.

In order to contextualize the above statement, it is important to acknowledge that worldwide safety and security has become a growing concern (Body-Gendrot, 2012), and this also relates to safety and security in transit environments. Security, a complex and context-dependent concept, is generally defined in relation to an individual's risk of being a victim to crime and, very importantly, their perception of crime (Ceccato, 2012). Perception and fear of crime are similarly complex and cannot simply be described by 'mathematical functions of actual risk but are rather highly complex products of each individual's experiences, memories, and relations to space' (Koskela, 1997: 304). There are a number of factors influencing the fear of crime, including psychological factors that impact on perceptions of risk and danger, and which may be linked to specific environments or unsafe places, as well as reports by the media on the reputation of the urban fabric (Loukaitou-Sideris, 2012: 86). In addition, the fear of crime can be experienced differently on a range of levels. On the individual level it may be related to a personal experience; at the neighbourhood level it may be a function of people's experiences of where they live and visit; and finally, at a social macro level, it becomes generalized as a result of diffused anxieties generated by current global and social changes (Gerbner 1970, cited in Ceccato, 2012).

Any consideration of security in transit environments therefore needs to take into account the responses of residents to fear of crime, and furthermore how this influences the broader transit patterns of different groups within the city (Smith 2008). This is especially true in contexts such as South Africa, in which security concerns have become a dominant factor of social change. This is important, as 'cities cannot aim at being socially sustainable without considering their citizens' security seriously' (Ceccato 2012: 3). However, at the same time, attempts by specific groups or institutions to address security concerns should follow practices that have a wide sense of inclusion and fairness (ibid.).

While overall crime rates in South Africa have been falling since 2002, the levels of violent crimes are considered high by international standards (Burger, 2009). As a result, large sections of the population are fearful of crime (Mistry, 2004; Breetzke et al., 2014). According to Mistry (2004), after murder, respondents were most afraid of burglary with entry in areas in which they lived. The official crime statistics for South Africa for 2008/2009 and 2009/2010 indicate that house robberies[1] increased by 8 per cent nationally during both these time periods (Burger, 2009: 3; Burger et al., 2010: 4).

The relatively high crime rates in the country and especially the high levels of fear of crime have a direct influence on people's daily activities and travel choices in cities. A number of studies highlight the negative impact of crime and the fear of crime on the use of public transport in South Africa (including van der Reis, 1997; Page et al., 2001; and Stone, 2006). Crime is the first or second most frequently mentioned reason for not using public transport in metropolitan areas (Department of Transport, 2005). A consequence of this is a reduction in public transport use by those who can afford to travel by alternative means. At the same time, fear of crime results in changes to the built environment that further entrench non-use of public transport modes. A foremost example is the emergence of gated communities. The closing-off of neighbourhoods has become an increasing trend in South African cities on a meso-level, driven in large part by crime, the fear of crime and the perception that crime is increasing (Landman and Schönteich, 2002: 71; Lemanski, 2006: 397, Breetzke et al., 2014). Even if a household has never been a victim of crime, the fear of crime can be a good enough incentive to consider applying for or living within an enclosed neighbourhood (Landman, 2007a: 138).

There are broadly two types of gated communities in South Africa, namely enclosed neighbourhoods and security villages. Enclosed neighbourhoods refer to existing neighbourhoods that are closed off for security purposes, while security villages or developments include new private gated developments with a variety of land uses, including security estates, gated townhouse complexes and non-residential gated parks (Landman and Badenhorst, 2012). This chapter focuses on the former type of neighbourhood.

The objective of the chapter is to examine how the enclosure of residential neighbourhoods, as a response to crime and the fear of crime in South Africa, impacts on mobility and traffic patterns. While our focus is predominantly on short-term, local impacts, including changes in congestion and travel costs in the immediate vicinity of enclosures, we extend the discussion to more long-term issues related to environmental and social sustainability. We argue that neighbourhood enclosures may limit the use of public transport, leading to a complete dependence on private transport among residents. At the same time, these enclosures make it more difficult for others who are dependent on public transport to access the closed-off areas. We further argue that it is important to reconsider safety and security in transit environments from a more holistic approach which takes into consideration the entire journey. Given this, the chapter briefly discusses the whole-journey approach to establish the theoretical foundation for the discussion. Following this, it presents a brief outline of the method used to obtain the empirical data in two neighbourhoods in the City of Tshwane. The analysis then proceeds to investigate the impact of the neighbourhood closures on different groups in the city and the implications thereof in terms of travel behaviour and transport patterns both inside and outside these closed-off areas. Finally, we offer thoughts on the implications of the findings for practice and research.

The whole-journey approach

It is generally acknowledged that there is a relationship between crime and the built environment, that certain physical characteristics and the presence or absence of specific types of people can enhance or reduce opportunities for crime. In the 1980s and 1990s a number of environmental criminologists started to emphasize the spatial characteristics of crime and the role of crime locations (Loukaitou-Sideris et al., 2010). Approaches such as situational crime prevention are being applied to research, to understand and address crime in public transport (Smith and Clarke, 2000), with a few studies highlighting the importance of perceptions and the fear of crime related to the use of public transport (Smith and Clark, 2000; Cozens et al., 2004; Newton 2004; Smith 2008).

Investigating crime related to transport, however, requires one to distinguish between the various stages of the journey (Smith, 2008). As a result, Crime Concern in the UK developed the whole-journey approach to look at the entire journey and various stages of the trip (Maxson et al., 2000 cited in Smith 2008), including which parts are considered the most dangerous, as this has the greatest influence on people's choices of whether to undertake the journey or not (Crime Concern and Transport and Travel Research, 1997, cited in Smith, 2008). Utilizing a whole-journey approach offers the opportunity to investigate the entire journey from point of origin to destination and back again. Moreover, passengers may use more than one mode of transport, including walking, cycling, driving or taking a bus or taxi, to reach a transit node (stop or station), and therefore the particular physical features encountered during different stages of the journey can have an influence on fear of crime and patterns of victimization (Smith, 2008). The adoption of the whole-journey approach should therefore go beyond a restricted focus on public transport, to also consider private transport and the impact of crime reduction measures on both public and private transport use.

Applying a whole-journey approach may also assist explanations of the emergence of gated communities (and other attempts to privatize space) in response to the fear of crime. If the out-of-vehicle parts of a trip are considered to be the most vulnerable for crime, then it makes sense that the duration and length of this aspect would be kept to a minimum and that every effort would be made to maximize control over the environment in which these vulnerable segments occur. The natural tendency would thus be towards car use rather than public or non-motorized transport (which requires more walking and waiting), and ensuring that the start and end of trips take place exclusively in security-controlled (enclosed) areas. However, a result of this change may be unintended consequences for those who are more vulnerable and less mobile. Loukaitou-Sideris (2012) specifically argues for consideration of the impacts of particular interventions or responses to crime in the transit environment on those who may be most vulnerable, such as the elderly, woman or children. Part V of this book also highlights how gender, age and disability can influence perceptions of crime. It is within this context that the closure of existing neighbourhoods may start to play a role, influencing the travel behaviour of residents and visitors to these areas and impacting on the broader transport patterns outside these neighbourhoods in terms of greater congestion and reduced accessibility into the areas. The whole-journey approach can therefore also be linked to the right to be mobile and starts to highlight questions about this right: do crime reduction measures have an influence on patterns of congestion, impacting private transport users, but even more significantly, accessibility into closed-off areas for employment, due to a dependence on public transport, cycling and walking? This amounts to the externalization of security costs and raises issues of fairness.

Study area and method

This study focuses on enclosed neighbourhoods in the City of Tshwane, a sprawling metropolitan area that incorporates Pretoria, the capital of South Africa. The 2011 population of Tshwane was about 2.4 million people. Like other South African cities, Tshwane's spatial footprint reflects large income inequalities: most high-income households are located towards the east and south of the Central Business District (CBD), with poorer households located further towards the north and west (Figure 13.1).

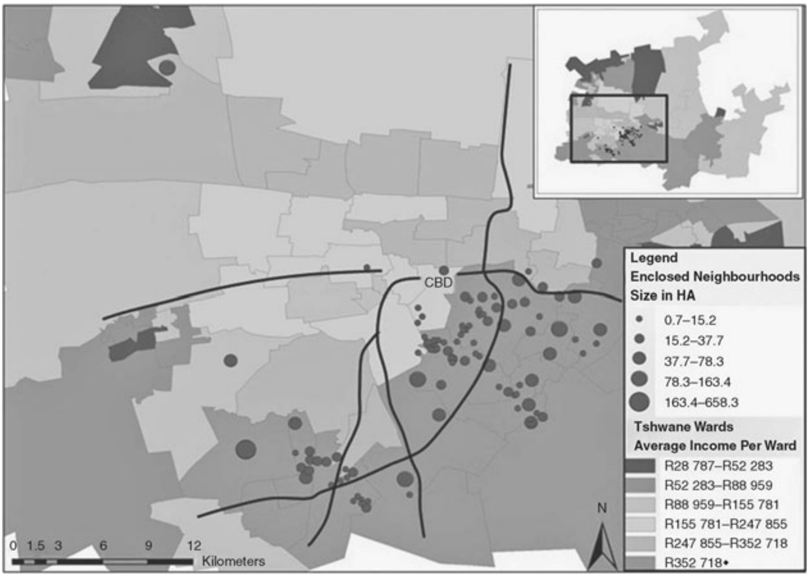


Figure 13.1 The location and extent of enclosed neighbourhoods in the City of Tshwane

Cities are permitted, in terms of the *Rationalisation of Local Government Affairs Act* (Act 10 of 1998), to consider applications to enclose existing neighbourhoods and to approve such applications, if the restriction of access enhances safety and security. This Act enables local councils to enforce access restrictions to existing neighbourhoods (for purposes of enhancing safety and security) and further allows the local council to determine the subsequent (non-refundable) administration or application fee. The exact number of applications received by the City of Tshwane is disputed. Various published by the City Planning, Development and Regional Services Department has put the number of applications received at between 99 and 120 (City of Tshwane, 2010: 183; City of Tshwane, 2003). An independent survey performed by the authors put the number of enclosed neighbourhoods at 71. These consist of any existing neighbourhood or section of an existing neighbourhood that has been closed off by means of gates, booms, walls, palisades or any other obstruction, whether manned or operated by remote control, and regardless of its legal status. The spatial distribution of the enclosed neighbourhoods shows clear clustering in the higher income areas of the City: about 92 per cent are situated in the eastern region and southern region of the City of Tshwane (Figure 13.1).

In terms of the city's spatial history both the eastern and southern regions mainly consist of former white residential suburbs (Horn, 2004: 319). Even though spatial segregation has been abolished in South Africa, and racial integration (desegregation) in these neighbourhoods is occurring, the income profiles of the former white areas and black areas have remained similar (Horn, 2002: 318). It therefore appears that neighbourhood enclosure is largely a phenomenon among the higher income groups, which are able to shoulder the financial burden of setting up and maintaining access control more easily.

An important component of this study was to gain greater insights into the practical implications of enclosed neighbourhoods, in particular in relation to patterns of access and mobility, and two neighbourhoods were selected as appropriate case study areas. The neighbourhoods were selected as examples of not only the typical issues associated with enclosure but also of the diversity of approaches that can be adopted towards enclosure, and are not necessarily intended to be representative of all enclosed neighbourhoods in the City of Tshwane.

Eldoraigne X18 Security Village is located in the southern region of the City of Tshwane. This region is characterized by medium- to high-income areas, high car ownership, well-established infrastructure, an extensive road network (City of Tshwane, 2007b), low-density suburban development and a lack of mixed zoning and diversity. These factors make public transport less viable; private vehicles and walking account for 98 per cent of all trips to work (GPMC, 2000). The only significant public transport service is provided by minibus-taxis, informal para-transit services operated using 16-seater vehicles. Eldoraigne X18 Security Village covers an area of approximately 44.5 hectares, bordering onto a metropolitan distributor road towards the east and onto an urban collection road towards the south. Both of these roads carry a considerable amount of traffic during the day and become congested during peak hours. The low-density residential character that once existed along the urban collector has made way for commercial activities and medium-density residential units. Eldoraigne X18 Security Village consists of some commercial facilities, but is predominantly residential, with approximately 376 households (260 detached residential dwellings and 116 townhouses). The enclosed neighbourhood contains two main entrances, one towards the south eastern corner and one towards the north western corner in which the neighbourhood borders onto a public primary school.

Lynnwood Glen Estate is located within the Lynnwood Glen neighbourhood in the eastern region of the City of Tshwane. This region contains the greatest number of enclosed neighbourhoods and has the City's highest income per capita (City of Tshwane, 2007a). As is the case with Eldoraigne X18 Security Village, Lynnwood Glen Estate is characterized by low-density, single-use residential zoning. Although the area is served by municipal bus services and minibus-taxi routes, the car is by far the dominant mode, capturing 94 per cent of all work trips (GPMC, 2000). Lynnwood Glen

Estate covers an area of approximately 85 hectares and borders onto a busy freeway towards the west and onto a metropolitan distributor towards the north. Contained within this neighbourhood are a public park/bird sanctuary, tennis club and some commercial properties. The neighbourhood has two main entrances, one towards the east and one towards the south of the enclosed neighbourhood, and consists of 336 households (266 single detached residential dwellings and 70 townhouses).

What sets the two case study areas apart is the different approaches they adopted towards enclosure. Lynwood Glen Estate opted for permanent closure of five out of seven former entrances to the neighbourhood, and 24-hour manned access control on the remaining two, thus creating an enclosure with a relatively impermeable edge. Eldoraigne X18 Security Village is an example of an approach with a much lighter touch. No streets are closed during peak commute periods, and during off-peak periods (between 7:15 to 16:30 and 17:45 to 6:15), three entrances are closed off with sliding gates, while the remaining two are operated as access-controlled entrances that require visitors only to stop, but not to identify themselves. The traffic impacts can be expected to be very different in the two cases, with the more restrictive closure in the case of Lynwood Glen Estate likely to generate much more significant impacts on residents and users, as will be shown later.

A travel survey was conducted to determine the travel behaviour of households in these enclosed neighbourhoods. A 10 per cent sample was drawn from the households in each area, randomly distributed within the neighbourhood, producing a sample size of 35 households per area. Apart from household demographic and vehicle ownership data, the survey collected detailed travel information from all persons (over the age of six) in the household, using standard travel diary procedures. Each respondent was asked to report all trips made over the preceding two weekdays, including the purpose, timing, origin, destination and mode used (for example, car, public transport, walk, cycle) for each trip.

Where possible, interviews were conducted with each household member, but in some cases proxy reporting by the head of household was accepted. The household head was also asked some further opinion-based questions regarding reasons for deciding to reside within the neighbourhood, reasons for applying to enclose the neighbourhoods, the respondent's involvement with the application procedure, the perceived impact of enclosed neighbourhoods on traffic congestion, and time spent entering and exiting the enclosed neighbourhood.

Whereas the travel diary data provided complete data on travel patterns of residents within the enclosed neighbourhoods, it did not allow quantification of the impacts of the enclosures. A before-after study design was needed for this purpose. Since no before-enclosure data were available, we opted to make use of a traffic simulation model[2] to simulate the counterfactual, namely the movements of vehicles without the enclosure. The model was calibrated using historic traffic studies and updated traffic counts, to ensure it was properly calibrated for the current year. The model further provided us with data on traffic movements *outside* the neighbourhoods, to enable quantification of the impacts on non-residents of each area.

Analysis

The analysis firstly examines residents' motivations for seeking enclosure of their neighbourhoods, as this allows us to link crime and crime perception to the transport outcomes under consideration. We then identified three distinct interest groups which might be affected by neighbourhood enclosures in different ways: residents, non-resident users of the surrounding road network, and non-resident pedestrians and public transport users who enter and leave the area on foot. The results for each are presented separately.

Main reasons for enclosure

Both applications to enclose Eldoraigne X18 Security Village and Lynnwood Glen Estate were approved and implemented in 2009. The opinion surveys conducted within these two enclosed neighbourhoods confirmed that safety and security was the main reason for enclosing the neighbourhoods (Figure 13.2). Yet, it is not clear whether these concerns correlate with *actual* crime figures. Unfortunately, recorded crime data for each area are not available from police statistics. However, applications submitted by residents at the time of enclosure seem to reflect different scenarios. On the one hand, residents acknowledged that the crime rates within Eldoraigne X18 Security Village were not alarmingly high, and that other advantages such as 'lower short term insurance premiums, higher selling prices for houses in the security area and safer streets for children and pedestrians' should be considered

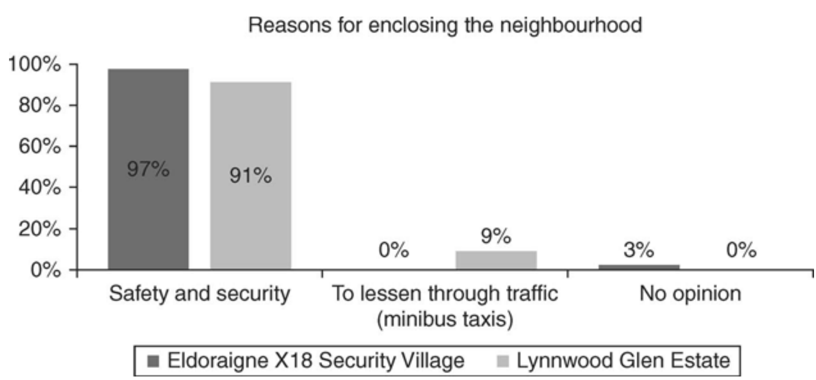


Figure 13.2 Households' reason for enclosing the neighbourhood

when reviewing an application for an enclosed neighbourhood. On the other hand, it was indicated by the residents in the application for enclosure that from 1998 to 2000, the crime rate within the Eldoraigne X18 Security Village increased by approximately 59 per cent per month. The application for Lynnwood Glen Estate likewise reported a rise in criminal activities and attempted crime during the period 2000 to 2004, with most criminal activities classified as either property-related crimes such as burglary and damage to property (85 per cent) or contact crimes such as aggravated assault and murder (15 per cent).

Approximately 9 per cent of respondents from Lynnwood Glen Estate indicated that the neighbourhood was enclosed to stop through-traffic or 'rat running' from occurring within their neighbourhood. 'Rat running' refers to traffic with an origin and destination outside the area, cutting through neighbourhood streets to avoid congested main routes, and is usually associated with decreased safety and excess speed. What is interesting is that rat running was associated with minibus taxis, underscoring the negative perception of public transport among non-users.

It is therefore clear that the search for greater security was the primary driver for the neighbourhood closure, as indicated by the majority of residents in both areas, and also used as motivation in the formal application to the municipality. Closing these neighbourhoods, however, does not only have an effect on the sense of security in the area but also influences the transport choices of residents inside and the general transport patterns outside.

View from the inside: Impacts on the travel behaviour and experiences of residents

The travel diaries indicated that within Eldoraigne the average household makes approximately nine trips per day, and the average trip distance is approximately eight kilometres and takes about 31 minutes to complete. In Lynnwood Glen Estate the average household makes approximately six trips per day, with an average trip distance and time of about sixteen kilometres and 24 minutes respectively (Table 13.1).

The use of different modes within the two enclosed neighbourhoods is very similar in the sense that the majority of trips conducted are by driving or being a passenger of a private vehicle. Except for the use of school buses by children living within Eldoraigne X18 Security Village, the use of public transport is very uncommon. In addition, few people opted to walk or cycle in the neighbourhoods (Table 13.2).

The picture that emerges is one of overwhelming car dependence within each neighbourhood. Unfortunately, no behavioural data are available to determine whether neighbourhood enclosures have led to any *increased* car usage. Given the car-oriented development patterns of the larger region and the paucity of public transport services, it is likely, however, that enclosures

Table 13.1 Travel behaviour of residents

	Eldoraigne X18 Security Village	Lynnwood Glen Estate
Average household size	**3.14**	**3.09**
Average number of cars per household	2.17	2.06
Average number of trips per day per household	9	6
Percentage work trips	28%	16%
Average travel time per trip	31 min	24 min
Average VKT per household per day	67.59 km	87.94 km
Average trip distance	8 km	16 km

Table 13.2 Modes of travel by residents

	Eldoraigne X18 Security Village	Lynnwood Glen Estate
Private vehicle	88%	97%
Walk or cycle	8%	3%
Bus/school bus	3%	0%
Minibus taxi	1%	0%
Total	**100%**	**100%**

just further entrench a car-based lifestyle orientation that was already extant.

Do neighbourhood enclosures affect the driving behaviour and travel costs of residents? The answer depends significantly on the approach taken towards enclosures. Few respondents from the two neighbourhoods (14% of respondents from Eldoraigne X18 Security Village and 6% of Lynnwood Glen Estate) believed that enclosures raise traffic congestion, while 91 per cent and 77 per cent of residents respectively believed their normal travel routes were not affected by the gates and booms. Approximately 20 per cent of respondents from Eldoraigne X18 Security Village and 6 per cent of respondents from Lynnwood Glen Estate mentioned that they sometimes wait in queues to enter or exit the neighbourhood. However, the majority of respondents from each area felt that safety gains outweigh the possible congestion that occurs at these entrances and exits. The findings suggest that the neighbourhood closures work very well for residents, and that residents are quite willing to offset the limited impact on their travel times and costs with improved security.

Respondents from Lynnwood Glen Estate perceive the time it takes to enter and exit the neighbourhood on average as much longer than those residing within Eldoraigne X18 Security Village. This is consistent with the more permeable edge in Eldoraigne, created by the opening of all entrances during peak hours. Visual observation confirmed that queue formation at entrances and exits was negligible during peak hours. In Lynnwood Glen

Estate, by contrast, the effect of the permanent closure of five out of seven entrances was much more severe, as evidenced by the build-up of long queues at entrances and exits during the morning and afternoon peaks.

The extent of these queues, and their effect on travel routes, distances and delay, was assessed using the traffic simulation model. The results showed that, over the course of a single afternoon peak period (the most congested part of the day) Lynnwood Glen street closures added a total of about 35 hours of additional travel time to the trips of all drivers in the area. This additional travel time is mostly caused by longer delays at junctions in and around the neighbourhood, for three reasons: firstly, external (i.e. non-resident) traffic that previously used the neighbourhood streets as short-cuts to bypass congested main roads (so-called rat runners), no longer do so, thereby increasing traffic volumes and delays on the main road; secondly, many residents can no longer use the nearest entrance/exit to their homes, thus incurring extra travel time due to additional route circuitry; and finally, more neighbourhood traffic is concentrated at fewer entrance/exit points to the neighbourhood, causing longer queues and longer delays both to residents and to non-residents using the surrounding main roads.

Table 13.3 shows that residents incur about a third of the additional delay overall, with each driver adding about a minute to their trip time on average. This represents a 35 per cent rise in travel times within the neighbourhood – a significant impact overall. The majority of this extra travel time occurs at congested junctions, rather than as a result of longer trips within the neighbourhood.

View from the outside: impacts on non-resident transport patterns, congestion and emissions

What are the traffic costs that street closures impose on non-resident car users on the surrounding road network? Simulation results suggest that these impacts are much larger than those imposed on residents.

The majority of the extra delay (68 per cent) is borne by non-resident drivers who experience extra congestion on the main roads around the neighbourhood (Table 13.3). The simulations suggested that a significant amount of rat running is avoided – between 10 per cent and 20 per cent

Table 13.3 Additional travel time due to street closures (Lynnwood Glen)

	Non-residents on external roads	**Residents on internal roads**
Total extra minutes of travel time (PM peak)	1,444 minutes	656 minutes
Average extra minutes per vehicle (PM peak)	44 seconds	61 seconds
% increase compared to no-closure scenario	+20%	+35%
% of travel time impact	68%	32%

Source: Own observations and traffic simulations of pre-closure traffic on neighbourhood streets is displaced back onto the main road,[3] indicating that these trips were heading elsewhere, and used the neighbourhood streets as short-cuts. The result is that each main road driver experiences an average increase of 44 seconds in their travel time on this section of the main road, which is about a 20 per cent rise attributable to the street closures. This sounds like little time, but to put it into context, standard traffic engineering practice holds that a 45-second increase in waiting time at a traffic signal will most likely render it unacceptable to most users and lead to severe dissatisfaction.

To get a sense of the energy and environmental costs of the street closures, the impacts on fuel consumption and emissions were estimated in comparison with the no-closure case. The results indicated that fuel consumption rose due to the extra delay and extra travel distances incurred, by a total of about 3 per cent. Carbon emissions rose by about 7 per cent due to the extra idling at queues. These figures are less severe than the travel time impacts reported above, as the extra fuel consumed while driving longer distances and while idling in queues is partly offset by fuel savings whilst moving at reduced speeds.

View from the ground: impacts on pedestrians and cyclists

A final group affected by neighbourhood enclosures consists of people entering or leaving the area on foot, as their access and shortest walking routes may be severely affected. Little commercial employment exists within each of the case study areas, but the surveys indicated that approximately 71 per cent of households within Eldoraigne X18 Security Village and 91 per cent of households in Lynnwood Glen Estate have a domestic worker in their employment, of whom 84 per cent and 69 per cent respectively commute to these households on a daily basis. These workers are mostly low-income women who commute by public transport and are dropped off on main roads on the peripheries of residential areas from where they walk to the limited access gates and then to their places of employment inside. Public transport is generally discouraged from entering the closed-off areas.

In the case of Lynnwood Glen, one additional pedestrian-only gate was allowed, to give access to a pedestrian bridge crossing an adjacent highway. Nevertheless, using pedestrian counts and shortest-path routings, it was estimated that the average pedestrian's walk trip increased by 400 meters after the street closures. Some of the worst-off faced trips that were 1,800 meters longer than before.

This raises issues of equity and fairness, both in relation to socio-economic group and gender. Longer walking distances imply extra travelling time, as well as increased discomfort and vulnerability linked to longer travelling times. Taking into consideration the whole-journey approach, increased travelling times may then increase vulnerability and the fear of crime during other parts of the journey, especially in poorer neighbourhoods, when these transport nodes are reached late at night. Existing studies in South Africa have indicated that the dislocation of the poor on the peripheries of South African cities results in long and costly commuting patterns, exposing travellers to increased opportunities for crime at transport nodes, especially when forced to travel in the dark or twilight periods or when walking or cycling early in the morning or late at night (Landman, 1999). It also points to an inconsistency between the practice of street closures and the promotion of public transport use, which sits high on government's agenda for mobility and environmental reasons. Given the fact that 400 meters is, in developed countries at least, considered the maximum desirable walking distance for public transport users, it is likely that the closure of some exit streets severely curtails the attractiveness of public transport use to residents and non-residents alike. This is perhaps reflected by the low occurrence of walk trips in residents' present travel patterns, as referred to earlier.

Conclusion

The discussion described how crime and the fear of crime in South Africa lead to changes in the physical environment through the establishment of neighbourhood closures. Closing off neighbourhoods also has an impact on the daily activity patterns and transport choices in and around these areas. However, the impacts of these enclosures are not equally distributed among different groups. The findings indicated that the impact on residents inside is minimal, and easily internalized by them.

The study highlighted the importance of the manner in which street closures are planned, in terms of their impacts on traffic, congestion and emissions. A more open, permeable approach that avoids closure of most entrances during peak periods minimizes the risk of significant disruption to street connectivity, traffic patterns and walkability, but this might come at the cost of slightly higher operating costs and reduced perceived security from crime. A stricter closure regime with more impermeable edges and few entrance/exit points that are under strict surveillance, such as one of the cases studied here, can generate significant avoidable traffic costs. The study showed that about two-thirds of the additional costs attributable to the street closures are passed on to non-residents, in the form of extra travel delay incurred while travelling on the surrounding street network. These costs can be significant on a per-person basis. Fuel consumption and emissions also increase, albeit more moderately, as a result of closures. These are essentially externality costs resulting from security responses for which non-residents are not compensated. One way to reduce the externality costs is to pay more attention to engineering upgrading of junctions and entrances/exits to reduce queuing and delays. This would further raise the costs of enclosing a neighbourhood, but would be fairer to all concerned, especially to non-residents and businesses located just outside the edge who bear a disproportionate share of the traffic costs.

The biggest concern, however, relates to the impact on pedestrians and cyclists and on those who are dependent on public transport. The mobility of these users may be severely affected by the closures. The study showed that the interests of pedestrians seem to be neglected when planning enclosed neighbourhoods, resulting in significantly increased walking distances that can reduce the attractiveness and use of public transport, and also increase their risk to crime as it may extend their travel times into the hours of darkness, thus increasing their vulnerability during other phases of the journey. This might be regressive as pedestrians and public transport users – at least in South Africa at present – tend to be predominantly low-income people – often women – who do not have another choice and are forced to make use of public transport. Ironically, by closing off public transport access in the short run, increased modal shift towards public transport is inhibited – which is exactly part of the solution to the high traffic delay externalities that residents might need to reduce in the long run. There is thus also an issue of intergenerational equity, as future sustainable transport options are foreclosed by the actions of present generations. Clearly the security edge should be more permeable for pedestrians than for vehicles, and a good case can be made for the provision of more pedestrian-only accesses, as is advocated in some of the planning policies for access restriction or gated communities.

The inconsistency between the practice of street closures and the promotion of public transport, as well as the emphasis in South Africa on promoting greater integration and accessibility between neighbourhoods and different parts of the city, raises questions about the responsibility for ensuring a safe journey for all and the role of the state in relation to this. The state has an important role in ensuring the safety of those using public transport during all phases of the journey. The whole-journey approach involves addressing crime problems encountered by commuters during any part of the journey, whether travelling by foot, waiting at a stop or station, or travelling on a mode of public transport (Smith and Cornish, 2006). The whole-journey approach therefore implies the implementation of targeted crime reduction initiatives aimed at a range of crime types experienced in different situations or specific contexts throughout the public and private transport system (Kruger and Landman, 2007).

The challenge lies, evidently, in ensuring a safe journey even as different public transport services, together with segmented urban spaces, with differentiated levels of crime and risk of crime, co-exist. This is especially important given the impact of high levels of fear of crime on the use of specific modes of transport in South Africa. Given this, the concept of a whole-journey approach needs to be reinterpreted in terms of various country contexts and their specific challenges, and will therefore require a reconsideration of crime prevention strategies that over-emphasizes target hardening and access control to ensure that these strategies are beneficial to all urban residents and accommodate various transport and safety needs. Given this, future research should be context specific and investigate the specific crimes that occur around enclosed areas and the patterns of victimization, including how they influence different people and transport users, such as woman, children or the elderly, who may be more vulnerable to crime. In addition, it should also investigate the impact of extended travel times to increased vulnerability during other phases of the journey.

Through the results gained, the relationship and the importance of transport planning and land use management are highlighted, as well as how transit safety can be influenced by changes in the urban landscape at a meso-scale. In addition, the study also indicates the relationship between transit systems and safety at the neighbourhood level and within the wider city context. The findings are therefore not only relevant for criminologists to consider the wider impact of specific crime prevention measures but also for engineers and urban planners, who should similarly be aware how the modification of street patterns can influence travel behaviour and transport patterns and most importantly, affect the safety of other urban users such as pedestrians.

Acknowledgements

The authors would like to acknowledge two students, Erich Hansen and Gys-Reinard Rautenbach, who contributed to the gathering and modelling of traffic data. The authors may be contacted for more information on the simulation model and its results. This research was financially supported by the South African Department of Transport through the Sustainable Public Transport and Sport Project, implemented by the United Nations Development Programme (UNDP), and funded by the Global Environment Facility (GEF).

Notes

1. In line with international usage the term ‘robbery’ refers to theft with the use of force or threat of force. ‘House robbery’ is a term formulated by the South African Police Service (SAPS) to describe a robbery taking place in a residential premise.
2. The simulation model used a computerized microsimulation package, CORSIM, which randomly generates a vehicle population in accordance with user-specified traffic data inputs, and simulates its movements across a specified network using standard traffic flow theory and vehicle interaction models. More information on the package, its assumptions and models is available in Holm et al., 2007.
3. The simulation allows modelled drivers to choose their own routes (taking possible road closures into account) in a behaviourally realistic manner. Since the total number of trips is kept constant in the with- and without closure cases, it is possible

to identify the non-resident vehicles that, in the with-closure case, are shifted away from neighbourhood streets and onto surrounding streets, by comparing the two scenarios. These non-resident trips are by definition rat-running trips.

References

Body-Gendrot, S. (2012) *Globalisation, Fear and Insecurity: The Challenges for Cities North and South*. Basingstoke: Palgrave Macmillan.

Bolstad, P. (2005) *GIS Fundamentals: A First Text on Geographic Information Systems* (Second edition. White Bear Lake, Minnesota: Eider Press.

Breetzke, G. D., Landman, K. and Cohn, E. (2014) Is It Safer behind the Gates? Crime and Gated Communities in South Africa. *Journal of Housing and the Built Environment, 29*, 123–139.

Burger, J. (2009) Worrying Trends: The Official 2008/09 South African Crime Statistics. *South African Crime Quarterly, 30*, 3–11.

Burger, J., Gould, C. and Newham, G. (2010) The State of Crime in South Africa: An Analysis of the SAPS Crime Statistics for 2009/10. *South African Crime Quarterly, 34*, 3–12.

Ceccato, V. (2012) The Urban Fabric of Crime and Fear. In: Ceccato, V. (ed.), *The Urban Fabric of Crime and Fear*. London: Springer, 3–33.

City of Tshwane (2003) *Report of the Strategic Executive Officer: Housing, City Planning and Environmental Management: Policy: Restriction of Access to Public Places*. Pretoria: Housing, City Planning and Environmental Management Department (City Planning Division).

City of Tshwane (2007a) *Tshwane Regional Spatial Development Framework: Eastern Region*. Pretoria: City of Tshwane.

City of Tshwane (2007b) *Tshwane Regional Spatial Development Framework: Southern Region*. Pretoria: City of Tshwane.

City of Tshwane (2010) *Report on the Status Quo of Restriction of Access (Gated Communities) to Public Places for Safety and Security Purposes in the City of Tshwane*. Pretoria: City Planning, Development and Regional Services Department (City Planning and Development Division).

Cozens, P., Neale, R., Hillier, D. and Whitaker, J. (2004) Tackling Crime and the Fear of Crime While Waiting at Britain's Railway Stations. *Journal of Public Transportation, 7*(3), 23–41.

Department of Transport (2005) *National Household Travel Survey 2003: Technical Report*. Pretoria: Government of South Africa.

Gauteng Provincial Legislature (1998) *Rationalisation of Local Government Affairs Act, 1998 Act No. 10 of 1998*. Gauteng Provincial Legislature.

Greater Pretoria Metropolitan Council (GPMC) (2000) *Household Travel Survey 1998/99: Final Report*. Pretoria: Greater Pretoria Metropolitan Council.

Holm, P., Tomich, D., Sloboden, J. and Lowrance, C. (2007) *Traffic Analysis Toolbox Volume IV: Guidelines for Applying CORSIM Microsimulation Modeling Software*. Report FHWA-HOP-07–079. Washington, DC: Federal Highway Administration.

Horn, A. C. (2002) Update: Segregation and Desegregation in Pretoria, South Africa. In: Kim, I., Nam, Y. and Choi, J. (eds) *Diversity of Urban Development and Urban Life*. Seoul: Seoul National University Press, 309–323.

Horn, A. C. (2004) Urban Transformation and Changing Attitudes in Pretoria-Tshwane, South Africa. In: Pacione, M. (ed.) *Changing Cities: International Perspectives*. Glasgow: IGU Urban Commission and Strathclyde University Publishing, 319–328.

Koskela, H. (1997) Bold Walk and Breakings: Woman's Spatial Confidence versus the Fear of Violence. *Gender, Place and Culture*, *4*(3), 301–319.

Kruger, T. and Landman, K. (2007) Crime and Public Transport – Designing a Safer Journey. Paper presented at the *26th Annual Southern African Transport Conference*, 9–12 July.

Landman, K. (2006) Privatising Public Space in Post-Apartheid South African Cities through Neighbourhood Enclosures. *GeoJournal, 66*, 133–146.

Landman, K. (2007a) Exploring the Impact of Gated Communities on Social and Spatial Justice and Its Relation to Restorative Justice and Peace-Building in South Africa. *Acta Juridica, 7*, 134–155.

Landman, K. (2007b) The Storm That Rocks The Boat: The Systemic Impact of Gated Communities on Urban Sustainability, Cybergeo: *European Journal of Geography* [Online], Topics, Systemic impacts and sustainability of gated enclaves in the City, Pretoria, South Africa, February.28–March 3, 2005, document 399, Available Online http://cybergeo.revues.org/11133, accessed 1 April 2015.

Landman, K. (2009) Boundaries, Bars and Barricades: Reconsidering Two Approaches to Crime Prevention in the Built Environment. *Journal of Architectural and Planning Research*, *26*(3), 213–227.

Landman, K. and Badenhorst, W. (2012) *Gated Communities and Spatial Transformation in Greater Johannesburg*, Johannesburg, SA. WITS Publication

Landman, K. and Schönteich, M. (2002) Urban Fortresses: Gated Communities as a Reaction to Crime. *African Security Review*, *11*(4), 71–85.

Lemanski, C. (2006) Spaces of Exclusivity or Connection? Linkages between a Gated Community and Its Poorer Neighbour in a Cape Town Master Plan Development. *Urban Studies*, *43*(2), 397–420.

Loukaitou-Sideris, A. (2012) Safe on the Move: The Importance of the Built Environment. In: Ceccato, V. (ed.) *The Urban Fabric of Crime and Fear*. London: Springer, 85–110.

Loukaitou-Sideris, A., Liggett, R., Iseki, H. and Thurlow, W. (2001) Measuring the Effects of the Built Environment on Bus Stop Crime. *Environment and Planning B: Planning and Design*, *28*, 255–280.

Mistry, D. (2004) Falling Crime, Rising Fear. *Crime Quarterly*, *8*, 17–24.

Newton, A. D. (2004) Crime on Public Transport: 'Static' and 'Non-Static' (Moving) Crime Events. *Western Criminology Review, 5*(3), 25–42.

Page, O., Moeketsi, P., Schurink, W., Molefe, L. and Bruce, D. (2001) *Crime and Crime Prevention on Public Transport*. Pretoria: UNISA Press.

Saunders, M., Lewis, P. and Thornhill, A. (2007) *Research Methods for Business Students*, Fourth edition. Harlow: Pearson Education Limited.

Smith, M. J. (2008) Addressing the Security Needs of Woman Passengers on Public Transport. *Security Journal*, *21*, 117–133.

Smith, M. J. and Clarke, R. V. (2000) Crime and Public Transport. *Crime and Justice – A Review of Research*, 27, 169–233.

Smith, M. J. and Cornish, D. B. (2006) *Secure and Tranquil Travel: Preventing Crime and Disorder on Public Transport, London, UK,* Jill Dando Institute of Crime Science, University College London.

Van der Reis, P. (1997) Transportation Surveys Among Illiterate and Semiliterate Households in South Africa, Conference on Transport Surveys: Raising the Standard, Grainau, Germany, E-C008.

14

Crime in and around Metro Transit Stations: Exploring the Utility of Opportunity Theories of Crime

Nancy La Vigne

Introduction

The role that transit hubs play in relation to crime has long been a topic of interest in criminology and public planning. Researchers and planners alike have explored the impact of rail development on crime, assessing the degree to which new transit stations generate opportunities for various types of criminal acts. Similarly, researchers have sought to understand the distribution and types of crimes that occur within and surrounding existing transit hubs, examining crime in relation to demographic and land use characteristics and drawing conclusions about how these factors are correlated with – or predictive of – both transit crime and that which occurs in the immediate vicinity of transit hubs. Only a few studies, however, examine the environmental features of subway transit stations to determine the degree to which they present or close off opportunities for offending. Among those, two studies (La Vigne, 1996; La Vigne and Lowry, 2011) examine crime in and around Washington Area Transit Authority (WMATA) commuter light rail (Metro) stations.

Findings from the earlier study (La Vigne, 1996) indicate that environmental features consistent with opportunity theories of crime were likely instrumental in Metro's efforts to prevent crime across a variety of offence types. However, much of that success relied on Metro's built-in design and crime prevention features, which afford a high degree of surveillance, and its ability to control access to the rail system by requiring the use of a purchased fare card upon both entrance to and exit from the system. By contrast, the environment of the above-ground property in which Metro stations are located was not as closely controlled or monitored, and presented a host of challenges with regard to access control and surveillance, particularly in the parking facilities in which the vast majority of serious crimes on Metro property were occurring. Efforts to prevent crime in these parking facilities, while guided by environmental design principles, were compromised due to resource constraints and thus were found to be ineffective (La Vigne and Lowry, 2011). Nonetheless, much can be learned from both the successes and the failures of Metro's efforts to control crime on its premises in the context of criminological theory. Specifically, this chapter aims to answer the following overarching research question: are criminological theories of place and offender decision-making useful in predicting the impact of crime prevention features in the context of crime in and around subway transit stations?

This chapter focuses on meso settings in that, while each transit hub has its own criminogenic properties, it is housed within the larger city context, particularly because parking facilities are located above ground in less controlled environments that theoretically are more amenable to criminal opportunities. Transit systems, however, are also composed of stations, each of which is its own micro-level setting consisting of nodes. Both micro- and meso-level contexts are informed by theories underlying the incidence and prevalence of crime in and around transit hub. This chapter begins by describing those theories, followed by an exploration of what can be learned from past subway transit crime studies. A description of the findings of the two Metro studies follows, comparing and contrasting the factors associated with crime occurring in Metro's rail and parking areas, and describing how those findings comport with theory. Key findings are synthesized and common themes are discussed with a focus on implications for policy and practice.

Theoretical framework: opportunity theories of crime

The basis for understanding and assessing crime changes and prevention efforts is grounded in opportunity theories of crime, such as rational choice perspective (Cornish and Clarke, 1986) and routine activities theory (Cohen and Felson, 1979), and frameworks for their practical application, such as Crime Prevention Through Environmental Design (Jeffery, 1971, 1977), Situational Crime Prevention (Clarke, 1992, 1997) and environmental criminology (Brantingham and Brantingham, 1981, 1995). These theories and frameworks are described in Chapter 2 of this volume, and therefore are not described in detail here. Together, they suggest that the design and management of environments can influence offender decision-making. Three of the most common design and management features that are employed to enhance security are target hardening, access control and surveillance. Target hardening refers to making locks, windows and entryways more impenetrable. Theoretically, target hardening will deter offenders who perceive the effort to gain access too great, and either move on to an easier target or refrain from that offending opportunity altogether. Access control is often enhanced through target hardening, for example, stronger gates, but can also be bolstered through the placement of staff, such as ticket takers or doormen, or the use of technology through radio-frequency-enabled access cards or credit cards. Enhancing access control through additional staff both increases an offender's perceived effort to gain access to offending opportunities and increases risk of detection. Surveillance represents a broader category of crime control and has multiple components, often categorized by type of surveillance – natural surveillance, employee surveillance and formal surveillance (Clarke, 1992; 1997).

Natural surveillance features are perhaps most closely aligned with Crime prevention through environmental design (CPTED) principles, as they rely heavily on design features to increase the ability of anyone to view or identify offenders and crimes in progress. It is therefore enhanced through brighter lights (Ramsey and Newton, 1991; Poyner and Webb, 1993; Pease, 1999; Welsh and Farrington, 2007) physical maintenance and the removal of visual obstructions, such as signage covering shop windows and shrubs affording hiding places (La Vigne, 1993). Enhancements to improve the perceived safety of an environment and therefore encourage more legitimate users to make use of its amenities can also enhance natural surveillance by putting 'more eyes on the street' (Jacobs, 1961).

Surveillance can also be enhanced by the addition of employees, or 'place managers', who by nature of their jobs are in a position to detect and prevent crimes from occurring (Felson, 1995). Such managers may include store clerks, maintenance personnel and parking attendants. Employee surveillance can be enhanced by positioning employees strategically so they are more likely to be able to detect attempted criminal acts and by increasing the number of employees during particular periods of vulnerability.

Formal surveillance is represented by trained security personnel, such as security guards and law enforcement officers. Technology can also serve as stand in for formal surveillance staff, affording a more expansive view of potential criminal activity through the use of cameras. Indeed, cameras that are routinely monitored by security staff can increase the certainty of apprehension by intervening on crimes in progress (Goold, 2004; Levesley and Martin, 2005) or by capturing evidence by video that can aid in investigations and prosecutions (Chainey, 2000; Gill and Hemming, 2004; Ratcliffe 2006). Moreover, cameras may enhance natural surveillance by increasing perceptions of safety among legitimate users of public areas monitored by cameras, encouraging people to frequent places they may have previously avoided (Gill, 2006; Ratcliffe, 2006). As more people use these spaces for pro-social purposes, their presence may serve as a further deterrent to crime, providing natural surveillance as informal guardians and potential witnesses (Welsh and Farrington, 2002, 2004).

The preventive measures implicit in the theories described above – from access control, to physical maintenance, to designs that allow for increased surveillance – have been applied to many subway transit systems. While in some cases these features are designed into the system at the outset, most of those documented in the literature are added to the environment post design to enhance security.

Applying environmental criminology to transit crime

The literature on transit crime can be divided into two broad categories: studies that explore relationships between the location of subway stations and the crime that occurs in and around them, and evaluative research of efforts to prevent transit-related crime. Many examples of this are found in this volume and elsewhere (Smith and Clark, 2000; Newton, 2014), and therefore not reviewed in detail here. This chapter focuses on how environmental design and other tactics can reduce crime on subway transit systems. Before examining the evaluative literature on transit crime prevention, however, it is critical to develop a clear understanding of transit environments as opportunities for crime. For the purposes of this chapter, a transit hub is considered as a station, or node, on a light rail system designed for inter-city and commuter use. The station is composed of (1) areas behind the entry and exit gates ('rail areas'), consisting of station mezzanine areas, platforms and trains; and (2) the station property outside the entry and exit gates, which may include parking facilities ('parking areas').

Brantingham and Brantingham (1995) define transit hubs as crime generators, producing both high crime counts and crime rates through the convening of large numbers of people for reasons other than committing crime. In other words, offenders do not arrive at a subway station with the intention of committing crime, but take advantage of the opportunity fostered by high volumes of people congregating there. These opportunities may be expanded by the context of the transit system overall, in that its mere existence may enhance potential offenders' awareness spaces, generating crime that may not have existed otherwise.

The parking facilities associated with transit hubs, however, may serve more as attractors of crime. Parking facilities have been documented as crime attractors due to the wide array of available targets, a lack of surveillance, proximity to major thoroughfares for easy escape, the access afforded to pedestrians (Mayhew and Braun, 2004) and the fact that they tend to be public facilities (Smith, 1996). Commuter parking facilities – typically those associated with light rate systems – are especially vulnerable to crime because users park their cars and leave them unattended for long periods of time; such facilities have particularly high rates of car crime (Clarke, 2002; Clarke and Mayhew, 1998).

Transit hubs consist of both rail and parking areas, and present multiple opportunities for crime, with each inviting different crime problems. Theoretically, we would expect more petty offences, such as fare evasion, theft and pickpocketing to occur in rail areas, at least during peak hours, given the large volume of people entering and exiting the system. Parking areas, which are more accessible to potential offenders, would attract offenders aiming to steal cars and/or their valuable contents. Each may therefore require alternative crime prevention strategies. Conversely, if similar crimes occur in both areas, such as assaults and robberies during off-peak hours, they may respond to a similar crime prevention tactic. A third hypothesis is that for both settings, the types of criminal opportunities offered are varied enough that the most effective strategies will take a comprehensive holistic approach to crime prevention.

Given the unique differences in environment between rail property and parking facilities, the review of prevention efforts associated with transit crime described below is divided by location. Both sets of evaluations, however, have largely focused on two categories of prevention tactics: increased access control (often complemented by target hardening) and enhanced surveillance. The following review of literature examines the use of these two approaches in preventing crimes occurring in rail areas and those occurring in parking facilities.

Preventing crime in rail areas

Studies aimed at reducing crime in rail areas are dominated by those that prevent fare evasion. Efforts at increasing access control to prevent fare evasion include the installation of floor-to-ceiling turnstiles in New York, which reduced fare evasion arrests by 84 per cent over a three-year period, with little evidence of displacement (Weidner, 1997). Clarke (1993) found that the installation of automated ticketing machines on the London Underground reduced fare evasion by two-thirds. Clarke et al. (1994) found that retrofitting token machines to reject 50p slugs reduced slug use dramatically. Importantly, while studies of the impact of enhanced access control are largely confined to the problem of fare evasion, some research indicates it also reduces more serious crimes based on the premise that those who evade fares commit other crimes while on the system (Kelling and Coles, 1996).

Whereas access control is primarily a means of preventing fare evasion, surveillance enhancements have been employed for a wide array of crime prevention efforts on rail systems. Enhanced surveillance through the addition of civilian and/or law enforcement staff, for example, has reduced fare evasion (DesChamps, Brantingham and Brantingham, 1991; Hauber, 1993; Clarke, 1991; van Andel, 1992) as well as robbery (Chaiken et al., 1974) and graffiti (van Andel, 1992). Similarly, informal guardians may reduce crime under certain contexts (Reynald and Elffers, 2009; Ceccato and Haining, 2004).

Surveillance has also been enhanced through the installation of public surveillance cameras, or what are often referred to as closed-circuit televisions

(CCTVs). In the context of rail crime, CCTV was found to reduce theft and robbery (Burrows, 1980), although impact on robberies was mixed (Webb and Laycock, 1992). Similarly, an evaluation of CCTV in the Stockholm subway concluded it led to fewer property crimes but had no impact on assaults (Priks, 2009). In a Stockholm study, Ceccato et al. (2011) found CCTV presence was associated with less crime and disorder as measured through police records, but this relationship did not hold up when analyzing transport data, which may be the result of endogeneity (e.g. CCTVs were placed in high crime areas to begin with). A subsequent study confirms the challenge of isolating the impact of CCTV, with larger peripheral stations both more likely to have CCTVs and more likely to experience a higher volume of crime (Ceccato and Uittenbogaard, 2014). Surveillance, whether human or aided by cameras, can also be enhanced though increased visibility. Increased lighting and the absence of dark corners and hiding places are likely to prevent crime (Loukaitou-Sideris et al., 2002; Cozens, 2003).

These prior examples, however, are specific to crimes occurring in rail areas – within the stations or on train cars – rather than on the transit property surrounding transit stations. The presence of parking facilities tends to dominate these areas, presenting unique opportunities for crime.

Preventing crime in parking areas

Very little research exists specific to preventing crime in parking facilities associated with subway transit systems, but evaluations of efforts to reduce crime in parking facilities in general can provide guidance about the types of preventive strategies that may be successful. Perhaps the most recent and notable of these is a study by Batley et al. (2012), which found that while there was no evidence of an effect of a parking-related crime prevention strategy alone on crime in parking facilities, it was effective when combined with a similar strategy in rail stations. Apart from this comprehensive study, few studies examine the impact of access control. Poyner and Webb (1987) found that installing fencing around the perimeter of a parking facility, fitting the pedestrian entrance with a self-closing door for exit only, increasing lighting and installing a taxi company kiosk together reduced auto theft significantly with no evidence of displacement. These findings are consistent with other studies of comprehensive approaches to reducing crime in parking areas that place a strong emphasis on access control (see Clarke and Goldstein, 2003; Geason and Wilson, 1990).

Some argue that enhanced surveillance is likely the most effective environmental characteristic for reducing parking facility crime (Poyner, 1997). For example, lighting improvements have reduced some types of crimes in parking facilities (Painter and Farrington, 1997; Poyner, 1997). Most other evaluations of enhanced surveillance in parking facilities have focused on security personnel and the use of surveillance cameras. The introduction or addition of security staff or parking attendants has been credited with crime reductions (see Barclay et al., 1997; Laycock and Austin, 1992; Poyner, 1997). However, as observed by Poyner (1997), the placement and coverage of parking facility security measures can influence the types of crimes that occur within it. Additionally, in a study of the Green Line stations in Los Angeles, Loukaitou-Sideris et al. (2002) found that two station parking lots with the most serious crime were those with a parking attendant.

While prior evaluations of the impact of cameras on crime have yielded mixed results (Maccubbin et al., 2001; Welsh and Farrington, 2003; Welsh and Farrington, 2004; Eck, 2002; Gill and Spriggs, 2005; Ratcliffe et al., 2009; La Vigne et al., 2011), their use specifically in parking facilities suggests that camera implementation helps reduce the occurrence of vehicle crimes (Eck 2002; Farrington et al., 2007; Poyner, 1997; Tilly, 1993; Welsh and Farrington, 2009). However, Clarke (2002) advises that cameras work best in parking facilities if the CCTV system is tailored to the facility; the monitors are constantly watched; the system includes public address capability; and the lighting is adequate (Clarke, 2002).

Similarly, Poyner (1997) offers additional cautions on cameras and other parking security measures, advising that while stationing security at entrance and exit barriers may deter the theft of a car, it alone will have little effect on theft from cars (Poyner, 1997). This effect occurs because while there is surveillance over the ingress and egress of cars in the facility, activity within it may proceed unsupervised. Thus, the effect of any security measure may be heavily dependent on how and where it is implemented.

The challenge is that a range of crimes occurs on transit systems, including both rail property and property surrounding the station such as commuter parking facilities. The most serious crimes– robberies and assaults – are associated with what Smith and Clarke (2000) characterize as 'lack of supervision'. The theoretical suggestion is that increased surveillance would close off such criminal opportunities. Similarly, crimes that tend to occur in parking facilities, thefts of and from automobiles, are more easily facilitated in the absence of formal (employee and camera-facilitated) and natural (lighting and absence of visual obstructions) surveillance. In both cases, prior research suggests that access control can deter all manner of crimes by preventing criminals from gaining entrance to the system altogether.

Taken together a common theme can be suggested. Given the difference in crime types between rail stations and rail parking facilities, a comprehensive crime prevention approach – one that is both crime specific with regard to the crimes that most commonly occur in and around transit hubs (fare evasion, car theft, robbery) and far reaching (addressing factors that create attractors and generators based on time of day and nature of crime) may yield the most success in suppressing crime. The two studies on Washington's Metro, described below, present opportunities to test this hypothesis.

Preventing crime on Metro's rail system

Washington, DC, has the second-largest commuter rail transit system in the United States (WMATA, 2013). Housed in the nation's capital, Metrorail (Metro) has over 212 million riders per year, spans 50 miles, has 47 stations and serves a population of over 5 million spanning Maryland, Virginia and the District of Columbia (WMATA, 2013). As documented by La Vigne (1996), Metro is often held as an example of designing out crime from the outset: the system's architects and planners deliberately designed a system that would prevent crime and increase use by legitimate users, with a primary focus on stringent access control policies and enhanced surveillance.

From the day of its opening in 1976, Metro employed the innovative use of barcode-encrypted fare cards as the sole means of access to the system. Importantly, they were designed to be used for both entry and exit to the system, enabling different fares to be charged, scaled by length of journey. Thus, Metro introduced a payment system that designed in stringent access control features, increasing the efforts associated with fare evasion as well as the risk of detection of such acts, unlike other American systems that still used metal tokens for payment.

Metro's access control was enhanced by a number of key surveillance features integral to the architectural design. Metro's platforms are crowned by high vaulted ceilings that preclude the need for supporting columns, which can cast shadows and provide cover for criminals. This wide-open design enhances employee surveillance, affording unobstructed views of the platforms and tracks below them. Formal surveillance is bolstered by CCTVs, which are prominent and strategically positioned on the ceilings of each end of the platform as well as in potential blind spots and areas of vulnerability. Elevators are also equipped with cameras and designed with large glass side panels to increase natural surveillance. Attendants monitor CCTVs from kiosks located at the entrances to the platforms and make use of cameras and Metro's public address system to identify rule violations (for example, eating, drinking, vandalism, hooliganism) and broadcast public reprimands of rule breakers.

Overall, the design and management of Metro are fully consistent with principles of environmental criminology, having strong access control and high natural, employee and formal surveillance features reinforced by the system's rigorous maintenance policies and stringent rule enforcement. Graffiti is removed, and vandalism is repaired promptly, and even the most minor of rule violators are reprimanded or issued fines or citations. Consistent with broken windows theory (Kelling, 1982; Kelling and Coles, 1996), Metro's philosophy is to stringently enforce minor violations to signal to more serious offenders that criminal behaviour will be detected and will not be tolerated.

Methodology and findings

The methodology employed here was multipronged, consisting of five separate analyses. First, Metro's environmental design and accompanying enforcement practices were compared qualitatively to theories of criminal opportunity. Then, Metro's crime rates (per 1 million riders) were compared to those of three other United States subway systems (Metropolitan Atlanta Rapid Transit Authority [MARTA], the Metropolitan Boston Transit Authority [MBTA], and the Chicago Transit Authority [CTA]). Importantly, rail crime on these systems was isolated from total subway crime rates to ensure that parking facility crimes were not driving comparisons. F-tests (using the Scheffe correction for multiple comparisons) of an ANOVA (analysis of variance) were used to compare mean rates per rider. The third analysis examined Metro's crime rates (per 1 million riders) for their degree of stability over time, comparing crime rates by month for a 24-month period by calculating Pearson correlation coefficients for Metro crime rates by station in 1993 to those in 1994. Fourth, in order to assess the degree to which Metro's environment was conducive to crime prevention regardless of crime occurring in the areas in which stations were located, Metro crime rates (per 1 million riders) were compared over time to crime rates (per 100,000 residents) in the areas served by Metro, employing F-tests to compare coefficients of relative variation (SD/mean). Finally, Metro's crime rate trends were compared to crime rate trends for the greater Washington, DC, area, employing Z-scores to standardize for differences in base rates between the two data sets.

The results of these qualitative and quantitative analyses were almost uniformly consistent with the hypothesis that Metro successfully designed out crime from the outset: Metro's design and management features were consistent with theory and prior research, and its crime rates were lower than those for other subway systems, and more stable both over time and from station to station than the crime rates in the above-ground areas that Metro serves. The sole exception to these findings pertains to assaults, which covaried with above- ground incidents. While the overall volume of assaults was relatively low, this finding suggests that there are limits to the degree to which a subway system can inoculate itself from the criminal elements that exist in the immediate vicinity of its stations.

While Metro's success story has been well established, the extent of its crime prevention reach appears to stop at the turnstiles: at the time of the original Metro study, and for over a decade following it, the real crime problem was happening in Metro's parking facilities. Through 2007, approximately half of all crimes occurring on WMATA property took place in parking facilities, and over 60 per cent of all of WMATA's Part I (the most serious felony offences) crimes occurred there (La Vigne and Lowry, 2011).

Preventing crime in Metro's parking facilities

As with most urban cores, commuting patterns in the Washington, DC, area follow a suburban to urban core flow in the mornings, with a mass exodus of commuters from the city during the evening hours. A useful, functioning subway transit system therefore required the construction of parking facilities to accompany the subway stations located in the suburban areas beyond the city boundaries. In total, 52 parking facilities were constructed at 42 stations, providing both daily and hourly parking at all hours of the day and evening, with free parking on weekends and federal holidays. Of the 52 parking facilities, 32 are surface lots, 15 are multilevel garages, and 5 are combination facilities. Parking capacity ranges from 194 spaces to 5,069 spaces.

Unlike subway stations which require fare cards for entry, transit property in areas surrounding stations including parking facilities is much more open. In addition, Metro's parking facilities do not share the same uniformity in environmental design features characterized by its underground station environment. Some facilities are surface lots, while others are multilevel parking garages. Even within each of those categories, design features vary based on location and age of facility. This may in part explain why 80 per cent of the crime in Metro's parking facilities occurred in just one-third of Metro's stations (La Vigne and Lowry, 2011). In 2005, Urban Institute researchers partnered with Metro Transit Police (MTP) to identify which aspects of parking facility design and management features are predictive of crime with the goal of identifying, implementing and evaluating one or more promising crime reduction strategies.

Methodology

This study employed two phases of research, baseline identification of predictors of parking facility crime and impact analyses of selected randomly assigned interventions. The first phase involved collection and analysis of reported crime incidents to identify concentrations of and variations in crime by facility and predict environmental factors influencing crime rates crime. Data were collected on reported crime incidents in the areas surrounding each Metro parking facility (spanning seven independent jurisdictions); administrative data on parking facilities, such as hours of operation, staffing and parking facility utilization; interviews with MTP staff on reporting, patrol and investigative practices; and systematic site observations of environmental features in each of Metro's 52 parking facilities, including lighting, layout, natural surveillance, access control and the surrounding environment. Initial regression analyses were conducted to identify which design features were associated with crime. Regression results yielded just three variables – surrounding area crime rate, parking facility capacity and parking utilization. In light of these findings, researchers opted for a more theoretical approach, focusing on alterations to the environment that would enhance access control surveillance.

Phase two of the methodology entailed an impact evaluation of the chosen intervention (described below). The methodology assigned the treatment to randomly selected parking facilities employing a blocked random assignment approach for which facilities were first paired based on similarity on surrounding area crime rate (high, medium, low), facility capacity, AM/PM payment policy, facility type (garage, lot or combination facility), and Metro line (red, green, orange). The impact of the treatment was assessed using Difference-in-Differences (DID) analyses of crime rates pre- and post-implementation.

Findings

Baseline analyses of predictors of parking facility crime led to the identification of access control as focal point, as parking facilities that required payment upon entry into the facility had much higher rates of crime than those that required payment upon exit.[1] This suggests that car thieves and other offenders took advantage of the fact that no interaction with parking facility staff was required to exit the facility, that offenders did not need to worry about paying to exit the facility with a stolen car and that staff surveillance of the facility was minimal during afternoon hours due to the morning payment collection policy. In light of this observation, researchers identified the requirement of SmarTrip card use at both entry and exit of the facility as the most promising means of preventing crime. As with the design of Metro's rail areas, which requires use of a SmarTrip card upon both entry and exit, the theory was that this would both increase the effort associated with gaining access to the facility and increase the risk of detection associated with exiting the facility with a stolen car or its contents. Importantly, in order to acquire a SmarTrip card, a purchaser must submit identifiable information (for example, name, address, credit card information) to the transit system that can be used to track the identity of those individuals entering and exiting the facility.[2]

Efforts to change collection policies at these stations and thus increase both surveillance and access control, however, were ultimately not successful during the course of the study. Instead researchers, in conversations with MTP on the feasibility of various alternative interventions, ultimately recommended that WMATA install prominently placed cameras to deter offenders.

The cameras were originally envisioned as possessing closed-circuit capabilities, enabling live monitoring for at least some portion of the day. However, resource constraints led to the adoption of digital (still) cameras, which employ motion detection to trigger the capturing of images. These were to be installed at the exits of half of Metro's commuter parking facilities via random assignment using blocked pairs and positioned to capture both the image of the driver and the vehicle's license plate, complemented with signs that license plate numbers and exit times were being monitored and recorded. The cameras were intended to both deter criminals and to aid in investigations, generating more precise information about the time of thefts along with images of suspects. Unfortunately, Metro did not have sufficient resources to cover the costs of cameras at all of the treatment facilities. Live cameras accompanied by signage were installed at a third of stations, and dummy cameras with signage at the remaining two-thirds. While clearly a diluted intervention, the hope remained that these dummy cameras and signs would convey the perception of surveillance and thus deter criminals. However, no statistical differences were found in crime between the treatment and control groups from pre- to post-camera implementation periods.[3]

This lack of impact is perhaps not surprising. While post-implementation site observations to each of the treatment parking facilities confirmed that cameras and signage were implemented with fidelity, the treatment nonetheless was quite weak given the fact that two-thirds of the cameras were strictly symbolic. Moreover, researchers learned that the live cameras were not employed by MTP to support investigations, due in large part to the fact that its auto theft unit was disbanded during the study period due to budget cuts. This suggests that the intervention was confined to the placement of cameras (some live, some dummy) and signage, and did not involve any enhanced investigations or increased identification of suspects. This is an example of implementation failure found in many evaluation studies.

Discussion and implications

The findings presented in this chapter raise an important question relevant both to Metro and transit systems worldwide: namely, under what circumstances and contexts are crime prevention efforts effective? Both Metro's rail area use of cameras and its experience with cameras in the parking facilities point to some preliminary answers: the cameras employed within Metro's station (Metrorail) were present in high volumes (eight per platform), routinely monitored, complemented by a public address system and supported by a wide array of other environmental design features. By comparison, the parking facility cameras were not implemented in a wide-scale manner, lacked monitoring capabilities and were not integrated into patrol or investigation activities. While the presence of parking facility cameras was made prominent through the installation of signs advertising their existence, that factor alone was apparently not persuasive enough to deter offenders. Importantly, at the time of the study, Metro's parking facilities had only a limited degree of access control, as at a subset of stations payment was upon entry, enabling a thief to exit with no interaction with parking attendants whatsoever. By comparison, rail area access control was quite strong.

Table 14.1 Comparison of camera features on metrorail versus metro parking facilities

Crime Prevention Feature	**Metro's Rail Areas**	**Metro's Parking Areas**
Access control	High: SmarTrip card needed upon both entry and exit	Low: can pay by cash to exit; some stations require payment upon arrival, with no attendants stationed at exits during afternoon/evening hours
Natural surveillance	High: absence of columns and corners, ambient lighting	Variable: moderate in surface lots, poor in multilevel garages
Employee surveillance	Moderate: station attendants positioned at most exits/entrances during all hours of operation	Low: station attendants not consistently positioned at all exits/entrances during all hours
Formal surveillance	High: relatively high volume of cameras, strategically placed, with some degree of live monitoring by station attendants	Low: very few cameras, only one-third functional, no ability for live monitoring

When examining the results of camera use in the parking facilities, it is clear that their limited placement and use restricted their potential crime prevention impact. Theory and prior research suggest that to maximize effectiveness, cameras should be strategically positioned, prominently advertised, actively monitored and fully integrated into law enforcement activities (La Vigne et al., 2011). In this case, the cameras were limited in number and not employed in a manner that would illuminate blind spots and other areas of vulnerability. Moreover, the cameras were not used for investigative purposes. Perhaps more critically, the limited use of digital still cameras, as opposed to closed-circuit video cameras, rendered it impossible to engage in active monitoring activities. By comparison, Metro's cameras within the rail station were sufficient in number and strategically placed to ensure there were no obstructions and that the cameras were in plain view of all riders and potential offenders.

Another critical difference between crime prevention measures in Metro's rail areas versus its parking areas is that camera use in rail areas is but one of several key components associated with the system's success in designing out crime. The fact that cameras are routinely watched by station managers, and reinforced by the station public address system, enabling station managers to detect minor transgressions (vandalism, rule violations such as eating or drinking) and broadcast public reprimands, gives additional teeth to the

CCTV's surveillance capabilities, sending a clear message to would-be offenders that they are being watched and are at great risk of detection. Cameras also enhance the natural surveillance features of the environment and are bolstered by the fact that access to the system is restricted to those who purchased a SmarTrip card and are positioned to detect any attempts at fare evasion.

The larger theoretical question of this study is therefore the value of enhanced surveillance in the absence of increased access control. While limited in generalizability because the findings summarized in this chapter were generated from two studies on a single subway transit system, this chapter provides insights on the degree to which a single crime prevention measure such as the installation of cameras may be useful in preventing crime on transit property, particularly in areas that have not benefitted from extensive environmental design features. This chapter suggests that only a very comprehensive effort that attends to design issues, such as installing perimeter barriers, while enhancing both surveillance and increasing access control, is likely to yield positive reductions. These findings comport with Newton's study on the London Underground (Chapter 6 in this volume), which identifies increased risk of theft based on accessibility in the areas surrounding tube stations.

It is useful to revisit the Brantinghams' (1995) hypothesis of generators and attractors: while they categorize transit stations at generators, it is actually the case that subway stations that include parking facilities are both generators (at the rail stations specifically) and attractors (in the parking facilities). Because different places can create opportunities for different combinations of crime types, the individual effect of any one crime prevention measure may be limited. This underscores the value of viewing a transit hub as a system that both creates and inhibits opportunities for a wide array of different crime types. Thus a comprehensive crime prevention approach such as the one documented by Felson et al. (1997) in the New York Port Authority is perhaps the best means of reducing crime in areas that by definition have limits on access control due to their public nature.

Since the initial evaluation, Metro implemented additional measures to enhance both surveillance and access control in its parking facilities. Perhaps the most significant change was the implementation of the key policy measure originally recommended: the requirement that all parking facility users employ a SmarTrip card *upon both entrance and exit of the facility.* Additional cameras were installed at the booths at which riders pay to exit parking facilities, which coincided with the use of credit card readers that allow riders to 'tap and pay'. These cameras replaced live parking attendants, but that removal of employee surveillance was replaced with additional mobile towers affixed with cameras; the towers are moved periodically to afford different surveillance views of the same facility and to enhance surveillance of facilities that recent crime data indicate are being targeted for crimes. In addition, local law enforcement agencies serving the areas in which Metro's parking facilities are located were supplied with free SmarTrip cards, enabling them to access the parking facilities and patrol them or investigate suspicious activities. These measures, combined with enhanced public outreach to drivers imploring them to secure their cars and remove valuable belongings from them, likely explain the dramatic drop in parking facility crime. Shortly after the conclusion of Urban's parking facility evaluation, Metro experienced a precipitous drop in crime in its parking facilities, with both Part I and Part II crimes declining by over 50 per cent from 2008 to 2012 (WMATA 2013).

These initial indications validate the notion that the transit crime prevention measures should be multifaceted, enhancing both access control and surveillance, and implemented comprehensively, rather than as an isolated undertaking. Doing so is consistent with observations that different settings and contexts promote different opportunities for crime – even within the same transit hub. Such an undertaking presents challenges from an evaluation perspective, in that it is difficult to discern what component (or collection of components) of the comprehensive crime control measure is yielding a beneficial impact. Regardless, it stands to reason that doing so will reap crime control benefits far beyond those focused on a single intervention or tactic. These findings, while limited to two studies in a single jurisdiction, have much to offer urban planners, transit authorities and transit police. They suggest that comprehensive approaches are best able to prevent crime and underscore the importance of designing in security measures at the outset.

Notes

1. During the study period, the parking facilities throughout the WMATA Metro system were served by over 100 parking attendants who collect parking fees on weekdays. At least one attendant was assigned from 9:00am to rail closing (midnight on Monday through Thursday, 2:00am on Friday) for exit payment policy stations; additional attendants are assigned to these stations from 2:00pm to 10:00pm to accommodate the evening rush hours. For the entrance payment stations, additional attendants are available from 5:00am to 10:00am to accommodate the morning rush hours. Attendants were stationed at a kiosk in the parking lot or, in the case of stations with multiple parking facilities, they patrolled on foot.
2. This policy has since changed, as purchasers may now use cash to purchase SmarTrip cards from kiosks with in the station.
3. Analyses of the impact of camera installation were accomplished through Difference-in-Differences (DiD) analysis, which yields the net change in crime in the treatment area using a matched comparison area to account for changes that presumably would have occurred in both areas due to their similarities.

References

Barclay, P., Buckley, J., Brantingham, P.J., Brantingham, P. L. and T. Whin-Yates. (1997) Preventing Auto Theft in Suburban Vancouver Commuter Lots: Effects of a Bike Patrol. In: Clarke, R. V. (ed.) *Situational Crime Prevention: Successful Case Studies*, Second edition, Guilderland, NY: Harrow and Heston, 133–162.

Barr, R. and K. Pease (1990) Crime Placement, Displacement, and Deflection. *Crime and Justice*, *12*, 277–318.
Batley, R., Rogerson, M., Nellthorp, J., Wardman, M., Hirschfield, A., Newton, A. D., Shires, J., Monchuk, L., Armitage, R., Sharratt, K., Johnson, D. and Chintakayala, P. K. (2012) *Evaluating Measures to Improve Personal Security and the Value of Their Benefits*. Project Report. Huddersfield, UK: Rail Safety and Standards Board.
Becker, G.S. (1968) Crime and Punishment: An Economic Perspective. *Journal of Political Economy, 76*, 169–217.
Brantingham, P. J., and Brantingham, P. L. (1981) *Environmental Criminology*. Beverly Hills, CA: Sage Publications.
Brantingham, P. J., and Brantingham, P. L. (1995) Criminality of Place: Crime Generators and Crime Attractors. *European Journal on Criminal Policy and Research*, *3*(3), 5–26.
Burrows, J. (1980) Closed Circuit Television and Crime on the London Underground. In: Clarke, R. V., and Mayhew, P. (eds) *Designing Out Crime*. London: H.M. Stationary Office for Home Office Research Unit.
Ceccato, V., and Haining, R. (2004) Crime in Border Regions: The Scandinavian Case of Ö resund, 1998–2001. *Annals of the Association of American Geographers*, *94*(4), 807–826.
Ceccato, V., and Uittenbogaard, A. (2014) Space-Time Dynamics of Crime in Transport Nodes. *Annals of the Association of the American Geographers*, *105*, 131–150.
Ceccato, V., Uittenbogaard, A. and Bamzar, R. (2011) Safety in Stockholm's Underground Stations: the Importance of Environmental Attributes and Context. *Security Journal*, *26*, 33–59.
Chaiken, J. M., Lawless, M. S. and Stevenson, K. A. (1974) *The Impact of Police Activity on Crime: Robberies on the New York City Subway System*. New York: Rand Institute.
Chainey, S. (2000) Optimizing Closed-Circuit Television Use. In: La Vigne, N. and Wartell, J. (eds) *Crime Mapping Case Studies: Successes In the Field,* Volume 2. Washington, DC: Police Executive Research Forum, 91–100.
Clarke, R.V (1992) *Situational Crime Prevention: Successful Case Studies*. Guilderland, NY: Harrow and Heston.
Clarke, R. V. (1993) Fare Evasion and Automatic Ticket Collection on the London Underground. In: Clarke, R. V. (ed.) *Crime Prevention Studies*, Volume 1. Monsey: NY: Criminal Justice Press, 135–146.
Clarke, R. V. (1997) *Situational Crime Prevention: Successful Case Studies*. Second edition. Guilderland, NY: Harrow and Heston.
Clarke, R. V. (2002) *Theft of and from Cars in Parking Facilities*. Problem-Oriented Guides for Police Series No. 10. Washington, DC: US Department of Justice.
Clarke, R.V., and Goldstein, H. (2003) *Thefts from Cars in Center City Parking Facilities: A Case Study in Implementing Problem-Oriented Policing*. Washington, DC: US Department of Justice.
Clarke, R. V., and Mayhew, P. (1998) Preventing Crime in Parking Lots: What We Know and What We Need to Know. In: Felson, M. and Peiser, R. B. (eds) *Reducing Crime through Real Estate Development and Management* Washington, DC: Urban Land Institute.
Clarke, R. V., and Weisburd, D. (1994) Diffusion of Crime Control Benefits: Observations on the Reverse of Displacement. In: Clarke, R. V. (ed.) *Crime Prevention Studies,* Volume 2, Monsey, NY: Criminal Justice Press, 165–183.
Cohen, L. E., and Felson, M. (1979) Social Change and Crime Rate Trends: A Routine Activity Approach. *American Sociological Review*, *44*(4), 588–608.

Cornish, D. B., and Clarke, R. V. (1986) *The Reasoning Criminal: Rational Choice Perspectives on Offending*. New York: Springer.

Cornish, D. B., and Clarke, R. V. (2003) Opportunities, Precipitators and Criminal Decisions: A Reply to Wortley's Critique of Situational Crime Prevention. In: Smith, M. J., and Cornish, D. B. (eds) *Theory for Practice in Situational Crime Prevention, Crime Prevention Studies*, Volume 16. Monsey, NY: Criminal Justice Press, 41–96.

Cozens, P., Neale, R., Whitaker, J. and Hillier, D. (2003) Managing Crime and the Fear of Crime at Railway Stations – A Case Study in South Wales (UK). *International Journal of Transport Management*, *1*(3), 121–132.

DesChamps, S., Brantingham, P. L. and Brantingham, P. J. (1991) The British Columbia Transit Fare Evasion Audit. *Security Journal*, *2*, 211–218.

Eck, J. E. (1993) The Threat of Crime Displacement. *Criminal Justice Abstracts*, 25, 527–546.

Eck, J. E. (2002) Preventing Crime at Places. In: Sherman, L., Farrington, D., Welsh, B. and MacKenzie, D. (eds) *Evidence-Based Crime Prevention*. New York: Routledge, 241–293.

Farrington, D. P., Gill, M., Waples, S. J. and Argomaniz, J. (2007) The Effects of Closed-Circuit Television on Crime: Meta-analysis of an English National Quasi-Experimental Multi-Site Evaluation. *Journal of Experimental Criminology*, *3*(1), 21–38.

Felson, M. (1986) Linking Criminal Choices, Routine Activities, Informal Control, and Criminal Outcomes. In: Cornish, D. B., and Clarke, R. V. (eds) *The Reasoning Criminal*. New York: Springer-Verlag, 119–128.

Felson, M. (1995) Those Who Discourage Crime. In: Eck, J. E., and Weisburd, D. (eds) *Crime Places in Crime Theory*. *Crime Prevention Studies*, Volume 4, Monsey, NY: Criminal Justice Press, 53–66.

Felson, M., Belanger, M. E., Bichler, G. M., Bruzinski, C. D., Campbell, G. S., Fried, C. L., Grofik, K. C., Mazur, Irene S., O'Regan, A., Sweeney, P. J., Ullman, A. L. and Williams, L. M. (1997) Redesigning Hell: Preventing Crime and Disorder at the Port Authority Bus Terminal. In: Clarke, R. V. (ed.) *Preventing Mass Transit Crime*. *Crime Prevention Studies*, Vol. 6, Monsey, NY: Criminal Justice Press, 5–91.

Geason, S., and Wilson, P. (1990). *Preventing Car Theft and Crime in Car Parks*. Canberra, Australia: Australian Institute of Criminology.

Gill, M. (2006) CCTV: Is It Effective? In Gill, M. (ed.), *The Handbook of Security*. New York: Palgrave Macmillan.

Gill, M., and Hemming, M. (2004) *The Evaluation of CCTV in the London Borough of Lewsham: A Report*. Leicester: Perpetuity Research and Consultancy International.

Gill, M., and Spriggs, A. (2005) *Assessing the Impact of CCTV*. London, UK: Home Office Research, Development and Statistics Directorate.

Goold, B. J. (2004) *CCTV and Policing: Public Area Surveillance and Police Practices in Britain*. New York: Oxford University Press.

Guerette, R. T., and Bower, K. J. (2009) Assessing the Extent of Crime Displacement and Diffusion of Benefits: A Review of Situational Crime Prevention Evaluations. *Criminology 47*, 1331–1368.

Hauber, A. R. (1993) Fare Evasion in a European Perspective. *Studies on Crime and Crime Prevention 2*, 122–141.

Hesseling, R. B. P. (1994) Displacement: A Review of Empirical Literature. In: Clarke, R. V. (ed.) *Crime Prevention Studies*, Volume 3. Monsey, NY: Criminal Justice Press, 195–230.

Jacobs, J. (1961) *The Death and Life of Great American Cities*. New York: Random House.

Jeffery, C. R. (1971) *Crime Prevention Through Environmental Design*. Thousand Oaks, CA: Sage Publications Inc.
Jeffery, C. R. (1977) *Crime Prevention Through Environmental Design*, Second edition. Thousand Oaks, CA: Sage Publications Inc.
Kelling, G., and Coles, C. (1996) *Fixing Broken Windows: Restoring Order and Reducing Crime in Our Communities*. New York: Free Press.
Kelling, G., and Wilson, J. Q. (1982) Broken Windows: The Police and Neighborhood Safety. *The Atlantic*, March 1.
La Vigne, N. G. (1996) Safe Transport: Security by Design on the DC Metro. In: Clarke, R. V. (ed.) *Crime Prevention Studies*, Volume 6, Monsey, NY: Criminal Justice Press.
La Vigne, N. G. (2012) Using Rational Choice and Situational Crime Prevention to Inform, Interpret, and Enhance Public Surveillance Efforts: A Three-City Study. In: Tilley, N. and Farrell, G. (eds) *The Reasoning Criminologist: Essays in Honour of Ronald V. Clarke*. New York: Routledge.
La Vigne, N. G., and Lowry, S. S. (2011) *Evaluation of Camera Use to Prevent Crime in Commuter Parking Facilities: A Randomized Controlled Trial*. Washington, DC: The Urban Institute.
La Vigne, N. G., Lowry, S. S., Markman, J. A. and Dwyer, A. M. (2011) *Documenting the Use of Public Surveillance Cameras for Crime Control and Prevention in Three U.S. Cities*. Washington, DC: US Department of Justice, Office of Community Oriented Policing Services.
Laycock, G., and Austin, C. (1992) Crime Prevention in Parking Facilities. *Security Journal*, *3*, 154–160.
Levesley, T., and Martin, A. (2005) *Police Attitudes to and Use of CCTV*. London, UK: Home Office.
Loukaitou-Sideris, A., Liggett, R. and Iseki, H. (2002) The Geography of Transit Crime: Documentation and Evaluation of Crime Incidence on and around Green Line Stations in Los Angeles. *Journal of Planning Education and Research*, *22*(2), 135–151.
Maccubbin, R. P., and Staples, B. L. (2001) *Automated Enforcement of Traffic Signals: A Literature Review*. Washington, DC: Federal Highway Administration.
Mayhew, P., and Braun, G. (2004) Parking Lot Security. In: Maxfield, M. G., and Clarke, R. V. (eds) *Understanding and Preventing Car Theft. Crime Prevention Studies*, Volume 17. Monsey, NY: Criminal Justice Press.
Mazerolle, L., Hurley, D. and Chamlin, M. (2002) Social Behaviour in Public Space: An Analysis of Behavioural Adaptations to CCTV. *Security Journal*, *15*(3), 59–75.
Newman, O. (1972) *Defensible Space*. New York: Macmillan.
Newton, A. (2014) Crime and Public Transport. In: Weisburd, D. and Bruinsma, G.(eds) *Encyclopedia of Criminology and Criminal Justice*. New York: Springer-Verlag, 709–720.
Painter, K., and Farrington, D. P. (1997) The Crime Reducing Effect of Improved Street Lighting: The Dudley Project. In: Clarke, R. V. (ed.) *Situational Crime Prevention: Successful Case Studies*, Second edition, Guilderland, NY: Harrow and Heston.
Pavlik, R. (2013) Personal email communication with Ronald Pavlik, Chief, Metro Transit Police, 29 August 2013.
Pease, K. (1999) *A Review of Street Lighting Evaluation: Crime Reduction Effects*. Huddersfield, UK: University of Huddersfield Press.
Poyner, B. (1997) Situational Crime Prevention in Two Parking Facilities. In: Clarke, R.V. (ed.) *Situational Crime Prevention: Successful Case Studies*. Second edition. Guilderland, NY: Harrow and Heston.

Poyner, B., and Webb, B. (1987) *Successful Crime Prevention: Case Studies*. London, UK: The Tavistock Institute of Human Relations.

Poyner, B., and Webb, B. (1993) What Works in Crime Prevention: An Overview of Evaluations. In: Clarke, R.V. (ed.) *Crime Prevention Studies*, Volume 1. Monsey, NY: Criminal Justice Press.

Priks, M. (2009) *The Effect of Surveillance Cameras on Crime: Evidence from the Stockholm Subway*. Stockholm: Department of Economics Stockholm University.

Ramsey, N., and Newton, R. (1991) The Influence of Street Lighting on Crime and Fear of Crime *Crime Prevention Unit,* Paper 29. London, UK: Home Office.

Ratcliffe, J. (2006) *Video Surveillance of Public Places*. Washington, DC: US Department of Justice, Office of Community Oriented Policing Services.

Ratcliffe, J. H., Taniguchi, T. and Taylor, R.B. (2009) The Crime Reduction Effects of Public CCTV Cameras: A multi-method spatial approach. *Justice Quarterly, 26*(4), 746–770.

Reynald, D. M., and Elffers, H. (2009) The Future of Newman's Defensible Space Theory. *European Journal of Criminology*, *6*(1), 25–46.

Smith, Martha J. (1996) *Crime Prevention through Environmental Design in Parking Facilities*. Research in Brief. Washington, DC: US Department of Justice, National Institute of Justice.

Smith, M. J., and Clarke, R.V. (2000) Crime and Public Transport. *Crime and Justice*, *27*, 169–233.

Tilley, N. (1993) Understanding Car Parks, Crime and CCTV: Evaluation Lessons from Safer Cities. *Police Research Group Crime Prevention Unit Series* Paper No. 42. London, UK: Home Office, Police Research Group.

Van Andel, H. (1992) Crime Prevention That Works: The Case of Public Transport in the Netherlands. In: Clarke, R.V. (ed.) *Situational Crime Prevention: Successful Case Studies*. Guilderland, NY: Harrow & Heston.

Webb, B., and Laycock, G. (1992) Reducing Crime on the London Underground. *Crime Prevention Unit Paper* 30. London, UK: Home Office.

Weidner, R. R. (1996) Target-Hardening at a New York City Subway Station: Decreased Fare Evasion – at What Price? *Crime Prevention Studies*, Volume 6, Monsey, NY: Criminal Justice Press.

Weisburd, D., Wyckoff, L. A., Eck, J. E., Hinkle, J. C. and Gajewski, F. (2006) Does Crime Just Move around the Corner? A Controlled Study of Spatial Displacement and Diffusion of Crime Control Benefits. *Criminology*, *44*, 549–591.

Welsh, B. C., and Farrington, D. P. (2002) Crime Prevention Effects of Closed Circuit Television: A Systematic Review. *Home Office Research Study* 252. London: UK Home Office, Research, Development and Statistics Directorate.

Welsh, B. C., and Farrington, D. P. (2003) Effects of Closed-Circuit Television on Crime. *The Annals of the American Academy of Political and Social Science*, *587*, 110–135.

Welsh, B. C., and D. P. Farrington (2004) Surveillance for Crime Prevention in Public Space: Results and Policy Choices in Britain and America. *Criminology and Public Policy*, *3*(3), 497–526.

Welsh, B. C., and Farrington, D. P. (2007) Crime Prevention and Hard Technology: The Case for CCTV and Improved Lighting. In: Byrne, J., and Rebovich, D. (eds) *The New Technology of Crime, Law, and Social Control*. Monsey, NY: Criminal Justice Press, 81–102.

Welsh, B. C., and Farrington, D. P. (2009) Public Area CCTV and Crime Prevention: An updated systematic review and meta-analysis. *Justice Quarterly*, *26*(4), 716–745.

WMATA. 2010. Metro Facts. Washington, DC: Washington Metropolitan Area Transit Authority. WMATA. 2013. Metro Facts. http://www.wmata.com/about_metro/docs/metrofacts.pdf, accessed on 20 August 2013.

15

Perception of Disorder and Crime, and Responses to Them in Japanese 'Mega' Railway Stations

Seiji Shibata, Kazunori Hanyu, Tomoko Doi Hata and Yoshiko Yamaoka

Introduction

The crime rate in Japan is far lower that the crime rates of other industrialized countries. However, the severely high fear of crime among Japanese citizens has been considered a priority political issue for the last few decades. Thus, the fear of crime rather than crime itself can be considered as a more important issue to be examined in Japan. There seem to be certain places in which the fear of crime is high in Japan, and one type of these felt unsafe places is the mega railway station/terminal (Funyu and Hanyu, 2003).

The railway is one of the most popular forms of public transportation in Japan. Saito (1997) indicated that railways contributed 33.4 per cent of passenger-km of passenger transport in Japan, and this was the second-largest percentage after automobiles, at 50 per cent, in 1994. Especially in metropolitan cities like Tokyo, the railways play a vitally important role. In Tokyo alone, there are 18 railway companies, and more than 60 surface/subway lines are in operation. Today, Tokyo has one of the world's largest networks of railways, and many passengers use them daily. According to a report from the nationwide Person-Trip survey, the modal share of rail in commuting was 79 per cent (cf. the modal share of car was 4 per cent and that of bicycle was 7 per cent) in the central Tokyo area in 2008 (Tokyo Metropolitan Area Transport Planning Council, 2011). In addition, a survey conducted by the Ministry of Land, Infrastructure and Transport Japan reported that the number of passengers in Tokyo and its neighbouring areas was more than 50 million a day in 2000 (Ministry of Land, Infrastructure and Transport Japan, n.d.). During the morning rush hour, the occupancy rates of train cars usually exceeds 150 per cent, and may even reach 200 per cent on some commuter lines that connect suburbs with central business districts (CBDs) of Tokyo, even though trains arrive every few minutes during these hours. In addition, there are many shopping and recreation facilities in and around large-scale stations. In recent years, Japanese railway companies have afforded great attention to businesses other than those transporting passengers, for example, *eki-naka* (in station) and *eki-chika* (by station) shopping malls, in anticipation of the declining population in Japan. Because of this, many people come to the railway stations not only to travel by train but also to engage in shopping or other leisure activities.

Despite being busy areas, railway stations are perceived as being more unsafe than any other public facility (Funyu and Hanyu, 2003). According to a special public opinion survey on public security conducted by the Cabinet Office, Government of Japan (2012), the percentage of people who experience fear of crime at railway stations increased from 19.3 per cent in 2006 to 26.8 per cent in 2012. However, many railway station patrons, like commuters, have no choice but to use railways in their daily lives. Corresponding to the increase in people's concern about safety on train cars and in railway stations, Japanese railway companies have introduced various measures to improve safety in railway environments. Such measures include women-only cars, emergency buttons on station platforms and on train cars, closed-circuit cameras and the removal of trash bins as a precaution to prevent terrorist bomb attacks.

The objective of this study was to investigate people's perceptions of station environments with regard to their estimation and experience of unpleasant events in their use of railway stations, with a focus on events of crime and disorder. Although much research has been done on safety in railway stations in other countries, few systematic research studies, particularly on people's feelings concerning their safety and discomfort as they use the railways, have been conducted in Japan.

Previous studies and hypotheses

Likelihood, control and consequence of risk are considered key factors in the field of fear of crime and risk research (Jackson, 2009). For example, Ferraro (1995) indicated that people's estimation of likelihood was an important predictor of fear and mediated most of the impact of environmental perceptions associated with crime. Jackson (2006) stated that this estimation has received the most attention in the field. In addition, it has been pointed out by various researchers that people's perception of the risk of being victimized is not accurate, and is affected by the potential consequence or outcome (Ferraro, 1995; Shimada et al., 2004). For example, people's fear of being the victim of assault tends to be high despite the relatively low frequency of this kind of crime, and people's fear of vandalism is very low even though its frequency is high (Ferraro, 1995; Shimada et al., 2004; Warr, 2000).

As for the safety of railway stations, Uzzell et al. (2000) investigated passengers' experiences of security concerning events at railway stations in three cities – London, Paris and Rome. The researchers indicated that the estimated frequencies of unpleasant events at the stations were higher than the experienced frequencies of those events. In addition, respondents tended to expect the events to be more unpleasant than was experienced. These results coincide with the reported relationship between people's risk estimation and experience of crime (Uzzell et al., 2000).

One of the main factors to be considered when understanding the relationship between estimated risk and experience of crime, is how affective meaning, a person's connotation of an event, informs their process of making judgments. Heilbrun et al. (2010) stated that affect may lead to a preoccupation with, and overestimation of, a threat of violence in an affect-rich context. Slovic et al. (2005) noted that the estimation of impact and frequency of events tended to be overstated to a greater degree when participants had a negative affective impression towards the outcome of the event. This is explained by people use their affective impressions as cues for probability judgements and risk perceptions.

Based on the previous studies described above, the following hypotheses were formulated:

> Hypothesis 1: People's estimation of the frequency and expected unpleasantness of an event with a strong negative outcome will be much higher than the experienced frequency and unpleasantness of such an event.
>
> Hypothesis 2: A higher frequency of experience will lead to more unpleasant feelings related to the event.

Hypothesis 1 was derived from Slovic et al.'s (2005) finding that people's estimation of the frequency and expected unpleasantness of the event is largely influenced by their affective impression towards the outcome of the event. Thus, the estimation of serious events will be exaggerated in relation to their actual frequency and experienced unpleasantness. As for the relationship between frequency and unpleasantness, more frequent experiences of unpleasant events would cause stronger affective reactions towards them. Thus, as stated in Hypothesis 2, the experienced unpleasantness of the events would increase compared to a case in which the events are experienced less frequently.

Another important factor in understanding people's fear and discomfort as related to unpleasant events is perceived control and responsibility attribution of the event. It has been shown in many studies that the perception of less control leads people to find an event more unpleasant (Evans and Cohen, 1987; Jackson, 2009). Uzzell et al. (2000) suggested that passengers often think the station staff are responsible for the unpleasant events. Attributing the responsibility of the events to station staff can lead to the perception of less control over the events, thereby creating stronger feelings of unpleasantness. Therefore, a third hypothesis was formulated:

> Hypothesis 3: The unpleasantness of events will be perceived to be higher when people attribute the responsibility of such events to station staff.

Method

Stations

Three stations in the Tokyo area were selected for this study (Stations A, B and C) based on the size of the ridership, the number of lines connected and the station's location. All three stations are typical large-scale railway stations in the Tokyo area and serve as terminal and junction stations for many lines. There are also many shopping facilities and restaurants in the station buildings and adjacent to them.

Station A is one of the major commuter hubs located near the old centre of Tokyo. This station used to be the main terminus for long-distance trains, although most of the lines have now been extended to other stations. As well as many commuter lines, two subway lines are connected to this station. Approximately 0.6 million passengers on average use this station each day.

Station B is the main intercity rail terminal, and is located in the largest CBD of Tokyo. Most of the Shinkansen lines start from this station, and many other commuter lines and subway lines are connected here. Approximately 1.05 million passengers on average use this station every day.

Station C is located in the middle of the mixed business, shopping and entertainment district in Tokyo. Many subway and suburban lines are connected to this station, and approximately 3.2 million passengers on average use this station per day.

Data collection

The questionnaire used in our study was a modified, Japanese translation of the questionnaire developed and used in Uzzell et al. (2000). Following Uzzell et al. (2000), two versions of the questionnaire were developed in our study. Questionnaire A assessed people's perceptions about the expected frequency and expected unpleasantness of events in the target railway station. Questionnaire B assessed people's past experiences of such events. These two versions of the questionnaire were administered to different groups of participants. Both Questionnaire A and B contained a list of 17 events that might occur in a target railway station and that would have a negative impact on the respondents.

The 17 items used in Uzzell et al. (2000) include experiences ranging from difficulty purchasing a ticket to being involved in a terrorist attack. In Uzzell et al.'s (2000) study, over 100 events were initially collected and then collapsed into the 17 events listed in Table 15.1. These items were intended to offer a comprehensive and inclusive set of criteria in evaluating people's safety perceptions in railway stations. As Uzzell et al. (2000) explain, the list includes items denoting the salience of information and services (items 1, 3 and 9); items concerning activities related to time and space in using railway stations that have the potential to cause fear of crime (items 2, 6, 10 and 14); items associated with being a victim in the railway station (items 4, 11, 13 and 17); and items relating to incivility in the railway station (items 5, 7, 8, 12, 15 and 16). Although the present study's main purpose was not to conduct an international comparison, by using the same 17 events as Uzzell et al.'s (2000) study, comparisons between the results gained in the Tokyo study and those of Uzzell et al.'s (2000) study were also possible.

Questionnaires A and B consisted of three sections. In the first section, respondents were asked to rate the frequency of each event listed in Table 15.1. In Questionnaire A, they were asked to rate the expected frequency of these events on a 4-point Likert scale ranging from *very unlikely* (1) to *very likely* (4). In Questionnaire B, they were asked to rate how often they experienced these events, from *never* (1) to *often* (4).

In the second section, respondents were asked to rate the unpleasantness of each event. In Questionnaire A, they were asked to rate how unpleasant they would find each of the events (expected unpleasantness) on a 4-point scale ranging from *not at all unpleasant* (1) to *very unpleasant* (4). In Questionnaire B, they were asked to rate the experienced unpleasantness of the events on a 4-point scale ranging from *not at all unpleasant* (1) to *very unpleasant* (4). In

Table 15.1 List of the events included in the questionnaire

Events	
1.	Having difficulty purchasing a ticket
2.	Traveling alone
3.	Hanging around due to inadequate travel information
4.	Being attacked
5.	Seeing graffiti in the station
6.	Walking to/from the station
7.	Being aware of visible police presence
8.	Being approached by homeless people
9.	Not having information about connecting transport services
10.	Traveling at night
11.	Being involved in a terrorist attack/bomb scare
12.	Being aware of visible presence of station staff
13.	Being involved in a fire incident
14.	Walking between the subway and the mainline trains
15.	Seeing the results of vandalism in the station
16.	Witnessing a suicide on the tracks
17.	Being pickpocketed

addition, in case they had never experienced the event, the option *I've never experienced this* (5) was added to the scale in Questionnaire B.

In the third section of the questionnaire, respondents were asked to rate who they believed was responsible for each event. They were asked to choose one of the following responses from *totally my responsibility* (themselves), *totally the police/station staff's responsibility* (staff), *partly mine, partly the police/station staff's responsibility* (both), and *neither mine nor the police/station staff's responsibility* (neither). Finally, in the last part of the questionnaire, the respondents' demographic data (gender, age and annual income) were collected.

A total of 6,000 questionnaires were distributed by hand to passengers and facility users at three stations. Permission from the railway company and the station manager of each station was obtained before distributing the questionnaires. The completed questionnaires were collected by postal mail. The total number of questionnaires collected was 2,130 (35.5 per cent). This response rate was approximate to that of Uzzell et al.'s (2000) study (39.2 per cent).

The questionnaires, to which postage-free return envelopes were affixed, were distributed at two or three ticket gates at Stations A, B and C on 2 September (Thursday) and on 4 September (Saturday) 2004. A total of 2,000 questionnaires (1,000 each for Questionnaires A and B) were distributed at each station. On 2 September, 400 questionnaires were distributed from 3pm to 5pm at each station. Another 400 were distributed from 5pm to 7pm, and another 400 from 7pm to 9pm. On 4 September, 400 questionnaires were distributed from 3pm to 5pm, and 400 more were given out from 5pm to 7pm.

Data with missing values (n = 170) were omitted from the data analyses. Table 15.2 gives the demographic characteristics of the sample. Male and female respondents were equally represented for each station, as well as for Questionnaire A (likelihood) and Questionnaire B (past experience). As for the age distribution of respondents, the rate of teenagers was relatively low for Station B compared with other stations. The rate of respondents whose income was less than 2 million yen was also relatively low for Station B. However, there were no major differences in the distribution of respondents among the three railway stations.

Modelling

In this study, linear mixed model (LMM) regressions were used for analysing the relationship between the frequency and the unpleasantness of events in railway stations. LMM regressions were carried out because the data in this study were collected at three major railway stations in Tokyo so that the results would be generalizable to other large-scale railway stations in the Tokyo area. By using LMM regression, it was possible to isolate the effects of individual differences by station due to factors such as location,

Table 15.2 Details of the sample in this study

	Station											
	A				B				C			
	A		B		A		B		A		B	
Questionnaire[a]	***N***	**(%)**	***N***	**(%)**	***N***	**(%)**	***N***	**(%)**	***N***	**(%)**	***N***	**(%)**
Gender												
Male	127	(40.8)	152	(44.8)	172	(51.3)	160	(45.1)	163	(51.6)	145	(49.0)
Female	178	(57.2)	183	(54.0)	161	(48.1)	195	(54.9)	158	(48.4)	149	(50.3)
No answer	6	(1.9)	4	(1.2)	2	(0.6)	0	(0.0)	3	(48.4)	2	(0.7)
Age												
< 20	27	(8.7)	34	(10.0)	14	(4.2)	9	(2.5)	29	(9.0)	18	(6.1)
21–30	93	(29.9)	91	(26.8)	73	(21.8)	81	(22.8)	99	(30.6)	87	(29.4)
31–40	62	(19.9)	70	(20.6)	77	(23.0)	81	(22.8)	77	(23.8)	80	(27.0)
41–50	41	(13.2)	44	(13.0)	64	(19.1)	78	(22.0)	48	(14.8)	51	(17.2)
51–60	55	(17.7)	58	(17.1)	70	(20.9)	66	(18.6)	45	(13.9)	27	(9.1)
61–70	23	(7.4)	29	(8.6)	25	(7.5)	28	(7.9)	19	(5.9)	21	(7.1)
70 <	4	(1.3)	8	(2.4)	10	(3.0)	11	(3.1)	5	(1.5)	10	(3.4)
No answer	6	(1.9)	5	(1.5)	2	(0.6)	1	(0.3)	2	(0.6)	2	(0.7)
Yearly income (million JPY)												
< 2	27	(8.7)	32	(9.4)	19	(5.7)	23	(6.5)	41	(12.7)	26	(8.8)
2–3	56	(18.0)	69	(20.4)	57	(17.0)	54	(15.2)	70	(21.6)	59	(19.9)
3–4	70	(22.5)	53	(15.9)	53	(15.8)	84	(23.7)	56	(17.3)	61	(20.6)
4–5	57	(18.3)	74	(21.8)	60	(17.9)	57	(16.1)	63	(19.4)	51	(17.2)
5–6	33	(10.6)	44	(13.0)	65	(19.4)	58	(16.3)	32	(10.2)	38	(12.8)
6–7	21	(6.8)	31	(9.1)	29	(8.7)	36	(10.1)	26	(8.0)	26	(8.8)
7<	27	(8.7)	23	(6.8)	40	(11.9)	34	(9.6)	24	(7.4)	25	(8.4)
No answer	20	(6.4)	12	(3.5)	12	(3.6)	9	(2.5)	11	(3.4)	10	(3.4)

Note: [a] Questionnaire A focused on expected frequency and unpleasantness of the events in the station, and Questionnaire B on experienced frequency and unpleasantness.

characteristics of passengers and so on, as a random effect, and then assess more genuine relationships between factors related to the security of railway stations. The same can be said of the unpleasant events included in this study. The features of each event – such as the severity and uncommonness – differed, and the LMM regression allowed us to isolate the individual differences by such event characteristics. In performing LMM analysis, the *lme4* package (Bates et al., 2013) was used to estimate fixed and random coefficients, and the *anova* and *lmerTest* package (Kuznesova et al., 2013) to test the significance of fixed and random effects. These packages are supplied in the statistical computing environment *R* (version 3.0.0) (R Core Team, 2013).

To assess factors that affect people's estimation of event unpleasantness, an LMM regression with random intercepts and random slopes was fitted to the data with expected unpleasantness (Questionnaire A) and experienced unpleasantness (Questionnaire B), respectively, as a target variable. In each regression model, respondents, type of events and stations were treated as random effects. This means that there may be variation in the value of the intercept or the slope in the regression model. For stations and respondents effects, random intercept was tested respectively. For the type of events, it is highly likely that ratings of event unpleasantness differ among the types of events, because the events evaluated in the present study were very different from one another in terms of frequency, impact and attribution pattern; therefore, random intercepts and random slopes were tested for event effect.

The fixed effects of each analysis were demographic variables (age, gender [male = 1, female = 0], and annual income), attribution of the events (dummy coded as neither = [0,0,0], staff=[1,0,0], both=[0,1,0], themselves=[0,0,1]), and expected/experienced frequency of the events. In regression models, the ratings for expected/experienced frequency of the events were centralized to the overall mean.

To test the significance of each random effect, a likelihood ratio test was conducted. In this test, a more general model that estimates the variance in the effect was compared against a model that has the same fixed effects structure, but without the particular random effect. The significance of fixed effects was calculated based on Satterthwaite's approximation for the degrees of freedom.

Results

Frequency and unpleasantness of events

To test Hypothesis 1, the mean ratings of expected/experienced frequency and the mean ratings of expected/experienced unpleasantness of the event were calculated. Figure 15.1 shows the respondents' mean ratings of the expected and experienced frequency of the 17 events, as well as the respondents' mean ratings of the expected and experienced unpleasantness of the events. The events in Figure 15.1 were sorted in ascending order by the mean expected unpleasantness of the event and ordered from left to right. Thus, the events on the left of the figure were considered minor events, and those on the right were considered serious ones. In the calculation of the mean ratings of experienced unpleasantness of each event, the data of respondents who answered they had never experienced it were excluded, so the range of data for experienced unpleasantness was from one to four, as was that of expected unpleasantness.

As seen in Figure 15.1, the mean values of expected unpleasantness and frequency for minor events were very close to those of experienced unpleasantness and frequency. The mean values of expected unpleasantness and frequency for serious events were different in the upward direction from those of experienced unpleasantness and frequency, as consistent with

Hypothesis 1. The results also showed that these differences were more salient in relation to unpleasantness values.

The responsibility attribution of events

To assess the characteristics of each event, the ratios of respondents that attributed the responsibility of each event to themselves, both, staff or neither were plotted as a stacked bar graph. The order of events in this graph is the same as in Figure 15.1. From a visual inspection of Figure 15.2, respondents' percentages of attribution to themselves were high in events with high frequency, while the percentages of attribution to station staff were high for events with moderate to low frequency.

Factors affecting perception of the event unpleasantness

To test Hypotheses 2 and 3, factors affecting participants' evaluation of event unpleasantness was assessed using LMM regression with the data from Questionnaire A (expected unpleasantness) and Questionnaire B (experienced unpleasantness), respectively. For experienced unpleasantness, data with the response *I've never experienced this* were excluded from the analysis.

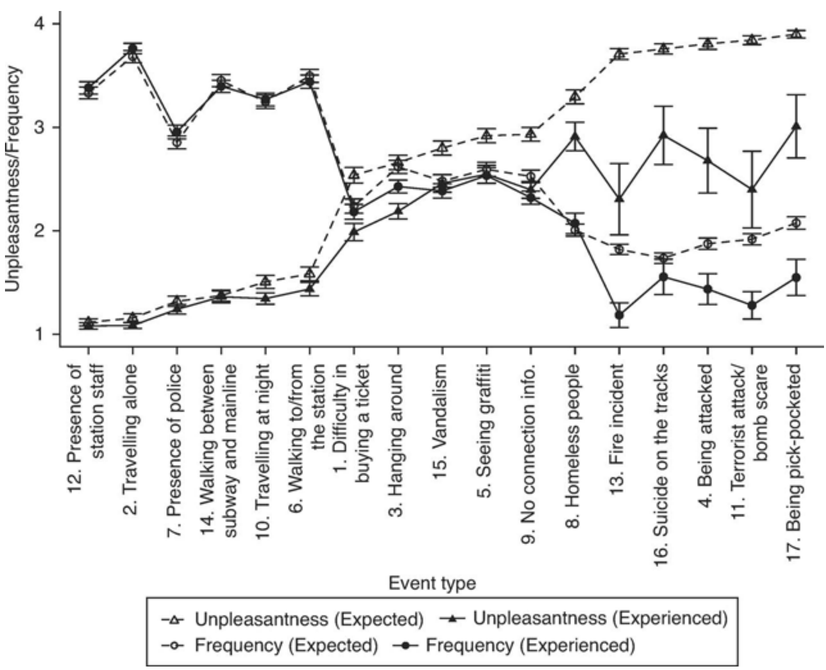


Figure 15.1 Mean values of expected/experienced unpleasantness and expected/experienced frequency of each event

Error bars indicate 99 per cent confidence intervals of mean values.

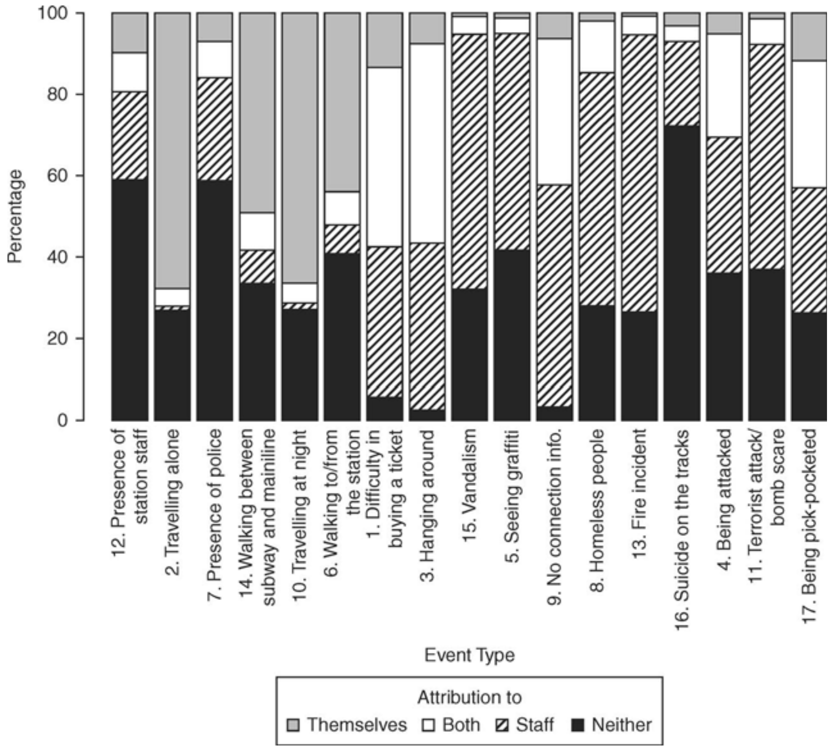


Figure 15.2 Percentage distribution of responsibility attribution for each event

The responsibility for the events was attributed as follows: *totally my responsibility* (themselves), *totally the police/station staff's responsibility* (staff), *partly mine, partly police/station staff's responsibility* (both), or *neither mine nor the police/station staff's responsibility* (neither).

The summaries of the results of LMM regression analyses are shown in Tables 15.3 (expected unpleasantness) and 15.4 (experienced unpleasantness). As can be observed in these tables, none of the demographic variables used as fixed effects (gender, age and income) showed significant effects either on expected unpleasantness or on experienced unpleasantness of the event.

For expected unpleasantness, the frequency of each event was not a significant predictor and the only significant predictor was how responsibility for the event was attributed. The results showed that the total attribution of responsibility to the participants themselves decreased the expected unpleasantness of the event (estimated regression coefficient = −0.156), and total attribution to station staff or to both station staff and participants increased the expected unpleasantness of the event compared to when they

Table 15.3 Summary of the results of the mixed-effects regression model for expected unpleasantness

	Variance	χ^2	Estimate	*SE*	*t*	*p*
Random effects[a]						
Station						
Intercept	0.001	1.5				.217
Respondents						
Intercept	0.065	1152.2				<.001
Event						
Intercept	0.919	10501.0				<.001
Frequency	0.013	209.6				<.001
Covariance (intercept, frequency)	0.012	2.1				.151
Residual	0.393					
Fixed effects[b]						
Intercept			2.577	0.235	10.969	<.001
Gender (male = 1, female = 0)			−0.016	0.020	−0.769	.442
Age			−0.003	0.007	−0.459	.646
Income			0.005	0.006	0.931	.352
Frequency			0.000	0.029	0.012	.991
Attribution[c]						
To staff			0.208	0.015	14.145	<.001
To both			0.081	0.019	4.316	<.001
To themselves			−0.155	0.019	−8.126	<.001

Note: −2 × log-likelihood = 31436.

[a] The significance of random effects was tested using the log-likelihood ratio tests.
[b] The *p* values for fixed effects were calculated based on Satterthwaite's approximation for the degrees of freedom.
[c] Each attribution effect was calculated using attribution to *neither* as the baseline.

attributed it to neither station staff nor themselves. In accordance with Hypothesis 3, the increase in expected unpleasantness was much larger when respondents totally attributed the event to station staff than when they attributed it to both station staff and themselves (estimated regression coefficients = 0.208 and 0.081, respectively).

As for the experienced unpleasantness, experienced frequency of the event and responsibility attribution of the event were significant predictors. The estimated regression coefficient of experienced frequency of the event was 0.281 and was significant. This means that experienced unpleasantness increased as experienced frequency of the event rose, and this result was consistent with Hypothesis 2.

The pattern of the effect of responsibility attribution on experienced unpleasantness was that, when the participants attributed the responsibility for the event to themselves, the unpleasantness decreased (estimated

Table 15.4 Summary of the results of the mixed-effects regression model for experienced unpleasantness

	Variance	χ^2	Estimate	*SE*	*t*	*p*
Random effects[a]						
Station						
Intercept	0.001	2.6				.105
Respondents						
Intercept	0.073	894.7				<.001
Event						
Intercept	0.723	3280.9				<.001
Frequency	0.069	470.4				<.001
Covariance (intercept, frequency)	0.198	24.4				<.001
Residual	0.375					
Fixed effects[b]						
Intercept			2.241	0.217	10.339	<.001
Gender (male = 1, female = 0)			−0.009	0.024	−0.394	.694
Age			−0.007	0.008	−0.927	.354
Income			0.005	0.007	0.823	.410
Frequency			0.281	0.068	4.142	<.001
Attribution[c]						
To staff			0.364	0.021	17.432	<.001
To both			0.204	0.251	8.137	<.001
To themselves			−0.091	0.021	−4.179	<.001

Note: −2 × log-likelihood = 21054.

[a] The significance of random effects was tested using log-likelihood ratio tests.
[b] The *p* values for fixed effects were calculated based on Satterthwaite's approximation for the degrees of freedom.
[c] Each attribution effect was calculated using attribution to *neither* as the baseline.

regression coefficient = −0.091), and when they attributed it to both staff and themselves or totally to station staff, the experienced unpleasantness increased. Furthermore, the effect was bigger for the attribution to station staff compared to the attribution to both staff and themselves (estimated regression coefficients = 0.364 and 0.204, respectively). These results were consistent with Hypothesis 3.

Characteristics of perception concerning security in Tokyo

Table 15.5 shows the mean ratings for expected/experienced unpleasantness, expected/experienced frequency and the difference in scores between expected ratings and experienced ratings for incivilities and victimization in Tokyo and three European cities, specifically London, Paris and Rome. The data for these European cities were obtained from Uzzell et al. (2000).

Table 15.5 Summary of the results concerning perception of incivility and victimization between passengers in Tokyo and three European cities

		Unpleasantness			**Frequency**		
		Expected	**Experienced**	**Diff.**	**Expected**	**Experienced**	**Diff.**
Events	**City**	**A**	**B**	**A–B**	**A**	**B**	**A–B**
Visible presence of station staff	Tokyo	2.80	2.46	+0.34	2.48	3.38	+0.09
	London	2.66	2.36	+0.30	2.29	3.07	+0.39
	Paris	3.24	3.18	+0.06	2.81	2.94	+0.74
	Rome	3.54	3.21	+0.33	2.59	3.02	–0.34
Visible police presence	Tokyo	2.92	2.55	+0.37	2.59	2.95	+0.06
	London	2.45	2.31	+0.14	2.45	2.45	+0.33
	Paris	2.69	2.61	+0.08	3.02	2.88	+0.48
	Rome	2.18	2.55	–0.37	2.79	3.39	–0.32
Seeing the results of vandalism	Tokyo	2.80	2.46	+0.34	2.48	2.38	+0.09
	London	2.66	2.36	+0.30	2.29	1.90	+0.39
	Paris	3.24	3.18	+0.06	2.81	2.07	+0.74
	Rome	3.54	3.21	+0.33	2.59	2.93	–0.34
Seeing graffiti	Tokyo	2.92	2.55	+0.37	2.59	2.53	+0.06
	London	2.45	2.31	+0.14	2.45	2.12	+0.33
	Paris	2.69	2.61	+0.08	3.02	2.54	+0.48
	Rome	2.18	2.55	–0.37	2.79	3.11	–0.32
Being approached by homeless people	Tokyo	3.29	2.91	+0.38	2.01	2.07	–0.07
	London	2.58	2.59	–0.01	2.64	2.28	+0.36
	Paris	2.84	2.59	+0.25	3.03	2.81	+0.22
	Rome	2.50	2.54	–0.04	2.91	2.66	+0.25
Being attacked	Tokyo	3.81	2.68	+1.13	1.87	1.44	+0.44
	London	3.80	3.33	+0.47	1.51	1.03	+0.48
	Paris	3.84	3.47	+0.37	2.68	1.20	+1.48
	Rome	3.94	4.00	–0.06	2.00	1.06	+0.94
Being pickpocketed	Tokyo	3.90	3.01	+0.89	2.08	1.55	+0.53
	London	3.66	2.96	+0.70	1.88	1.03	+0.85
	Paris	3.68	3.31	+0.37	2.82	1.19	+1.63
	Rome	3.79	4.00	–0.21	2.76	1.20	+1.56

Note: Data for London, Paris and Rome were from Uzzell et al. (2000).

The difference in the estimation of event frequency was about the same size or smaller for respondents in Tokyo compared to those in European cities. However, the difference between expected and experienced unpleasantness tended to be larger in Tokyo than other cities for all events. However, only mean scores were provided in Uzzell et al. (2000), and statistical analyses of the difference among cities were not applicable to the data shown in Table 15.5.

Moreover, differences of these item scores were examined among three stations A, B and C in Tokyo using univariate ANOVAs with Holm correction to control overall type I error rate. Significant differences were found in experienced and expected frequency of seeing graffiti ($F(2,713) = 7.00$, $p <.001$, $\eta^2 = 0.019$ for experienced frequency and $F(2,956) = 13.57$, $p <.001$, $\eta^2 = 0.028$ for expected frequency) and expected frequency of seeing the result of vandalism ($F(2,956) = 6.41$, $p = .002$, $\eta^2 = 0.013$). In all cases, the mean score of station C was the highest, and that of station B was the lowest.

Discussion of the results

In the present study, people's perceptions about their unpleasant experiences at railway stations were investigated. This study evaluated the expected and experienced frequency, as well as the expected and experienced unpleasantness of these events. As also mentioned in the following chapters, it is often pointed out that women's fear of crime is high when they use public transport. In our study, however, no significant difference between men and women was found with respect to the expectation or the experience of unpleasant events in railway stations. One of the reasons for this could be the selection of the events used in this study. The 17 events used in this study were mainly the ones that occur in railway stations, not in train cars, and as shown in the criminal situation report by the National Police Agency (2014), the number of incidents of indecent exposure or assault, in which women tend to be victimized much more than men, is three to four times higher in train cars than in railway stations.

Our results on event frequency and unpleasantness, in which expected values were higher than experienced values when it came to serious events, were consistent with Uzzell et al. (2000) and matched Hypothesis 1. However, in our study, since the frequency of the event and its seriousness were highly correlated, it was difficult to distinguish whether the overestimation of event frequency and unpleasantness were due to the seriousness of the event or to the rarity of the event. Nevertheless, the differences between the expected and the experienced values of unpleasantness were much larger than the difference between the expected and the experienced frequency of those events. The affective impression concerning the event could have influenced the estimation about the event, as has also been observed in fear of crime research (e.g. Ferraro, 1995; Shimada et al., 2004).

The results given in Figure 15.1, which show that the unpleasantness of rare events was high, might seem to contradict Hypothesis 2. However, these results illustrate the differences in the frequency-unpleasantness relationship among various events. As for the frequency-unpleasantness relationship within the same events, the results of LMM regression showed that the experienced unpleasantness of the events increased with the frequency of experiencing the events, and this result supported Hypothesis 2. However, it should be noted that the expectation of unpleasantness was not affected by the estimated frequency of the events.

From our results, it is difficult to explain why expected frequency did not affect the unpleasantness of the event. One possible explanation is that the respondents in our Tokyo study had a strong fear of being victimized, regardless of the likelihood of such events. This explanation was deduced from the result that the difference between expected and experienced unpleasantness of being victimized were salient and were very high compared to that of the expected and experienced frequency of the event. In addition, the fact that the difference between expected and experienced unpleasantness of being victimized was large in Tokyo compared to London, Paris and Rome could support this explanation. According to the Organization for Economic Co-operation and Development (OECD) *Factbook 2009* (OECD, 2009), Japan's fear of crime score was very high in 2009, even though its victimization rate was the second-lowest of all OECD countries. The results in our study could be interpreted as reflecting this tendency for Japanese people to have an extreme fear of being victims of crime, such that there was not a clear relationship between expected frequency and unpleasantness of the event.

That the attribution of responsibility of the event to station staff led to higher ratings of unpleasantness confirmed Hypothesis 3. The results also showed that the responsibility attribution of unpleasant events had strong effects on both the expected and the experienced unpleasantness of the events. In Uzzell et al. (2000), it was reported that people in London, Paris and Rome attributed the responsibility for events – such as having difficulty in buying a ticket and getting lost because of inadequate information – largely to station staff. The Tokyo respondents in our study tended to attribute responsibility for these events not only to station staff but also to themselves. Consistent with Hypothesis 3 and the results in the present study, both the expected and the experienced unpleasantness of those events were lower in Tokyo compared to the results reported by Uzzell et al. (2000).

Implications of the results

Based on the results of the present study, it is suggested that it is important to address problems related to the security of the railway station that tend to be considered the station staff's responsibility. Those problems include facility incivility (for example, seeing the results of vandalism, seeing graffiti and being approached by homeless people) and being involved in a serious incident (terrorist threats or fire incidents). In terms of frequency, these events are moderate-to-rare events in railway stations. It was indicated in this study that a lower experienced frequency of these events was related to lower unpleasantness when they occurred.

Therefore, regarding incivilities related to a facility, it is considered important to lower or eliminate the chance that passengers or facility users will encounter such events. Wilson and Healy (1987) and Carr and Spring (1993) also argued for the importance of quickly removing graffiti and traces of vandalism to improve safety in the railway environment. Covington and Taylor (1999) revealed that incivilities such as graffiti or litter in the environment evoked fear of crime, while Perkins et al. (1990) found that such incivilities actually lead to higher crime rates. As the broken window theory indicates (Wilson and Kelling, 1982), even minor graffiti or evidence of vandalism can escalate to have a much greater effect. Therefore, graffiti and the results of vandalism should be removed as quickly as possible.

An attempt from a different perspective would also be effective in preventing graffiti and vandalism. Wilson and Healy (1987) noted that involving the local community in the process of improving the environment to be enjoyable is very effective when it comes to preventing graffiti and vandalism. In the results of this study, the responsibility for vandalism and graffiti was largely attributed to station staff. Involving the facility users in preventing incivilities could cause them feel they themselves are a part of the situation, and thus it could motivate them more to keep the station facilities clean. There have been several of these attempts in Tokyo, such as programs in which students from local art schools painted murals in some stations.

However, for large-scale stations, such as stations A, B and C in this study, only involving the local community would not be sufficient for improving the environment, because passengers who use this station only to transfer to other lines, and tourists from other parts of, or outside of Japan are also largely included among the users of these stations. Among the three stations targeted in this study, both the experienced and the expected frequencies of graffiti were the highest in the station C and the lowest in the station B. Unlike the station B, which is located in the business area, the location of the station C is in a mixed area of business, shopping and entertainment. This situation would cause much more diverse groups of people to come to the station C for various purposes, compared to the station B. Therefore, some way of involving these various station users in preventing graffiti is also needed.

Tackling incivilities in railway stations is also important from other points of view than crime prevention. The function of railway stations in Japan has been changing recently. Basically, railway stations have functioned as a crime generator because there are many possible targets for criminal activities, such as groping in crowded train cars or luggage lifting in railway stations, and they have also provided offenders with their escape route; therefore, it has been considered that railway stations are one of the focal points for crime prevention. However, Japanese railway companies recently have started to pay much attention to businesses such as *eki-naka* (in station) and *eki-chika* (by station) shopping malls in addition to providing transport services. Given this situation, it is becoming important for the railway companies not only to reduce and deter actual and possible risks of crime in railway stations, but also give railway station patrons more reassurance and enjoyment. Keeping the station facilities as clean and kept up as much as possible is, then, very important from this perspective.

For rare but severe events, such as being attacked, it is difficult to lower people's encounter with these events because they are already very rare, and many people have never experienced them. As indicated in many studies, people's estimation of events is largely influenced by their perception of the potential outcome (Ferraro, 1995; Heilbrun et al., 2010; Shimada et al., 2004; Slovic et al., 2005). Thus, it would be advisable to temper the overestimation of the unpleasantness of these events. How could this be accomplished? As previous studies have indicated, negative feelings about potential events increase when people feel they have less control over a situation (Evans and Cohen, 1987; Jackson, 2009). Thus, a possible option would be to provide information to station users on safety measures in the station (evacuation routes, location of emergency call units etc.), which they can use to protect themselves in case of a real emergency. Such information would mitigate people's perceived lack of control of the types of events mentioned above and would temper the overestimation of unpleasantness concerning the events.

This chapter assessed the expectation and perception of crime and disorder experienced in railway stations in Tokyo, Japan. The findings showed that keeping the incivility of the environment to a minimum is important when it comes to improving people's comfort level in their use of railway facilities. However, the event list used in this study was originally from a European study, and did not include events specific to Tokyo, such as too much crowding on a train; thus, further studies are needed to clarify the issue and enhance Japanese people's comfort with using railway.

Acknowledgements

The authors especially thank Hana Oya, Seiro Kameoka, Masako Yamashita and Shinsai Sasaki for their great co-operation and support on this research project as working group members. We would also like to thank Vania Ceccato, Royal Institute of Technology, Sweden, for the useful comments and suggestions on the draft of this chapter, as well as the anonymous reviewers for their helpful and constructive comments.

Correspondence concerning this chapter and requests for copies should be addressed to Seiji Shibata, Department of Human Psychology, Sagami Women's University, 2–1-1 Bunkyo Minami-ku Sagamihara, Kanagawa, Japan. E-mail: s-shibata@star.sagami-wu.ac.jp.

References

Bates, D., Maechler, M. and Bolker, B. (2013) *Lme4*: Linear Mixed-Effects Models Using S4 Classes, R Package Version 0.999999–2, http://CRAN.R-project.org/package=lme4, accessed 20 April 2013.

Cabinet Office, Government of Japan (2012) Summary of the Special Survey of Public Opinion on Public Security [Chian ni kansuru tokubetsu chōsa' no gaiyō]. http://www8.cao.go.jp/survey/tokubetu/h24/h24-chian.pdf, accessed on 1 October 2013.

Carr, K., and Spring, G. (1993) Public Transport Safety: A Community Right and a Communal Responsibility. In: Clarke, R. V. (ed.) *Crime Prevention Studies*. New York: Criminal Justice Press, Volume 1, 147–155.

Covington, J., and Taylor, R.B. (1999) Fear of Crime in Urban Residential Neighborhoods: Implication of Between- and Within-Neighborhood Sources for Current Models. *Sociological Quarterly*, *32*, 231–249, doi: 10.1111/j.1533–8525.1991.tb00355.x.

Evans, G. W., and Cohen, S. (1987) Environmental Stress. In: Stokols, D., and Altman, I. (eds) *Handbook of Environmental Psychology*. New York: John Wiley, 571–610.

Ferraro, K. F. (1995) *Fear of Crime: Interpreting Victimization Risk*. New York: State University of New York Press.

Funyu, M., and Hanyu, K. (2003) Fear of Different Crimes in Different Types of Areas in a City. *EDRA Proceedings*, *34*, 220.

Heilbrun, K., Wolbransky, M., Shah, S. and Kelly, R. (2010) Risk Communication of Terrorist Acts, Natural Disasters, and Criminal Violence: Comparing the Processes of Understanding and Responding. *Behavioral Sciences and the Law*, *28*, 717–729, doi: 10.1002/bsl.940.

Jackson, J. (2006) Introducing Fear of Crime to Risk Research. *Risk Analysis: An Official Publication of the Society for Risk Analysis*, *26*, 253–264, doi: 10.1111/j.1539–6924.2006.00715.x.

Jackson, J. (2009) A Psychological Perspective on Vulnerability in the Fear of Crime. *Psychology, Crime and Law*, *15*, 365–390, doi: 10.1080/10683160802275797.

Kuznetsova, A., Brockho, P. B. and Christensen, R. H. B. (2013) *LmerTest:* Tests for Random and Fixed Effects for Linear Mixed Effect Models. R package Version 1.2–0, http://CRAN.R-project.org/package=lmerTest, accessed 20 April 2013.

Ministry of Land, Infrastructure and Transport Japan. (n.d.) The Present State of Urban Transport in the Three Biggest Metropolitan Areas: Based on the Metropolitan Transport Census in 2002 [Sandai toshiken ni okeru toshitetsudō no genjō]. http://www.mlit.go.jp/kisha/kisha03/01/010522/01/01_01.html, accessed 20 April 2013.

National Police Agency (2014) The Crime Situation in 2012 [Heisei 24nen no hanzai jōsei]. http://www.npa.go.jp/toukei/seianki/h24hanzaizyousei.pdf, accessed 5 May 2014.

OECD. (2009) Victimisation Rates. In: *OECD Factbook 2009: Economic, Environmental and Social Statistics*. Paris: OECD Publishing, 268–269.

Perkins, D. D., Florin, P., Rich, R. C., Wandersman, A. and Chavis, D. M. (1990) Participation and the Social and Physical Environment of Residential Blocks: Crime and Community Context. *American Journal of Community Psychology*, *18*, 83–115.

R Core Team. (2013) R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria, http://www.R-project.org, accessed 15 April 2013.

Saito, T. (1997) Japanese Private Railway Companies and Their Business Diversification. *Japan Railway & Transport Review*, *10*, 2–9.

Shimada, T., Suzuki, M. and Harada, Y. (2004) Fear of Crime and Perceived Risk: The Causes and Structures. *Japanese Journal of Sociological Criminology*, *29*, 51–64.

Slovic, P., Finucane, M., Peters, E. and MacGregor, D. (2002) The Affect Heuristic. In: Kahneman, D., Slovic, P. and Tversky, A. (eds) *Judgment under Uncertainty: Heuristics and Biases*. New York: Cambridge University Press, 397–420.

Slovic, P., Fischhoff, B. and Lichtenstein, S. (1982) Risk Perception. In: Gilovich, T., Griffin, D. and Kahneman, D. (eds) *Heuristics and Biases: The Psychology of Intuitive Judgment*. New York: Cambridge University Press, 463–493.

Slovic, P., Peters, E., Finucane, M. and MacGregor, D. (2005) Affect, Risk, and Decision Making. *Health Psychology*, 24m S35–S40, doi: 10.1037/0278–6133.24.4.S35.

Tokyo Metropolitan Area Transport Planning Council (2011) The Fifth Person Trip Survey of the Tokyo Metropolitan Area [pāson torippu chōsa kekka]. http://www.tokyo-pt.jp/person/01.html, accessed 1 October 2013.

Tversky, A., and Khanemann, D. (1974) Judgment under Uncertainty: Heuristics and Biases. *Science*, 185, 1124–1131, doi: 10.1126/science.185.4157.1124.

Uzzell, D., Brown, J. and Breakwell, G. (2000) *Public Perceptions and Attitudes Towards Crime, Safety and Security in Three International Railway Stations: Waterloo, La Gare de Lyon and Roma Termini*. Report to International Union of Railways, Paris.

Warr, M. (2000) Fear of Crime in the United States: Avenues for Research and Policy. In: Duffee, D. (ed.) *Measurement and Analysis of Crime and Justice: Criminal Justice 2000*. Washington, DC: US Department of Justice, 451–489.

Wilson, J. Q., and Kelling, G. L. (1982) Broken Windows. *Atlantic Monthly*, 249(3), 29–38.

Wilson, P., and Healy, P. (1987) Research Brief: Graffiti and Vandalism on Public Transport. *Trends and Issues in Crime and Criminal Justice, 6*, http://www.aic.gov.au/publications/tandi/ti06.pdf, accessed 1 May 2013.

Part V

A User Perspective on Transit Settings

16

Intimidated Riders: US Women's Perspectives about Safety in Transit Settings

Anastasia Loukaitou-Sideris

Introduction

> I am parking as close to my destination as I can. I'm definitely looking around and being very self-aware, understanding that it is important to be alert ... Some of our members are terrified about where they live; they are terrified for their children ... walking from bus stops to their home.
>
> (Amy Stear, personal communication, 2008)

Fear of victimization and crime is quite widespread among women. Fear of crime surveys report that women are more fearful of crime than men (Gordon and Riger, 1989). The fear of rape is prominent among women, but feminist scholars also argue about a continuity of violence that concerns women, and may include intimidation, groping, sexual comments, harassment and threats (Stanko, 1990; Morrell, 1996).

Fear affects mobility. Whether women travel by bus, automobile or other modes, their fear of transportation facilities – such as parking structures, buses, train cars and bus stops – affects the way in which they engage in travel and may preclude them from a basic right to the city: the ability to move carefree from origin to destination without worrying that a 'wrong choice' of mode, transit setting or time of travel might have consequences for their safety. Fear leads women to utilize precautionary measures and strategies that affect their travel patterns. These range from the adoption of certain behavioural mechanisms when in public, to choosing specific routes, travel modes and transit environments over others, to completely avoiding particular settings and activities (e.g. walking, bicycling) deemed as more unsafe. Additionally, researchers have argued that fear for personal safety can contribute to the social exclusion of women or other social groups, if it precludes their use of public spaces and/or transport services (Church et al., 2000; Lucas, 2010). This situation particularly applies to low-income, minority women living in high-crime neighbourhoods that typically have few transportation options.

Importantly for transit agencies, users' perspective of transit safety affects their ridership patterns. While captive riders (those with no other transportation alternatives) may seek to change their riding habits to avoid fearful settings, choice-riders (those who have access to alternative transportation modes) will simply not ride transit if they are afraid of the transit setting.

Some municipalities and local non-profits around the world have begun to address this issue by initiating programs and interventions to assess and remedy safety gaps in the built environment (Whitzman et al., 2012). A few of these programs have targeted transportation settings,[1] but still a lot needs to be done. Indeed, women suffer from sexual harassment on buses and trains in cities around the world, as recent 'transit rapes' in New Delhi, Rio, Los Angeles and Philadelphia have painfully indicated (Romero, 2013; Best, 2013).

This study documents the safety concerns and needs of women riders as identified by secondary data from empirical studies as well as first-hand interviews with representatives of women's interest groups in the United States. A literature review was conducted of scholarly studies, professional reports and newspaper articles focusing on women's fears and concerns about safety in public environments with a particular emphasis on transit settings. Additionally, 16 representatives of high-profile national women's interest groups in the United States were interviewed. All respondents had a leadership role in their organization. Each interview followed a semi-structured protocol and lasted for about one hour. A set of questions was initially sent to the interviewees inquiring about feared public and transit settings, the mobility needs and challenges faced by women in general and specific subgroups, in particular, as well as suggested actions and policies for women's safe travel. During the interview, respondents were asked to elaborate freely based on their own knowledge and with references to their members' experiences. Interviews were transcribed verbatim and sent back to the respondents for corrections and/or further elaboration.

The following sections set the issue of women's mobility in its larger theoretical and gendered perspective and proceed to examine women's fear of transit environments as a further impediment to mobility. Drawing from both primary and secondary sources, the article examines the needs, challenges and aspirations of women for safe travel.

Understanding gendered mobility

Historically, and in most societies, women's mobility in the city has been more hindered than men's. Feminist scholars agree that how people move (where, how fast, how often, etc.) is demonstrably gendered and continues to reproduce gendered power hierarchies" (Cresswell and Uteng, 2008:2). Indeed, gender distinctions in travel patterns hold true for both the Global North and the Global South (Law, 1999; Tanzarn, 2012).

This is attributed to a series of inequalities that impede women's mobility. For one, in many past and present societies women have had inferior access to power and economic or educational resources in comparison to men (Uteng, 2009). This often decreases their transportation options and makes them less likely to afford cars (TRANSGEN, 2007). While women's ownership and use of private automobiles has increased steadily over the years, women in most cities are more dependent on public transit than men. Such dependence may reduce the geographic range of their trips. One could even speculate that some women have to forgo 'extraneous' trips, which in turn reduces economic, educational or leisure opportunities.

Impeding women's mobility are also persistent sociocultural norms and roles that tend to code masculinity and femininity with a series of binaries, such as public/private, breadwinner/homemaker, mobile/static and bold/afraid. Depending on the sociocultural and temporal context, such binaries are more or less applied, but in general have served to hinder women's mobility. Thus, women in 19th-century America and Europe were expected to be primarily static, confined to the domestic/private sphere, while the city was widely open for the visual exploration of male flâneurs. Even today women in public (walking on the street, waiting for the bus or riding the train) are open to harassment and may be intimidated, followed or abused with sexual comments. Women's disproportionate domestic responsibilities also persist as they remain the primary caregivers for children and are the most responsible for domestic chores and household shopping. This reduces time for discretionary travel, increases obligatory short trips related to household chores and often forces women to look for jobs closer to home (Women's Planning Network, Inc., 1995; TRANSGEN, 2007).

One of the biggest hurdles to women's mobility remains the anxiety over possible victimization in public spaces, buses and trains. It has been argued that such fear represents a form of gender inequality embedded within the transit system (Dunckel-Graglia, 2013). Feminists have warned against the danger of stereotyping all women as vulnerable or afraid, reminding us that '*fear and boldness, although maybe gendered, are not essentially female or male qualities*' (Pain, 2001: 905). The fact, however, remains that fear constrains many women's movements around the city. Many of the feared spaces include transportation settings.

Women's fear of transportation settings

Fear and anxiety about personal security are important concerns for women transit riders. Fear of transit is more pronounced among certain social groups than others, but gender emerges as the most significant factor related to anxiety and fear about victimization in transit environments (Department for Transport, 2002). Researchers have also identified more pronounced levels of fear of public settings among the elderly (Brownson et al., 2001), certain ethnic groups (Clancy et al., 2001), the disabled (Iudici, Chapter 19 in this volume) and low-income people living in high-crime neighbourhoods (Craig et al., 2002; Seefeldt et al., 2002). For this reason, and as explained in the next chapter, it is important to 'situate individual experiences in particular social and geographic contexts' (Levin, Chapter 17 in this volume). Important differentiations may exist among women because of age, race, class, cultural and educational background, sexual orientation, prior victimization experiences and disability status (Loukaitou-Sideris, 2006). Thus, studies have found that women in poor neighbourhoods are typically afraid of being assaulted on the street (Ross, 2000), and that non-white women often experience higher levels of fear than white women (Ross, 2000). Similarly, women with disabilities and lesbian women are often more fearful of assault in public spaces (Morrell, 1996; Valentine, 1996). Nevertheless, researchers also explain that fear has its roots in different and complex causes (Alexander and Pain, 2012).

A study using crime data from Stockholm found that women and men respond to similar environmental conditions differently. Women are typically more fearful because they perceive a higher risk in public settings. Researchers attribute this to men's threatening sexual behaviour towards women that is displayed at times in public settings (Smith and Torstensson, 1997). Other empirical studies have also shown that women tend to be more sensitive than men to signs of danger and social disorder, graffiti, and unkempt and abandoned buildings (Wekerle and Whitzman, 1995).

Valentine (1990) emphasizes two categories of spaces as particularly frightening to women: enclosed spaces with limited exit opportunities such as multistorey parking structures, underground passages and subway stations, and empty open spaces such as desolate transit stops. The first provide opportunities for criminals to trap and attack their victims, while the second allow potential offenders to act outside the visual range of others.

Many of the feared spaces include transportation settings. Desolate transportation settings generate anxiety that no one will be there to help if a crime occurs. Surveys find women fearful of empty train wagons and bus stops and they also report anxiety if only one male passenger is present (Department for Transport, 1997, 2004). Women report feeling safer being on the bus than waiting at the bus stop because the presence of a bus driver is more reassuring than the unpredictability of the more open bus stop setting (Loukaitou-Sideris, 2009).

Significantly higher percentages of British women than men feel unsafe after dark in various transportation settings, as evidenced in surveys conducted by the British Department for Transport (2002, 2004) (Table 16.1). Thus, for example, 60 per cent of women, but only 25 per cent of men declared they feel afraid waiting on train platforms after dark. Similarly 49 per cent of women, but only 20 per cent of men stated they were afraid waiting at the bus stop after dark (Department for Transport, 2004). Empirical studies have

Table 16.1 Transportation settings where (British) women and men feel unsafe after dark

Women	Men
Walking in multistorey parking structures (62%)	Waiting on underground station platforms (32%)
Waiting on underground station platforms (61%)	Travelling on the underground (32%)
Waiting on train platforms (60%)	Walking in multistorey parking structures (31%)
Travelling on the underground (60%)	Waiting on train platforms (25%)
Walking from bus stop or station (59%)	Walking from bus stop or station (25%)
Travelling on train (51%)	Walking in surface parking lot (21%)
Walking in surface parking lot (51%)	Walking to bus stop or station (20%)
Waiting at a bus stop (49%)	Waiting at a bus stop (20%)
Walking to bus stop or station (48%)	Travelling on Train (20%)
Travelling on bus (40%)	Travelling on bus (18%)

Source: Department for Transport (2004), London, UK, p. 28

shown that women take precautions and make behavioural adjustments to the perceived risk in public and transit settings. If their financial situation allows, they often prefer to use their car or take a taxi rather than walk or use public transit (Wekerle and Whitzman, 1995; Stanko, 1990; Levin, Chapter 17 in this volume). Half of the women surveyed in a Canadian study, indicated that fear prevents them from using public transportation or parking garages (METRAC 2006). Women more than men tend to confine their use of public transit to certain hours of the day, or use it only if accompanied by boyfriends, spouses or friends (Atkins, 1989; Ross, 2000).

Research of passengers' perceptions of transit safety has intensified in response to the recognition that anxieties about crime are impeding travel choices and affecting transit ridership and revenue (Austin and Buzawa, 1984; Atkins, 1989; Ingalls et al., 1994; Wallace et al., 1999; Loukaitou-Sideris, 1999; Reed et al., 1999), and researchers have written guidelines for safer cities and transit environments (Wekerle and Whitzman, 1995; Needle and Cobb, 1997; Boyd and Boyd, 1998). Some of the aforementioned studies incorporate an analysis of gender differences in perceptions of safety on transit; however, the focus is not specifically on women and safety. A subset of studies has focused on women's concerns about personal safety in transit environments (Lynch and Atkins, 1988; Trench et al., 1992; Loukaitou-Sideris, 2005; Smith, 2008; Loukaitou-Sideris and Fink, 2009). But our increased knowledge about the causes of fear has not necessarily translated into nuanced policy responses tailored to the particularities of different groups and physical settings (Polk, 2008). Additionally, there remains a general lack of knowledge regarding specific female requirements for transit environments, even though 35 years have passed since Rosenbloom (1978) and Giuliano (1979) rejected the concept of the neutral commuter and brought attention to women's patterns of travel as distinguished from men's. Researchers have reasoned that this is partly due to the imperceptibility of women ... and the assumption that women and men are in the same situation, and therefore, have the same needs and attitudes' (Larsen and Topsøe-Jensen, 1984: 2).

Input of women riders

Empirical research in different countries has clearly established that women have distinct transportation needs (Rosenbloom, 1995; Loukaitou-Sideris and Fink, 2009). But few researchers, transit agencies or policymakers have directly asked women riders about their needs and preferences regarding safe travel. The limited information we have on this topic comes primarily from surveys and safety audits undertaken by women in the United Kingdom, Canada, Australia and Scandinavia.[2] From such surveys and audits, we know that women generally prefer staffing to technological solutions and are sceptical of transit agencies' tendency to replace staff with automated machines (Trench et al., 1992; Koskela, 2000). Discussing the findings of a 2002 survey by the Department of Transport in the United Kingdom, Carter (2005:100) explained that

> when traveling by bus, women prefer an additional staff member and the refusal by the driver to board those influenced by alcohol or drugs, whereas men prefer CCTV and in-vehicle radio contact for the driver. On trains, women and men both prefer to have a staff member walking through a train, although for women the preference is more marked.

Similarly, an earlier survey of women in Southampton, England, found that they repeatedly favoured more staff and police officers on buses, parking lots and streets (Lynch and Atkins, 1988).

Retrofitting station platforms and bus stops with closed-circuit television (CCTV) cameras seems to offer little comfort to women. Problematizing this practice, Koskela (2000) argues that it contributes to accentuating gender imbalances, as most of the subjects under control in public transportation settings are women, while most of the people behind the surveillance cameras are men. Furthermore, CCTV cameras can do little to interrupt sexual harassment. Indeed, female participants in focus groups and workshops in Nottingham, England, argued that they '*do not feel more secure in the knowledge that someone, somewhere is supposed to be watching them*' (Trench et al., 1992: 291). Similarly a study of transit passenger reactions to implemented safety measures in Ann Arbor, Michigan, found that while CCTV cameras were the most noticed of the various security improvements, they did not have a significant impact on passengers' feelings of safety (Wallace et al., 1999).

Certain design measures seem to have a positive effect in reducing women's fear. Surveys of women passengers in the United Kingdom (Lynch and Atkins, 1988; Trench et al., 1992), Canada (Scarborough Women's Centre/METRAC, 1991) and the United States (Wallace et al., 1999) showed that good lighting has a positive role in reducing women's fear. Women conducting safety audits in Scarborough, Canada, indicated, however, that good lighting should extend from the bus stops to the adjacent streets so that bus stops avoid the 'fishbowl effect'[3] (Scarborough Women's Centre/METRAC, 1991). Good visibility and natural surveillance opportunities of transit stops and stations from surrounding establishments emerged as a positive feature in a nationwide survey in the United Kingdom. In contrast, survey participants argued that they often felt unsafe and entrapped in corridors and ramps leading to underground stations. The same respondents also stated that the presence of graffiti and litter at transit settings, the absence of visible staff, the inadequacy of travel information, long wait times and infrequent service contributed to feelings of insecurity (Transport for London, 2004).

Women have mixed reactions to segregated transport schemes, which establish women-only services or women-only cars on trains and buses. Women in Brazil and Mexico seemed to appreciate these services (Khimm, 2006; Dunckel-Graglia, 2013), while women in Southampton, England, were concerned that segregated transport facilities would draw attention to them as targets (Lynch and Atkins 1988). Policies that receive high marks include request-stop programs, which allow women to disembark from the bus at locations closer to their final destination during late-evening hours, and public awareness campaigns denouncing groping (Trench et al., 1992; Schulz and Gilbert, 1996).

Interviews with representatives of women's interest groups in the United States

To get a better grasp of the concerns of women riders in the United States, we conducted 16 in-depth interviews with leaders of national women's interest groups (see list at end of this chapter). Their representatives talked eloquently and passionately on behalf of their members and themselves, and highlighted a number of issues relating to women's fears, needs and aspirations for safe travel.

Many interviewees stressed the interconnectedness of transit safety/security to other issues important to both men and women. They reasoned that transit security relates to economic security (access to better jobs, educational opportunities and pay), which leads to better housing and neighbourhood environments. For poor women, safe public transportation is also important in order to accomplish everyday tasks (Amy Stear, personal communication).

Women's fear of public settings. The overwhelming sentiment was that safety issues are more prominent for women than men. Some believed that women's fears are justified because '*most public spaces in urban communities are dangerous for women*' (Eleanor Hinton Hoytt, personal communication, 2008), while others indicated that this fear is socially constructed:

> Our culture has done a very good job of convincing women that we are unsafe in public space and that we should not go to certain places at certain times, where certain people might be present, and that if we follow those rules we'd be safe. I think that we are probably safer in public space, and those arbitrary forms of social control are lies. (Lynne Johnson, personal communication 2008)

Some respondents referred to statistics showing that the majority of violent acts against women happen by people they know in domestic and private environments. Others, however, pointed to the significant underreporting of sexual harassment in public spaces, stating that 'harassment transcends age, race, and income for both harassers and victims. It is consistently felt by women in transit or walking around the city' (Brittney Hoffman, personal communication, 2008). One interviewee estimated that 60 per cent to 80 per cent of sexual assault and harassment incidents are never reported to the police (Denise Snyder, personal communication, 2008). This claim is consistent with a 2007 survey that found that 63 per cent of respondents had been sexually harassed on the New York City subway, but only 4 per cent of those harassed contacted the authorities to file a report (Stringer, 2007). Underreporting was attributed by some to a misplacement of the blame for the crime onto the victim rather than the perpetrator:

> What happens if a woman is harmed or hurt? If she is out in public in the evening, or at a place she shouldn't go, then she is blamed for violating the rule of social control. (Lynne Johnson, personal communication, 2008)

Feared transit settings. Women preferred private automobiles and taxis to riding public transit because of their perceived safety, even though one respondent emphasized that considerable harassment also occurs in taxicabs for lesbian, gay or transsexual individuals. Riding on the metro was considered safer than riding the bus, which was in turn preferred to walking or waiting at a bus stop:

> I don't take the bus because it is unpredictable, uncomfortable, unsafe, and not fast – the worst of all worlds ... Most women feel much safer and

> don't hesitate to go out at night if they have a car and a safe place to park it. They do hesitate if they have to walk three blocks to the bus stop. (Diana Zuckerman, personal communication, 2008)
>
> It is definitely safer to be waiting at a metro station than on a street corner for the bus. (Denise Snyder, personal communication, 2008)

Other feared transportation settings included 'dimly lit parking lots', 'parking garages', 'walkways connecting station platforms to park-and-ride facilities' and 'unstaffed stations with no service and ticket booths'. Representatives of the Older Women's League (OWL) also characterized as unsafe, settings in which older women may trip and fall, such as

> streets without sidewalks, bus shelters without lighting, benches too close to the curb, crosswalks with short signal timing, and metro escalators not well marked for ingress and egress. (Shelia Willet, personal communication, 2008)

Consistent with the findings of other empirical studies, many respondents argued that certain environmental characteristics, such as dark, desolate or confined spaces, contribute to a perceived lack of safety.

> I got off the wrong stop, and it was really deserted. My heart rate went up a little bit because there wasn't anybody around. (Nancy Hughes, personal communication, 2008)
>
> The smaller more confined spaces where there aren't a lot of people around are more dangerous for women. (Brittney Hoffman, personal communication, 2008)

In contrast, positive environmental characteristics such as cleanliness, good visibility and presence of staff, police or other passengers contribute to feelings of safety. Interviewees living in Washington, DC (where many of the women's interest groups have national headquarters), gave the DC Metro high marks in terms of safety because it exhibits these positive environmental characteristics.

> The DC Metro, which has lots of transit safety personnel and is designed well with lots of lighting and numerous station managers at entrances, and officers who ride its trains, is safer than other public transit systems in large cities. (Jan Erickson, personal communication, 2008)

<u>Behavioural adjustments</u>. Fear felt by many women leads to behavioural adjustments and precautions – not walking alone, avoiding certain settings, avoiding travel in the evening, not using public transportation, not wearing

certain types of clothing or jewellery. Some of the interviewees confirmed the argument of feminist criminologists, that the fear of crime may be more potent than the actual risk.

> I am always looking for cues to establish if the environment is safe. Does the parking lot have lights? Are the street lights on? Is there anyone else entering the elevator? There's definitely a need to be aware of all that whenever I am walking from my car to the transit station. (Rev. Della Fahnestock, personal communication, 2008)
>
> When you are by yourself you have to really watch where you go, try to eliminate going in certain areas, going alone at dark, and watch what you carry in your purse. When I am at the metro I watch who is in the car. I am very uncomfortable if I'm the only woman in the car. I'll move to another car... You really have to use precautions wherever you are. You don't want to go out at night carrying a big purse and look like a target. I try not to wear hooded clothing that someone can grab. (Nancy Hughes, personal communication, 2008)
>
> You have to be thinking of things that could happen and try to limit those situations. Not running around scared, but at the same time don't leave yourself open for something to happen. (Alma Morales Roja, personal communication, 2008)
>
> Whenever I use the bus or metro I have my fare card or bus money ready and never open my purse in public. Otherwise, you are asking for mugging. (Shelia Willet, personal communication, 2008)

The perception of women's not belonging in public was echoed in some responses. Some argued that fear makes them feel the need to manufacture legitimacy for their presence in public spaces. Jogging, walking the dog or waiting for the bus are viewed as more legitimate activities in public spaces than 'aimlessly' waiting at a street corner.

Distinct needs of women. There was consensus that women riders have distinct safety needs, which are influenced by age, race and income. Some argued that 'safety issues are more prominent for women. Not only are they fearing for their own safety, but for their kids' safety as well' (Anita Rees, personal communication, 2008). Others reasoned that 'women passengers have distinct safety needs because they are not physically built to be as strong as most men and they are often preyed upon by men' (Diana Zuckerman, personal communication, 2008). Still others argued that women are easier targets and more susceptible to transit crime because they carry easy-to-grab purses (Ashley Carson, personal communication, 2008). Some underlined that it is the risk of sexual assault in transit settings that makes women's needs different from those of men.

> Women face different issues than men in regards to security in public transport. I'd be concerned about my son riding the bus as it relates to groups of young men targeting and picking on him, but I would be worried about my daughter as it relates to sexual assault. I don't think that I would allow her to ride alone. (Amy Stear, personal communication, 2008)

Some made special mention of the hardship and resulting greater safety needs of older women, who 'are easier to prey upon and overcome' (Diana Zuckerman, Caroline Andrew, personal communication, 2008) and mothers travelling with children (Shelia Willet, personal communication, 2008), as well as low-income women who are 'less likely to have a car and more likely to use buses, and are more at risk because they have to work late and rely on public transportation' (Rees, Anita; Snyder, Denise; Morales Roja, Alma, personal communication, 2008). One respondent also stressed that the environmental characteristics of transit settings in low-income neighbourhoods are inferior to those in more affluent areas.

Suggested Actions and Policies. Respondents had a wealth of suggestions to offer for making transit environments safer and more fitting to the needs of women. These suggestions can be classified into strategies that use environmental design, security technology, policing and education/information, as well as other policy changes

Design strategies. Design can be applied to different components of the transportation network in an effort to enhance the environmental factors that reduce fear and eliminate or curtail those who promote it. Siting bus stops near people and activities was deemed essential to achieving 'safety in numbers.' Additionally, general maintenance and upkeep of transit facilities, and the regular cleaning of graffiti and litter were found to provide comfort to riders.

> Keeping an environment clean not only encourages positive behaviour therefore discouraging potential perpetrators; it also makes things feel comfortable for someone who might have anxiety or fear. (Denise Snyder, personal communication, 2008)

Good lighting of all aspects of the transportation network, including bus stops, platforms, parking lots and streets, was mentioned by all as extremely important:

> Lighting is huge. It's not that crime doesn't happen in broad daylight, but it seems that lighting would reduce incidents. (Amy Stear, personal communication, 2008)
>
> Transit settings do not have as much lighting as they should. Every parking lot at every line should have good lighting. Agencies should make

> sure that there is a well-lit area around the station with no dark corners. That's an easy fix. There's no excuse for not having good lighting. (Alma Morales, personal communication, 2008)

Some respondents also asked for bus shelter designs that allow good visibility from the surroundings, have minimum advertising blocking views from the street and incorporate armrests on benches to discourage public sleeping.

Security technology strategies. Respondents emphasized that the presence of staff provides a level of security unattainable through technological substitutes. Nevertheless, one respondent found that technology could be very useful in providing real-time scheduling information at bus stops for predictability, reliability and efficiency, and to reduce extended waiting. Other security technology devices mentioned included emergency buttons and phones on trains, buses and bus stops. CCTV cameras received mixed marks, but most respondents were in favour of using them:

> Cameras are controversial. Some people want more; others realize that they just move crime from one corner to the other. But if we are talking about transit, I can see an impact of having this kind of presence, so that women do not feel alone standing at the bus stop. (Lynne Johnson, personal communication, 2008)

> I am not sure how I feel about security cameras. We are a surveillance society but at the same time I am sure that cameras help catch people doing what they shouldn't be doing, or maybe even possibly be a deterrent to acts of crime. (Amy Stear, personal communication, 2008)

Policing. Some respondents argued that hiring additional security guards and staff to patrol transit stops and the routes connecting them to various destinations, especially in poor neighbourhoods, would increase safety. They stressed that security officers should be visible primarily during the early-morning and late-evening hours, when transit settings are desolate. Security officers should not only be present on station platforms but also at parking lots and pathways leading to the platform. The presence of homeless and other destitute individuals at transit settings, while often harmless, was mentioned as a cause of concern for many women riders.

Education/Information strategies. Some respondents expressed the desire to see transit agencies organizing public education workshops and events, and encouraging the reporting of sexual harassment, instead of hushing up their incidence. Others stressed the importance of public signs which encourage victims or bystanders to speak up and report crime, such as those that started appearing at New York's subway stations pointing out that 'sexual harassment is a crime in the subway, too', which encourage victims or bystanders 'to speak up and report crime'. Some also argued that responsibility should not stop with the transit agency. Cultural shifts in attitudes can only be achieved through education in schools. Education and awareness for both women and men of all ages is needed to help define appropriate behaviour, redirect responsibility to the perpetrator, promote awareness and encourage intervention. As stressed,

> We need more public education and messages to achieve an enormous cultural change in how our system responds to gender-based bias ... The very first narrative from the media and everyone is 'what did she do wrong to cause this'. The recipient of violence is responsible for ensuring her own safety. That's the wrong message. It should be the other way around: Why do we have a culture that breeds this level of violence and how can we disrupt it? (Lynne Johnson, personal communication, 2008)

Other Policies. Respondents suggested a number of policies as particularly beneficial to women riders, such as 1) providing escort programs for female passengers during early-morning or late-evening hours; 2) allowing female passengers to get off the bus where they want at night; 3) providing reliable information about bus schedules to minimize waits; 4) ensuring reliable public transportation and locating more bus stops in poor neighbourhoods so that people do not have to walk for long distances; 5) providing cab vouchers to low-income women for use in emergency situations; 6) developing demonstration projects or best practice case studies so that cities and transit agencies learn from one another; and 7) ensuring better incorporation of women's voices into the transportation planning process.

It was also argued that policymakers should consider policies that enable car ownership and car sharing for low-income women because private automobiles and car-sharing programs provide women with more safety and convenience. Lastly, some emphasized the importance of grass-roots actions and community responsibility for fighting back against harassment and violence:

> It would be helpful if the community in general, whether it is government, community organizations, churches, is verbal in the spaces they occupy (shops, libraries, clinics), and say 'this is a safe place that you can come'. This means that you can come in here to just take a break, or report crime, or just get support. This community-based strategy is a way to make the community feel that they have a role to play in our safety. (Lynne Johnson, personal communication, 2008)

Conclusion

The previous suggestions outline a clear gender perspective in transportation planning, which is unfortunately often neglected and misunderstood. In the United States, surveys of transit operators have found that they are gender neutral in their policies, leading to a significant mismatch between the security needs of female riders and the adopted strategies. Two-thirds of transit operators do not perceive the need for women-focused safety programs (Loukaitou-Sideris and Fink, 2009). Even countries such as the United Kingdom and Sweden that have initiated gender mainstreaming policies have encountered important challenges in their implementation.[4] Polk (2008: 232) attributes this to lack of knowledge about and systematic strategy for gender equality as well as lack of resources for implementation.

But this 'gender gap' in mobility should concern transit agencies and policymakers. For one, women's reluctance to walk, bike or use public transit out of safety concerns counteracts many cities' promotion of greener travel modes. Second, an aging society means that many more elderly women than in previous generations would have to rely on public transportation after they became unable to drive. They need to feel comfortable that their transit trip will deliver them safely to their destination. Lastly, and importantly, planning and implementation of strategies seeking to close the gender gap in mobility would not only improve life for women but also positively affect their families, and should not be narrowly classified as just a 'woman's issue.' A daughter, mother or wife who feels comfortable in her travel around the city does not need to rely on a parent, spouse or child to transport her. Indeed, unimpeded mobility and accessibility to safe transportation are extremely important for both men and women. Safe travel should, therefore, be seen as an important right of citizens. The safety and security suggestions presented by the women interviewed are relevant not only for transit and police agencies but also for city planners and policymakers. They represent the necessary first steps towards a transportation system that serves the needs of both male and female passengers, and achieves what one of our interviewees referred to as 'nothing less but transportation justice'.

Acknowledgement

This study was supported by a grant from the Mineta Transportation Institute.

List of Interviews

- Andrew, Caroline, Board President, Montreal, Canada, *Women in Cities International.*

- Burkhardt, Patricia, Legislative Officer, Washington DC, *Church Women United*.
- Carson, Ashley, Executive Director, Arlington, VA, *Older Women's League (OWL)*
- Erickson, Jan, Director of Programs, Washington DC, *National Organization for Women Foundation*.
- Rev. Fahnestock, Della, President, York, PA, *Alliance of Faith and Feminism*.
- Gallagher, Mary Jane, Chief Executive Officer, Washington, DC, *National Family Planning and Reproductive Health Association*.
- Hinton Hoytt, Eleanor, President, Washington, DC, *Black Women's Health Imperative*.
- Hoffman, Brittney, Campus Director, Washington, DC, *Gender Public Advocacy Coalition*.
- Hughes, Nancy, Director of the Center for Occupational and Environmental Health, Washington, DC, *American Nurses Association*.
- Johnson, Lynne, Director of Advocacy, Chicago, *Chicago Foundation for Women*.
- Morales Roja, Alma, President and Chief Executive Officer, Washington, DC, *National Latina Association (MANA)*.
- Rees, Anita, Associate Director, San Leandro, CA*; Low Income Families Empowerment Through Education (LIFETIME)*.
- Snyder, Denise, Executive Director, Washington DC, *DC Rape Crisis Center*.
- Stear, Amy, Wisconsin Director, *9 to 5, National Association of Working Women*.
- Willet, Shelia, President, Washington, DC, *Older Women's League (OWL)*.
- Zuckerman, Diana, President, Washington, DC, *National Research Center for Women and Families*.

Notes

1. Transport for London (TfL) has initiated plans targeting the needs of women riders. In Mexico City, the municipal government started the WE TRAVEL SAFE program in 2007, with the goal of preventing physical and sexual violence in the city's public transportation system. In Canada, a number of municipal governments have funded METRAC to train community and women's groups to conduct safety audits of transportation settings. In 2005, the Government of South Australia launched a program called Our Commitment to Women's Safety, which focuses on improving the safety and security of transportation settings.
2. In safety audits, women walk around a transportation setting or public environment noting their fears and concerns, and making suggestions for improved safety.
3. The 'fishbowl effect' describes the situation in which a bus shelter is brightly lit, but the surrounding environment is dark. In such a case the passenger is seen, but he/she is unable to see others outside the bus shelter.

4. Gender mainstreaming denotes the integration of a gender perspective into policy processes with the goal of promoting equality of men and women.

References

Alexander, C. and Pain, R. (2012) Urban Security: Whose Security? Everyday Responses to Fears. In: Ceccato, V. (ed.) *The Urban Fabric of Crime and Fear.* New York and London: Springer, 37–53.

Atkins, S. (1989) *Critical Paths: Designing for Secure Travel.* London: Design Council.

Austin, T., and Buzawa, E. (1984) Citizen Perceptions on Mass Transit Crime and Its Deterrence: A Case Study. *Transportation Quarterly*, *38*(3), 103–120.

Best, A. (2013) Transit Violations: Locating the Bus Rape in L.A. and Other Public Geographies of Violence. *The Feminist Wire.* http://thefeministwire.com/2013/02/transit-violations-locating-the-bus-rape-in-l-a-and-other-public-geographies-of-violence/, accessed 21 June 2013.

Boyd, A., and Boyd, P. (1998) *Transit Security Handbook*, Report FTA-MA-90–9007–98–1, DOT-VNTSC-FTA-98–4, FTA, Washington, DC: US Department of Transportation.

Brownson, R. C., Baker, E. A., Houseman, R. A., Brennan, L. K. and Bacak, S. J. (2001) Environmental and Policy Determinants of Physical Activity in the United States. *American Journal of Public Health*, *91*(12), 1995–2003.

Carter, M. (2005) Gender Differences in Experience with and Fear of Crime in Relation to Public Transport. In: *Research on Women's Issues in Transportation*, Volume 2, Conference Proceedings 35, Washington DC: Transportation Research Board, 100.

Church, A., Frost, M. and Sullivan, K. (2000) Transport and Social Exclusion in London. *Transport Policy, 7*, 195–205.

Clancy, A., Hough, M., Aust, R. and Kershaw, C. (2001) *Policing and Justice: The Experience of Ethnic Minorities – Findings from the 2000 British Crime Survey*, London: Home Office.

Craig, C. L., Brownson, R. C., Craig, S. E. and Dunn, A. L. (2002) Exploring the Effect of the Environment on Physical Activity: A Study Examining Walking to Work. *American Journal of Preventive Medicine*, *23*(2), 36–43.

Cresswell, T., and Uteng, T. P. (2008) Gendered Mobilities: Towards a Holistic Understanding. In: Uteng, T. P., and Cresswell, T. (eds) *Gendered Mobilities*. London: Ashgate, 1–14.

Department for Transport. (1997) *Crime Concern and Transport and Travel Research: Perceptions of Safety from Crime on Public Transport.* London. Department for Transport.

Department for Transport. (2002) *People's Perception of Personal Security and their Concerns about Crime on Public Transport: Literature Review.* London. Department for Transport

Department for Transport. (2004) *People's Perception of Personal Security and their Concerns about Crime on Public Transport: Research Findings*. London, UK.

Dunckel-Graflia, A. (2013) Women-Only Transportation: How 'Pink' Public Transportation Changes Public Perception of Women's Mobility. *Journal of Public Transportation*, *16*(2), 85–106.

Giuliano, G. (1979) Public Transportation and the Travel Needs of Women. *Traffic Quarterly, 33*(4), 607–616.

Gordon, M., and Riger, S. (1989) *The Female Fear.* New York: The Free Press.

Ingalls, G., Hartgen, D. and Owens, T. (1994) Public Fear of Crime and Its Role in Bus Transit Use. *Transportation Research Record*, No. 1433, 201–211.

Khimm, S. (2006) Warning: No-Groping Zone. Available at http://www.alternet.org/module/printversion/35753, accessed 6 June 2006.

Koskela, H. (2000) 'The Gaze without Eyes': Video-Surveillance and the Changing Nature of Urban Space. *Progress in Human Geography*, *24*(2), 243–265.

Larsen, V., and Topsøe-Jensen, H. (1984) *Urban Planning and the Everyday Life of Women*. Hørsolm: Danish Building Research Institute, Urban and Regional Planning Division.

Loukaitou-Sideris, A. (1999) Hot Spots of Bus Stop Crime: The Importance of Environmental Attributes. *Journal of the American Planning Association*, *65*(4), 395–411.

Loukaitou-Sideris, A. (2005) Is It Safe to Walk Here? Design and Policy Responses to Women's Fear of Victimization in Public Places. In: *Research on Women's Issues in Transportation*. Volume 2, Conference Proceedings 35, Washington DC: Transportation Research Board, 102–112.

Loukaitou-Sideris, A. (2006) Is It Safe to Walk? Neighborhood Safety and Security Considerations and Their Effects on Walking. *Journal of Planning Literature*, *20*(3), 219–232.

Loukaitou-Sideris, A. (2009) *How to Ease Women's Fear of Transportation Environments: Case Studies and Best Practices*. San Jose, CA: Mineta Transportation Institute Report 09–01.

Loukaitou–Sideris, A., and Fink, C. (2009) Addressing Women's Fear of Victimization in Transportation Setting: A Survey of US Transit Agencies. *Urban Affairs Review*, 44(4), 554–587.

Lucas, K. (2010) Transport and Social Exclusion: Where Are We Now? 12th World Conference On **Transport** Research Society (WCTR), 11–15 July 2010, Lisbon, Portugal http://www1.caminos.upm.es/music1/files/04_seminarios/1_Sem/05/descargas/5_Transport_Exclusion_Karen%20Lucas.pdf. Accessed 4 September 2013.

Lynch, G., and Atkins, S. (1988) The Influence of Personal Security Fears on Women's Travel Patterns. *Transportation*, 15, 257–277.

Metropolitan Action Committee on Violence Against Women and Children (METRAC). (2006) Why Women's Safety? http://www.metrac.org/programs/safe/why.htm, accessed on 16 October 2007.

Morrell, H. (1996) Women's Safety. In: Booth, C., Darke, J. and Yeandle, S. (eds) *Changing Places: Women's Lives in the City*. London, Paul Chapman Publishing Ltd, 100–110.

Needle, J.R. and Cobb, M. (1997) *Improving Transit Security*. Transit Cooperative Research Program, Washington DC: National Academy Press.

Pain, R. (2001) Gender, Race, and Fear of the City. *Urban Studies*, 38(5/6), 899–914.

Polk, M. (2008) Gender Mainstreaming in Swedish Transport Policy. In: Uteng, T. P. and Cresswell, T. (eds) *Gendered Mobilities*. London: Ashgate, 229–242.

Reed, T. B., Wallace, R. W. and Rodriguez, D. A. (1999) Transit Passenger Perceptions of Transit-Related Crime Reduction Measures. *Transportation Research Record*, No. 1731, 130–141.

Romero, S. (2013) Public Rapes Outrage Brazil, Testing Ideas of Image and Class. *New York Times*. 25 May 2013. http://nytimes.com/2013/05/25/world/Americas/rapes-in-brazil-spur-class-and-gender-debate.html?pagewanted=all&_r=0, accessed 20 June 2013).

Rosenbloom, S. (1978) Editorial: The Need for Study of Women's Travel Issues. *Transportation*, *7*, 347–350.

Rosenbloom, S. (1995) Travel by Women. In: *Demographic Special Reports* (1990 NPTS Publication Series), FHWA, US Department of Transportation, 2–1 to 2–57.

Ross, C. E. (2000) Walking, Exercising, and Smoking: Does Neighborhood Matter? *Social Science and Medicine*, *51*(2), 265–274.

Scarborough Women's Centre/METRAC (1991) *Making Transit Stops Safer for Women: Scarborough Moves Forward*. Scarborough, Canada, METRAC.

Schulz, D. and S. Gilbert. (1996) Women and Transit Security: A New Look at Old Issues. In: *Women's Travel Issues Second National Conference*. Washington, DC: Federal Highway Administration, 551–562.

Seefeldt, V., Malina, M. R. and Clark, M. A. (2002) Factors Affecting Levels of Physical Activity in Adults. *Sports Medicine*, *32*(3), 143–168.

Smith, M. J. (2008) Addressing the Security Needs of Women Passengers on Public Transport. *Security Journal*, *21*, 117–133.

Smith, W., and Torstennson, R. (1997) Gender Differences in Risk Perception and Neutralizing Fear of Crime – Towards Resolving the Paradoxes. *British Journal of Criminology, 37*(4), 608–634.

Stanko, E. (1990) *Everyday Violence: Women's and Men's Experience of Personal Danger*, London: Pandora.

Stringer. S. M. (2007) *Hidden in Plain Sight: Sexual Harassment and Assault in the New York City Subway System,* 26 July, http://www.nytimes.com/packages/pdf/nyregion/city_room/20070726_hiddeninplainsight.pdf. Accessed on 2 October 2008.

Tanzarn, N. (2008) Gendered Mobilities in Developing countries. In: Uteng, T. P., and Cresswell, T. (eds) *Gendered Mobilities*. London: Ashgate, 145–159.

TRANSGEN (2007) *Gender Mainstreaming European Transport Research and Policies*. Copenhagen: Coordination for Gender Studies, University of Copenhagen

Transport for London (TfL) (2004) *Expanding Horizons: Transport for London's Women's Action Plan*. London, Department of Transport.

Trench, S., Oc, T. and Tiesdell, S. (1992) Safer Cities for Women: Perceived Risks and Planning Measures. *Town Planning Review*, *63*(3), 279–293.

Uteng, T. P. (2009) Gender, Ethnicity, and Constrained Mobility: Insights into the Resultant Social Exclusion. *Environment and Planning A*, *41*, 1055–1071.

Valentine. G. (1990) Women's Fear and the Design of Public Space. *Built Environment*, *16*(4), 288–303.

Valentine, G. (1996) (Re)negotiating the 'Heterosexual Street': Lesbian Production of Space. In: Dunkan, N. (ed.) *Body Space: Destabilizing Geographies of Gender and Sexuality*. London: Routledge, 145–153.

Wallace, R. R, Rodriguez, D. A., White, C. and Levine, J. (1999) Who Noticed, Who Cares? Passenger Reactions to Transit Safety Measures. *Transportation Research Record*. No. 1666, 133–138.

Wekerle, G., and Whitzman, C. (1995) *Safe Cities: Guidelines for Planning, Design and Management*. New York: Van Nostrand Reinhold.

Whitzman, C., Legacy, C., Andrew, C., Klodawsky, F., Shaw, M. and Viswanath, K. (eds) (2012) *Building Inclusive Cities: Women's Safety and the Right to the City*. London: Routledge.

Women's Planning Network Inc. (1995) *Women's Transport Needs*. Victoria: Australia.

17

Gender Equality and Safety, a Challenge for Transport Planning: Moving Away from Stereotypes and Stereotypical Attitudes and Habits

Lena Levin

Introduction

For a long period of time, developments in technological and traffic safety for transport policy and planning have been dominated by an engineering perspective. However, transport policy is now increasingly facing dilemmas between the sustainability dimensions of economic, environmental and social constraints. The aim of this chapter is to examine how gender equality and safety for transport users have been adopted into policy and practice in Sweden. The chapter takes as its starting point previous research, European conditions and conditions in Sweden, in which the gender equality concept has a long tradition in both policy and practice. The empirical examples are taken from research data on focus group discussions, qualitative interviews and discussions in meetings between planning staff. The gender equality objective taken most notice of in transit and transport planning in Sweden is in fact safety, but sometimes this negatively reflects stereotypes of both women and men.

More recent examinations and thinking into transportation safety, in combination with the concepts of mobility and accessibility, make it clear that this is not (and cannot be) a 'gender neutral' subject. Travel trajectories and safety issues are gendered; moreover, they have accumulated during earlier 'technological solutions' and are manifest in traffic safety programmes, road construction, urban planning, parking strategies, constructions of transit points, walking paths and so on, all of which have implications for people's everyday lives. In the past few decades, in transport planning and research, complicated methodological and theoretical questions have been addressed, and nowadays more social science-oriented views, comprising more user-oriented knowledge, have entered the discussion on transport planning and technological development.

Safety and security issues in transport planning have long been influenced by studies originating in feminist research, with contributions about the gendered organization of places and the male control of public space (Burns Lehman Schlozman and Verba 2001; Cresswell and Uteng, 2008). However, the relationship between physical space and its social and psychological dimensions is very complex and constantly changing (Ceccato, Uittenbogaard and Bamzar, 2013; Uittenbogaard and Ceccato, 2014). Transport environments may have some influence on fear but, following the notions of Koskela and Pain (2000), perhaps of equal or even greater significance are the ways in which fear shapes our understanding, perceptions and use of space and place. In contrast, the concept of 'gender equality' is connected with a wider discussion of social impacts on development, which influence safety issues and, moreover, imply a need to reconsider previous strategies. There is a need for studies to situate individuals' experience in particular social and geographical contexts (see also Sochor in this volume). From a social constructionist view, many activities, professions/roles and positions in Western societies are already gender marked and often reinforced by popular culture. Social programmes can stimulate opposition to existing arrangements and descriptions, and presume encouragement for individuals (see also Loukaitou-Sideris in this volume).

After this introduction, the next section briefly outlines the concepts of safety and social implications, and the policy objectives based on the concept of gender equality. This is followed by a section on methodology and descriptions of the empirical material used for the analysis in this chapter. A section presenting results, with examples, is followed by a final discussion.

Social dimensions and safety development

In addressing the free movement of citizens and goods, Europeans take mobility for granted. At the same time, however, free movement raises questions as to how transport infrastructure affects social life. In European countries, transport planning is often carried out by staff such as engineers with no training in the social sciences. More generally, social issues are only sporadically integrated into practice, and only in certain development projects. In the case of 'safety', we have recently witnessed a rising awareness of the importance of gender issues and issues of ageing (in other words, older people's perceptions of transport environments), which has stimulated spatial planning prospects, but there is still uncertainty among planners about how to adopt and implement gender equality perspectives.

The International Conference on Women's Issues in Transportation, organized by the Transportation Research Board (TRB) and sponsored by several associations and national agencies, usually has at least one session addressing transport safety for women and women's personal security. At the fourth conference (2008), the session on fear and anxiety in public spaces and transport environments addressed research questions such as: How does fear obstruct women's movement around the city? How have research and practice responded to women's concerns about safety and security in travel? What research and policy directions would be promising in terms of addressing women's fear of transport environments? Researchers in these areas highlight how female passengers have distinct safety and security needs, and report on specific safety programmes for women. Programmes of this kind include, for example, 'request stops' late in the evening (which means the driver will pick up or set down anywhere along the route, rather than only at designated bus stops), real-time information on vehicle arrival times, taxi vouchers for women on low incomes, and public signs denouncing sexual harassment (TRB, 2010). These programmes illustrate a dilemma, which is that safety in transport is often considered and discussed as a women's issue. Talking about gender and safety in public transport environments has traditionally been surrounded by discussion about women's fear of violence and harassment in connection with crime reports. However, violence and fear are context bound, and an intersectional perspective (cf. Lykke, 2003, 2005, 2008) based on transport users' experiences (as suggested in this chapter) could widen the discourse and our understanding. An intersectional approach means taking into account people's multiple identities and considering that categories are overlapping (such as e.g. gender, age, ethnicity, economy, profession and experiences). When used in combination with the concepts of activity and interaction, the intersectional approach may widen our understanding of people's everyday life and opportunities for safe mobility.

The process of broadening discussions to transport environments widens the concept of place and space to the 'whole journey' and the time-space experience of users. It enables the combination of various modes of transport, public transport in combination with bicycling, walking and private cars. The whole-journey concept implies not just interdisciplinary research questions (and collaboration with different disciplines) but also transdisciplinary questions that come from the transport users' experiences and the planning practitioners' interpretations of the solutions (Geurs 2009; Hadorn et al., 2006).

Over the past few decades there has been a critique of 'gender-blind' transport and urban planning (cf. Law, 1999; Listerborn, 2002). It has been stated that, in order to meet people's mobility needs, gender and other social issues should be more integrated into the everyday planning and organization of transport systems; that is, the concept of accessibility is more than just the introduction of new train and bus schedules and of minimizing physical barriers in transport environments. Accessibility includes the perceptions, experiences and habits of travellers. Harassment and violence can be barriers to travel and result in avoidance of certain environments. The physical environment itself is not the reason why women need to relate to a risk of violence. It is not possible to change the gender power structure by spatial planning alone. However, according to Andersson (2005), it is possible to design physical environments that are both perceived as, and actually are safe, by bringing gender issues into the theory of planning, and the planning process, too, through a participatory approach, with the right of citizens to be informed upheld through dialogue (cf. Vanclay and Esteves, 2012). Listerborn (2007) shows in her research how citizens could be able to influence the process in collaborative meetings and argues that gender awareness is theoretically part of the participatory approach.

Gender mainstreaming has its origin in the context of feminist work in development processes with different ways of including gender equity. The concept entered the international arena and was adopted by the UN in 1995 at the conference on women in Beijing (UN, 1995). Gender mainstreaming in transport means considering whether and how transport and transport environments affect women and men and their ability to attain the overall political goals of gender equality. It is suggested that gender mainstreaming would be both internal (organizational, work culture and so forth.) and external (the output of planning, interactional, structural) (Christensen et al., 2007; Christiansen, 2006; Uteng and Cresswell, 2008).

A couple of years ago, EU policy developed a broad definition: 'Social impacts are any impacts that affect individual citizens or groups of individuals (e.g. households, families, specific population sub-groups such as women, ethnic minorities or low-income groups, or those living in a particular area or region)' (CEPS, 2010, p. 12). Experience internationally from work with social impact assessment (SIA) shows that poor access to transport can be both a cause and a result of economic and social disadvantage and exclusion. It can also be an outcome of poor planning. Problems tend to be concentrated in specific geographic areas, districts and communities and among particular sections of populations. A new narrative of accessibility has developed in policy discourse in, for example, the United Kingdom and New Zealand concerned with broader conceptualization in relation to sustainability, globalization and new mobilities (Fitzgerald, 2012; Lucas, 2004). Experts stress that it is impossible to describe in detail all the dimensions of social impact in general terms since most changes are situated and context bound. There is a need for more research on how social dimensions can be operationalized in transport planning (Geurs et al., 2009; Jones and Lucas, 2012). A Finnish study has shown that the know-how of practitioners and their choice of methodology are important, and that assessments should extend from anticipating possible impacts to suggesting the development of alternatives (Heikkinen and Sairinen, 2007). A challenge for transport planning is that place-based accessibility varies widely between different segments of the population.

In measuring accessibility, planners need data that distinguish travel trajectory from travel needs and that take account of the experience of various individuals and the prospect of safety. Research in Denmark, Finland, Norway and Sweden, for example, has problematized the stereotypes of women and travel trajectories. However, if not always first and foremost an issue of individual safety, preferences are clearly connected with how various individuals experience the environment and evaluate their actual options (Sirén, 2005; Siren et al., 2004; Siren and Hakamies-Blomqvist, 2006; Sirén and Hakamies-Blomqvist, 2005; Sirén, Heikkinen and Hakamies-Blomqvist, 2001). Extensive research in Norway has demonstrated how people living in one and the same area may experience things quite differently (Hjorthol, 2000, 2001, 2003, 2006; Hjorthol, Jacobsen et al., 2005). For example, people with access to a private car have different experiences from those who rely on public transport or have to walk because of lack of transport. However, a deserted car park and an isolated bus stop can be perceived as equally daunting. Women's fears should be neither underestimated nor overestimated. Decreasing mobility, which affects the individual's freedom of choice, can be caused by impairment and by environmental constraints, including safety issues. Women are at the greatest disadvantage in these respects.

Studies in the United Kingdom and New Zealand show that reliable and safe public transport connections can widen people's opportunities, and that poor transport connections and negative experiences as a traveller can affect lives (Fainstein, 2005; Farrington and Farrington, 2005; Fitzgerald, 2012; Geurs et al., 2009; Grant, 2004; Lucas, 2006, 2012, 2004; Lucas et al., 2007; Lucas et al., 2009). Traditionally, access to resources such as time, money, skills, technology and safety has been unequally distributed between women and men. In the context of various access to daily mobility, it has been stated that: 'some of the gender variations in mobility now observable among older men and women may diminish, and the cultural meaning of driving as a marker of masculine power may alter' (Law, 1999: 578), and also that recently retired people have different travel trajectories from older cohorts (cf. Hjorthol, Levin and Sirén, 2010). Gender and safety mean different things to different age groups, especially in terms of how individuals' physical capacities relate to their areas of residence and the transport environments in these areas (Friberg et al., 2005).

Gerontological studies dealing with the activities of older people in relation to access to transport resources show variations in relation to environmental and personal characteristics. A study of 3,950 older adults in Finland, Germany, Hungary, Italy and the Netherlands (Gagliardi et al., 2007) has shown that sports activities and hobbies are more often the preserve of younger men, of men in good physical condition and of men who drive a car. Women and those who use public transport are more likely to engage in social activities. Home activities are carried out more often by those with poor physical function and women. It was highlighted that, even though the number of driving licences among older people, particularly older women, is likely to change dramatically in the coming years, it is important to promote access to and the use of public transport. In addition, the study from these five European countries stressed that walking as a transport mode was 'a last resort', since it remained available to many older people who could no longer drive, and was important in combination with public transport. Overall, it is clear that the ability to access different means of transport strongly influences the variations in leisure activities and well-being, which again highlights the relevance of the whole-journey concept and the importance of safety in all parts of the transit journey.

Furthermore, an example from a study of the mobility patterns and constraints of a particular group, in this case non-Western immigrant women in Oslo, identified differences in socio-economic conditions, difficulty accessing friends and networks, and a sense of powerlessness among non-Western immigrants compared to ethnic Norwegians. An argument here is that if safety should be perceived from a gender perspective, then so should culture and ethnicity. Uteng (2009) identifies differences in family profiles, education, participation in the labour market and earnings, and a systematic failure in the updating of public transport options, as factors in the differentiated space-time interplay here. The location of key activities and different mobility trajectories and abilities to move can exclude some individuals and groups from using services and from acquiring information. These differences can be cultural, but they may also be due to family economics and conditions influencing the immigrant woman's space in the city.

In a study of the movements of teenage inhabitants in the suburbs of a medium-sized Swedish city, both young men and young women reported being afraid of travelling or of being alone in transport environments late in the evening (Aretun, 2009). Their mobility was documented using travel diaries, photographs and individual interviews. One conclusion was that it was difficult to find out how safe men (in this case young men) feel in transport environments, because few express their fear in public, and also that teenagers feel braver when in a social group with their peers. Compared to the safety risks for women, the social mechanisms operating in this situation and how these interact with the physical environment are relatively unknown.

We can assume from these examples that it is crucial to have knowledge of social mechanisms and relationships so that effective physical measures can be developed for transport environments and investigations made that are sensitive to participants' ways of expressing their experiences.

Data and method

The analysis in this chapter is based on recordings and transcriptions of discussions in focus groups, qualitative interviews and dialogue meetings addressing questions of gender equality in transport planning. It is argued that detailed analysis of these communications can be used to better understand their shared experience. Socially shared knowledge underlies most activities that organize daily life, for example, ways of knowing other people, and ideologies that circulate through public discourse and transform into new forms and new ideas, as part of an ongoing process (Gubrium and Holstein, 1998; Marková et al., 2007).

Research and planning both suffer from a risk of ignoring the everyday problems that people face when it comes to gender equality. Either we assume the current gender-specific patterns and risk cementing them, or we assume a hypothetical egalitarian society and threaten to ignore today's inequalities. One way to overcome this problem is to find concepts that focus on change rather than stability. For example, instead of talking about men's and women's *needs*, we can shift to talking about men's and women's *experiences*. The concept of *needs* tends to be connected with individuals and certain categories of people, and reinforces the old patterns rather than dissolving them. The concept of *experience*, on the other hand, refers to people's everyday lives, but is also something that changes with the development of society. Men and women can have both different experiences and similar experiences. To understand how experience affects the perception of safety in transport environments, we need to study accounts drawn from the everyday life of men and women.

Data

Empirical materials referred to in this chapter are from two research projects. The analysis was carried out specifically for this chapter (for further analysis from these studies, see: Berg and Levin, 2011; Faith-Ell and Levin, 2012; Faith-Ell et al., 2010; Levin, 2008; Levin and Faith-Ell, 2011a, 2011b).

The first set of examples comes from observations and recordings of dialogue meetings with citizens about a planning project entitled 'The Future Public Transport in the City of Malmö'. Malmö is a city of about 300,000 inhabitants and is situated in the south of Sweden. The future transport system in the city will give priority to trams, buses, bicycles and pedestrians over cars. The dialogue meetings were carried out by the planners and researchers together, with the aim of gathering opinions about the future of public transport projects and hearing how the residents of the Malmö feel about their ability to use public transport.

Altogether seven dialogue meetings were achieved. Traffic planners in the city invited high school students, representatives of the local business community, sports and cultural associations, hospital staff and members of the police force to attend. The dialogue groups were put together in a strategic way because the planners wanted to have the opinions of these particular groups. They were especially interested in the opinions of young people and of male and female commuters with different work patterns and working hours (Levin and Faith-Ell, 2011a).[2]

From the same research project we also conducted focus group discussions with planning personnel: eight focus groups with four to six participants in each group, giving a total of 36 persons (24 men and 12 women). In this chapter I use examples of sequences in which the planners were discussing their views on gender and safety.

The second set of examples are from a research project entitled 'Older Women and Men in Public Transport: Active Actors in Creating Their Own Mobility?', which focused on older people's mobility and experiences of public transport. This study included 30 qualitative interviews with older people from Östergötland and Jönköping, two regions in the middle of Sweden. For this project, 18 women and 12 men aged 58–94 years were interviewed during the summer and autumn of 2008. Fifteen interviewees also wrote travel diaries for two weeks. The analysis of this study is based on the interviewees' stories (narratives).

In studying the dialogue meetings, we took field notes of observations and made audio recordings of the meeting discussions. Focus groups and interviews were also audio-recorded and transcribed word for word. In the focus groups with planning personnel and in the qualitative interviews with older people we asked the participants to express themselves in their own words and also to contribute any additional questions and formulations of problems and solutions. The transcriptions followed conventions developed during the past few decades by researchers in communication studies. This means transcribing word for word (and for some purposes also including pauses, emphases, hesitations, overlapping speech etc.). The excerpts presented in this chapter have been translated from Swedish into English by the author.

Analytical perspectives

In this chapter I follow an ethnomethodological methodology (Garfinkel, 1987), in other words I take a social understanding of gender as an everyday practice, a habitual or recurring accomplishment (West and Zimmerman, 2002). When gender is viewed as an accomplishment, and an achieved property of situated conduct, attention shifts from matters tied to a certain group of people (or internal to the individuals) and centres on interactional and institutional arenas. In a certain sense, 'doing' gender is an individual matter, but ultimately it is a situated doing. Ethnomethodology studies the actions people carry out and the processes of creating a sense of orderliness within a particular institution, community or setting. The analysis methods of ethnomethodology stay close to the empirical data, through meticulously documented ethnographic fieldwork notes, audio recordings of conversations and video recordings of participants' interactions. The analyses in this chapter stay close to the views on safety and gender expressed by participants in the study of the 'Future Public Transport in the City of Malmö' development project, and to the older women's and men's discussions of public transport, and how they expressed their ideas and views on safety, in the study on 'Older Women and Men in Public Transport: Active Actors in Creating Their Own Mobility?' Qualitative content analysis was conducted using the transcripts and then organized thematically.

Results

The presentation of the results follows the thematic structure derived from the analysis of the empirical material. 'Being out of doors at night', 'safe journeys in the city' and also 'age, gender and safety' were three key themes that emerged in the dialogue meetings and the interviews and focus groups with older women and men. The fourth theme is a specific 'professionals' point of view' on the issue gender and safety in public transport that emerged from the analysis of the focus groups of transport planners.

Being out of doors at night

From the 'Future of Public Transport in the City of Malmö' study, aspects relating to safety came up mostly in dialogue meetings with young people, hospital staff and police. We noticed a clear gender pattern in that it was women (especially young women) who often spoke of a sense of insecurity associated with the use of public transport. It was in this context that the notion of staying in the city in the evenings and at night was brought up.

The first example comes from the high school student discussion groups, which were organized with one male group and two female groups comprising about 10–15 persons each. Discussion of safety and security in the context of travelling by public transport was initiated by the participants themselves in both groups of women, but not in the men's group. However, the male group conducted the discussion in terms of order (i.e. public order) and to the ability to be safe walking around anywhere in the city. The female students gave concrete examples, gave explanations in their narratives and also added suggestions for improved safety in transport environments – for example, they explored a desire for frequent trips (e.g. around the clock), which they thought would have an impact on traffic flow, but was important from a safety point of view. One young woman said, *'you would take a taxi rather than wait a long time at a bus stop late at night'*. Participants also indicated they felt that safety increases when bus stops are sited near cafes and nightclubs that are open late at night: *'the more life and goings-on there are around (the bus stop), the safer it is'*.

Safety is also important when it comes to the bus ride. Travelling by bus was assumed to be a safe means of travel from a road safety perspective, but at the same time as risky because of the possibly of being exposed to violent behaviour from other passengers. The level of 'safety' could be defined in terms of the absence of anxiety and the fear of other people, e.g. *'weird people'* or *'drunken youths late on Saturday nights'*. Female participants in the discussion groups said that they would prefer to cycle on a main road late at night than stand about waiting for the bus in a dark place, and would avoid walking in pedestrianized areas in the city out of fear. As one woman said, *'You never know who may be lurking in the gloom and the dark'*.

Safe journey in the city

The next example comes from discussions among representatives of local traders, where safety was related to diversity of choice of restaurants, shops and activities in the city and how to have a safe journey to them.

One of the local traders (a woman) pointed out the importance of *'being seen when you get on the bus, if you get on at the back with a buggy, it is unsafe if the driver hasn't seen you, I would prefer a better level of service on the buses, which is good for safety'*.

The example with a person with a child's buggy (unspecified as to whether it is a man or a woman), suggests that perhaps this is not just an issue of fear. The next quote, from a woman, further expresses the complexity of the issue, that safety and accessibility for various groups of travellers may include an intersectional perspective based not only on gender but also, for example, on age and personal experience:

> *safety in finding your way, parking, knowing the way there ... I would really like to be able to evaluate gender, now this is difficult, I agree with you that it might just as well be a matter of age, experience of working life, personality.*

The local traders' dialogue group also raised questions about how various modes of transport should be linked and the importance of a proper logistics network for public transport – one that embodies a 'whole-journey' concept. The term *'all-inclusive'* was introduced into the discussions in terms of being offered the opportunity of buying a *'whole package, with the activity and a safe round trip there and back'*. The same topic occurred in the group with people from sports and culture associations: *'safer to get the bus ticket* (or other public transport ticket) *on the same ticket as the ticket for the event'*. Here, the discussion is about safety for people attending or taking part in various events in the city: how to get home safely after a concert, film or theatre play, for example. The discussants have adopted the term 'all-inclusive' from the world of charter and holiday travel.

Age, gender and safety

People from the dialogue meetings involving sports and cultural associations expressed age variations among citizens as an upcoming issue for the city planning. The city population is in fact ageing, but the issue of new generations of older people being more active and mobile than previous generations was also brought into the discussion:

> *older people are an active group that is getting bigger, it's important to involve the local community in the discussion, that's what will decide whether older people are able to get home in evenings*
>
> /---/
>
> *avoid them being exposed to violence, when cultural events are on late in the evening*

These lines express an interesting discussion about ageing people's needs, and concerns for their preferences. Older people are expected to be more active today than previous generations, and also to be a growing group of travellers in the city, taking part in cultural events and leisure activities, but still considered a vulnerable group and perhaps more worried about violence than other groups of citizens.

Women expressed their experience of public transport in narratives more often than men, and from travel diaries we might conclude that (in this study) women were the more experienced public transport travellers. The men expressed that they find it more convenient to go by car than by bus. In contrast, the majority of the older women also considered it convenient to go by bus and suburban train, and talked about these as good and safe places, although very different depending on the environment and fellow passengers. 'Punctuality', 'quality', 'safety' and 'security' were mentioned as important themes in these discussions. Quality was defined in terms of the vehicles, but also in terms of platforms and bus shelters in waiting areas. The behaviour of fellow travellers, bus drivers and conductors on the trains was held up as important in creating a feeling of safety and comfort on the journey: '*the best trips are when travelling with people who are nice. They don't have to be anyone you know, you just ought to feel secure travelling with them*' (cf. Levin, 2008).

In the study of older people, more women than men expressed worry and talked about unsafe places, and feelings of being unsafe in public transport. Among the 30 older persons we met there were several reasons for their worry about the transport environments. Older people (both women and men) fear failing to keep up with the system: there are several different steps that you must be able to cope with when taking public transport, and it is also important to understand and feel comfortable with managing tickets, entry and exit, and so on. Many of the older people talked about how one can experience uncertainty and insecurity when getting on and off, if one is not sure of getting to the door when the bus has stopped. Also, travelling is done with a stick with one hand and a bag in the other. They feel anxious that they will fall or be knocked over. In the next example, three older women (83, 86 and 69 years) talk about using the bus when the driver cannot see what is going on during the journey, and does not take account of older passengers:

> *Woman 83: /…/ and then before I had got up (into the bus) /…/ he suddenly pulled out or started off like this ((she waves her hands in front of her)) and I fell backwards, I just fell over backwards and got badly injured, and those injuries are still causing me trouble.*
>
> *Woman 86: But I'm very afraid of public transport in general. A relative and a good friend of mine, an accident happened to him on the bus. And I could understand why. They had to keep to time, it's all about money nowadays. So I understand very well that they are in a hurry to get away from a bus stop, for example.*
>
> *Woman 69: you do not believe they have trained /…/ staff on the buses, they haven't prepared for the situations /…/ and /…/ nobody er feels unsafe to do it.*

The three women above are experienced bus travellers, and their stories express their worry and doubt about the situation for older people as travellers on public transport. There are some general problems which may be drawn from what they say: that older people need more time to get on the bus/tram/train, that staff and fellow travellers are not always aware of them and that staff do not seem very well informed.

One point here is that, since more women than men indicated that they chose to travel with public transport, we also recorded more stories from women about incidents in transport environments. However, there were only 30 informants in the study, and to generalize from a qualitative approach to sweeping statements about women or men in general would be risky. Nevertheless, collecting stories of this kind undoubtedly is very valuable to an understanding of travellers' experiences and points of view.

The professionals' points of view

In the focus groups involving city planners, the moderator introduced questions about gender equality, asking how the planners address this issue in their work, also mentioning the national objectives of gender equality.[1],[2]

> *Moderator: But when you get to specific stretches of routes like this, you can look at the stops, can you get there safe and sound, can you go there in the evening, without slipping, without being mugged, etc.*
>
> */…/ public transport provides access to workplaces*
>
> */…/ women are often more worried about violence, if you can avoid the worry, more of them will dare to travel.*
>
> *Planner 1 (man): But shouldn't that apply generally, always? For everybody.*

Planner 2 (woman): But it is not certain that it's done consistently.

Planner 3 (woman): But sometimes I think it's also a bit superficial, you do a bit but not very much, men and women, you get a bit into integration and those issues but not /.../ maybe (it) comes into the strategic plan, an analysis of gender.

/.../

Planner 3 (woman): When we do a project, we have to cover /.../ with various aspects, headings we have to take into account, the issue of safety for children, for example, but it is quite standardized, the same questions coming up (every time).

Here the male and female planners are talking from different points of view. Planner 1 (a man) has a more comprehensive point of view, talking about 'everybody', while planners 2 and 3 (women) take a gendered viewpoint at once. Planner 1 simply does not seem to recognize the problem from a gender (male/female) point of view, but instead takes a broad point of view, which can be interpreted as gender blind. The two female planners are more dubious about the outcomes of the gender equality objectives in the planning process, planner 2 believing it is 'not certain that it is consistent', and planner 3 saying it is 'superficial' and then suggesting that it perhaps will come into the strategic plan (which is not an issue for this development project). Planner 3 also explains there are certain headings to be filled in the planning reports, but that the sections on social issues (the example given is the child perspective) are fairly standardized and based on the same questions, which means there is limited space.

It was also stated that verbal reflections such as the focus group discussion that the researchers conducted (the analytical discussion) within the planning team were important for understanding variations among citizens and groups of citizens, thus increasing awareness about women's and men's various experiences. Such discussions were rare in their everyday work, however.

Discussion

This chapter on gender and safety in transport environments highlights a couple of examples from recent research and thoughts originating in gender, activity and interaction theory, while taking account of women's and men's experiences of space in transport environments (Swedish: resans rum, or 'the journey space' cf. Friberg, 2006; Friberg et al., 2005). Transport environments are not perceived equally by all, and moving through them can be a problem for some individuals and groups of individuals. Safety has an impact on accessibility and social inclusion (cf. Lucas, 2006, 2012), and thus constitutes a major issue in the striving for a more sustainable society (WCED, 1987).

Sweden has a comprehensive national policy on gender equality with a total of four objectives: equal power, equal work opportunities and livelihood, equal responsibility for domestic and care work, and a safety objective conceptualized in terms that violence against women must stop. A gender equality objective is also inscribed in national transport policy. The objectives are interconnected, in that, for example, power over the transport environment and users' resources affects their opportunities to take part in society, the labour market, leisure activities and so forth. In the 'Future Public Transport in the City of Malmö' study we found that safety was the most considered of the national gender equality objectives, with the power dimension second most considered in the local municipal planning process. Planners in this study said that group discussions with planning staff increase awareness about women's and men's different experiences, but that such discussions were rare in their everyday work. In an action-based part of the study we also encouraged the planning team to try other consultation methods, seeking strategically chosen groups of citizens: for example, young women and men from a secondary school, sports and cultural associations, and women and men with various working and commuting situations.

A notable finding of this chapter is the differing points of view of female and male planners. Female planners expressed more suspicion about how the gender point of view comes into planning in their current work. Also, conclusions of the Malmö study were that aspects relating to safety came up mostly in dialogue meetings with young people, hospital staff and police. We noticed a clear gender pattern, in that it was women (especially young women) who often spoke of a sense of insecurity associated with the use of public transport. In this context, the notion of staying in the city in the evening and at nights was brought up. In the group involving representatives of cultural associations, safety was mentioned but with no clear examples given. Only the group of young men mentioned 'order', in the context of less crime and less order for traffic planning. This point of view was confirmed in the study of older women's and men's use and experience of public transport. The respondents in our interviews, especially older women, raised issues of orderliness and feeling safe when deciding how to travel. Older passengers can have highly negative experiences on bus journeys if the drivers do not accommodate older passengers and if other passengers behave inappropriately.

In the case of transport planning, given the increased complexity of citizens' lifestyles, employment and need for multipurpose trips, the conventional approach to travel opportunities and the valuation of travel time may need to be rethought in line with the everyday lives of households and family units. Developing work on gender mainstreaming and gender impact assessment in transport planning has clearly demonstrated this need. Gender impact assessment developed from a background in environmental impact assessment and social impact assessment, which are tools and methods developed to help meet policy requirements relating to environmental and social questions of land use and public space. The process of impact assessment started in the US *National Environmental Policy Act* (NEPA) of 1969 and has since developed into international principles and methods (Vanclay and Esteves, 2012). In Scandinavia, environmental impact assessment is mandatory in the large majority of transport infrastructure building projects governed by the Environmental Codes (Swedish: *Miljöbalken*). Social impact assessment, however, is voluntary. It has often suffered from insufficient standardization and poor funding compared to the environmental impact assessment, and is often given too little attention. The impact assessment process itself, however, has an interdisciplinary background and a history of stakeholders' and users' participation that would be of benefit to today's planning for accessibility.

Going for the creation of an urban space and transport environment that can be used equally by all men and women does not mean that women should be protected, nor does it imply a negative view of public space, such as that the public space is 'unsafe' for women to live in. We have emphasized the importance of not generalizing too much between the groups (men/women), and instead taking context into consideration questions such as the following: What kind of life opportunities do they have? What are the environmental and individual opportunities for subgroups? What experiences do they express?

For example, the complexity of gender and safety in the public space requires paying attention not just to being a woman or a man, but, in addition, to the intersections of gender, age, ethnicity, financial resources, individual experiences, behaviour, culture, common sense, policy, ideas and so on. Discussions of gender and safety therefore need to consider context: for example, the relation between a particular place, a mode of transport and ideas about the function and use of this transport mode.

Safety for all is part of the notion of a more sustainable society, and it is often divided into three dimensions: ecological, economic and social. Gender awareness in the planning process would improve safety for all, and so would an awareness of heterogeneity beyond the narrower categories of women and men.

Viewed in this way, safety is one of the features that create accessibility of transport or a transport mode, that is, people's inclusion in or exclusion from a particular environment. For future work on this, more interdisciplinary research and increased cooperation between professionals from planning, security, social and health services are suggested.

Notes

1. Policy objectives:
   European objectives. In order to promote gender equality at the local and regional level, the Council of European Municipalities and Regions (CEMR) European

section of United Cities and Local Governments in 2006 launched the European Charter for equality of women and men in local life. The document proposes concrete methods by which the latter can be pursued in different fields of competences: political participation, employment, public services, urban planning etc. http://www.ccre.org/en/activites/view/11.

National objectives. The official goal of gender equality (which is taken as a background in research projects reported in this chapter) is formulated by the Swedish Government (Gov. Bill 1993/94:147), and there has been political consensus during the past decades about its appropriateness for public activities. This goal includes, but not solely the feminist perspectives on safety and gendered violence (i.e. violence against women). There are four national objectives for gender equality formulated by the Swedish Government and Parliament. In short: *Equal distribution of power and influence; Economic equality; Equal distribution of unpaid care and household work; Violence against women must stop.* It means that women and men will have the same opportunities, rights and responsibilities within all vital areas of life, whereas gender equality in practice has often been seen as a special interest issue (cf. Polk, 2008; Vagland, 2004).

2. This example is from the Working Paper 'Hållbar jämställdhet i framtidens kollektivtrafik: Observationer och utvärdering av dialogmöten i Malmö stad' [Sustainable gender equality in future public transport: Observations and evaluations of dialogue meetings in Malmö] which is published on www.vti.se/publications.

References

Andersson, B. (2005). Mäns våld blir kvinnors ansvar. Riskkalkylering i det offentliga rummet [Male violence becomes women's responsibility. Calculation of risk in the public domain]. In: Friberg, T., Listerborn, C., Andersson, B. and Scholten, C. (eds.), *Speglingar av rum. Om könskodade platser och sammanhang* [Reflections of room. About gender-coded places and contexts] Stockholm/Stehag: Symposion, 69–85.

Aretun, Å. (2009). *Ungdomars utsatthet i bostadsområden. Trygghetsprinciper för fysisk planering* [Adolescent vulnerability in residential areas. Security principles for planning]. Linköping: Linköping University Electronic Press.

Berg, J., and Levin, L. (2011). *Äldres vardagliga resor. Val av färdmedel och erfarenheter av kollektivtrafik* [Older people's everyday travel – Choice of travel mode and experience of public transport]. Linköping: VTI.

Burns, N., Lehman Schlozman, K., and Verba, S. (2001). *Private Roots of Public Action: Gender, equality, and political participation*. Cambridge, MA/London: Harvard University Press.

Ceccato, V., Uittenbogaard, A. and Bamzar, R. (2013). Security in Stockholm's Underground Stations: The Importance of Environmental Attributes and Context. *Security Journal*, *26*, 33–59.

CEPS. (2010). *Study of Social Impact Assessment as a Tool for Mainstreaming Social Inclusion and Social Protection Concerns in Public Policy in EU Member States*. London: European Commission and Centre for European Policy Studies, CEPS.

Christensen, H. R., Poulsen, H., Oldrup, H., Malthesen, T., Hvidt, M. and Holmen, M. (2007). *Gender Mainstreaming European Transport Research and Policies. Building the Knowledge Base and Mapping Good Practices*. Köpenhamn: TRANSGEN.

Christiansen, C. C. (2006). Intersektionalitet. *Kvinder, køn og forskning, 15*(2/3), 3–104.

Cresswell, T., and Uteng, T. P. (eds). (2008). *Gendered mobilities*. Aldershot: Ashgate.

Fainstein, S. (2005). Planning Theory and the City. *Journal of Planning Education and Research*, *25*(2), 212–130.

Faith-Ell, C., and Levin, L. (2012). *Jämställdhet och genus i infrastrukturplanering – en studie av tillämpningen inom järnvägsplaneringen* [*Gender equality in infrastructure planning – a study of implementation in railway planning*]. Linköping and Stockholm: VTI and WSP.

Faith-Ell, C., Levin, L., Engelbrektsson, E., Dahl, E., Nilsson, S. and Yazar, M. (2010). *Jämställdhet i samrådsprocesser vid svenska vägprojekt: genusperspektiv på annonsering, deltagande och mötesinteraktion vid samråd med allmänheten [Gender equality of public participation in Swedish road building projects. A gender perspective on announcements, participation and interaction in public meetings].* Stockholm/Linköping: WSP/VTI.

Farrington, J., and Farrington, C. (2005). Rural Accessibility, Social Inclusion and Social Justice: towards Conceptualisation. *Journal of Transport Geography, 13*, 1–12.

Fitzgerald, G. (2012). *The Social Impacts of Poor Access to Transport in Rural New Zeeland*. Wellington: NZ Transport Agency.

Friberg, T. (2006). Towards a Gender Conscious Counter-Discourse in Comprehensive Physical Planning. *GeoJournal*, *65*(4), 275–285.

Friberg, T., Listerborn, C., Andersson, B. and Scholten, C. (2005). *Speglingar av rum. Om könskodade platser och sammanhang* [Reflections of room. About gender-coded locations and contexts]. Stockholm/Stehag: Symposion.

Gagliardi, C., Spazzafumo, L., Marcellini, F., Mollenkopf, H., Ruoppila, I., Tacken, M. and Szémann, Z. (2007). The Outdoor Mobility and Leisure Activities of Older People in Five European Countries. *Ageing and Society*, *27*(5), 683–700.

Garfinkel, H. (1987). *Studies in Ethnomethodology.* Englewood Cliffs, NJ: Prentice Hall.

Geurs, K., Boon, W. and Van Wee, B. (2009). Social Impacts of Transport: Literature Review and the State of the Practice of Transport Appraisal in the Netherlands and the United Kingdom. *Transport Reviews: A Transnational Transdisciplinary Journal*, *29*(1), 60–90.

Gov. Bill 1993/94:147. *Jämställdhetspolitiken: Delad makt – delat ansvar.* Stockholm: Regeringskansliet [Equal opportunities policy: Shared power – shared responsibility].

Grant, M. (2004). Ensuring Access and Participation in the Liverpool City Region. In: K. Lucas (ed.), *Running on Empty: Transport, Social Exclusion and Environmental Justice*. Bristol, UK: Polity Press, 55–68.

Gubrium, J. F., and Holstein, J. A. (1998). Narrative Practice and the Coherence of Personal Stories. *Sociological Quarterly*, *39*, 163–187.

Hadorn, G. H., Bradley, D., Pohl, C., Rist, S. and Wiesmann, U. (2006). Implications of Transdisciplinarity for Sustainability Research. *Ecological Economics*, *60*(1), 119–128.

Heikkinen, T., and Sairinen, R. (2007). *Social Impact Assessment in Regional Land Use Planning – Best practices from Finland*. Stockholm: NORDREGIO.

Hjorthol, R. (2000). Same City – Different Options. An Analysis of the Work trips of Married Couples in the Metropolitan Area of Oslo. *Journal of Transport Geography*, *8*(3), 213–220.

Hjorthol, R. (2001). Gendered Aspects of Time Related to Everyday Journeys. *Acta Sociologica*, *44*(1), 37–49.

Hjorthol, R. (2003). Gendered Aspects of Travel Behaviour Development – Are the Differences Disappearing? *Paper presented at the European transport conference, ETC 2003*, 8–10 October, Strasbourg, France.
Hjorthol, R. (2006). *Gender Equality in Transport*. Oslo: Transportøkonomisk institutt, TØI.
Hjorthol, R., Jacobsen, M., Ling, R., Nordbakke, S. and Haddon, L. (2005). *Den mobile hverdag. En kvalitativ studie om bruk av bil og kommunikasjonsmedier i barnefamiljer [The mobile world. A qualitative study on the use of car and communication media in families]*. Oslo: Transportøkonomisk institutt, TØI
Hjorthol, R., Levin, L. and Sirén, A. (2010). Mobility in Different Generations of Older persons: The Development of Daily Travel in Different Cohorts in Denmark, Norway and Sweden. *Journal of Transport Geography*, *18*(5), 624–633.
Jones, P., and Lucas, K. (2012). The Social Consequences of Transport Decision-Making: Clarifying Concepts, Synthesising Knowledge and Assessing Implications. *Journal of Transport Geography*, *21*, 4–16.
Koskela, H., and Pain, R. (2000). Revisiting Fear and Place: Women's Fear of Attack and the Built Environment. *Geoforum*, *31*(2), 269–280.
Law, R. (1999). Beyond 'Women and Transport': Towards New Geographies of Gender and Daily Mobility. *Progress in Human Geography*, *23*(4), 567–588.
Levin, L. (2008). Äldre kvinnor – osynliga i statistiken men närvarande i trafiken [Older women – invisible in statistics but present in traffic]. In: Brusman, M., Friberg, T. and Summerton, J. (eds), *Resande, planering, makt* [Travel, planning, power]. Lund: Arkiv, 23–40.
Levin, L., and Faith-Ell, C. (2011a). *Genusperspektiv på utvecklingen av kollektivtrafik. Hållbar jämställdhet vid planeringen av framtidens kollektivtrafik i Malmö* [Gender perspective on public transport development. Sustainable equality in the planning process of public transport in the city of Malmö]. Linköping/ Stockholm: VTI/ WSP.
Levin, L., and Faith-Ell, C. (2011b). Women and Men in Public Consultation of Road Building Projects. Publication of selected articles from *the Fourth International Conference on Women's Issues in Transportation, Washington DC*. TRB.
Listerborn, C. (2002). TRYGG STAD. Diskurser om kvinnors rädsla i forskning, policy-utveckling och lokal praktik [SAFE CITY. Discourses on Women's Fear in Research, Policy Development and Local Practices]. PhD Dissertation. Department of Urban Design and Planning, Chalmers University of Technology, Göteborg:
Listerborn, C. (2007). Who Speaks? And Who Listens? The Relationship between Planners and Women's Participation in Local Planning in a Multicultural Urban Environment. *GeoJournal*, *70*, 61–74.
Lucas, K. (2006). Providing Transport for Social Inclusion within a Framework for Environmental Justice in the UK. *Transport Research Part A*, *40*, 801–809.
Lucas, K. (2012). Transport and Social Exclusion: Where Are We Now? *Transport Policy*, *20*, 105–113.
Lucas, K. (ed.). (2004). *Running on Empty: Transport, Social Exclusion and Environmental Justice*. Bristol, UK: Polity Press.
Lucas, K., Marsden, G., Brooks, M. and Kimble, M. (2007). Assessment of Capabilities for Examining Long-Term Social Sustainability of Transport and Land Use Strategies. *Journal of the Transportation Research Board*, *2013*, 30–37.
Lucas, K., Tyler, S. and Christodoulou, G. (2009). Assessing the 'Value' of New Transport Initiatives in Deprived Neighbourhoods in the UK. *Transport Policy*, *16*, 115–122.
Lykke, N. (2003). Intersektionalitet – ett användbart begrepp för genusforskningen? [Intersectionality – a useful concept for gender research?] *Kvinnovetenskaplig tidskrift*, *1*, 47–56.

Lykke, N. (2005). Nya perspektiv på intersektionalitet. Problem och möjligheter. *Kvinnovetenskaplig tidskrift, 26*(2/3), 7–17.

Lykke, N. (2008). *Kønsforskning. En guide til feministisk teori, metdologi og skrift [Gender Research - A Guide to feminist theory, methodology and writing].* Fredriksberg, DK: Forlaget Samfundslitteratur.

Marková, I., Linell, P., Grossen, M. and Orvig, A. S. (eds). (2007). *Dialogue in Focus Groups: Exploring in Socially Shared Knowledge*. London: Equinox Publishing.

Polk, M. (2008). Gender Mainstreaming in Swedish Transport Policy. In: Uteng, T. P., and Cresswell, T. (eds), *Gendered Mobilities*. Hampshire, UK and Burlington, USA: Ashgate. 51–77.

Sirén, A. (2005). *Older Women's Mobility and Transportation Issues: Restraints and Regulations, Lust and Splendour.* (Avh). Helsingfors: Helsingfors universitet, forskn rapport nr 30.

Siren, A., Anund, A., Sörensen, G. and Hakamies-Blomqvist, L. (2004). *Förnuft och känsla: en narrativ studie om äldre kvinnors bilkörning [Sense and Sensibility – A narrative study of older women driving].* Stockholm: VINNOVA.

Siren, A., and Hakamies-Blomqvist, L. (2006). Does Gendered Driving Create Gendered Mobility? Community-Related Mobility in Finnish Women and Men Aged 65+. *Transportation Research Part F*, *9*, 374–382.

Sirén, A., and Hakamies-Blomqvist, L. (2005). Sense and Sensibility. A Narrative Study of Older Women's Car Driving. *Transportation Research Part F*: Traffic Psychology and Behaviour.

Sirén, A., Heikkinen, S. and Hakamies-Blomqvist, L. (2001). Older Female Road Users. Linköping: VTI, *Rapport* 467 A.

TRB. (2010). Women's Issues in Transportation. *Summary of the 4th International Conference*. Volume 1: Conference overview and plenary papers. 27–30 September 2009, Irvine, CA. Washington, DC: Transportation Research Board (TRB).

Uittenbogaard, A., and Ceccato, V. (2014). Safety in Stockholm's Underground Stations: An Agenda for Action. *European Journal of Crime Policy Research*, *20*, 73–100.

UN (1995). *Action for Equality, Development and Peace* 4–15 September 1995 – Beijing, China, http://www.un.org/womenwatch/daw/beijing/official.htm, accessed 10 December 2013.

Uteng, T. P. (2009). Gender, Ethnicity, and Constrained Mobility: Insights into the Resultant Social Exclusion. *Environment and Planning A*, *41*, 1055–1071.

Uteng, T. P., and Cresswell, T. (eds). (2008). *Gendered Mobilities*. Aldershot: Ashgate.

Vagland, Å. (2004). Gender Equality as a Subsidiary Objective of Swedish Transport Policy. Paper presented at the *Conference for Research on Women's Transportation Issues*, Chicago, 18–20 November 2004.

Vanclay, F., and Esteves, A. M. (eds). (2012). *New Directions in Social Impact Assessment. Conceptual and Methodological Advances*. Cheltenham, UK; Northampton, MA, USA: Edward Elgar.

WCED. (1987). *Report of the World Commission on Environment and Development: Our Common Future*. Oslo: UN.

West, C., and Zimmerman, D. (2002). Doing Gender. In: Fenstermaker, S. and West, C. (eds), *Doing Gender, Doing Difference. Inequlity, Power, and Institutional Change.* New York and London: Routledge, 3–23.

18

Sexual Harassment against People with Mental Disabilities in Transit Environments: Implications for Services and Clinics

Antonio Iudici

Introduction

Security is one of the most important human rights for the life of all citizens. An absence of security can impact on everyday life in a number of ways, and in particular limit key activities such as work, leisure, meeting with friends, shopping and trips to the cinema, the supermarket, or the doctor, for example. This is true for every citizen, but even more so for certain categories of citizens, such as people with disabilities who are more exposed to situations of insecurity, isolation and marginalization.

After discussing the importance of gender equality in the context of transit safety and related best practices, this chapter highlights the perspective of users with disabilities in respect to transit safety. In effect, insecurity, or the perception of insecurity on transit systems, leads many people to live their lives with a reduced mobility. Often people with disabilities become insecure as a result of living with constant anxiety and fear. This process results in a slow, gradual and inexorable reduction in the possibilities for social inclusion and, in some cases, total isolation within the home. A more serious issue is that of sexual harassment, and this process of victimization, which consists of a series of symptoms and attitudes based on the idea of oneself as a victim, can result in considerable clinical relapses (von Hentig, 1948; Karmen, 2003). The impact on the health of disabled people is also likely to worsen because of pre-existing morbidity and the specificity of the condition in which the person has disabilities.

The United Nations Convention on the Rights of Persons with Disabilities (UN, 2006) highlights member states' ownership of this vulnerable group and promotes their 'freedom from exploitation, violence and abuse'; indeed, it obliges member states to 'take all appropriate measures' to prevent violence and to provide for the rehabilitation of victims'. However, vulnerability is closely linked to certain social conditions, especially those that generate isolation and exclusion (European Disability Forum, 2010), and a significant number of this vulnerable group have both mobility and safety issues.

Objectives and structure

The general purpose of this study is to raise awareness among professionals who deal with safety in the transport sector and to examine the risks faced by people with disabilities, in particular the problems of harassment. Specifically, this chapter is divided into four parts: the first part aims to raise awareness as to how disability and vulnerability are related to social responsibility. It also describes the social model of disability and the international references associated with the topic. The second part highlights the main literature related to sexual violence and harassment against persons with disabilities on public transport. The third part focuses on some of the barriers to transit, in particular those related to the lack of knowledge of the phenomenon, the non-reporting of crimes and the reasons for not reporting. The final section describes potential management policies and strategies for intervention, with a focus on how measures can be implemented at the legislative, research, training and community level.

Vulnerability and disability as social constructs

Personal or situational vulnerability?

The concept of vulnerability is often used when talking about people with disabilities and transportation, both by professionals and by transport agencies. A person is considered 'vulnerable' when they have, or may need, community care services and, because of a mental disorder, disability or illness, cannot arrange this themselves, or are unable to protect themselves against significant harm or exploitation (Lord Chancellor's Department, 1997). Frequently, disabled people are described as 'vulnerable' subjects. One of the results of this situation is protectionism (Hingsburger, 1995). The impact of this is to restrict, rather than expand individual freedom, limiting the possibility of movement and activating processes of addiction to assistants of support, rather than creating opportunities for independence.

An alternative perspective is that identifying a disabled person as vulnerable 'in and of itself', consolidates the assumption that the vulnerability is intrinsic to the person. Indeed, research has demonstrated that some persons are of the opinion that a disability is pervasive of the whole person. For example, some people questioned in a study thought there was a widespread lack of genuine empathy in people for those with disabilities (Baladerian, 1991). Others believe that people with disabilities cannot fully comprehend what is happening to them and that is why they can suffer more than those without disabilities. In some cases, sexual offenders have used the excuse that the victims did not feel pain or suffering as they were disabled (Calderbank, 2000). In the face of harassment perpetrated against people with disabilities, research shows how some people believe that the culprit may be the attendant, not the husband, because they do not think people with disabilities can have an emotional private life (Baladerian, 1991). These ideas become further justification for offenders who commit crimes of violence against persons with a disability.

In our society, we are accustomed to thinking of people with disabilities with pity, sympathy or support. It is then important to clarify that it is not the disabled person who creates their own 'subservience' and own 'submission'. The following examples are used to demonstrate this assertion. If a person lives in the suburbs and there is no public transportation available, they will always be more 'disabled' than a person who lives in a town, where several taxi companies are based and where there may be several public transport services too. The need to reserve a seat on the train with 15-day notice is a condition that can make a person with disabilities even more 'disabled' than if they did not have that condition. The ability to travel by bus after a concert makes the event more accessible to a disabled a person, compared to a situation in which the bus stops running after a certain time. The level of control that an individual is able to exercise over their own life, the level of contact with their community or the transport conditions in the immediate context are all factors that influence the levels of risk they face (Calderbank, 2000). Oliver (1983) questions whether the problems related to harassment experienced by persons with disabilities are the result of being a vulnerable individual, or are the consequence of social attitudes towards people with disabilities.

The social model of disability

Compromise is a characteristic of the mind, the body or the senses of the individual, and may or may not be the result of a disease, injury or genetics. By contrast, disability is considered the disadvantage, restriction or exclusion of social activities to persons who have impairments, which may be the result of politics, economics or the cultural norms of a society (Oliver and Barnes, 2012). The International Classification of Functioning, Disability and Health (ICF) has suggested that 'disability' is defined on the basis of contextual or environmental factors, and that the negative social attitudes are one of the most debilitating things for people with disabilities (World Health Organization, 2001). In 2006, the United Nations Convention on the Rights of Persons with Disabilities (European Union, 2006) defined disability as 'the result of the interaction between persons with impairments and behavioral and environmental barriers that hinders their full and effective participation in society on an equal basis with others'. A new concept recognizes that the exclusion and segregation of people with disabilities is always determined by the prejudices and presumptions about disability, which, too often, are also the basis of political and social decisions that produce barriers, obstacles and unequal treatment, in other words, discrimination.

In practice, one does not become 'disabled' just because one cannot see or hear or walk, or does not understand, or because one is not able to behave in an appropriate manner, but rather only when one meets behavioural barriers and environments that prevent one from living with others. Disability is a condition of discrimination, and this is being fought on a daily basis as regards to our attitude towards diversity, and our mindset towards the way of understanding things. This can be seen in the way we express ourselves, in our everyday language, for example, when we ask a pregnant woman if the baby is a boy or a girl, she may promptly reply, 'the important thing is that it is healthy'; or, considering that in 2010 the total number of abortions because of suspected disability increased by 10 per cent over the previous year (Hollomotz, 2013); or when travelling by car many persons reduce the speed because there is a small bus with the adhesive of the 'wheelchair symbolizing the disability'; or on a crowded bus a person complains when they discover they cannot sit in a seat reserved for the disabled. Thus, there are laws and cultural attitudes that lead people to think 'disabled' and to treat people with impairments differently. Another example is the presence of specific toilets for the disabled: a facility necessity for all people, yet society has been relatively slow to provide disabled toilets. If one enters a room, it is possible very quickly to identify who is disabled' and who is not it due to this culture. A common experience might be for a person to say without a doubt that the bald gentleman, with glasses, a few tics and who is overweight, is definitely normal', while the lady next to him with almond eyes and a stocky body is 'Down' (Hollomotz, 2013). People make very quick judgments by sight regarding who is disabled and who is not. It is clear that disability is often the product of some preconceived visual criteria and the meaning attributed to a disability. As the paraplegic Italian journalist Franco Bonprezzi said, 'You don't carry disability, you find it'. This means that when we speak about a disabled person, we in fact speak about 'ourselves' and how much we have or have not managed to create conditions of social integration.

Therefore, we are talking about politicians, ordinary people, teachers, religious leaders, engineers, architects, social workers and researchers. As researchers, we must not shirk the responsibility that we have to report on a very large group of people about whom there is very little knowledge. Yet this group compromises about 15 per cent of the world's population, with over one billion people having physical or mental disabilities (World Health Organization, 2011).

Crimes committed on public transport against disabled people

There are a number of definitions of public transport, as discussed in the first section of this volume. This chapter refers to the transport of passengers that any member of the public can pay to use (Vuhic, 1981). This may apply to both private and public forms of transport. The most common form of public transport is found in urban transport operating on fixed routes, with regular stops and scheduled timetables, which is often referred to as 'mass transit'.

The transport of the masses performs a variety of functions: it is crucial to reducing pollution in big cities; it protects the energy resources in an area; it is a catalyst for business; it is a source of savings and a service for many workers; and it facilitates the mobility of many assisted people and provides jobs for millions of citizens. The use of transport predominantly reflects the idea of 'service', so that wise administrators and politicians consider transport as a key component of their environmental and energy policy (Yaro and Hiss, 1996). For many people, therefore, the use of public transport has immeasurable social importance and constitutes a privileged space for social interactions. For many people, it is the only sustainable means of transport, and different ethnic groups, particularly those who cannot afford other means (Smith and Cornish, 2006), often use it. There are many impact factors that determine how public transport is used, such as the environment, the population density and the urban structure (Ceccato, 2011; Loukaitou-Sideris, 2012).

Studies in the field (Smith and Clarke, 2000; Clarke, 1997) have revealed that there are two aspects which promote internal transport crime: (a) the lack of supervision and (b) overcrowding during peak hours. Lack of supervision, both day and night, mainly contributes to producing vandalism, such as graffiti and damage to the buses or trains and robberies of staff or passengers (Moore, 2010). Overcrowding mainly provides ideal conditions for theft and indecent assaults. The mechanisms for this include rubs, harassment, gestures of a sexual nature, advances of direct and indirect approaches and approaches that are unsolicited or rejected (Crime Concern, 2004). This behaviour is in line with the definition of sexual harassment used in this study, which is 'unwelcome sexual advances, requests for sexual favors, and other verbal or physical conduct of a sexual nature, including flashing, groping, fondling, and masturbation in public' (Stringer, 2007).

One potential impact of low levels of security is that persons may be less likely to use public transport. The literature agrees that the more exposed users of transport are the so-called 'vulnerable' groups, that is, women, people with disabilities and the elderly. These subjects have some restrictions on their ability to either use transport less or to change their transport journeys due to fear of being subjected to sexual harassment (Hsin-Ping Hsu, 2011). In fact, some research (Department for Transport, 2008; Grandville and Campbell-Jack, 2005) indicates that the insecurity, or the mere perception of insecurity, constitutes a reason for deterring the use of public transport. These studies point out that fear, or perception of fear, are not necessarily correlated. The perception of fear can be subjective (Del

Castillo, 1992) and, therefore, can be considerable, even though the actual risk of the offense is much less than the perceived risk (Benjamin et al., 1994). It can also be related to a lack of knowledge of an area or a focus on certain areas (Loukaitou-Sideris, 2009; Loukaitou-Sideris and Fink, 2009). The main fears of travellers concern the time spent waiting at the bus stop (Clark, 1996), travelling with few personnel on board and stops where there are no security personnel present (Millie, 2008).

In addition, the research suggests that certain conditions of carriage can reduce the likelihood of crime, such as the provision of adequate staff, a good system that manages the payment of fees, the possibility of making transfers easily and the presence of frequent and regular services (Gaylord and Galiher 1991; LaVigne, 1996; 1997). Crime is, therefore, a danger to the security of citizens (especially the vulnerable), but also for trade and for social inclusion.

Harassment and violence against people with disabilities

People with disabilities often require help as part of their daily activities, and this often results in their seeking and receiving help, especially for mobility. Empirical research has consistently documented the presence of harassment, sexual violence and abuse against persons with disabilities, whether it is for children with developmental disabilities, or women, or for people with mental disorders. Several international studies have shown a higher prevalence of crimes committed against persons with disabilities in comparison to the general population (Teplin et al., 2005). Sources from the British Council (2007) have found that people with disabilities are four times more likely to be exposed to the possibility of being subjected to sexual offenses, compared to people without disabilities. A search of the Disability Rights Commission (DRC) (Disability Rights Commission, 2003) showed that 22 per cent of people with disabilities interviewed had suffered harassment in public because of their disability. Sobsey and Doe (1991) have noted that prior to 1960, there were very few studies related to disability and crime, as it was naively believed that people with disabilities were not vulnerable to sexual offences.

A number of important findings have been published as a result of directly involving those with disabilities in the research. For example, in a British study it was found that 8 per cent of people with disabilities had suffered a violent attack compared with 4 per cent of those people without disabilities in 2001/2002 (Greater London Authority, 2003). People with disabilities consistently reported suffering higher incidences of intimate violence compared to the average population (Smith et al., 2011). Lumley and Miltenberger (1997) reviewed the literature involving the sexual abuse of people with intellectual disabilities. The main results indicated that students with intellectual disabilities suffered situations of abuse more frequently than their peers without disabilities. In some cases, some researchers estimated this was higher by a percentage of four times (Disabled Crime Victims Assistance, Inc., 2006). Additional studies (Casteel et al., 2008; Martin et al., 2006; Hershkowitz et al., 2007) have arrived at similar findings: people with developmental disabilities have a very high risk of sexual abuse, and those with severe disabilities have even greater risk. Other studies confirm the particularly high rates of sexual assault against females with developmental disabilities (Sobsey, 1994). In Scotland, 41 per cent of people with mental health conditions had experienced harassment, compared with 15 per cent of the general population (National Schizophrenia Fellowship Scotland, 2001).

Although the phenomenon remains under researched, the data from research and those studies endorsed by institutions show that women with disabilities are vulnerable to crimes such as harassment and sexual violence (Hughes, 2003; Hughes at al., 2012). Surveys conducted in Europe, North America and Australia have shown that more than half of all women with disabilities have experienced physical violence, compared to a third of women without disabilities (Brownridge, 2006). The estimates show that about 30 per cent to 50 per cent of women with disabilities have suffered some kind of violence (Barrett et al., 2009; Cohen et al., 2006). The preamble of the UN Convention on the Rights of Persons with Disabilities (UN, 2006) recognizes that 'women with disabilities are often at greater risk, both in the home and outside, of violence, injury and abuse, neglect or negligent treatment, maltreatment or exploitation, and also recognizes that children with disabilities should have full enjoyment of all human rights and fundamental freedoms on an equal basis with other children'.

The removal of transit barriers and the enhancement of mobility for disabled people

Thus far this chapter has noted the issue of sexual harassment on public transport, and demonstrated that sexual harassment against disabled people is a problem that affects this group of vulnerable persons to a greater extent than previously acknowledged. It is clear that there is much more research required in this area, and, more engagement is required by stakeholders to introduce protection measures for this group.

Lack of awareness and non-reporting

The first problem concerns a lack of information on the part of the institutions. Transportation agencies have limited knowledge as to the extent of the problem within the environments for which they are responsible; the police have limited information on the number of people who are victims of harassment; the courts intercept very few cases; local authorities have data only related to their own information systems; and schools have limited information on how much harassment is present. The situation is perhaps more difficult for those people with disabilities who live in rural settings (European Disability Forum, 2010). Therefore there is a need to adopt a more accurate system of detection and recognition.

Secondly, the available data shows that the majority of crimes of harassment and sexual violence are not reported to the police. In a telephone survey by the National Crime Victimization Survey (US Department of Justice, 1999), 4 per cent of respondents did not report a crime immediately, as the calls were initially filtered by those first taking the calls, (McCleary and Wiebe, 1999), and therefore there are methodological inaccuracies in the data (Petersilia et al., 2001). In a similar study conducted in Australia, it was found that 40 per cent of crimes against people with mild or moderate mental retardation were not declared to the police, and this averaged 71 per cent in respect of persons with severe mental retardation (Wilson and Brewer, 1992). Another study carried out in Canada found that nearly 75 per cent of cases of sexual abuse were not reported (Sobsey and Varnhagen, 1989). A further study found that only 3 per cent of cases of sexual violence involving people with developmental disabilities were reported to the authorities (Tharinger, 1990). Bryen et al. (2003) found that out of 40 people with disabilities surveyed; 45 per cent indicated that they had experienced a crime, but only 28 per cent had made a complaint to the authorities. By contrast, 37 per cent of the victims in the general population of the United States reported the crime to the police (US Department of Justice, 2002). In 1997, in California, the Crime Report (Committee of the Victims of Sorensen) analysed the crimes against people with disabilities living in institutions funded by the state, finding that between 80 per cent and 85 per cent of the abuse was never reported to the police (Tyiska, 1998). In a survey by social services, Horner-Johnson and Drum (2006) found that the operators themselves failed to make a complaint regarding about 75 per cent of crimes of sexual victimization which happened to people with disabilities.

Reasons for not reporting

There are a number of potential explanations for the low levels of reporting of crimes against persons with disabilities. One possibility is there may be a natural difficulty in expressing words about the violence or harassment suffered. Frequently these rare situations require a recollection and description of the event, which may be still painful for those who have suffered as a victim. The literature suggests that in these cases, people with disabilities can

- be ashamed or feel guilty. Some people believe that the acceptance of their situation is good behaviour, while complaining and talking about it is improper behaviour (Carlson, 1997);

- be afraid because they are unsure of the consequences of reporting, such as fear of losing privileges, restrictions of suffering, no longer using services, or being transferred to a nursing home (Petersilia et al., 2001);
- feel economically and emotionally threatened by the harasser (Waxman, 1991);
- feel isolated and be unaware that many other people with disabilities are victims of violence (Powers et al., 2002);
- not have the physical ability to make a report or accomplish a communication (Nosek et al., 2001);
- have difficulty in relating to authority figures present among law enforcement officers (Roeher Institute, 1994). McAfee and Musso (1995) have also highlighted the fact that the police do not attend any course in order to better understand the people with disabilities;
- may be afraid of not being believed, not being taken seriously, and that in general there will not be any positive changes as a result of the complaint (Davis and Abramson, 2000);
- not know the procedure. This also applies to individuals who assist people with disabilities. In fact, Protection and Advocacy (2003) found that journalists, educators, health professionals, social workers and social services therapists often do not always know the laws for mandatory reporting, and often have different interpretations of what behaviour constitutes a criminal offense, as well as using protocols differently when to deciding when and to whom to report. The situations presented often involve the renunciation of signalling, which ultimately can not only compromise the security of the victims but also become a practice that breeds violence and impunity, recidivism and impotence.

Management policies and strategies for intervention

The offenses of harassment and sexual violence that occur in the environments of public transport against persons with disabilities have received relatively little attention from scholars in the social sciences and criminology (Moore, 2010). In general, the institutions most directly involved (UE, 2003; WHO, 2011a; US Department of Justice, 2002) believe that the success of initiatives for achieving security is measured by the expansion of opportunities for persons with disabilities to travel. The ability to feel and be free is certainly related to the possibilities of movement and the serenity with which to do so (Equality and Human Rights Commission, 2009). Mobility is not an isolated process, however, and cannot be confined only to transport systems. In fact, mobility includes several actions involving services, institutions and the whole community and, as such, requires the co-responsibility of multiple agencies and multiple levels.

Consequently, it is necessary to involve of scholars from various disciplines, for example, criminologists, psychologists, engineers, urban planners, traffic experts, agencies, police officers, security guards, nongovernmental organizations and municipalities. For this, violence on public transport can be addressed through a comprehensive approach, mainly according to specific strategic lines: community, legislative actions, research and training.

Community and research actions

- Ensure good access to urban areas in terms of communication and technology in police stations, courts and emergency services in an emergency. This means that systems can be set up to report any harassment quickly; the prompt intervention of the police and the legal system can deter potential offenders (Baladerian, 1991).
- It is important to develop a close collaboration between transportation agencies and government authorities in order to
  - ensure that the areas around transit stations and bus stops are safe and that bus stops are safe (Smith and Cornish, 2006);
  - create a database of more specific places that are experiencing greater levels harassment or violence and take the correct measures. For example, there is a link between stops and crime rate (Levine et al., 1986);
  - develop signalling reciprocal agreements between providers so that people can report harassment experienced during the course of the trip (bus stops, train stations, adjacent areas etc.);
  - involve representatives of people with disabilities in the development of policies for public transport.
- Ensure that the majority of people with disabilities are involved in the research, in which they may offer their own voice and learn how to handle situations which may be unfavourable to them.
- Promote research to detect violence against individuals with disabilities, specially detecting risk situations which they may encounter on their trips. In particular, more attention should be given to the role of the person who accompanies the disable; the perception they have of their 'caregiver' as well as the barriers and motivations to use public transportation. It also important to identify what types of disabilities put people most at risk and what specific tools can be used by these people to protect themselves from crime.

Legislative and training actions

The following recommendations can be made to improve training and legislation, namely,

- promoting recognition of disability as a cross-cutting issue area and including it in all policies, actions and measures taken to prevent a number of crimes, especially those affecting those with reduced mobility;

- considering disability as an aggravating circumstance of the crimes of violence and abuse, and applying more severe penalties for the perpetrators of violence and abuse against women and girls with disabilities;
- ensuring the presence of disability-related issues in all training courses aimed at professionals working: a) in the social, personal assistance, psychological and volunteering areas (Furey and Kehrhahn, 2000); b) in the context of public and private transport (including drivers, people selling tickets, and control stations); c) in law enforcement.

Furthermore, it is important to encourage rehabilitation programs aimed at developing necessary skills, such as the ability to recognize risky situations, harassment and sexual violence, and the ability to call for help in an easy way (Hughes, 2005). There is evidence of some success in a limited number of courses, for example, developing behavioural skills (Robinson-Whelen et al., 2007), strengthening the ability to escape (Miltenberger et al. 1999); employing residual cognitive abilities (Khemka and Hickson 2000), and teaching the identification of practical solutions (Lumley et al., 1998). In some cases, the programs were taught to discriminate against people with sexual intentions or become a nuisance to others (Lumley and Miltenberger, 1997), whereas others with impaired social skills require rapid assistance (Watson, 1984). In these cases, it is useful to recognize the harassment which takes place through small actions, such as making derogatory comments of a sexual nature, interfering with the movement of the body, asking intrusive questions, invading personal space, telling offensive jokes or vulgar sexist jokes, making obscene gestures or suggestive sounds or unwelcome contact or displaying visual harassment of a person (US Department of Justice, 1994).

Conclusion

The present chapter aimed to raise the awareness to all professionals who deal with security on public transport, and to show that it is essential to consider that the work and skills needed to remove the barriers to transit for people for whom the means of transport are of fundamental importance. A first barrier is the fact that vulnerability and disability are often mistaken for physical impairment and inappropriately attributed to the individual person. A number of studies and international institutions have agreed that disability is often the effect of political strategies and cultural and social factors that are carried out against persons with disabilities, who cannot participate in society on equal terms. In fact, the crimes on public transport, as well as causing psychological distress to the victim, seriously limit the possibility for people with disabilities and their families to have access to a range of services for their needs, from labour to care services, schools and universities, to the ability to purchase of basic necessities. The ultimate result of this is that social inclusion will be severely restricted.

The available data demonstrated a compelling argument that people with disabilities are much more at risk than people without disabilities. However, the extent of the phenomenon and the ways in which the offenses are committed are as of yet not well understood. One of the reasons why the commissioning of crimes such as harassment is hidden, is that only a very low percentage of victims chooses to report incidents. Often, this is due to a lack of personal tools to do so. This may have to do with the psychological condition of the person, or fear of retaliation or fear of losing the relationship with the offender, who is sometimes a family member or caregiver. A further reason is the lack of clear procedures for intercepting such incidents. 'Barriers', as described, severely limit the understanding of the phenomenon and the possibility of identifying the most effective interventions. On closer inspection, however, there are limits to which action can be taken, as long as one makes choices at very precise times to avoid a) the discrimination that we implement unknowingly towards people with disabilities and b) the caring attitude we often associate with this category. This chapter has also presented some operational guidelines recognized by the international community, in particular, legislative action, community resources, research and training. These actions can be implemented with shared responsibility by actors who deal with security and social inclusion of the disabled (Iudici et al., 2014a, Iudici et al., 2014b). This can be done through the awareness that disability is not a product of the individual's impairment but also society's incapacity to understand it and deal with it.

References

Baladerian, N. J. (1991) Sexual Abuse of People with Developmental Disabilities (Review). *Sexuality and Disability*, *9*(4), 323–335.

Barrett K. A., O'Day B., Roche A. and Carlson B. L. (2009) Intimate Partner Violence, Health Status, and Health Care Access among Women with Disabilities. *Women's Health Issues*, *19* (2), 94–100.

Benjamin, J. M., Hartgen, D. T., Owens, T. W. and Hardiman, M. L. (1994) Perception and Incidence of Crime on Public Transit in Small Systems in the Southeast. *Transportation Research Record*, *1433*, 195–200.

Bonprezzi F. (1999). *La contea dei ruotanti*. Ed. Il prato, Padova.

British Council of Disabled People (2007) Disabled Hate Crime Law Planned. BBC News. Available at http://news.bbc.co.uk/1/hi/uk_politics/7081085.stm, accessed 23 February 2013.

Brownridge, D. A. (2006) Partner Violence against Women with Disabilities: Prevalence, Risk, and Explanations. *Violence Against Women, 12*(9), 805–822.

Bryen, D. N., Carey, A. and Frantz, B. (2003) Ending the Silence: Adults Who Use Augmentative Communication and Their Experiences as Victims of Crime. *Augmentative and Alternative Communication (AAC), 19,* 125–134.

Calderbank, R. (2000) Abuse and Disabled people: Vulnerability or Social Indifference?. *Disability & Society*, *15*(3), 521–534.

Carlson, B. E. (1997) Mental Retardation and Domestic Violence: An Ecological Approach to Intervene. *Social Work*, *42*(1), 79–89.

Casteel C., Martin S. L., Smith J. B., Gurka K .K. and Kupper L. L. (2008) National Study of Physical and Sexual Assault among Women with Disabilities. *Injury Prevention*, *14*(2): 87–90.
Ceccato, V. (2011) Safety in Underground Stations: The Importance of Environmental Attributes. Presented at the *Annual Meeting of the American Association of Criminology*, 16–19 November, Washington, DC.
Clarke, R. V. (1996) *Preventing Mass Transit Crime. Crime Prevention Studies* . Volume 6. Monsey, NY: Criminal Justice Press.
Clarke, R. V. (1997) *Situational Crime Prevention: Successful Case Studies*, Second edition. Guilderland, NY: Harrow and Heston.
Cohen M. M., Forte T., Du Mont J., Hyman I. and Romans S. (2006) Adding Insult to Injury: Intimate Partner Violence among Women and Men Reporting Activity Limitations. *Annals of Epidemiology*, *16*(8): 644–651.
Crime Concern (2004) *People's Conceptions of Personal Security and Their Concerns about Crime on Public Transport: Research Findings* . London, UK: Department for Transport.
Davis, L. A., and Abramson, W. (2000) More Common Than We Think: Recognizing and Responding to Signs of Violence. *Impact*, *13*(3), 8–9.
Del Castillo, V. (1992) Fear of Crime in the New York City Subway. Doctoral dissertation, Fordham University, New York, NY.
Department for Transport (2008) *Experiences and Perceptions of Anti-Social Behaviour and Crime on Public Transport*. London: Department for Transport.
Disabled Crime Victims Assistance, Inc. (2006) *Statistics*. Available at http://www.dcvainc.org/, accessed 2 April 2015.
Disability Rights Commission (2003) *NOP Survey on Disabled People's Experiences of Access to Services in Britain*. London: Disability Rights Commission.
Equality and Human Rights Commission (2011) Hidden in Plain Sight: Inquiry into Disability-Related Harassment. Manchester: EHRC.
European Disability Forum (EDF) (2010) Response to the Consultation on an EU Strategy to Combat Violence against Women. Available on the EDF Website at: www.edf-feph.org.
European Union (2003) Council Resolution of 15 July 2003 on promoting the employment and social integration of people with disabilities. *Official Journal C 175* , 24/07/2003 P.0001–0002.
European Union (2003) Council Resolution on 'Promoting the Employment and Social Integration of People with Disabilities' (15 Luglio 2003). http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32003G0724%2801%29 [Accessed 2nd April 2015]Furey, E. M., and Kehrhahn, M. T. (2000) What Supervisors, Managers, and Executives Know about Abuse of People with Mental Retardation. *Developmental Disabilities Bulletin*, *28*, 40–60.
Gaylord, M., and Galliher, J. F. (1991) Riding the Underground Dragon: Crime, Control and Public Order on Hong Kong's Mass Transit Railway. *British Journal of Criminology*, *31*(1), 15–26.
Granville, S., and Campbell-Jack, D. (2005) *Anti-Social Behaviour on Buses*. Edinburgh: The Scottish Executive.
Greater London Authority (2003) *Disability Capital 2003*. Greater London Authority, Available at www.london.gov.uk, accessed 2 April 2015.
Hershkowitz, I., Lamb, M. E. and Horowitz, D. (2007) Victimization of Children with Disabilities. *American Journal of Orthopsychiatry*, *77*, 629–35.
Hingsburger, D. (1995) *Just Say Know! Understanding and Reducing the Risk of Sexual Victimisation of People with Developmental Disabilities*. Quebec: Diverse City Press.

Hollomotz, A. (2013) Disability, Oppression and Violence: Towards a Sociological Explanation- *Sociology*, *47*, 477–493.

Horner-Johnson, W., and Drum, C. E. (2006) Prevalence of Maltreatment of People with Intellectual Disabilities: A Review of Recently Published Research. *Mental Retardation and Developmental Disabilities Research Reviews*, *12*(1), 57–69.

Hsu, H-P (2011) How Does Fear of Sexual Harassment Affect Women's Use of Transit? *Proceedings of the 4th International Conference on Women's Issues in Transportation*. Volume 2: Technical Papers, Transportation Research Board: Washington, DC, 85–94. http://onlinepubs.trb.org/onlinepubs/conf/cp46v2.pdf.

Hughes, C. (2003) *Stop the Violence, Break the Silence Training Guide: Building Bridges between Domestic Violence and Sexual Assault Organizations, People with Disabilities, Families and Caregivers*. Austin, TX: Disability Services ASAP/SafePlace.

Hughes K., Bellis M. A., Jones L., Wood S., Bates G., Eckley, L., McCoy, E., Mikton, C., Shakespeare, T., Officer, A. (2012) Prevalence and Risk of Violence against Adults with Disabilities: A Systematic Review and Meta-Analysis of Observational Studies. *The Lancet*, *379*, 1621–1629.

Hughes, R. B. (2005) Violence against Women with Disabilities: Urgent Call for Action. *The Community Psychologist, 38,* 28–30.

Iudici, A., de Aloe, S., Fornaro, G., Priori, M., and Strada, A. (2014a) Countering the "Career of Disability": From Clinical Institutionalization to the Creation of Opportunities for Biographical Change. The Intervention of the Service for Integration, Accompaniment and Orientation for Students with Disabilities of the Municipalities of Melzo and Liscate (Mi). *Procedia- Social Behavioral Sciences*, *116*, 3271–3275.

Iudici, A., Trabattoni ,L., Degiorgi, C., de Aloe, S., Strada, A., and Priori, M. (2014b) Outlines of an Architecture of a Service Oriented to the Development of Skills of Persons with and without Disabilities. an Innovative Practice Experience of Inclusive Research in Italians Public Services. *International Journal of Humanities and Social Science* (IJHSS) *4*(8), 56–63.

Karmen A. (2003) *Crime Victims: An Introduction to Victimology*, Wadsworth Publishing.

Khemka, I., and Hickson, L. (2000) Decision Making by Adults with Mental Retardation in Simulated Situations of Abuse. *American Journal on Mental Retardation, 38*, 15–26.

La Vigne, N. G. (1996) Safe Transport: Security by Design on the Washington Metro. In: Clarke, R. (ed.) *Preventing Mass Transit Crime. Crime Prevention Studies*. Volume 6. Monsey, NY: Criminal Justice Press, 165–198.

La Vigne, N. G. (1997) *Visibility and Vigilance: Metro's Situational Approach to Preventing Subway Crime*. National Institute of Justice-Research in Brief. US Department of Justice.

Levine, N., Wachs, M. and Shirazi, E. (1986) Crime at Bus Stops: A Study of Environmental Factors. *Journal of Architectural and Planning Research*, *3*(4), 339–361.

Lord Chancellor's Department (1997) *Who Decides? Making Decisions on Behalf of Mentally Incapacitated Adults*. London: Stationery Office.

Loukaitou-Sideris, A. (2009) *How to Ease Women's Fear of Transportation Environments: Case Studies and Best Practices*. San Jose, CA: Mineta Transportation Institute: Report 09–01.

Loukaitou-Sideris, A. (2012) Safe on the Move: The Importance of the Built Environment. In: V. Ceccato (ed.), *The Urban Fabric of Crime and Fear*. Dordrecht, Heidelberg, New York, London: Springer, 85–110,

Loukaitou-Sideris, A., and Fink, C. (2009) Addressing Women's Fear of Victimization in Transportation Settings: A Survey of U.S. Transit Agencies. *Urban Affairs Review, 44*, 554–587.

Lumley, V. A. and Miltenberger, R. G. (1997) Sexual Abuse Prevention for Persons with Mental Retardation. *American Journal on Mental Retardation*, *101*, 459–472.

Lumley, V. A., Miltenberger, R. G., Long, E. S., Rapp, J. T. and Roberts, J. A. (1998) Evaluation of a Sexual Abuse Prevention Program for Adults with Mental Retardation. *Journal of Applied Behavior Analysis*, *31*, 91–101.

Martin, S. L., Ray, N., Sotres-Alvarez, D., Kupper, L. L., Moracco, K. E., Dickens, P.A., Scandlin, D., Gizlice, Z. (2006) Physical and Sexual Assault of Women with Disabilities. *Violence against Women*, *12*, 823–837.

McAfee, J. K., and Musso, S. L. (1995) Training Police Officers about Persons with Disabilities: A 50 State Policy Analysis. *Remedial and Special Education*, *16*(1), 53–63.

McCleary, R., and Wiebe, D. J. (1999) *Measuring the Victimization Risk of the Developmentally Disabled: Methodological Problems and Solutions*. Unpublished manuscript. Washington, DC: National Research Council.

Millie, A. (2008) *Anti Social Behavior*. Maidenhead: McGraw-Hill. Open University Press.

Miltenberger, R. G., Roberts, J. A., Ellingson, S., Galensky, T., Rapp, J. T., and Long, E. S., Lumley, V. A. (1999) Training and Generalization of Sexual Abuse Prevention Skills for Women with Mental Retardation. *Journal of Applied Behavior Analysis, 32*, 385–388.

Moore, S. (2010) Preventing Anti-Social Behaviour on Public Transport: An Alternative Route?, *Crime Prevention and Community Safety*, *12*(3), 176–193.

National Schizophrenia Fellowship (Scotland) (2001) *Give Us a Break: Exploring the Harassment of People with Mental Health Problems*. Edinburgh: NSF.

Nosek, M. A., Foley, C. C., Hughes, R. B. and Howland, C. A. (2001) Vulnerabilities for Abuse among Women with Disabilities. *Sexuality and Disability, 19,* 177–189.

Oliver M. (1983) *Social Work with Disabled People*. London: Macmillan.

Oliver, M., and C. Barnes (2012) *The New Politics of Disablement* . London: Palgrave Macmillan.

Petersilia, J., Foote, J. and Crowell, N. (2001) *Crime Victims with Developmental Disabilities: Report of a workshop*. Washington, DC: National Research Council.

Powers, L.E., Curry, M. A., Oschwald, M., Maley, S., Saxton, M. and Eckels, K. (2002) Barriers and Strategies in Addressing Abuse: A Survey of Disabled Women's Experiences. *Journal of Rehabilitation*, *68*(1), 4–13.

Protection and Advocacy, Inc. (2003) Abuse and Neglect of Adults with Developmental Disabilities: A Public Health Priority for the State of California. Available at http://www.pai-ca.org/pubs/701901.pdf, accessed 2 April 2015.

Robinson-Whelen, S., Hughes, R. B., Taylor, H. B., Hall, J. W. and Rehm, L. P. (2007) Depression Self-Management Program for Rural Women with Physical Disabilities. *Rehabilitation Psychology, 52,* 254–262.

Roeher Institute (1994) *Violence and People with Disabilities: A Review of the Literature*. Ottawa, ON: National Clearinghouse on Family Violence.

Smith, K., Coleman K., Eder, S. and Hall, P. (2011) *Homicides, Firearm Offences and Intimate Violence 2009/10: Supplementary Volume 2 to Crime in England and Wales 2009/10*. London: Home Office Statistics.

Smith, M. J., and Clarke, R. V. (2000) Crime and Public Transport. In: Tonry, M. (ed.) *Crime and Justice: A Review of Research*. 27. Chicago: University of Chicago Press. 169–233.

Smith, M. J., and Cornish, D. B. (2006) *Secure and Tranquil Travel – Preventing Crime and Disorder on Public Transport*. London. UCL Jill Dando Institute of Crime Science, University of London.

Sobsey, D. (1994) *Violence and Abuse in the Lives of People with Disabilities: The End of Silent Acceptance?* Baltimore: Brooks.
Sobsey, D., and Doe, T. (1991). Patterns of Sexual Abuse and Assault. *Sexuality and Disability*, *9*(3), 243–259.
Sobsey, D., and Varnhagen, C. (1989) Sexual Abuse and Exploitation of People with Disabilities. In: Csapo, M. and Gougen, L. (eds), *Special Education across Canada*. Vancouver: Center for Human Development and Research.
Stringer, S. M. (2007) *Hidden in Plain Sight: Sexual Harassment and Assault in the New York City Subway System*. New York: Manhattan Borough President's Office.
Teplin, L. A., McClelland, G. M., Abram, K. M. and Weiner, D. A. (2005) Crime Victimization in Adults with Severe Mental Illness: Comparison with the National Crime Victimization Survey. *Archives of General Psychiatry*, *62*, 911–921.
Tharinger, D. (1990) Sexual Abuse and Exploitation of Children and Adults with Mental Retardation and Other Handicaps. *Child Abuse and Neglect: The International Journal*, *14*(3), 301–312.
Tyiska, C. (1998) *Working With Victims of Crime with Disabilities*. *Office for Victims of Crime Bulletin*. Washington, DC: US Department of Justice, Office for Victims of Crime.
UN (2006) The Convention on the Rights of Persons with Disabilities. www.un.org/disabilities/convention/conventionfull.shtml.
US Department of Justice, Bureau of Justice Statistics (1999) *National Crime Victimization Survey*. Washington, DC: Author.
US Department of Justice, National Institute of Justice (1994) *Basic Course Instructor Unit Guide*. Cultural Diversity Discrimination Sexual Harassment Hate Crimes. National Institute of Justice, Rockville, MD
US Department of Justice, Office of Victims of Crime (2002) *First Response to Victims of Crime Who Have a Disability*. Washington, DC: Author.
VonHen Tig (1948) *The Criminal and His Victim*. New Haven, CT: Yale University Press.
Vuhic, V. R. (1981) *Urban Public Transportation: System and Technology*. Englewood Cliffs, NJ: Prentice-Hall.
Watson, J. D. (1984) Talking about the Best Kept Secret: Sexual Abuse and Children with Disabilities. *The Exceptional Parent*, *14*, 15–20.
Waxman, B.F. (1991) Hatred: The Unacknowledged Dimension in Violence Against Disabled People. *Sexuality and Disability, 9*(3), 185–199.
World Health Organization (2001) *International Classification of Functioning, Disability and Health*. Geneva: World Health Organisation.
World Health Organization (2011) *World Report on Disability*. Geneva: World Health Organization.
Yaro, R., and Hiss, T. (1996) *A Region at Risk: The Third Regional Plan for N. York-N. Jersey-Connecticut Metropolitan Area*. Covelo, CA: Island Press.

19

Enhancing Mobility and Perceived Safety via ICT: The Case of a Navigation System for Visually Impaired Users

Jana Sochor

Introduction

Many nations' transport policy goals include fulfilment of the mobility needs of their citizens via accessible, reliable, safe and sustainable transportation systems, although limited resources and demographic changes such as population growth and ageing are creating additional demands. As such, many cities and companies are looking to Information and Computing Technology (ICT) systems and applications (such as positioning, navigation, ubiquitous two-way communication and Internet access) to help address the challenges in reaching these goals, for example, by improving choices and system accessibility via data collection and information provision. This integration of ICT in transportation is also referred to as Intelligent Transportation Systems (ITS).

While many systems and applications are geared towards helping the general traveller, such as travel planners, real-time information and push notifications (Vautin, 2011), they may not be accessible to all users due to sensory or cognitive disabilities. Disabled users also face physical and information-related mobility barriers in the transportation system (TRB, 2001; Hunter-Zaworski, 2011), as well as real and perceived safety and security barriers (Pain, 2000; Petersilia, 2001; Stiles et al., 2003; Smith et al., 2007). For vulnerable social groups, access to information may be the deciding factor in whether or not to travel (Waara, 2013). As persons with disabilities also face higher rates of unemployment and poverty (SCB, 2009; BLS, 2012; She and Livermore, 2009), ICT assistance to alleviate these mobility and safety barriers and to improve transportation accessibility is crucial for gaining access to jobs and social services (Lubin and Deka, 2012), and increasing social inclusion and social capital (Currie and Stanley, 2008). Furthermore, such ICT assistance can be integrity enhancing via increased perceived safety, independence and autonomy.

While full assessments of ICT systems should weigh the benefits and risks to different stakeholders, the potential positive and negative ethical aspects of ICT use are difficult to quantify, and end users are too rarely included in this evaluation process. In order for mobility-enhancing ICT to reach its full potential, we need to not only examine the ethical issues and trade-offs of its use from a theoretical perspective but also investigate the perceived benefits and risks from the user perspective.

The aim of this study, conducted in Sweden, is to investigate the case of visually impaired persons and the possible effects of a tailored navigation system (e-Adept) on their mobility and perceived safety. Included are the users' perceptions of potential risks and benefits, which prove to offer insight into fundamental ethical issues related to mobility and ICT such as privacy and autonomy. This study presents a pilot project investigating user perspectives other than those related to strict technological development. It also studies applied ethics in the transportation context by framing mobility, safety, and potential risks and benefits of ICT use in terms of broader principles, such as social inclusion and the accessibility of transportation, technology and information.

The structure of the chapter is as follows: it will begin by providing an overview of those methods of supporting mobility investigated in the case study, as well as of related ethical concerns. It then moves on to describe the methods and data used in the study. Following on from this is a discussion of the findings and the results of the study, and the final section presents the author's conclusions and suggested further work.

Background

The importance of safe and independent mobility

People have many reasons to be mobile, from day-to-day activities involving work, studies and family life, to maintaining participation in society, health and quality of life. Indeed, mobility is not only a characteristic of modern social life but also a precondition for it (Thomsen et al., 2005). When considering personal mobility, one finds a broad range of mobility barriers such as accessibility, availability, affordability, safety concerns, lack of information and so forth, Moreover, demographic factors such as age or disability can serve to compound such barriers.

People with disabilities tend to restrict their travel more than the general population and prefer car travel. For example, during a 12-month period in Sweden, an estimated 40 per cent of disabled persons did not use public transportation (SRA, 2001). Special transportation service vehicles are generally more accessible, provide door-to-door service and eliminate the need to wait or to walk far, although using them also entails dependence on other drivers and constraints on scheduling and spontaneity. Although public transportation presents physical mobility barriers for disabled users, such as entering and exiting vehicles and navigating through stations, there are also information-related mobility barriers which make it difficult to access the correct vehicle, identify the desired stop, access real-time information and know what to do in an emergency situation (TRB, 2001; Hunter-Zaworski, 2011). Disabled persons also have a greater need for relevant information about the entire journey in order to plan and complete a trip (Waara, 2013). There is a greater need for more detailed pre-trip and on-trip information, including static information about schedules, ticketing and station layouts, and dynamic information about current conditions, delays and changes, and non-functioning facilities such as escalators and elevators (SRA, 2001).

'Personal security' also presents mobility barriers via concerns about discrimination, abuse or violence, accidents or emergencies (Smith et al., 2007). Despite this, disability has generally not received widespread attention in the literature. For example, there is a paucity of studies within the fear of crime or victimization literature (Pain, 2000; Petersilia, 2001). Although neither of these studies focuses specifically on visually impaired persons, Petersilia (2001) found that violence and abuse against persons with developmental disabilities occur at significantly higher rates and are also underreported and underprosecuted, while Stiles et al. (2003) found that actual physical disability contributes to fear of crime over and above perceptions of limited ability (in other words, perception of health). Stiles et al. also point out that for disabled persons, as is the case with women who have been researched in more depth, the built environment has a greater negative impact on their ability to remove themselves from real and/or perceived danger, thus increasing real and/or perceived vulnerability.

The various barriers discussed above are not only barriers to mobility and independence but may in turn act as impediments to public and private services, leisure activities, employment and education, potentially generating long-term social impacts. Mobility in and of itself contributes to an active lifestyle, which improves health, and is therefore related to being able to live an autonomous, independent life. This, in turn, is linked to a smaller need for public support and a savings of public funds (Hakamies-Blomqvist et al., 2004). As such, enabling mobility that is safe and accessible in terms of physical movement as well as information provision is vital for social inclusion. ICT systems such as e-Adept present opportunities to alleviate some of these barriers via relevant, real-time information provision and access to help when needed, thus contributing to mobility, perceived safety, independence and inclusion.

Methods of supporting mobility

The customary way of supporting mobility has been in the form of door-to-door physical assistance, in other words Special Transportation Services (STS), also known as Dial-a-Ride, paratransit and so forth. In Sweden, STS

('Färdtjänst' in Swedish) is provided to those who have 'significant difficulties with independent mobility or with travelling via public transportation because of non-temporary, functional hindrances' (Swedish law 1997:736) and have been granted a permit. It is ultimately the responsibility of every municipality to provide this mandatory service, and the municipalities in Stockholm county cooperate in offering this service.

Understanding the use of STS and public transportation, and supporting a mode shift is of interest to authorities due to the costs of providing this special service. In the Stockholm region, there are approximately 71,000 permit holders in total who make 2.9 million annual trips worth approximately 600 million Swedish crowns (SEK) (exchange rate ≈ 8 SEK/USD), of which 85 per cent is subsidized by the regional health-care council (Färdtjänst, 2010). Promoting a mode shift can come, for example, via increasing the accessibility of public transportation and the built environment, which Stockholm focused on improving during the decade-long Easy Access Project (Otter and Östergren, 2010). It can also come from ICT, such as a tailored pedestrian navigation system.

There are difficulties in capturing exact statistics regarding the number of STS permits based on visual impairment in Stockholm, but it has been estimated that navigation aid for the visually impaired alone could reduce the STS cost for Stockholm by 10 per cent (Karlsson, 2008). In general, it is difficult to determine the exact number of visually impaired persons in Sweden due to a desire to protect the integrity of disabled persons (and due to the various types and degrees of visual impairments), but it is estimated at about 120,000 persons out of a population of almost 10 million (Funka, 2014), which equates to about 1.25 per cent of the population.

ICT is enabling new forms of information-based assistance. There are many examples of projects that have targeted not only mobility-impaired persons in general, for example, Ambient Intelligence System of Agents for Knowledge-based and Integrated Services for Mobility Impaired users (ASK-IT, nd), but also specific subgroups such as visually impaired persons (examples include: e-Adept [2012]; Assisting personal guidance system for people with visual impairment (ARGUS, nd); NOPPA [2012]; Drishti [Ran et al., 2004]) or cognitively impaired persons (for example, TAD [Bolechala et al., 2011]; Opportunity Knocks [Patterson et al., 2004]; MAPS [Carmein et al., 2005]). The Swedish e-Adept (Electronic Assistance for Disabled and Elderly Pedestrians and Travelers) project is based on a smartphone (with buttons and GPS) and an inertial navigation system connected to an integrated database containing digitally represented pedestrian, bicycle and road networks, as well as information about the built environment (including seasonal information and temporary road work). Users can receive audio feedback and step-by-step instructions, such as distance, obstacle warnings and directions along the pedestrian network, including sidewalks, paths and crosswalks.

Although e-Adept is designed with visually impaired users in mind, anyone can use it for different types of navigation by changing a profile, for example, for use by driver, cyclist, pedestrian, wheelchair user or visually impaired user. The system also includes public transportation information and route planning and guidance, as well as emergency and support alarms for which the user can set his or her own level of visibility. The system's functionalities also enable indoor navigation. The system has been tested in Stockholm and several other municipalities, as it has been intended to be available throughout most of Sweden and perhaps internationally (e-Adept Project, 2012).

Method and material

The analysis presented in this chapter is of a case study by the author of visually impaired persons, using data that was collected as part of a larger research project exploring the ethical impacts of using ICT to enhance mobility. One main aim of the project is to investigate end users' attitudes towards various systems and applications, as well as the perceived impacts on daily life (Sochor, 2013). For this case study, the data was collected via individual, structured interviews by telephone or in person. In structured interviews, each respondent receives the same predetermined questions in the same order, and questions tend to have a limited set of predetermined responses. This consistency between individual structured interviews enables data to be analysed quantitatively through aggregation and comparisons across respondents and time periods. Traditionally, structured interviews only permit minimal responses, but for this study respondents were allowed to elaborate if they so desired, with additional comments recorded by the interviewer. The interviews included approximately 80 questions covering background information; travel situation; general attitudes towards technology, such as privacy, trust and its benefits and possible risks; and scenarios based on specific ICT systems or applications. The interviews were completed in the autumn of 2009, and the data analysed using the statistical software package SPSS. Due to the ordinal nature of the data (for example, using the Likert rating scale of 1 to 5), non-parametric tests (discussed below) are used to test for statistically significant differences ($\alpha = 5\%$) in responses.

The initial recruitment for volunteers took place at a Stockholm Traffic Administration 'Digital Pedestrian Network' reference group meeting, whose visually impaired, volunteer members were recruited via the Stockholm chapter of the Swedish Association of the Visually Impaired (SRF). Additional recruitment took place via an additional email call to the reference group, as well as via single calls in four information channels for the visually impaired, including local and regional audio newspapers, an internal newsletter for members of the Swedish Association of Visually Impaired Youth (members aged 12–30) and SRF's newsletter. Volunteers were only required to have a visual impairment and be at least 18 years old. The resulting convenience sample consists of 23 respondents/interviews.

A number of interview questions are of a stated-preference nature, and a possible limitation therefore is the reliability of responses, which potentially limits the strength of claims made. However, as the e-Adept navigation system has been developed in Stockholm, and as the second interview scenario describes such a system, the study has controlled for previous experience with e-Adept. One of the final interview questions establishes each respondent's level of experience with e-Adept, and the resulting indicator splits the respondents into two groups. Ten respondents were classed within the 'experienced' group, indicated by direct personal experience with e-Adept via testing the system or having participated in the above reference group during system development. The remaining 13 respondents formed the control group with 'no experience', indicated by only having heard about the system or having no previous knowledge whatsoever.

Very few statistically significant differences are found between the two groups' responses. Any such findings are indicated by an * in the results, together with the corresponding Mann-Whitney U test- and p-values. The fact that previous experience has such little influence, positive or negative, on the responses strengthens claims made regarding potential changes in behaviour as a result of a similarly described navigation system. Although the findings can be considered representative within the Swedish setting, as the system and scenarios are based upon the availability of public transportation and pedestrian networks (and network data), the results may not apply to settings lacking such networks. However the extent to which this is true remains to be determined.

Results and discussion

Socio-demographic characteristics

Table 19.1 provides an overview of the socio-demographic characteristics of the respondents. The average age is 47 years old, and the majority of respondents live in Stockholm county, are male, and have some university-level education, although a minority are employed. A majority also retain some vision, use a white cane as their primary mobility aid, live in a single-person household and have no available vehicle (74% as compared to 25% nationwide [SIKA, 2007]). All respondents are eligible for STS, which is free for those respondents living in Stockholm county.

Travel Situation

The second section of the interview focuses on the respondents' travel situation, with a targeted interest in their choices of STS and public transportation, and includes some rating questions. Minimal car use is expected

Table 19.1 Socio-demographic characteristics of the respondents

Demographic	
e-Adept Experience Indicator	10 = yes 13 = no
County (Län) of Residence	18 = Stockholm 5 = other
Gender	16 = male 7 = female
Age (years)	$\bar{x} = 47.17$, $\tilde{x} = 48$, range [23,92]
Education Level	17 = university (or equivalent) 6 = high school (or equivalent)
Main Occupation	7 = employed, full time; 1 = employed, part time; 3 = student; 4 = unemployed; 8 = retired
Level of Visual Impairment	6 = totally blind (previous vision); 3 = totally blind from birth; 14 = partial vision
Most Commonly Used Aid	17 = white cane; 2 = guide; 4 = none
Persons in Household	14 = one person; 7 = two people; 2 = four people
Visually Impaired Persons in Household	21 = one person 2 = two people
Available Vehicles in Household	17 = zero vehicles; 5 = one vehicle; 1 = two vehicles
STS Eligibility	23 = yes 0 = no
Gross Monthly Income of Household (SEK) (Exchange Rate ≈ 7 SEK/USD)	4 = 0 – 7500 SEK; 4 = 7501 – 15,000 SEK; 7 = 15,001 – 25,000 SEK; 6 = 25,001 – 40,000 SEK; 2 = more than 40,000 SEK

due to the respondents' socio-demographic characteristics. When asked to describe their most common trip in terms of modes used, walking was the most common mode (22 trip segments for all respondents together), followed by STS (9), subway (8), bus (6), train and commuter train (4), and car passenger (1).

Most respondents use both STS* and public transportation at least once a week or daily, and usually travel alone. The nearest public transportation access point is estimated, on average, to be 200m and a four-minute walk from home. Respondents' attitudes towards understanding the public transportation system and their sense of assurance when using public transportation are generally favourable ($\bar{x}$ = 2.45 and $\bar{x}$ = 2.26*, respectively, on reverse scales). The 'experienced' group uses STS significantly more often, $U = 15$, $p = 0.001$, and they also feel significantly less assured while using public transportation, $U = 31$, $p = 0.036$, illustrating how familiarity tends to be associated with greater feelings of assurance, and vice versa (Crime Concern, 1997).

The specific reasons behind the 'experienced' group's relative lack of assurance while using public transportation was not explored. On the one hand, if the lack of assurance is linked to issues such as discrimination, abuse or violence, falling or accidents (Smith et al., 2007), then it is unlikely that ICT will be able to offer much in terms of solutions (although the alarm function may be useful here). On the other hand, if it is linked to a lack of information, which can be a deciding factor in whether or not to travel for vulnerable social groups (Waara, 2013), then improved information provision can potentially shift the 'experienced' group's relatively greater use of STS over to public transportation. This is underscored by the general respondent group feeling that public transportation companies do *not* provide enough relevant travel information ($\bar{x}$ = 3.35); a situation potentially mitigated by ICT together with organizational efforts.

Although STS is an important transportation mode for vulnerable social groups, it is an expensive and limited service. Therefore it is of interest to understand the respondents' mode choices, in particular their reasons for choosing public transportation or STS over other modes. The respondents' most common reasons (maximum three per respondent) for choosing public transportation are

- time savings (8 of 23);
- familiarity with the trip/destination (5 of 23);
- STS' perceived unreliability (5 of 23);
- a conscious attempt to prioritize public transportation when it provides a reasonable alternative (5 of 23).

Other, less frequent, responses for choosing public transportation included spontaneity, lack of STS trips, cost, accompanied travel and desire for independence.

For STS, the most common reasons are

- a lack of familiarity with the trip/destination (16 of 23);
- avoidance of public transportation transfers (6 of 23);

- time savings (4 of 23);
- access to personal help (4 of 23).

Although these responses indicate various ways in which one can improve service, the two most common responses as to why respondents choose STS indicate the potential for a modal shift away from STS to public transportation via information provision and guidance, for example, via a pedestrian navigation system. This could also increase spontaneity and independence (stated as some reasons for choosing public transportation). This observation is also supported by the results of the navigation system scenario below.

However, some respondents pointed out several other factors affecting the choice between using STS or public transportation, which re-emphasizes the need for a coordinated, system-wide approach including physical, technological, organizational and individual efforts. For example, the number of STS trips is limited, so one may be forced to choose public transportation. Also, the accessibility of the built environment and the public transportation system are important – the ability to get to/from and navigate in the actual stops or stations. Furthermore, lack of experience with the public transportation system may be a hindrance to using it.

Attitudes towards technology and privacy

The third part of the interview focuses on the respondents' general attitudes towards technology, in terms of privacy, trust, and its benefits and risks.

Technology

The respondents feel that technology in general benefits individuals and society ($\bar{x}$ = 4.13) and express a personal interest in new technology ($\bar{x}$ = 4.17*). The experienced group expresses a significantly higher personal interest, U = 33, p = 0.049, which may have influenced their willingness to participate in the 'Digital Pedestrian Network' reference group. During the open response question, Respondent 13 adds that *'I had not thought about how much one could benefit from ICT'*, while Respondent 2 points out the potential downside: *'Good technology benefits individuals and society, but bad technology hurts them. Hopefully an accessibility law for technology will be passed. It's discrimination if there isn't any technology that handicapped people can use'*.

A vast majority (22 of 23) own a mobile phone, which may reflect modern Swedish society in general, and try to carry their mobile phone with them at all times ($\bar{x}$ = 4.77). However, Respondent 2 points out that not all mobile phone features are ideal for visually impaired persons: *'Touch screens, for example, are worthless, but they're becoming more and more common. Fewer and fewer mobile phones come without a touch screen so in the end you have to buy the most basic model anyway. In the end maybe there won't be any mobile phones* *without a touch screen'.* It is possible for application software to alleviate or overcome some hardware barriers, so adoption of touch screen phones by visually impaired persons will likely be highly influenced by which applications are available for the various operating systems (Seraphin, 2010).

In the context of transportation, respondents also express an interest in planning their trips in advance ($\bar{x}$ = 3.96), and an increased sense of assurance when in possession of directions/instructions while travelling in an unfamiliar setting ($\bar{x}$ = 4.04). Furthermore, they feel it would be beneficial to know their exact location when travelling, for example via a GPS system ($\bar{x}$ =4.05). When asked which types of pre-trip ICT-based services they use, 43 per cent state that they use online travel planners and 26 per cent check online time tables.

The respondents clearly find technology useful and beneficial, and are interested in using ICT and information to better plan their travel. However, their open comments illustrate that ICT does not automatically result in greater levels of inclusion, and that, unfortunately, it may even create new barriers for vulnerable social groups (Coombs, 1990). Indeed, governments are stepping in to promote e-inclusion, e-accessibility, and so on (European Union e-Accessibility Policy, 2012), as they have previously done to promote physical accessibility in the built environment.

Privacy

When exploring the respondents' general attitudes regarding the generation and use of personal data in travel-related technologies and services, on average they perceive a greater benefit than risk ($\bar{x}$ = 3.87 and $\bar{x}$ = 2.65 respectively). Only two respondents rated the risk as higher than the benefit when comparing the ratings of the two statements. On average, the respondents also agree with the common idiom 'nothing to hide, nothing to fear' when it comes to being surveilled or tracked through personal data ($\bar{x}$ = 3.74), and are not willing to pay more for a technology that allows them to remain anonymous ($\bar{x}$ = 2.26). Although the results may be influenced by optimistic bias, where others are deemed to be at greater risk than oneself (Sjöberg, 2000), the findings are in line with another Swedish case study by the author (Sochor et al., forthcoming).

However, these results do not necessarily indicate an overarching disinterest in protecting personal data, as privacy concerns are highly contextual. For example,

- One may not trust the keepers of the data – the respondents' ratings of personal trust for government agencies and private companies to protect personal data are mixed, with approximately equal groups disagreeing (7 of 23), agreeing (8 of 23), and neither disagreeing nor agreeing (8 of 23).
- One may also expect that personal data protection be the default, for example, via laws such as the *Personal Data Act* (Personuppgiftslag

1998:204) in Sweden, rather than an additional feature or service requiring payment. This law aims to prevent the violation of personal integrity by the processing of personal data and includes voluntary, specific, unambiguous and informed consent of the registered person, as well as various 'fair information practices' (JD, 2006).

- One may be willing to have personal information registered in a database as long as it is kept isolated – *'I can agree to registration in a database if I gain something from it and if I know the risks involved. I do not want there to be a traceable connection between STS and the Stockholm Public Transport card'* (Respondent 16).
- One may have different levels of understanding about how the technology works – *'I hadn't thought about the privacy aspect before. The technology could facilitate things for many people, but the privacy aspect varies from person to person. It is probably influenced a lot by how much you understand about how the technology works'* (Respondent 14).

The motivations behind these privacy- and trust-related ratings were not explicitly explored in the interviews, but are of interest in future research in order to further the understanding of consumer expectations. These examples of trust, knowledge of how data is used, level of technological knowledge and so forth link back to greater issues of context, control and informed consent (Sochor, 2013).

Pedestrian navigation system

The last part of the interviews presents two scenarios followed by rating statements in order to capture responses to more specific technologies, although only the navigation system scenario results are presented in this paper. The scenario is as follows: *'There is a navigation system being developed that includes a smartphone, GPS, dead-reckoning system and earphones. The system accesses databases containing information about the pedestrian and bicycle networks, and other information about the physical environment. Using information about the user's location, the system can, for example, provide detailed instructions along the pedestrian network, access public transportation information, and send alarms to a security company. I will now ask some questions about how you think using such a navigation system would affect you'.*

Effects on assurance, mobility and lifestyle

An initial rating statement investigates how the described system would affect the respondent's sense of assurance *in general*. Responses are recorded on a scale of 1 (very negative) to 5 (very positive). The majority feel that there would be a positive or very positive effect on their sense of assurance (20 of 23).

The next questions are ratings of how the system would affect the respondent's sense of assurance *in specific situations*. Responses are recorded on a scale of 1 (much less reassured than normal) to 5 (much more reassured than normal). Comparing the situations of accompanied and unaccompanied travel, the navigation system's potential affect on assurance is judged to be most neutral (or even negative on average) when travelling with someone else ($\bar{x}$=2.74). The affect is judged to be positive when travelling alone ($\bar{x}$ = 4.09). This suggests that such a navigation system would most likely be used for unaccompanied travel, potentially in lieu of a personal guide when that assistance is of an informational nature (for example, public transportation employees helping with transfers). However, it cannot replace another human being for accompanying functions such as companionship and help with carrying items.

The four situations which resulted in a positive rating, in increasing order of the navigation system's (average) potential effect on assurance, are when travelling regularly to the same destination ($\bar{x}$=3.57*, the experienced group gave a significantly higher rating, U=15, p=0.001), when travelling alone ($\bar{x}$=4.09), when making a *planned* trip to an unfamiliar destination ($\bar{x}$=4.39), and when making an *unplanned* trip to an unfamiliar destination ($\bar{x}$=4.57). In general, the responses suggest that such a navigation system would contribute to assurance mostly when a person is travelling alone and in unfamiliar or unplanned situations. This, again, illustrates the compensating function of information, which is important for all travellers, but elderly and disabled travellers in particular (Waara, 2013).

Next, respondents rate a series of statements relating to potential changes in mobility and lifestyle due to the described navigation system. Responses are recorded on a scale of 1 (totally disagree) to 5 (totally agree). The statement related to an increase in the frequency of travel indicates that the respondents may travel slightly more frequently than normal with the help of such a navigation system ($\bar{x}$ =3.30), although Respondent 17 expresses doubts: '*I don't think technology can get people to get out and travel more, not even with public transportation. I have to make certain trips anyway so technology doesn't affect how often one travels*'.

Although travel frequency may not change, the nature of the trips may change as the respondents agree that such a navigation system would increase their frequency of travelling alone ($\bar{x}$= 3.61), travelling to unfamiliar destinations ($\bar{x}$ =3.61) and travelling with public transportation instead of STS ($\bar{x}$ =3.87), indicating the potential for ITS to enhance perceived safety. According to Respondent 7, '*I have to have a personal guide or a navigation system or STS; otherwise, I can't go anywhere because I can't travel alone. I'm looking forward to a navigation system that is so reliable and that tells me when I'm going the wrong way*'. Another, Respondent 19, states that such a system '*would expand my traveling both in the county and throughout the country if the service is available everywhere*'. Also, the respondents think the system would greatly increase their independence ($\bar{x}$ = 4.26). Independence here reflects more than just the ability to travel alone, but perhaps also reflects a potentially increased ability to be spontaneous and not have to depend on friends, relatives or the social system to move about. In this sense, the navigation system serves an integrity-enhancing function as it can increase the possibility of leading an autonomous life.

Effect on privacy

Another rating statement investigates how the described system would affect the respondent's sense of privacy. Responses are recorded on a scale of 1 (very negative) to 5 (very positive). Here, 14 of 23 respondents feel there would be no effect on their sense of privacy. Of note are the seven respondents who felt it would have a positive effect on their sense of privacy, which illustrates the complex nature of the concept, due in part to language (as the Swedish word has a broader connotation with regards to integrity), but also in part to its many connotations, such as trust, justice, control, dignity, autonomy and so forth (see e.g. Lyon, 2001; Rössler, 2005). As Respondent 9 points out, '*I can feel that a navigation system improves my sense of "personal integrity" because of increased independence, but that does not mean I am not concerned about a surveillance society*', which illustrates the need to engaged in a more nuanced debate about privacy, personal integrity and context.

Ratings of effects on assurance and privacy are compared to assess any potential perceived trade-off between assurance and privacy, where one may be willing to accept a reduction in one for a gain in the other, a classic privacy versus safety and security argument. In this scenario, there is no evidence supporting the existence of such a trade-off. This is consistent with findings that individuals who trust that increased surveillance will lead to increased security also believe that the security application in question will not invade their privacy, meaning that the trade-off between perceived risks and benefits is not made, as no risks are identified (Pavone and Esposti, 2007).

Personal benefit and consideration of purchase

Finally, the respondents rate statements of the perceived personal benefit of such a navigation system and whether they would consider purchasing such a system. The results indicate a high personal benefit ($\bar{x}$ = 4.35), and open responses illustrate how such a navigation system (and technology in general) can benefit users in different ways depending on their level of need. Respondent 15 frames the benefits in terms of facilitation and convenience: '*Visually impaired people who are independent get around anyway. It's more about being able to save energy, time, or effort by using the navigation system, so that one feels better*'. Many STS users also perceive its benefits as a matter of convenience (Nuworsoo, 2010), and in these cases users are unlikely to voluntarily shift to a less convenient mode.

However, from an alternative perspective, Respondent 1 describes more fundamental benefits, with technology playing a crucial role in the ability to live independently and maintain mental health: *'I'm very positive to technological development. The development goes quickly, but that's good because I need it. Technology helps me and gives me hope to be able to live independently. I would get depressed from being shut away at home. I get depressed at the thought of needing a personal guide in order to be able to go anywhere, or needing to decide when to go out in advance. I want to be able to get around by myself. I'm dependent on my daily walks. I think that technology can help me as long as I have partial vision. I want to be independent and try to live like everyone else'*. This again illustrates the integrity-enhancing possibilities of ICT assistance.

The respondents also express a positive interest in purchasing such a system ($\bar{x}$ = 3.91), although this rating statement is not based on a cost estimate, as the system in Stockholm was not yet available on the market. This is an encouraging response, but questions regarding the cost to the consumer and potential subsidies for specific user groups will need to be addressed. As such, it can be beneficial to explore the motivations of those who give low or neutral ratings to this consideration of purchase statement. For example, Respondent 4 considers it a matter of principle: *'GPS systems should be a help aid given to visually impaired persons, which is why I say I would not consider purchasing the system'*. Understanding such motivations was not a central objective of this study, but can contribute to understanding the market potential of the system.

Additional concerns

While the respondents' overall attitude to the system is positive, they clearly express various concerns, which can be classified into three types. First, there is concern for the continued support for such projects in general, for example *'nothing usually happens with handicapped-related projects after they are finished. The technology isn't updated'* (Respondent 2). Indeed, as of summer 2012 (when the research and development phase ended), Stockholm was trying to develop a sustainable business model for maintenance and operation. Second, there is concern for the nature of the e-Adept project specifically, for example, questioning why resources are being used to develop yet another system and how to maintain stakeholder interests and balance in the ownership of the product. Hopefully the e-Adept system will prove to be successful from both accessibility and economic perspectives, although this stakeholder group certainly has a right for concern regarding the economic interests involved, as profit-driven technological advancements have generally not taken inclusion into consideration. Here, as with the first category of concerns, advocacy organizations and governments play important roles in balancing interests.

The third type of concern emphasizes the need for a continued focus on the accessibility of the built environment. Respondent 17 feels that '[public transportation] *accessibility has a greater effect than technology'*, and Respondent 18 comments, *'What is needed is faster communication to the responsible parties and faster measures to fix problems'*. Additional comments include continued problems with illegal placement of signs on sidewalks and conflicts with bicyclists. Clearly a pedestrian navigation system is not a 'magic bullet', but can be viewed as part of the overall concerted endeavour to enhance mobility together with other technological, physical, organizational and individual efforts.

Conclusions and future work

The user perspectives presented in this case study indicate the potential of personal navigation systems for enhancing the mobility of visually impaired persons. Results indicate interest in purchase (although some feel the cost should be subsidized) and potential positive effects such as increased perceived safety (assurance), independence, frequency of travelling alone and in unplanned/unfamiliar situations, and use of public transportation instead of STS. The respondents also generally consider technology advantageous, already carry a mobile phone and utilize information to plan their travel, as well as perceive having instructions and knowing an exact location as beneficial. Responses do not reflect high levels of concern for data misuse or being tracked through data in this context, although this does not necessarily mean the respondents have no concerns about privacy in general as it is a highly contextual concept. Previous experience with the navigation system proved to have practically no influence on the participants' responses. Overall, as with the introduction of many ICT systems, expectations are high.

The user perspectives also offer insight into fundamental ethical issues related to mobility and ICT. As evidenced by their comments, these visually impaired respondents understand first-hand the extreme implications, from the promises of independence and autonomy to the dangers of exclusion and powerlessness. Thus, it is important for technology developers and policymakers to remember that so-called smart technology, although exciting and certainly offering opportunities for many, does not automatically imply ethically sound technology, for example, technology that is universally accessible or integrity enhancing. If accessibility, privacy and user perspectives in general are not included in the design and development processes, the result can mean new layers of vulnerability and exclusion.

Although government initiatives and the legal system are certainly important tools in promoting accessibility and privacy, they tend to be reactive and not at the forefront of technological development. As Borking (2005: 88) points out (in the case of privacy although it also applies to e-inclusion, etc.), *'The law alone cannot protect privacy, as it is not self-executing. Lawyers and technologists should proactively try to solve problems instead of responding to complaints when harm has already been done'*. As such, this study serves to remind us that a coordinated effort on multiple fronts – for example, universal design of ICT *and* the built environment, impact assessments, policy and legislation – are all vital in addressing users needs and meeting broader social goals.

As this study is based on potential effects of a navigation system, it is important to follow up with a before-and-after (revealed preference) study to examine the nature of the system's use and its actual effects on users' mobility and perceived quality of life. Convenience aspects of the door-to-door, car-based STS service may also prove to be too big of a pull to shift users to public transportation due to the use of a navigation system, particularly when the choice does not hinge on a lack of information. Further studies of the perspectives of users in secondary market segments are also necessary for generalization purposes. For example, elderly persons may not share the same positive outlook regarding technology or dependence on alternative forms of transportation, and indeed, the author has found that they do not perceive the same high benefits of the navigation system, which influences their interest in purchase and usage (Sochor, 2014). Finally, it is of interest to continue to explore the broader ethical aspects of other ICT systems and user groups within the transportation context. The situation of cognitively impaired users, for example, certainly presents an ethical quandary from the perspectives of paternalism and voluntary consent. In presenting such perspectives, the author hopes to contribute to a more nuanced debate regarding benefits, risks and stakeholder interests.

Acknowledgements

Thank you to ITS Sweden and the Swedish National ITS Postgraduate School, VINNOVA (Swedish Governmental Agency for Innovation Systems), Trafikverket (Swedish Transportation Administration), and Stockholm City for funding this study.

References

Ambient Intelligence System of Agents for Knowledge-based and Integrated Services for Mobility Impaired users (ASK-IT) Project (nd) http://www.ask-it.org/, accessed 31 July 2012.

Assisting personal guidance system for people with visual impairment (ARGUS) (nd) http://projectargus.eu/, accessed 10 November 2012.

BLS (2012) Persons with a Disability: Labor Force Characteristics – 2011. US Department of Labor, Bureau of Labor Statistics, News Release USDL-12–1125.

Bolechala, A. J., Miltenberger, R. G., Barbeau, S. J. and Gordon, M.E. (2011) Evaluating the Effectiveness of the Travel Assistance Device on the Bus Riding Behavior of Individuals with Disabilities. Presented at the 90th Annual Meeting of the Transportation Research Board, Washington, DC.

Borking, J. (2005) The Use and Value of Privacy-Enhancing Technologies. In: Lace, S. (ed.) *The Glass Consumer: Life in a Surveillance Society*. Bristol: Policy Press, 17–14.

Carmein, S., Dawe, M., Fischer, G., Gorman, A., Kintsch, A. and Sullivan Jr., J.F. (2005) Socio-Technical Environments Supporting People with Cognitive Disabilities Using Public Transportation. *ACM Transactions on Computer-Human Interaction*, *12*(2), 233–262.

Coombs, N. (1990) Disability and Technology: A Historical and Social Perspective. Paper presented to the *Organization of American Historians*, Washington, DC. March 1990

Crime Concern (1997) *Perceptions of Safety from Crime on Public Transport* (A Report by Crime Concern and Transport & Travel Research). London: Department for Transport (DfT).

Currie, G. and Stanley, J. (2008) Investigating Links between Social Capital and Public Transport. *Transport Reviews*, *28*(4), 529–547.

e-Adept Project (2012) http://eadept.se/, accessed 31 July 2012.

European Union e-Accessibility Policy (2012) http://ec.europa.eu/information_society/activities/einclusion/policy/accessibility/index_En.htm, accessed 1 August 2012.

Färdtjänst (2010) Färdtjänsten i siffror, October 2010. http://www.fardtjansten.sll.se/sv/Om-Fardtjansten1/Fardtjansten-i-siffror/, accessed 29 July 2012.

Funka (2014) http://www.funkanu.com/Design-for-alla/Tillganglighet/Statistik/, accessed 5 May 2014.

Hakamies-Blomqvist, L., Sirén, A. and Davidse, R. (2004) *Older Drivers – A Review*. Linköping, Sweden: Swedish National Road and Transport Research Institute (VTI). VTI Report 497A.

Hunter-Zaworski, K. M. (2011) Accessible Real Time Information for Travelers with Sensory and Cognitive Disabilities: The Next Frontier in Accessible Transportation. Presented at the 90th Annual Meeting of the Transportation Research Board, Washington, DC.

Justice Department (2006) *Personal Data Protection*. Stockholm, Sweden. Ministry of Justice, Sweden.

Karlsson, J. (2008) *Peng-analys navigeringsstöd för personer med synnedsättningar [Peng analysis navigation support for people with visual impairments*. City of Stockholm, Traffic Administration, Easy Access Project.

Lubin, A. and Deka, D. (2012) The Role of Public Transportation as a Job Access Mode: Lessons from a Survey of Persons with Disabilities in New Jersey. Presented at the 91st Annual Meeting of the Transportation Research Board, Washington, DC.

Lyon, D. (2001) *Surveillance Society: Monitoring Everyday Life*. Buckingham: Open University Press.

NOPPA Project, Finland (2012) http://virtual.vtt.fi/virtual/noppa/noppaeng.htm, accessed 31 July 2012.

Nuworsoo, C. (2010) A Need to Improve Demand Response Services for Mobility of Seniors. Presented at the 89th Annual Meeting of the Transportation Research Board, Washington, DC.

Otter, A. and Östergren, E. (2010) Stockholm – The City for Everyone: Twelve Years of the Project of Easy Access. City of Stockholm, Traffic Administration, http://international.stockholm.se/PageFiles/217039/Stockholm_the_city_for_Everyone.pdf, accessed 29 July 2012.

Pain, R. (2000) Place, Social Relations and the Fear of Crime: A Review. *Progress in Human Geography, 24*(3), 365–387.

Patterson, D.J., Liao, L., Gajos, K., Collier, M., Livic, N., Olson, K., Wang, S., Fox, D. and Kautz, H. (2004) Opportunity Knocks: A System to Provide Cognitive Assistance with Transportation Services. In: Davies, N., Mynatt, E. and Siio, I. (eds) *6th International Conference, Nottingham, UK, September 7–10, 2004. Proceedings* Berlin/Heidelberg: Springer 433–450.

Pavone, V. and Esposti, S.D. (2007) Public Assessment of New Surveillance-Oriented Security Technologies: Beyond the Trade-Off between Privacy and Security. *Public Understanding of Science*, *1*, 1–16.

Petersilia, J. R. (2001) Crime Victims with Developmental Disabilities: A Review Essay. *Criminal Justice and Behavior*, *28*(6), 655–694.

Ran, L., Helal, S. and Moore, S. (2004) Drishti: An Integrated Indoor/Outdoor Blind Navigation System and Service. *Proceedings of the Second IEEE International Conference on Pervasive Computing and Communications*, Washington, DC, USA IEEE Computer Society 23–30.

Rössler, B. (2005) *The Value of Privacy*. Cambridge: Polity Press.

SCB (2009) Labor Market Situation for Disabled Persons – 4th quarter 2008. ISSN 1654–4366 (online), Statistics Sweden.

Seraphin, A. (2010) My First Week with the iPhone. Behind the Curtain (blog), 12 June, http://behindthecurtain.us/2010/06/12/my-first-week-with-the-iphone/, accessed 10 November 2010.

She, P. and Livermore, G. A. (2009) Long-Term Poverty and Disability among Working-Age Adults. *Journal of Disability Policy Studies*, *19*(4), 244–256.

SIKA (2007) RES 2005–2006 The National Travel Survey. Östersund, Sweden: Swedish Institute for Transport and Communications Analysis. Report 2007, 19.

Sjöberg, L. (2000) Factors in Risk Perception. *Risk Analysis*, *1*, 1–11.

Smith, N., Beckhelling, J., Ivaldi, A., Kellard, K., Sandu, A. and Tarrant, C. (2007) *Evidence Based Review on Mobility: Choices and Barriers for Different Social Groups*. London: Department for Transport.

Sochor, J. (2013) User Perspectives on Intelligent Transportation Systems. PhD Dissertation, ISBN 978–91–85539–93–2, KTH Royal Institute of Technology, Stockholm, Sweden.

Sochor, J. (2014) The Reassuring Effects of ICT in Public Transportation: The Perspectives of Older Adults. Presented at the 93rd Annual Meeting of the Transportation Research Board, Washington, DC.

Sochor, J., Wester, M. and Bülow, W. (forthcoming) Privacy in the Eighteen-Wheel Workplace. Manuscript submitted for Transportation Research Part A: Policy and Practice (under revision).

SRA (2001) Evaluation of Disability Policies in the Transport Sector. Swedish Road Administration Publication 2001, 125.

Stiles, B.L., Halim, S. and Kaplan, H.B. (2003). Fear of Crime among Individuals with Physical Limitations. *Criminal Justice Review*, *28*(2), 232–253.

Thomsen, U.T., Nielsen, L.D. and Gudmundsson, H. (eds) (2005) *Social Perspectives on Mobility*. London: Ashgate.

TRB (2001) Communicating with Persons with Disabilities in a Multimodal Transit Environment – A Synthesis of Transit Practices (TCRP Synthesis Report 37). Transportation Research Board of the National Resource Council, Washington, DC.

Vautin, D.A. and Walker, J. (2011) Transportation Impacts of Information Provision and Data Collection via Smartphones. Presented at the 90th Annual Meeting of the Transportation Research Board, Washington, DC.

Waara, N. (2013) Traveller Information in Support of the Mobility of Older People and People with Sisabilities: User and Provider Perspectives. PhD Dissertation, CODEN:LUTVDG/(TVTT-1044)1–166/2013, Lund Technical University (LTH), Lund, Sweden.

20

Practical Challenges and New Research Frontiers for Safety and Security in Transit Environments

Vania Ceccato and Andrew Newton

This chapter brings together this edited volume, and highlights and summarizes the main findings presented in the book, based on each of the preceding five sections. It examines the conceptual framework, and the main findings that arise from each section. These include safety and security at the transit node, the journey, links to the surrounding settings and the perspective of the user. It provides an overview of why safety and security is challenging and complex, and discusses the utility of the conceptual framework in tackling this. It then suggests new research frontiers for safety in transit environments, before concluding with some recommendations for future policy.

Research into transit safety and security contains a number of overlapping themes, and, as presented in this book, they have, to some extent, become united. The book illustrates a rich multidisciplinary field (for example, criminology, urban planning, transport planning, sociology, transportation engineering, psychology, geography, architecture, designing, security expertise), the areas of which, in practice, have each developed within their own professions, from different disciplines and theoretical principles. It is suggested this multi- or interdisciplinary approach is the way forward, as reality demands more integrated, holistic and cross-disciplinary research, particularly methods that are capable of guiding and dealing with an ever-increasing volume of space and time data, constituting the new frontier of research in urban safety, not least in transit environments.

The conceptual framework

This book was divided into six sections: the first provided an introduction to safety and security on transit environments. In Chapter 1, the book's scope, context and definitions of some key concepts were discussed. A conceptual framework for safety and security in transit environments was also identified, and this provided the basis for the structure of the book. The main sections of this book followed on from this: section two considered *the micro* *settings of transit environments*; section three examined *the transport journey*; and section four investigated the *meso and macro settings of transit environments* and their links to the wider environment. Section five then examined transit settings from the point of *the user*, those persons who use the system for a variety of purposes.

In Chapter 1, some of the key concepts used by authors in the book were defined, namely, *safety and security; public transportation; transit environments/settings; transport nodes; and transit crime*. Whilst these may seem fairly simple to define, it was evident that the authors had a different understanding of, and offered a range of definitions for each of these. This suggests that there is a high level of complexity within public transit settings and that the safety and security of these systems must be addressed through a multidisciplinary perspective. The challenge is to draw out the best of these disciplines, both theoretically and practically, and merge them in a coherent and consistent approach.

Chapter 2 provided a discussion of the main theoretical perspectives that can be used to examine safety and security on public transit. It was evident that a number of salient theoretical perspectives could be used here, stemming from a range of fields. What was concluded in this chapter was that none of the current theories have been applied specifically to transit systems, and none offer an overarching explanation for safety and security in transit environments. The complexity of the transit system presents a series of challenges, born out of its complexity, as a rapidly changing setting, the diverse nature of its users and the complex level of interaction between the transit system and its wider environment. However, some important lessons can be learned by examining each aspect of the conceptual framework, which parts II to IV of the volume examine in considerable detail.

There were a number of fundamental reasons for the conceptual framework. Firstly, the transit setting is itself multifaceted. It contains fixed infrastructure such as stops and stations. Some of these may be large and highly complex, such as a sizeable interchange across several platforms. Some may be linked to integrated shopping centres, have several platforms and levels, and if multimodal, connect a number of transport modes. Some may be very simple such as a single post representing a bus stop. However, as was evident in the book, even the crime patterns around a single bus stop can be quite varied. These stops and stations have routes that connect them. This connection is made through a range of vehicle types, and travel may be on different modes such as bus, rail (over-ground and underground), ferry, tram, for example. However the extent of the transit system goes beyond these stations and routes.

When considering the passenger, it is necessary to take a whole-journey approach, door to door from start to end of the journey. Thus, transit environments consist of a walking environment, a waiting environment and an on-vehicle environment. Safety and security has been shown to vary across each of these different components and settings. However, they are all integral and fundamental to the user. If one link is unsafe, the user may change their journey or switch to alternative modes of (non-public) transport. Thus, safety and security should be maintained for all users at all sections of the journey. However, perceptions and risk of victimization are not homogeneous, and the book explores this from the perspective of different passengers. For example, gender, age, income and disability are all factors that can influence the user, and these may all impact on their ability to travel, their reliance on, and their fear of travelling on public transport.

Transit settings have a further layer of complexity, and it is not just passengers who are at risk. There are a range of peripatetic staff who work on the system such as drivers, conductors, ticket officers, ticket inspectors, security staff, police and a range of other persons who may work within these settings. In addition, beyond the users (staff and passengers), the infrastructure itself may be at risk, so the target may be a platform, a bus shelter, a moving vehicle or a rail track, for example.

An additional layer of complexity is provided by the transient nature of the system. This may seem obvious, but users travel across this system for different purposes, for example, commuters, schoolchildren, retired persons, tourists, those working on the system, those who use the system for entertainment and leisure. Therefore as a function of usage the system will receive low and high volumes of passengers at different times of the day and different days of the week. Certain times are considered peak and others off-peak, and travel patterns reflect movement to specific places for particular activities. Moreover, stops and stations serve different functions within the urban environment. Some are on the periphery, transporting persons in an out of an area, some serve as central areas of convergence, and others are more specialized, such as an out-of-town shopping centre. The safety and security concerns related to each of these are different. Therefore, this is, in effect, a highly mobile system, and the risk and perceived risk from a safety and security perspective can change rapidly.

A final additional level of complexity is provided by the fact that the transit system is not isolated. Whilst it is unique, it also interacts with its surrounding environment. The boundaries of the transit system may become blurred when we consider the walking aspect of the whole-journey approach. Whilst many transit nodes have access controls, and defined boundaries with physical perimeters, there are differences in the extent of how and where access is restricted to the transit setting. Often there is a paid access control, although some parts of a station may be accessible to all. For some bus stops there may not be any physical separation from its surrounding environment. However, the movement of users ensures the transit system interacts with what is around it. For that reason alone, there is a need for safety and security of transit environments to consider both the places in the immediate vicinity of transit settings and the transit system as a function of the wider urban (or rural) setting itself. A number of chapters in this book discuss this interaction or interplay between the transit system and the surrounding areas, which is, at present, only partially understood.

Therefore a focus on the layout of the transit environment, and the users of the system, is a structured and appropriate approach for examining safety and security in these environments. This allows an examination not only those at risk, the persons who use the system, but also, the system infrastructure itself. In turn, it is argued that responsibilities for minimizing such risk can be also examined within the same framework, by assigning responsibility to those who police, manage, regulate, design and maintain these settings.

Part 2: Safety and security at transit nodes

This section considered safety and security at the transit node, the micro setting. Three of the chapters examined a specific crime type that is often problematic at transit nodes, namely theft. Each chapter identified specific sets of risk factors that increased or reduced opportunities for theft at these transport nodes in three different countries. The fourth chapter examined safety and security at stations from the perspective of opportunities for 'guardianship' against crime, and the extent to which features of the station influence this. All the chapters identified that the transit node was not the only factor that influenced the extent of opportunity and risk (for both committing and preventing crime), and that the surrounding environments of transit stops and stations also influenced risk and opportunity.

The chapters by Ceccato and colleagues (Chapter 5) and Newton et al. (Chapter 6) investigated pickpocketing at bus stops and underground railways respectively. Both identified that crowded conditions can increase opportunities for stealth crimes at stops and stations and that levels of ridership were related to theft. Both identified there were concentrations of pickpocketing at particular stops and stations on the network. Both found micro concentrations of theft in 'hot spots'. The position of the stops and stations on the network was also deemed relevant, for example, those that served the periphery and likely the start and the end of the journey, those that were in the central business districts, and those that were an interchange. Levels of risk varied by station position within the transit network (periphery, central, interchange, entertainment centre), and, moreover, by the time of day at these station positions on the network. Ceccato et al. found that when a bus stop was present, levels of theft were higher when than not present, although not all bus stops were high risk. A question raised here is what combined with a bus stop increases the risk of crime. Similar issues were raised by Ward et al. (Chapter 10) and Hart and Miethe (Chapter 7).

Newton et al. and Gentry (Chapter 3) found evidence of an interaction in theft levels between a transit setting and its surrounding environment.

Indeed the Newton et al. chapter found that whilst both station characteristics and features of the nearby environment influence theft risk, the combined effects of both the station and its surrounding setting were more powerful. Gentry examined a specific type of theft, focussed not on act of the crime itself and more on the target stolen. Theft today is increasingly been driven by theft of mobile electronic devices such as smartphones, and in transit settings this is becoming particularly problematic. These electronic devises are highly desirable for offenders, and transit settings provide favourable conditions for offenders. Again, levels of ridership at stations influence these thefts, and levels of theft were found higher at interchanges

Uittenbogaard et al. (Chapter 4) examine how guardianship may play a role in reducing crime at transit nodes, and how levels of guardianship might be influenced by the layout and design of a node. Potential capable guardians include police, guards, ticket inspectors, shop owners and drivers. Guardianship may even be unintended, the result of a passenger whose presence simply deters an offender. From the research, it is evident that lower levels of familiarity with an environment can impact on guardianship, as willingness to intervene is reduced. Unfortunately at transit stations, levels of familiarity are often low. The authors discuss how particular characteristics of a station can also increase or reduce opportunities for guardianship, based on visibility and surveillance measures. They found the micro environment of a station particularly influential here, and suggested 50 per cent of guardianship was influenced by station characteristics and line of sight. Furthermore their study suggested levels of guardianship varied between the different settings within stations, including platforms, lounge areas, transition areas, and exits and entrances. Moreover, guardianship did not seem to be influenced by environmental conditions outside of a station. This suggests that micro-level prevention measures inside a station as measured by line of sight and visibility can all influence levels of effective guardianship, but that outside a station setting other factors may influence guardianship and crime prevention opportunities. La Vigne (Chapter 14) for example discussed the very different conditions of subway stations and subway station car parks, and the implications this had on levels of victimization and the effectiveness of prevention measures.

Part 3: The journey

This part of the book contained three chapters. Sedelmaier (Chapter 7) examined the potential impact of building a new station in an area and how that might influence the travel behaviour of offenders. Wiebe et al. (Chapter 8) investigated young people's transit journeys and how fears of violence on different transport modes impacted their travel behaviour. Solymosi et al.

(Chapter 9) explored a very specific part of the transit journey, the entrance onto the bus, in effect the gateway to the public transport vehicle.

Solymosi et al. investigated a very specific setting, the boarding of a bus. This was identified as a potential bottleneck resulting in crowding, close levels of contact between passengers and possible opportunities for pick-pocketing. Audio messages, reminding passengers that there may be pick-pockets in operation, were also tested. Three settings, waiting for a bus, boarding a bus and being on a bus, were all simulated through laboratory conditions. The authors identified boarding a bus as a bottleneck when persons came into very close contact with each other, more than in the waiting and on-vehicle setting. However, they also found that the duration of this close contact was reduced compared to the waiting and on-vehicle environment, and thus the length of time available for an offender to pick-pocket might be reduced. Finally, it was evident that the audio messages did appear to impact on the behaviour of participants.

Sedelmaier examined arrest rates in an area in which a new rail station was introduced, to test whether this influenced levels of offending in an area, and, indirectly, whether offenders modified their travel behaviour as a result of a new station. Findings corroborated previous studies showing there was no evidence of an increase in crime. Thus, residents' fears of new offenders being brought into the area were not met. Potential explanations are that the infancy of the station had not yet impacted on travel behaviour; the system exported offenders out of the area rather than bringing them in; levels of reporting or recording were not reflective of changes to crime levels; or other. It could be argued too that this supports other studies in this volume and elsewhere, which find that it is the presence of a station as well as additional factors nearby, in combination, which increases or reduces crime risk, as opposed to the presence of a transit network or system.

Wiebe et al. examined in detail the movement of young people, a group who, in general, are often reliant on public transit. This chapter compared use of different modes of travel, subway, bus and also on foot and by car, the latter two possibly outside of the public transit system. Perceptions of fear by travel mode at different times of the day were compared with actual risk based on levels of victimization from recorded crime. Levels of fear increased after dark, and there was no difference by travel mode during daylight hours. However, young people felt safer in cars and buses, and less safe on the subway at night. This may be reflective of the particular study area, as many studies internationally have found levels of fear are higher on buses than on subways. Another interesting aspect of this study was that fear was not linked to the amount of time the young people actually spend in high-crime areas. Two possible explanations are that they were either unaware of risk, or were in familiar areas and thus did not feel risk was greater in these places.

Part 4: The meso and macro settings: the wider context

In this section, Ward and colleagues (Chapter 10) introduced the concept of malignant mixes and examined how transit settings and nearby features interact to influence safety and security. Hart and Miethe (Chapter 11) examined violence around bus stops and how the environment of a bus stop is related to victimization. La Vigne (Chapter 14) discussed crime at transit settings within and near the Washington, DC, Metro, both in the subway setting and in nearby car parking facilities. Yu and Smith (Chapter 12) examined the use of and fear of transport systems by different neighbourhood user groups based on a range of socio-economic and demographic factors. Smit and colleagues (Chapter 13) investigated the impact of a gated community in South Africa and how modification of the built environment can influence travel behaviour and patterns.

Ward et al. introduce malignant mixes, which they identify as combinations of facilities which together create more crime than would otherwise be present. Their chapter demonstrates these through two case studies, robbery in New York and violent assaults in Houston. They suggest that whilst some combination of facilities may increase crime, others may actually reduce it. This and the study by Hart and Miethe (Chapter 11) on violence at bus stops, using very different methodologies and data, both found evidence for particular configurations of places as more conducive to crime. This also supports findings in Parts 2 and 3 of the book, that it is the transport system in combination with the presence or absence of particular factors nearby that is more risky. Time of day was also shown to be a key factor in this, as malignant mixes were found to be both location and time specific.

Hart and Miethe found concentrations of violence clustered around a small number of bus stops, as did Ceccato et al. (Chapter 5). They profiled the configuration of land parcels in which violence occurred, and found that where a bus stop was present, violence was more likely. They examined the configuration of eight different land-use types, and found the majority of robberies occurred in only about 10 of the 256 possible land-use combinations under investigation. This is complementary to the Ward et al. chapter on malignant mixes, but suggests the mixes may be the result of more than two types of facilities..The overall configuration of the environment of which transit settings are part of also influences the safety and security at these places. Furthermore, whilst some configurations of bus stops and other nearby features increased the chances of robbery by seven times, other configurations next to bus stops actually reduced risk by three times.

La Vigne (Chapter 14) described safety and security at two connected but perhaps distinctly different transit settings, subway stations and subway car parks. The Washington, DC, metro was identified as an example of good practice in terms of designing out crime. A number of factors here included access control, surveillance, and place management and communication.

This was one of the few examples in this volume in which stations in high-risk areas were protected from surrounding crime levels, with the exception of larceny. Most other studies found a transmission of risk between stations and their surroundings. Many of the factors found by La Vigne as good practice for security by design are complementary with the guardianship work of Uittenbogaard et al. (Chapter 4). However, outside of the station, a very different picture emerged in station car parks. There were perhaps a number of implementation failures that restricted the impact of good design here, including problems with restricting access control, difficulties in the surveillance techniques used and less effective place management structures.

Yu and Smith (Chapter 12) and Smit et al. (Chapter 13) examine transit settings amongst wider communities, and how the transit system is an integral component of its wider environment. Yu and Smith analysed travel behaviour patterns of passengers whom they describe as transit captives, those unable to travel without public transport. Their analysis of journey-to-work patterns found two distinct vulnerable groups. The first were low income, below poverty Hispanic and foreign born immigrants who tended to work in jobs that required travel at non-conventional and more risky times of the day, and also tended to live in areas that overlapped with high-crime levels. The second were aged over 55, females, with no access to vehicles, who did not live in areas overlapping high-crime levels, but did experience more property crime in areas they lived. These two groups of transit captives accounted for a high levels of vulnerability amongst transit users measured by victimization, fear of crime and access to alternative forms of transport. Therefore these vulnerable groups lived in areas with high concentrations of public-transit-commuting residents with characteristics related to personal security vulnerability.

Smit et al. examined the influence of enclosed communities in South Africa and found that the gating of these communities had little impact on travel patterns of persons who resided within them, as they tended to be more affluent. Most of these persons travel by car, and this has not changed since the introduction of the enclosed areas. However, these perimeters did impact on the travel patterns of those with lower incomes who perhaps rely more on transit systems, as it increased their travel time considerably, and in some instances increased the walking component of their journey, which was perhaps the time at which they were most vulnerable. This is an example of the built environment impacting on a transit system.

Part 5: The user

Section 5 of the book focussed on the transit system from the perspective of the user: those without whom the system could not operate. Shibata et al. (Chapter 15) considered perceptions of crime and disorder by riders in Tokyo. Loukaitou-Sideris (Chapter 16) and Levin (Chapter 17) both discussed transit from a gender perspective, acknowledging the higher levels of fear perceived by female users. Uidici (Chapter 18) and Sochor (Chapter 19) considered another group who are suggested as highly vulnerable, those with disabilities, and discuss the experiences and perception of these groups when using transit systems.

Shibata et al. analysed expectations of how many crime and disorder incidents passengers may encounter at stations, levels of actual experiences and perceived levels of unpleasantness of each. They found a significant difference between perceived and expected unpleasantness of more serious rare events, and that the expected seriousness was a predictor of perceived unpleasantness. Thus, reducing the expected frequency of unpleasantness serious events is likely to have positive benefits even if they were to occur.

Loukaitou-Sideris and Levin both consider the perspective of the female user. The first author found that on transit systems, women's fears of crime were greater than those of men; that women have specific travel needs and are more fearful of the bus than the metro (contrary to Wiebe's findings for young people after dark); that some female user groups such as the elderly and those who are low income can be particularly fearful; that certain environments and settings such as poorly lit and unsupervised settings or remote areas are seen as particularly unsafe. More important, these fears of crime can translate into the altering of travel behaviour. Suggested measures to alleviate such fears included better design features, policing, security technology and some education and outreach activity. Many of these findings are echoed in the chapter by Levin. For example, higher levels of fear are evident amongst female transit passengers especially after dark. However, Levin argues that it is important not to overgeneralize between groups, and that a range of factors can influence fear of crime on transit systems including age, gender, ethnicity, economics, behaviour, culture and experience, for example. The author argues for a more holistic approach to safety, designing transit settings that are safe based on the needs of all users. This does not mean, however, that by not designing safety features specifically for women that they would be unsafe. The design should be specific to the setting and the user, and meet the needs of all users to be safe from harm when travelling.

Uidici and Sochor investigated the needs of a further vulnerable group, those with disabilities. Whilst both chapters used slightly different approaches, there were some consistent messages. Both authors identify that this group is considered as highly vulnerable. Both argue that transit systems should be designed to meet the needs of these users. Uicini advocates for the removal of a socially constructed barrier and says that the disabled person is viewed as having a characteristic or a personal attribute that disables them from using the system. They argue that if fear stops any person from travelling on this system, with or without any physical impairment per se, then that person is in effect then disabled by not being able to travel on public transit. Thus, systems should meet the needs of all passengers so as not to exclude anyone. Solutions suggested include community research action, better legislation and training. Sochor discussed a specific disability, visual impairment, and investigated how ICT can be used to remove some barriers to travel for these users. However it is advised that a one-size-fits-all solution does not work and that the design of this solution must meet the needs of the user. Whilst pedestrian navigation systems could improve access to public transport for this user group, a number of possible interventions exist; they include developing long term projects, deal with privacy issues related to the new technology, and asses the overall design of the built transit environment for travellers with visual impairments. The system must be designed to meet the needs of all users for autonomous independent travel.

This section has summarized the main findings of this book. The next section now moves on to review some of the key possible areas identified for further research.

Future research questions

This section draws on previous research and lessons from studies contained in this book to put forward a number of research questions and to map current research frontiers in safety and security in transit environments. This volume has demonstrated how safety and security in transit environments is dependent on multidimensional conditions that act at various geographical scales in the urban environment. These conditions are determined by the *micro-environmental attributes* of a node (a bus stop or a station); the characteristics of the immediate environment (short walk distance from the node); and the type of neighbourhood in which the node is located as well as the relative position of both the station and the neighbourhood in the city – *the meso and macro transit settings*. Safety and security should be examined in the content of a *whole trip approach,* the door-to-door movement – *all aspects of the journey*, particularly from the perspective of those who use the system, *the users*. Future research questions are discussed based on these four distinct dimensions of safety and security in the public transportation system.

Micro transit environments

Transport nodes such as bus stops and train stations are examples of micro transit environments. Findings from chapters in Part 1 of the book found that these may be highly criminogenic places and that there were distinct patterns of crime associated with higher levels of ridership around certain nodes. For future research, Ceccato et al. (Chapter 5) suggest a key challenge is to elucidate the processes through which other land use and socio-economic variables interact and influence levels of pickpocketing in bus stop cells using a long-term data series, perhaps broken down by time. Compared to other analytic approaches, the methods used by Ceccato and colleagues avoid the limitations imposed by using irregular arbitrary administrative zones, by applying small cells of 50-by-50 metres over the study area. Data permitting, future analysis should investigate the vulnerability of bus stops during peak and off-peak hours of the day. Although tests were performed in this study, the dataset was not appropriate for creating the same peak and off-peak time windows for both independent and dependent variables. The peak and off-peak hours should be examined, as changes in people's routine activities are expected to affect bus stops differently, for example, at different locations, at different hours of the day, the week and by season.

Newton and colleagues also identified that crime at transport nodes is influenced by ridership levels peak and off-peak travel hours, and a nodes relative position within the transit network. They also suggest that what happens at a node is symbiotic with its external surroundings. They advocate the importance of the interplay between a transit node and its environs. Moreover, the research by both Newton et al. and Gentry (Chapter 3) suggested that it is important for pickpocketing research to examine types of products stolen, as this might influence patterns of pickpocketing on transit networks. Gentry's findings from the United States indicate effects of guardianship opportunities, which were further studied in Uittenbogaard's chapter. The findings of both authors suggest the need for a more thorough investigation of the role of the environment on people's movement at transport nodes, as performed by Solymosi and colleagues in Part 2 of this book. An analysis of the movement of passengers at the stations can provide an idea for the best possible routes of guardians, where they should be present, and allow areas that have potential field of views.

The journey

The decision that an individual takes to be on the move may result in a reduction of their safety, depending on where and how they travel. Some crimes happen whilst a passenger is on the move, such as on a bus. Knowing the nature of people's interactions while they are on a bus can be helpful in preventing transit crime on board. Solymosi and colleagues' chapter uses data collected from laboratory experiments to address differences in interpersonal distances and crowding behaviour inside a vehicle, such as a bus. They showed that crowding peaks happen when passengers board the bus, creating opportunities for pickpocketing. Results also indicate that people are capable of modifying and willing to modify their behaviour within the crowded environment in light of audible warning messages. The authors suggest that further research should look into a time threshold for pickpocketing, and determine whether increased time spent close to one another during the waiting phase increases exposure to potential pickpockets, and also whether the time spent very close to one another while boarding is long enough for a contact crime to occur.

Some researchers believe that the implementation of new transportation systems introduces crime by facilitating access between crime-prone areas and relatively low-crime areas. Similar to previous research in other areas, Sedelmaier found little evidence for this and suggests a follow-up study, as the system has expanded to include more municipalities. It could be that the system's ability to influence offender awareness spaces or the opportunity structure had simply not reached maturity in the year-and-a-half following its introduction. Therefore, the author suggests that it would be instructive to determine how ridership patterns – and exposure to potential targets – have changed with the system's growth. Regardless of actual victimization risk, the perceived risk experienced by public transport users is a real component of trips, which was exactly what Wiebe and colleagues analysed by mode of transportation also in the United States.

Wiebe and colleagues' study produced novel insights into the perspectives of young people and their perceived safety from violence as they travelled in different transportation environments during their daily activities. The authors remind us that, whereas the study shows what factors appear to impact perceptions of safety, the analysis does not lend itself to understanding why they have such perceptions, which should be a focus for future studies. Wiebe and colleagues suggest findings from their study should motivate future mixed-methods research, using both qualitative and quantitative approaches to better understand the mechanisms by which transportation environments impact on young people's perceptions of safety and to find ways to make them actually feel safer.

The meso and macro settings

This part of the book considers the relationship between transit systems and safety across the wider neighbourhood and city context. It is in these environments, according to Ward and colleagues, that malignant mixes may be found. They suggest that certain combinations of activities adjacent to each other may serve to increase or reduce crime risk, of which the transit setting may play a key role. Their preliminary findings suggest further research into the malignant mixing of facilities is worthwhile and can be extended beyond the current study to include any number of facilities, such as malls and parking garages. Accordingly, Ward and colleagues suggest that future research consider not just one land use or activity, nor one hot spot pattern for the year under study. Rather, the authors suggest studying combined activities and land uses. They especially advise future research on crime and security in terms of both public and private transportation, both vehicle and pedestrian movement. As suggested in LaVigne's chapter, parking facilities associated with these transit hubs may serve more as attractors than as generators of crime. Parking facilities in general have been documented as crime attractors due to the wide array of available targets, a lack of surveillance and proximity to major thoroughfares for easy escape. The Hart and Miethe chapter also examines these configurations of land use and finds evidence to support future research here.

LaVigne suggests that future studies should consider the notion that transit crime prevention interventions cannot be evaluated in isolation; rather, they should be multifaceted. As her study found, successful interventions at transit stations were not replicated at transit car parks. The task, however, is not a simple one. Such an undertaking presents challenges from an evaluation component, in that it is difficult to untangle what component (or collection of components) of the comprehensive crime control measure is yielding a beneficial impact.

Hart and Miethe identified mixes of facilities that are highly criminogenic near bus stops. They suggest that once 'dangerous' bus stops have been identified, further research at these nodes should focus on what in particular are their risk-enhancing properties. They suggest future studies should identify the particular mechanisms that contribute to these differential risks for similar types of environments, some vulnerable to variations in time and people's routine activity. Some routine activities are hindered by geographical barriers in urban space that limit accessibility. Smit and colleagues analysed exactly that in South Africa and assessed the impacts of neighbourhood enclosure on travel behaviour, congestion and walking access of various interest groups inside and outside the neighbourhood. They suggest that future research should be context specific and investigate the particular crimes that occur around enclosed areas and the patterns of victimization, including how this specific context influences different people and transport users, such as woman, children or the elderly, who may be more vulnerable to crime. In addition, future studies should also investigate the impact of extended travel times on increased vulnerability during other phases of the journey. Smit and colleagues' findings raise equity and gender concerns around the fairness of neighbourhood enclosure practices on non-residents, and point to the need to rethink the conditions under which enclosures are allowed. Some of these issues are dealt with in the chapter by Yu and Smith, as well as in Part 5 of this book.

Yu and Smith identified two distinct types of transit commuters who were clustered in different parts of New York. They suggest that findings from their study can be used to build guardianship and assist place management in areas with high concentrations of what they call vulnerable transit commuters. As they assessed these groups in New York only, they suggest future similar studies should be performed in other cities. Yu and Smith also propose future studies look at ways to understand the heterogeneous population that constitutes vulnerable transit commuters and address their concerns in the most useful way.

The user's perspective

Mobility should be considered as an individual right, and as such this book explains why one should care about transit safety from the perspective of those who use the public transportation system. The book includes studies that examine safety and security in transit environments from the perspectives of gender, age and disability. As indicated by Ceccato (2013b), safety and security possesses a dimension of reflexivity, which means that they depend on those who observe and produce them. Thus, a better understanding of safety and security by different groups of society, especially those with special needs (such as the elderly, disabled individuals) is of particular importance for researchers. These groups themselves are the best sources of information about their own fears, needs and mobility barriers. Their opinions were taken into consideration especially in the last chapters of this book (Loukaitou-Sideris, Sochor, Levin, Shibata and Iudici), but they need to continue to be included in future studies and, more importantly, in planning interventions aimed at safety in transport settings.

Using railway stations in Tokyo as a unit of study, Shibata and colleagues assessed the expectation and perception of crime and disorder events using data collected from questionnaires. The findings showed that keeping incivility of the environment to a minimum is important when it comes to improving people's comfort level in their use of railway facilities. However, the event list used in this study was originally from a European study and did not include events specific to Tokyo such as too much crowding experienced on a train; thus, as suggested by the authors, future research is needed to clarify the importance of the local context of Japanese railway station on expectation and perception of crime and disorder events.

The study by Loukaitou-Sideris into women's safety in transit environments found that women have distinct safety/security needs, are often fearful of certain transit modes and frequently adjust their behaviour and travel patterns to avoid them. The author concludes that gender mainstreaming policies have encountered important challenges in their implementation all over the world. Gender-neutral safety policies in transportation environments are often gender blind. Therefore, a way forward is to decrease the current lack of knowledge in this area and promote a systematic strategy for gender equality in transit environments. Levin also agrees that it is important to consider gender equality from an intersectional perspective. This means that the complexity of gender and safety in the public space requires paying attention not just to a person's being a woman or a man, but, in addition, to the intersections between gender and, for instance, age, ethnicity, financial resources, individual experiences and culture. Future studies should consider the context needs in relation to gender and safety, for example, the relation between a particular place, a mode of transport and ideas about the function and use of this transport mode. For future work on this, Levin suggests that more interdisciplinary research and increased cooperation between professionals from planning, security, social and health services are needed.

Similar conclusions are put forward by Iudici in his study about the experiences faced by people with disabilities, in particular harassment. The author found that individuals with disabilities are much more at risk to be harassed than those without disabilities, however, the extent of the phenomenon and the ways in which the offences are committed are not yet clear or studied. Future research should shed light on the types of preventive activities that can be implemented and the way in which disability is viewed in society. As the author suggests, actions must be inclusive, and disability should not be seen as merely the impairment of which the person is a carrier, but it is also a social product resulting from the way in which society deals with individual differences.

Sochor goes a step further and looks at the case of visually impaired persons and the possible effects of a tailored pedestrian navigation system on their mobility. Interview results with Swedish respondents indicate that with information provision about the built environment and public transportation, positive potential effects include a greater degree of perceived safety, an increased ability to travel alone and in unplanned or unfamiliar situations, and the prioritizing of public transportation over special transportation services. The motivations behind these privacy- and trust-related ratings were not explicitly explored in the interviews, but are of interest in future studies to further understand consumer expectations. The use of ICT to enhance mobility and safety opens up a number of new research questions. For a detailed discussion, see Ceccato (2013a). For instance, data on individuals' detailed movement could help in understanding the link between transportation nodes' surroundings and fear of crime. Chapters by Wiebe and Sochor in this book are examples of this potentiality. Some of these future research questions are of a technical nature, while others trigger ethics questions surrounding the positioning and the tracking of individuals over space and time. As mobile technology advances and the demand for WiFi and phone coverage increases, the electronic device is becoming a target for theft in metropolitan public transportation systems. Future studies should expand on the research presented Gentry in this book, with specific detail concerning where electronic device thefts occur on moving subway cars and the addition of more subway characteristics.

Cross-cutting themes

Throughout the book several themes reoccurred. Some of these are now highlighted as they represent some of the complexities and challenges present in improving safety and security in transit environments, and provide a useful overview in the development of a holistic and theoretical framework to achieve this,

- A range of concepts were identified, many of which without a common definition, for example, safety and security; public transportation; transit environments/settings; transport nodes; and transit crime. This is unsurprising given the multidisciplinary nature of authors contributing to this volume
- The scope of the challenge on public transit is wide and diverse, across a range of crime types and offences, which is further broadened by disorder, and security-related serious incidents
- The complexity of the transit system, including nodes, routes and the walking setting makes this a difficult environment to examine. Whilst this seems simple, it is highly multifaceted. For example, a node may be a single bus stop, or a large interchange, and each one is very different. Stations may have a perimeter, several entrances and exits, lifts, waiting areas, shops, transition areas, ticket offices, information areas, escalators and platforms.
- Transit settings can potentially limit the potential positive influence of capable guardianship, due to issues such as unfamiliarity poor design may also restrict this.
- The transit system serves multiple functions (for example, a station at the periphery, one serving the CBD, a large interchange, one serving an out-of-town shopping centre).
- The interaction between the transit system and its surrounding environments adds a further layer of complexity, which goes beyond for example a comparison between two bus stops, to two bus stops and the areas surrounding two bus stops. The configuration of the built environment is also related to the transit settings. The relative position of a node on the transit network is relevant to safety and security, such as end stops, interchanges, those in the central business district and night-time economy, and those at specialized services such as out-of-town shops.
- Transit systems are influenced by the range of users of the system, and the particular vulnerabilities associated with different groups, for example, categories which are not mutually exclusive include transit captives: those on a low income, the young, the elderly, females, those with disabilities, schoolchildren; commuters, tourists, late-night NTE users, and leisure and entertainment passengers
- The dynamic and transient nature of the transportation system and the rapidly changing nature of its use makes it complex to understand
- A range of organizations have responsibility for the safety and security of the system, especially at large multimodal interchanges, thus there is a multi-ownership and management issue which adds to the complexity of the system.

Studies have often considered either the risk of crime in transit environments or perceived safety/fear of crime, separately. Future studies should instead combine both of these dimensions of safety and security. As Ceccato (2013b) shows in the Stockholm study, the most risky stations may not necessarily be perceived as the most unsafe ones. This assessment should include a multiple number of users (e.g. daily users, sporadic users, different ages, gender and income levels) as well as personnel who work in and around transportation nodes and in the transportation system itself.

Chapters of this book show examples of the need to take the whole trip into account both in terms of the risk of victimization and perceived safety. More studies, perhaps in other country contexts than the ones presented in this book, should shed light on issues of perceived safety beyond nodes and transportation system itself. Data permitting, future studies should also assess the quality of public transportation systems in relation to safety and security in countries of the Global South, specifically, where and for whom public transportation is the only way to have access to schools, jobs and leisure. Safety is a vital part in the provision of public transportation of the so-called ‘transit captives’.

There is a need to investigate the varying degrees of responsibility of individuals for discouraging crime in the transit system (Clarke, 1992; Felson, 1986; Eck, 1994). For instance, by investigating the role include investigating the role of *guardians* who keep an eye on targets, *handlers* who can positively influence potential offenders, and *managers* who monitor places.

A relevant issue in any future research is data accessibility and quality. Current research is limited by the police and other public authority recording procedures. A typical problem is that recorded data does not identify whether an offence happened inside the vehicle (when the bus was parked at the bus stop), at the bus stop, or on the way to/from the bus stop (a few metres from the bus stop). This uncertainty in the exact location of crime calls for a revision and a refining of recording practices. This imprecision limits both the advances that can be made in research and, more importantly, affects the scope of crime prevention and safety interventions.

The analytical challenges for research should be further investigated as a wide range qualitative and quantitative methods, as well as spatial techniques were employed in this book. They include analysis from interviews, focus groups, observations, quantitative analysis of crime data, transit system characteristics, socio-economic and crime data of surrounding environments, and experimental laboratory simulations and travel demand modelling. Quantitative techniques included range of regression methodologies, PCA, CCA, stratified sampling, statistical dispersion measures and other statistical tests, and analyses derived from Geographical Information Systems. Equally important is the selection of the appropriate method of analysis in relation to the research application’s goals, which, of course, is related to the choice of a theoretical framework guiding the analysis. This book provides a useful guide on 'what works' and 'what does not' in terms of methods applied to transit safety and security.

A key issue highlighted by Ekblom (2014) is the challenge of communicating these complexities to appropriate audiences, researchers and experts, including the relevant organizations responsible for safety and security on transit settings. Figure 20.1 attempts to visualize and provide a schematic of the complex interactions that occur at the transit system.

Figure 20.1 suggests the complex interactions that occur along the whole door-to-door transit journey. Whilst passengers are on board a moving vehicle, the vehicle will make several stops at which further interactions occur, but they are not locations at which the passengers board or exit. Here, other users and possible offenders may get onto the bus, thus changing the setting. At each point of interaction on the transit system, a range of possible factors may influence levels of safety and security, including

- passenger density – peak versus off-peak, low and high levels of ridership;
- offender proximity and familiarity with a setting/area;
- guardianship (passengers and peripatetic staff, including police, guards, ticket inspectors, shop owners and drivers);
- design and management (access control and surveillability, help points and information access, visibility and lighting);
- user proximity, familiarity and feelings of safety (transit captives; low-income people; the young, the elderly, females, people with disabilities, commuters, tourists, late-night economy users, people seeking leisure and entertainment, schoolchildren);
- the relative position within the network (peripheral, central business district, interchange, end of line, entertainment district)
- type of safety and security concern (violence, theft, disorder, criminal damage)
- time of day, day of week and season.

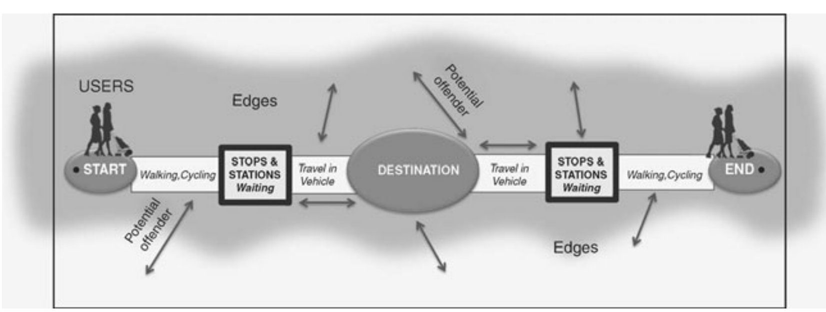


Figure 20.1 Transit settings and their environs: interactions between the settings, the user and the potential offender

Limitations of the book's conceptual model

The conceptual model used in this book (Figure 20.1) is, as suggested above, helpful in providing a framework for systematically relating transit environments to crime and perceived safety. However, it is not free of problems . One of the limitations is that it does not consider differences in the wider contexts (region, country) within which these transit systems are embedded. Economic, technical and institutional characteristics specific to each country are likely to affect the way in which both transportation and safety services are delivered and assessed. The implication of this in practice is that there is no such thing as a 'one-size-fits-all' solution for issues of crime and safety in transit systems.

Another limitation is that the idea of 'immediate context' is not theoretically well developed in the model. Whatever the approach adopted towards the 'immediate context', it is dependent on the inherent characteristics of the transportation system (bus vs. railway), the citywide context (morphology, size), the object of study (offender, target/victim or the environment in itself), and the types of crime (property vs. violent offences); therefore, a 'whole-journey approach' to safety is required. This complexity imposes a united but interdisciplinary theoretical framework that is, for the time being, lacking or is underdeveloped.

Finally, equally important is the need to position the conceptual framework adopted in this book within a wider effort that aims at creating sustainable environments. Public transportation is recognized as an important part of the solution to achieving a more sustainable future. In order to be sustainable, public transportation has to be reliable and safe. Recent statistics show evidence that ridership in public transportation has increased steadily in many countries over the last decade (UITP, 2012). Yet, across the world public transportation is not attained by all. Many still face constraints that impair their mobility and make full use of public transportation – an individual right and a basic requirement for any modern, efficient and sustainable city.

The next section identifies the key recommendations for policy that arise as a result of the research presented in this volume.

Policy recommendations

The policy recommendations put forward here take distance from the detailed suggestions made in each chapter of the book. This section disregards, for instance, potential crime differences that require a tailored, more specific look at each case study. Moreover, although this book includes examples from transportation systems around the world (the United Kingdom, the United States, Japan, Scandinavia, Italy and South Africa), this section attempts to highlight policy recommendations that go beyond these national contexts. This does not mean that they can be considered as a 'one-size-fits-all' solution for safety and security in transit environments. They are, however, expected to be of relevance for professionals worldwide.

The design of a transportation node (stop and or station) can affect safety and security. Certain design features are shown to be effective – for example, access control, line of sight and visibility, staffing – and should be considered when dealing with existing nodes or when building new ones.

Measures put in place should also increase guardianship and surveillance opportunities as they help reduce opportunities for criminal activity. These design issues to increase guardianship opportunities are particularly important at stops and stations. Staffing has been shown to be especially effective for providing reassurance to passengers and in reducing certain offences.

Interventions directed only at transit nodes have less chance of succeeding in reducing safety and security concerns at transit stations than those which also consider the nodes' nearby environments. Research has shown signs of interactions between a station and its surrounding environment and vice versa. Of particular importance, configurations of certain land types around stations have been shown to increase and or to reduce levels of risk.

These findings demand the cooperation of a range of actors who have responsibility for the transportation system itself and those who deal with safety and security issues in and around transportation nodes and the overall city. These actors include, for instance, those who run buses and trains, and those responsible for maintenance, management, planning and regulation of areas around the transit setting. However, this needs to go beyond joint planning and design, and requires joint implementation. It is argued in this book that safety and mobility require an understating of the barriers that lead to poor cooperation between actors within and across sectors and organizational scales. They demand more than a *quick fix* of the physical environment at transportation nodes (Ceccato, 2013b). The quality of joint collaborative work between actors involved in the provision of safety and transportation services would be worth investigation.

In practice, the whole-journey approach to safety demands the addressing of safety problems found by commuters, especially 'transit captives' during any part of a journey, whether walking, waiting in a station or travelling by bus. In countries in which urban spaces are disrupted by streets closures (e.g. gated communities), safety is compromised, as those who are dependent on public transportation have to walk further and pay more to use buses or trains. The South African case has illustrated the challenges of coordinating urban and transport planning to ensure an affordable and safe public transportation.

Any safety and security intervention should consider the spatial and temporal contexts of the transit node, for example, whether it is an interchange or a peripheral station, whether it serves the CDB, or whether it is an entertainment district which is highly used by tourists or schoolchildren.

The context is also important, as interventions need to be both place and time specific. What is effective at peak times might not be at off-peak times. Drawing conclusions using a number of events should be avoided because large transport nodes are bound to show a greater number of events than small ones. What is needed instead for properly defining interventions is to consider both the flow and the density of passengers by transportation node over time and by crime type. Moreover, the flow and density of passengers in transit nodes affect opportunities for surveillance and passengers' own perceived safety. Previous studies have indicated that the environmental features of transportation nodes are perceived as more risky by offenders (and less vulnerable by passengers) when active guardians are around, during the day, for instance. In contrast, nodes with hidden corners and low visibility at night often tend to be crime targets, or at least raise perceptions of vulnerability. Such space-time assessments of the environmental conditions of nodes contribute to making more informed decisions regarding safety interventions and allocation of resources.

The type of transit mode, such as bus, underground or train, is also linked to safety and security concerns along a trip and at transportation nodes. Evidence shows that certain users feel safer on certain types of systems. Additionally, levels of safety on these vehicles vary by day and by night. Indeed, subway systems are generally considered safer than buses, although this was not apparent for young people after dark in the Wiebe et al. chapter.

There is a need to place *users* at the centre of safety and security interventions in transit environments. Knowledge about the needs of different groups of users is relevant, as well as the obvious benefits of investigating why they might be fearful or at risk. The engagement of these groups in local safety issues might be an effective remedy for the lack of perceived safety. The effectiveness of various types of local participatory schemes for dealing with poor perceived safety on the way to transport nodes is also worth exploring in future safety interventions.

Overall, gender, age, disability and socio-economic exclusion are co-identified as contributing to a lack of safety while a passenger is on the move. Future actions must go beyond this preliminary diagnostic and support plans of action that consider the *intersectionality* of these individual dimensions when approaching those who are victimized or in fear when using public transportation (e.g. being a woman, old, disabled, with low income). The adoption of the concept of 'universal design' (often called 'inclusive design' in Europe) is expected to provide just that, environments that are fit for all (Mace et al. 1991), and at the same time can be tailored to the needs of particular subgroups. The use of ICT technologies can potentially be a resource as well, particularly for groups with special needs. ICT that supports safe mobility for groups with special needs is expected to move from prototypes into products on the market, in which anyone who feels the need for such aids would be able to access them. Some of them can be adapted to existing electronic products, such mobile phones.

This book, despite its limitations, makes an effort to provide examples of an integrated and holistic approach to transit safety from an international perspective. The task is far from complete, but as the examples illustrated in this book show, steps in such a direction have been taken.

References

Ceccato, V. (2013a). Integrating Geographical Information into Urban Safety Research and Planning. Proceedings of the ICE – *Urban Design and Planning, 166*, 15–23.

Ceccato, V. (2013b). *Moving Safely: Crime and Perceived Safety in Stockholm's Subway Stations*. Plymouth: Lexington.

Clarke, R. V. (1992). *Situational Crime Prevention: Successful Case Studies*. Albany, NY: Harrow and Heston.

Eck, J. E. (1994). Drug Markets and Drug Places: A Case-Control Study of the Spatial Structure of Illicit Drug Dealing. PhD dissertation, University of Maryland, College Park.

Felson, M. (1986). Routine Activities, Social Controls, Rational Decisions, and Criminal Outcomes. In: Cornish, D. and Clarke, R. V. G. (eds), *The Reasoning Criminal*. New York: Springer-Verlag, 119–128.

Mace, R. L., Hardie, G. J., and Plaice, J. P., (1991). Accessible Environments: Toward Universal Design. In: Preiser W., Vischer J. and White E. (eds) *Design Interventions: Toward a More Human Architecture*. New York: Van Nostrand Reinhold.

UITP – International Association of Public Transport (2012). *Public Transport: The Smart Green Solution!* International Association of Public Transportation, Manila, Belgium.

Index