

TRANSPORT AND SOCIETY



ASHGATE

# Travel Demand Management and Road User Pricing

Success, Failure  
and Feasibility

EDITED BY  
WAFAA SALEH  
AND  
GERD SAMMER

# Travel Demand Management and Road User Pricing

Success, Failure and Feasibility

*Edited by*

WAFSA SALEH

*Edinburgh Napier University, UK*

GERD SAMMER

*University of Bodenkultur, Austria*

**ASHGATE**

© Wafaa Saleh and Gerd Sammer 2009

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise without the prior permission of the publisher.

Wafaa Saleh and Gerd Sammer have asserted their right under the Copyright, Designs and Patents Act, 1988, to be identified as the editors of this work.

Published by

Ashgate Publishing Limited  
Wey Court East  
Union Road  
Farnham  
Surrey, GU9 7PT  
England

Ashgate Publishing Company  
Suite 420  
101 Cherry Street  
Burlington  
VT 05401-4405  
USA

[www.ashgate.com](http://www.ashgate.com)

**British Library Cataloguing in Publication Data**

Travel demand management and road user pricing : success,  
failure and feasibility. - (Transport and society)

1. Transportation demand management 2. Congestion pricing

I. Saleh, Wafaa II. Sammer, Gerd

388.3'1

**Library of Congress Cataloging-in-Publication Data**

Saleh, Wafaa.

Travel demand management and road user pricing : success, failure and feasibility / by  
Wafaa Saleh and Gerd Sammer.

p. cm. -- (Transport and society)

Includes index.

ISBN 978-0-7546-7303-3

1. Urban transportation policy. I. Sammer, Gerd. II. Title.

HE305.S26 2009

388.4'13142--dc22

2008045424

ISBN 978 0 7546 7303 3

e ISBN 978 0 7546 8906 5



**Mixed Sources**

Product group from well-managed  
forests and other controlled sources  
[www.fsc.org](http://www.fsc.org) Cert no. SA-COC-1565  
© 1996 Forest Stewardship Council

Printed and bound in Great Britain by  
MPG Books Ltd, Bodmin, Cornwall.

# List of Contributors

**Professor Kay W. Axhausen** is Professor of Transport Planning, Institute of Transport Planning and Systems, at the Eidgenössische Technische Hochschule, (ETH) Zurich. Before that he worked at the Leopold-Franzens Universität, Innsbruck, Imperial College London and the University of Oxford. He has been involved in the measurement and modelling of travel behaviour for the last 25 years contributing especially to the literature on stated preferences, micro-simulation of travel behaviour, valuation of travel time and its components, parking behaviour, activity scheduling and travel diary data collection. He was the chair of the International Association of Travel Behaviour Research (IATBR) and is an editor of *Transportation*.

**Professor Phil Blythe** is Professor of Intelligent Transport Systems and Director of the Transport Operations Research Group at Newcastle University. He leads one of the most committed and innovative teams of multi-disciplinary ITS researchers in Europe. His research portfolio covers a wide range of areas where ITS has been applied to transport, including: road to vehicle communications, road user charging and toll systems; ITS for assistive mobility, smartcards and RFID, wireless/smartdust technologies and future intelligent infrastructure. His forward-looking research attempts to bridge the technology-policy gap in terms of what technologies may evolve to meet future policy objectives or indeed influence future policy thinking. He has led and advised a major number of research initiatives/projects in the area of road user charging, info-mobility, smartcards and wireless networks in both the UK and Europe.

**Professor Giulio Erberto Cantarella** has a Civil Engineering degree in Transportation from the School of Engineering of the University of Naples Federico II. Since November 1999 he has been Professor in the School of Engineering at the University of Salerno. His research activity has mainly regarded: choice modelling for transportation system users through models derived from random utility theory or with fuzzy utility, or regressive ANN models; models and algorithms for travel demand assignment to congested transportation networks, under stationary conditions or with day-to-day or within-day dynamics; methods for transportation network design both with discrete and continuous variables; methods for urban network traffic monitoring and control; macro or micro-scopic models for transportation terminal analysis.

**Professor Peter Clinch** is an environmental economist at University College Dublin. Since 2003 he has been, concurrently, Jean Monnet Professor of European Environmental Policy and Professor of Planning. He was appointed by the European Union to the Jean Monnet Chair in 2003 in recognition of his research and scholarship in this field and, in 2006, was made an Honorary Member of the Royal Town Planning Institute for distinguished contributions to planning. Professor Clinch is editor of the international journal *Planning Theory and Practice* and a member of the editorial board of the *Journal of Environmental Planning and Management* (both Taylor and Francis).

**Professor Jonas Eliasson** is Professor of Transport Systems Analysis and Director of the Centre for Transport Studies at the Royal Institute of Technology in Stockholm. His main research focus is methodology for decision support for transport planning, in particular transport modelling and cost-benefit analysis. Research topics include integrated land use-transportation modelling, activity-based modelling, road pricing, travel time variability and stated preference valuation. He has been involved in a large number of applied analyses of transport investments and policy measures. He was the project manager for the design of the Stockholm congestion charging system, and later chaired the expert panel summarizing the extensive evaluation of the system. Currently, he is involved in the ongoing evaluation and refinement of the Stockholm congestion charges, and also provides expert advice for several other cities considering introducing congestion charging. He is also currently the chairman of the committee responsible for the transport modelling and cost-benefit analyses for the National Transport Investment Plan.

**Dr. Joel P. Franklin** is Assistant Professor in the Department of Transport and Economics at the Royal Institute of Technology, Stockholm, Sweden. He received a MS in Civil and Environmental Engineering in 1998 at the University of California, Davis, and a PhD in Urban Design and Planning in 2006 at the University of Washington, Seattle. Dr. Franklin also has prior experience as a transport consultant in Sacramento, California. His research involves the application of advanced quantitative methods to the evaluation of transport policies with respect to broad social goals such as social equity and urban sustainability, with particular emphasis on non-parametric methods and on the relationship between transport accessibility and land development. In his current post he teaches transport-related courses in policy, economics, and geographic information systems, and he serves as director of the International Master Programme in Transport Systems.

**Dr. Antonio Gschwender** presently assigns his time to professional work, academic work, board games, music, and being a husband. He works at the public transport authority in Santiago, Chile, and teaches public transport planning at the Universidad de Chile, where he collaborates in research as well. He worked in the early design phase of Transantiago (2001–2003) at the Chilean Transportation Planning Office (Sectra).

**Dr. Ha Hai Nam** is currently a lecturer at the Posts and Telecom Institute of Technology (Vietnam) exploring a range of topics from pervasive computing to smart graphics. He received his PhD in Computing Science at Newcastle University in 2008. For his doctorate he explored different ways of automating the lighting design process using both perception-based and example-based approaches. As a research associate at Newcastle University, he was involved in a number of projects such as Ask-IT (an EU-funded project), Document Management System (funded by Medical Research Centre, UK) Immersive Video, Head Shaping.

**Dr. Anders Karlström** is Associate Professor in Economics and Transport at the Royal Institute of Technology, Stockholm, Sweden. In his work he uses a spectrum of theoretical, econometric, and computational tools with a focus on ‘applied micro’. He has applied econometric tools to give insight and quantitative guidance to inform decisions on institutions and policies in various fields, in particular in the fields of labour economics and transport economics. His research activities include modelling activity-based transport demand, land-use, spatial computable general equilibrium, infrastructure and labour market productivity, and dynamic discrete choices.

**Dr. Andrew Kelly** is an environmental economist specializing in, climate and energy modelling, transport modelling, economics and policy, and air emissions modelling and policy formation. Dr. Kelly is a director of AP EnvEcon an environmental economics focused research firm in Ireland. As part of his current work Dr. Kelly is leading a national integrated assessment modelling project encapsulating air quality and greenhouse gas emissions modelling and policy formation. This work also includes the development of national level capacity for assessment of transport emissions and the effectiveness of both technical and non-technical policy measures.

**Dr. Jonas Larsen** is a lecturer in the Department of Environment, Society and Spatial Change at Roskilde University, Denmark. He co-authored *Performing Tourist Places* (Ashgate 2004), *Mobilities, Networks, Geographies* (Ashgate 2006) and *Tourism, Performance and the Everyday: Consuming the Orient* (Routledge 2009).

**Professor David Levinson** holds the RP Braun/CTS Chair in Transportation in the Department of Civil Engineering at the University of Minnesota. His research focuses on transportation policy, planning and deployment, transportation and land use interactions, and travel behaviour. He has authored or edited five books on transport: *Financing Transportation Networks*, *Assessing the Benefits and Costs of Intelligent Transportation Systems*, *Access to Destinations*, *The Transportation Experience*, and *Planning for Place and Plexus: Metropolitan Land Use and Transport*. He is also the editor of the *Journal of Transport and Land Use*.

**Professor Hong K. Lo** is Professor of Civil Engineering at the Hong Kong University of Science and Technology. He specializes in dynamic transportation system modelling, traffic control, network reliability, and public transportation analysis. He is managing editor for the *Journal of Intelligent Transportation Systems*, Editor (Asia/Pacific) for *Journal of Transport and Land Use*, and serves on the editorial boards of several international journals, including *Transportation Research Part B*, *Transportmetrica*, *Journal of Advanced Transportation*, *ASCE Journal of Urban Planning and Development*, and *International Journal of Sustainable Transportation*.

**Dr. Stefano de Luca** obtained a Civil Engineering degree in Transportation at the University of Naples Federico II. In 2003 he got a PhD degree in Transportation Engineering at the University of Rome La Sapienza. Since 2004 he has been Assistant Professor of Transportation Planning at the School of Engineering of Salerno. His research activity has mainly regarded: choice modelling for transportation system users through models derived from random utility theory or regressive ANN models; models and algorithms for travel demand assignment to congested transportation networks under stationary conditions; macro or microscopic models for transportation terminal analysis.

**Dr. Juan Carlos Muñoz** is Associate Professor at the Department of Transport Engineering and Logistics, Pontificia Universidad Católica de Chile (PUC). His areas of interest include transport networks, transit operations, logistics, and optimization, where he has published in the key journals in the field. He was personal adviser to the Minister of Public Works, Transport and Telecommunications (2003–2004) during the final design phase of Transantiago. He was also one of the 12 experts asked to provide guidance and suggestions for the plan in March 2008.

**Dr. Patrick Olivier** is a Senior Lecturer at Newcastle University UK. With an undergraduate degree in physics and a doctorate in computational linguistics he feels very much at home in an interdisciplinary research centre such as the Informatics Research Institute. He has spent most of his research career conducting both theoretical and applied research at the intersection of artificial intelligence, computer graphics and human-computer interaction.

**Professor Juan de Dios Ortúzar** is Professor and Head of the Department of Transport Engineering and Logistics, Pontificia Universidad Católica de Chile (PUC). He has taught and researched in travel demand modelling, particularly discrete choice model applications, since 1973. He has published more than 70 papers in journals and is co-author of the best selling *Modelling Transport* (Wiley 2001).

**Dr. Chih Wei Pai** got a BSc degree in computing in Taiwan. He obtained his MSc degree in Transport Engineering from Newcastle University and a PhD degree

(with focus on motorcycle safety) from Edinburgh Napier University. His main research area is road safety using advanced econometric models. His PhD research findings have been published in several highly-respected journals such as *Accident Analysis and Prevention*, *Traffic Injury Prevention*, and *Safety Science*.

**Dr. Wafaa Saleh** is a Senior Lecturer in Transportation in the School of Engineering and the Built Environment, Edinburgh Napier University. Her research and teaching areas include transport modelling, travel demand management, modelling travel behaviour and forecasting, transport and the environment, transport safety, transport management in developing countries and traffic engineering. She has published extensively in the area of travel demand management.

**Professor Gerd Sammer** is Professor of Transport Planning in the Department of Landscape, Spatial and Infrastructure Sciences at the Institute for Transport Studies, University for Natural Resources and Applied Life Sciences, Vienna (Universitaet für Bodenkultur Wien). From 1990 to 1994 he was the head of the Institute for Transport Studies and Road Construction at the Graz University of Technology in Austria. He has also been Honorary Professor at the Széchenyi István College Győr in Hungary since 1997. He is a civil engineer with specialization in transport planning. His key qualifications comprise the fields of transportation analysis and forecasting, planning and scenarios techniques for urban, regional and interurban transport problems, techniques of cost-benefit- and sustainable-development-analysis, behavioural modelling, stated response analysis as well as mode choice. He is author and co-author of over 100 papers and contributions to books in different languages.

**Dr. Pushpendra Singh** received his PhD in mobile computing at the INRIA Research Lab, Rennes, France in 2004. He developed a framework to provide fault tolerance to applications running on mobile devices. After the PhD, he joined inter-disciplinary research at the Department of Psychology at the University of Portsmouth, where he worked on developing mobile device based adaptive speech remediation software for Japanese English speakers. He joined the Informatics Research Institute, Newcastle University in December, 2005 as a research associate and worked on real-time visualization of 3D Data on mobile devices and prototyping and evaluation of ubiquitous computing environments. He is currently a research engineer in the ARLES research group at INRIA, Paris-Rocquencourt.

**Barbara W.Y. Siu** received her BEng in civil engineering and is about to finish her doctoral degree in transportation engineering from the Hong Kong University of Science and Technology. Her research interests include travel time reliability, travel behaviour modelling, integrated transportation network supply and demand management, network planning over time, spatial interaction of transportation and land-use.



**Dr. Kathryn Stewart** is a Lecturer in Transportation in the School of Engineering and the Built Environment at Edinburgh Napier University. Her ongoing research is on traffic assignment modelling examining the network effects of road tolls and she is involved in projects on dynamic traffic assignment and micro-simulation modelling.

**Nebiyu Tilahun** is a PhD candidate in the Civil Engineering Department at the University of Minnesota. His research interests are in travel behaviour, transportation planning and transportation economics.

**Professor John Urry** is a Distinguished Professor of Sociology, Lancaster University; Fellow of the Royal Society of Arts; Founding Academician, UK Academy of Social Sciences; Chair RAE Panels (1996, 2001); Honorary Doctorate, Roskilde University. He has published around 40 books and special issues, and approximately 100 refereed articles and 80 chapters. He is currently Director of the Centre for Mobilities Research. Recent books include *Sociology beyond Societies* (2000), *The Tourist Gaze* (2002), *Performing Tourist Places* (2004), *Mobilities, Networks, Geographies* (2006), *Mobilities* (2007), *After the Car* (2008).

**Craig Walker** has an MSc in Transport Engineering and Planning from Edinburgh Napier University. This follows a BA in Urban Geography and a MLitt. in Strategic Studies, from the University of Aberdeen. He is now a Transport Management Consultant with Faber Maunsell/AECOM in Edinburgh and continues to be interested in road traffic accident statistics and projects.

**Weihong Guo (Amy)** received her MSc in Transport Engineering and Operations from Newcastle University. She is currently in the final stage of completing a doctorate in Intelligent Transport Systems. Her PhD thesis is entitled 'Use of a New Methodology to Investigate the Effectiveness of a Pervasive and Intelligent Future Traveller Information System in Encouraging Public Transport Use'. Her main research interests are in the field of applying emerging technologies to improve the efficiency of transport networks, with particular interests in the area relating to smartcard applications, traveller information systems and travel behaviour. She is a researcher in the Transport Operations Research Group at Newcastle University.

# Contents

<i>List of Figures</i>	<i>vii</i>	
<i>List of Tables</i>	<i>xi</i>	
<i>List of Contributors</i>	<i>xiii</i>	
<i>Acknowledgements</i>	<i>xix</i>	
1	Travel Demand Management and Road User Pricing: Success, Failure and Feasibility <i>Wafaa Saleh and Gerd Sammer</i>	1
<b>PART I TRAVEL DEMAND MANAGEMENT: INVESTIGATION OF IMPACTS</b>		
2	Non-Negligible Side Effects of Traffic Demand Management <i>Gerd Sammer</i>	13
3	Validation and Comparison of Choice Models <i>Stefano de Luca and Giulio Erberto Cantarella</i>	37
4	On-Street Parking Pricing: <i>Ex Ante Ex Post</i> Profile Analysis following a 50% Increase in On-Street Parking Charges in Dublin City <i>Andrew Kelly and Peter Clinch</i>	59
5	Modelling Impacts of Tolling Systems with Multiple User Classes <i>Kathryn Stewart</i>	73
6	The Network Society and the Networked Traveller <i>Kay W. Axhausen, John Urry and Jonas Larsen</i>	89
7	An Evaluation of Future Traveller Information System and its Effectiveness in Demand Management Schemes <i>Amy Weihong Guo, Phil Blythe, Patrick Olivier, Pushpendra Singh, Hai Nam Ha</i>	109

**PART II INTERNATIONAL EXPERIENCES WITH TDM MEASURES**

8	Variable Message Signs: Are they Effective TDM Measures? <i>Wafaa Saleh, Craig Walker and Chih Wei Pai</i>	135
9	Transantiago: The Fall and Rise of a Radical Public Transport Intervention <i>Juan Carlos Muñoz, Juan de Dios Ortuzar and Antonio Gschwender</i>	151
10	Unexpected Delay and the Cost of Lateness on I-394 High Occupancy/Toll Lanes <i>Nebiyou Y. Tilahun and David M. Levinson</i>	173
11	Integrated Network Improvement and Tolling Schedule: Mixed Strategy versus Pure Demand Management <i>Barbara W.Y. Siu, Hong K. Lo</i>	185
12	Traveller Responses to the Stockholm Congestion Pricing Trial: Who Changed, Where Did They Go, and What Did It Cost Them? <i>Joel P. Franklin, Jonas Eliasson, and Anders Karlström</i>	215
13	Travel Demand Management Measures: Technical Answers or Political Gains? Closing Remarks <i>Gerd Sammer and Wafaa Saleh</i>	239
	<i>Index</i>	243

# List of Figures

2.1	City map of Graz with the toll and extended paid parking zone	16
2.2	Survey procedure	18
2.3	Behavioural reaction to congestion pricing for car users; comparison of two different approaches	21
2.4	Behavioural reaction of car users to congestion pricing, comparison of two different approaches (weekday traffic)	22
2.5	Behavioural reaction to congestion pricing for shopping trips by car (weekday traffic)	22
2.6	Behavioural reaction to congestion pricing for car users, comparison of two scenarios (weekday traffic)	23
2.7	Behavioural reaction to congestion pricing, modal shift (weekday traffic)	24
2.8	Comparison of the behavioural reaction of users of cars for shopping purposes to an obligatory pay parking scheme (parking fee per hour €1.80) for shopping centres in the Vienna Region for sub-scenario A and B	29
2.9	Behavioural reaction of cars for shopping purposes to obligatory pay parking schemes for shopping centres in the City of Vienna (weekday traffic)	29
2.10	Change of modal split for shopping purposes as a result of obligatory pay parking schemes for shopping centres in Vienna	30
2.11	Behavioural reaction of users of cars for shopping purposes to an obligatory pay parking scheme for shopping centres at the outskirts of Vienna	30
2.12	Change of modal split for shopping purposes as a result of an obligatory pay parking scheme for shopping centres at the outskirts of Vienna	31
3.1	Proposed models: tree structure and mathematical formulation	41
3.2	Interpretation, reproduction, generalization and transferability	45
3.3	Clearness analysis	49
3.4	Fraction of users as choice probability threshold changes	50
3.5	ASA versus systematic utility	53
3.6	Direct elasticity	55
4.1	Comparison of age and class from 2000 (n= 1062) and 2001 (n=1007)	64
4.2	Frequency of parking to area and purpose of trip 2000 (n = 1062) and 2001 (n = 1007)	65

4.3	Point of origin for those queried (2000) (n = 1062) and 2001 (n = 1007)	67
5.1	Two-link network	79
5.2	SSO: Min-Rev link tolls on link 1	83
5.3	SO: Min-Rev tolls on link 1	84
6.1	Qualitative model of market size for goods and services	91
6.2	Road travel time – scaled maps of Switzerland (same scale for both year)	92
6.3	Quality adjusted 2004 purchase prices for private cars 1906–2004	93
6.4	Real costs of US interstate and international telephone calls 1930–2000	94
6.5	Distribution of great circle distances between the respondents and their contacts	95
6.6	Share of respondents with a given share of contacts among all contacts within their residential postal code or municipality	96
6.7	Average number of annual contacts by distance and mode of contact	97
6.8	Mean number of persons travelling with the respondents of the 2003 Thurgau six-week travel diary survey by type of leisure	98
7.1	Reconstructed scene from a first person perspective using video streams captured by three cameras at a metro station	114
7.2	Use of three video cameras to capture the actual scenes	116
7.3	Final Cut Pro	116
7.4	A subject stands in the middle of the three screens	117
7.5	Key locations and information display	119
7.6	An xml file	121
7.7	State base design	122
7.8	The Wizard control panel	123
7.9	Map from Google Earth™	123
7.10	The designed journey	124
7.11	Participants' age and gender	125
7.12	Participants' level of education	125
7.13	Participants' economic status	125
8.1	Locations of VMS in Scotland	137
8.2	AADT and accidents	141
11.1	The example network	196
11.2	The time dependent OD Trip matrix under the optimal TS-DM strategy	198
11.3	OD Trip Matrix (pure locators)	200
11.4	OD Trip Matrix (pure non-locators)	200
11.5	Comparison of schemes	202
11.6	Comparison of schemes (large initial capacity)	202
11.7	Comparison of schemes (small initial capacity)	203
11.8	Sensitivity of the overall system performance	205

11.9	OD Trip Matrix under optimal TS-DM strategy with 5-year time frame	206
11.10	OD Trip Matrix( $\theta^i = \theta^j = 5$ )	209
11.11	OD Trip Matrix ( $\theta^i = \theta^j = 0.5$ )	209
12.1	The Stockholm congestion charging cordon and toll locations	
12.2	Traffic across the cordon, charged hours, 2005–2008	219
12.3	Work trips by car across the cordon, divided by O-D relation and remaining/disappearing	221
12.4	Discretionary trips by car across the cordon, divided by O-D relation and remaining/disappearing	222
12.5	Changes in private trip streams	223
12.6	Bivariate density of observed departure time changes in the morning and in the afternoon (measured in minutes)	225
12.7	Summary of shares of trips remaining and shifting, by purpose	236
12.8	Average welfare effects for toll effect sub-groups by refund scenario	236

# List of Tables

2.1	Toll fees	16
2.2	Sample for the travel behaviour survey	27
2.3	Sample of operators of various enterprises	28
2.4	Opinion of operators and developers about obligatory pay parking scheme (OPPS) for shopping centres	32
2.5	Opinion of operators and developers about parking space levy for shopping centres	33
3.1	Attributes used in systematic utility specification	42
3.2	Description of the analyzed models	43
3.3	Observed market shares ( $MS_{obs}$ ) vs estimated market shares ( $MS_{mod}$ )	46
3.4	Indices and tests based on Log-Likelihood value ( $L(0)=-2,805$ )	47
3.5	Aggregate indicators based on users choice fractions	48
3.6	Clearness analysis	49
3.7	Example of $\Delta ASA_{k,h}$ matrix (for MNL model), values are not scaled to $\beta_{cost}$	51
3.8	Number of users with k and h available	52
3.9	Example of matrix Q (MNL model – calibration sample)	52
3.10	Example of matrix Q (CNL model – calibration sample)	53
3.11	Differential and/or finite difference elasticity	54
3.12	Direct elasticity	55
3.13	Procedure	56
4.1	Nearby MSCP charges and OS charges for 2000 and 2001	62
4.2	Income and engine sizes	65
4.3	Parking duration of users on the day surveyed only	67
4.4	Time spent searching for a parking space for all users 2000 (n=1062) and 2001 (n=1007)	68
4.5	Time spent walking to destination from parking for all users 2000 (n=1062) and 2001 (n=1007)	68
4.6	Maximum amount of time all users would spend walking to destination from parking 2000 (n=1062) and 2001 (n=1007)	69
5.1	SSO flows and associated MSCP and Min-Rev link tolls: TNTC = 19728	81
5.2	MUC link tolls for HGV and cars to maintain SSO aggregate flow pattern	81
5.3	SO flows and associated Min-Rev link tolls: TNTC = 19557	81
5.4	SSO and SO flows and associated Min-Rev link tolls	83

8.1	Overall accident rate (k) 2000–2006	140
8.2	Accidents data before and after installing VMS	142
8.3	Percentage effectiveness of VMS	143
8.4	Percentage effectiveness of VMS including the control zone information	144
8.5	Chi-squared results for the 14 VMS	144
8.6	Regression analysis models	145
8.7	Statistics summary and estimation results of the binary logistic model of accident severity (KSI v.s. slight)	146
8.8	Statistics summary and estimation results of the binary logistic model of accident severity (KSI v.s. slight), conditioned on the absence of vms	147
10.1	Respondents in each category	178
10.2	Stated choice model predicting choice of HOT lane alternative	179
10.3	Willingness to pay estimates (\$US/hour)	181
11.1	Link characteristics	196
11.2	Population composition over time	196
11.3	Coefficients of the location cost functions over time	196
11.4	The Optimal TS-DM strategy	197
11.5	Trip ends by income class, locators and non-locators	199
11.6	Comparison of schemes	204
11.7	The optimal TS-DM strategy under the 5-year time frame	207
11.8	Optimal TS-DM strategy ( $\theta^i = \theta^j = 5$ )	208
11.9	Optimal TS-DM strategy ( $\theta^i = \theta^j = 0.5$ )	208
12.1	Schedule of Toll Prices	218
12.2	Joint model for changing mode and departure time for initial car-drivers	226
12.3	Estimates of average treatment effects on the treated	228
12.4	Average welfare effects by toll effect sub-group	231
12.5	Average welfare effects by income category	233
12.6	Average welfare effects by refund scenario	234



# Chapter 1

## Travel Demand Management and Road User Pricing: Success, Failure and Feasibility

Wafaa Saleh and Gerd Sammer

Traffic congestion and associated problems have become a major worry for transport planners, politicians and the public. These transport-related problems require immediate attention, particularly as many past policies have failed to deal with them adequately. The traditional approach of 'predict and provide' for dealing with traffic congestion is no longer viable. That is, it is no longer feasible that the forecasts of vehicle usage are accommodated by building more roads; it is widely accepted that unrestrained demand for travel by car cannot be sustained. Measures taken to address the problems have therefore shifted to 'predict and manage' or travel demand management (TDM).

TDM measures are sets of policies with the primary objective of influencing the travel behaviour of individuals through voluntary reduction or restriction on private vehicle use and ownership and the provision of travel alternatives. TDM measures are often referred to as 'push and pull' measures and can include regulatory, pricing, planning or persuasive policies. These policies attempt to modify the temporal and spatial dimensions of travel, mode choice and perhaps even the decision to travel. The objective of such measures is to encourage individuals to either make their trips outside peak times, by a different mode or to find another way of carrying out the trip purpose. Applying such measures can result in a more efficient transport system, improved environmental conditions and improvements in safety as well as revenue generation, which may be earmarked for investment in the transport system. TDM can generate positive effects on health and in the long term can also effect a change in spatial development of land use.

TDM can broadly be categorized as fiscal and non-fiscal measures. Non-fiscal measures that can be adopted by planners and policy makers include traffic calming and access controls and restrictions, parking management and control, public transport improvements, road space reductions, urban traffic management and control systems, traffic bans/restrictions, and travel awareness campaigns. Fiscal measures can include parking charges, workplace parking levies, fuel taxes, vehicle excise duty, car ownership permits, public transport subsidies, priority measures for walking and cycling and road-user charging.

During the 2005 symposium pricing measures, in particular road user pricing, dominated the research agenda. This is not unexpected since there is a growing interest in pricing measures, which gained a lot of popularity and support over