

Taxi Licensing, Regulation and Control
An analysis of taxi supply in medium sized UK cities

Submitted in partial fulfilment for the degree of Doctor of Philosophy at Napier
University, Edinburgh

James Michael Cooper

Nov, 2007

Acknowledgements

Significant thanks and grateful acknowledgement is appropriate for the assistance and advice of Mr Bill McIntosh of the Scottish Taxi Federation, Messrs Harry Fitzsimmons; William, and Christopher McCausland of the combined group of Belfast private hire taxi proprietors associations; Adele Watters of the Department of the Environment for Northern Ireland; and Jo Bacon of the Department for Transport.

I also wish to acknowledge and thank the following organisations for their input and comments (in no particular order), the cities and licensing authorities of Fresno, San Diego, Glasgow, Edinburgh, Belfast, and West Dunbartonshire. To the participants of all of the survey work completed in the course of the work, and particular thanks to the Accessibility Panels and Forum. Thanks also to the Community Transport Association; the Transport and General Workers Union; and the large number of individual council officers, taxi proprietors and taxi drivers whose comments have been invaluable in achieving a full picture of taxis.

Finally, the undertaking and completion of this thesis has been achieved in no small part thanks to the continued and appreciated encouragement and dedication of my supervisors, Professors Margaret Grieco, Ron McQuaid and Kevin Cullinane.

Dedication

For Ursula and Sarah.

Abstract

The primary objective of this thesis is to provide a new approach to optimizing the supply of taxis as applied in UK cities. Taxi supply, both in the UK and elsewhere, is controlled by a series of regulations (defined in relation to controls affecting Quantity, Quality and Economics – QQE) that influence the ability of the market to respond structurally - in terms of access to the market, and operationally – affecting the ability to provide services within the market. This thesis identifies the existing structures in taxi regulation. It explores legislative disagreement and differences in both academic and practitioner literature and perspectives.

The thesis provides both a new approach to, and a new model of, taxi regulation, which accommodates existing differences in regulatory structures. The thesis builds on existing methods applied in determining individual elements of control – which may be appropriate to some elements of control but fail to address a full cross section of impacts – and provides an enhanced approach and new modelling framework for taxi regulation. In constructing this approach use has been made of both survey and case study methodologies. Survey data has been collected from two surveys, of 52 cities and 21 licensing authorities respectively. The case studies used are of Glasgow¹ and West Dunbartonshire².

The thesis concludes that existing approaches to regulation are conducted in separate regulatory domains without sufficient comprehension of the impacts of action in one regulatory domain on another. It also concludes that the instruments used in the assessment of the impacts of regulation on taxi supply are insufficiently specified and inadequately coordinated. It is possible to identify issues across regulatory domains that can be improved to better optimize supply appropriate in any given circumstance to the benefit of existing and potential passengers - this includes those with particular access needs. In optimizing supply, awareness of the needs of the taxi industry and its regulators

¹ Although central to the Strathclyde conurbation, the Glasgow licensing area relates to the central city area only (Clydebank, Paisley, etc. being included in separate council licensing areas). The city is thus defined as medium sized location.

² Further focus city material has been collected from Belfast and Edinburgh, which is included in comparison within the text, and summarised in the appendices of this document.

has been an important element of consideration. The thesis makes recommendations for alterations in the application of standard methods of assessment of taxi supply.

Table of Contents

Chapter 1: Introduction, the development of regulatory models applicable to urban taxi supply

1.1	The role of taxis in an urban setting	16
1.2	Defining a taxi service	19
1.3	Competition and transport delivery	22
1.4	Taxi service delivery	24
1.5	History of taxi supply	25
1.6	Outline of thesis	28

Chapter 2: Taxi Regulation: literature review

2.1	Introduction: objectives of the chapter	30
2.1.1	Historical perspective on taxi supply and regulation	32
2.1.2	Nighttime and daytime: differentiated economies	33
2.2	Regulatory Economics	35
2.2.1	Market failure	37
2.3	Regulation in the transport sector: setting the context for taxi services	39
2.4	Regulation in the taxi sector and the identification of issues specific to the taxi mode	40
2.4.1	Quality regulation	43
2.4.2	Quantity regulation	45
2.4.3	Economic regulation	47
2.4.4	Critical appraisal of the literature	48
2.5	Methodological literature	49
2.6	Models and analysis pertinent to taxi regulation: assessment types and practices	50
2.6.1	Impacts of individual assessment	51
2.6.2	Current definition and use of the Significant Unmet Demand (SUD) Model	51
2.6.3	Cost Models	52
2.6.4	Inclusion of quality controls in taxi models	53
2.7	Conclusion	53

Chapter 3: Methodology

3.1	Introduction	55
3.2	State of the practice, building from existing study methods	57
3.3	Choice of methodology	58
3.4	Developing a mixed methods approach	63
3.5	Critique of the methods used	63
3.5.1	Literature review	67
3.5.2	Stakeholder analysis	68
3.5.3	Surveys of local authorities	69
3.5.4	Supply analysis	71

	3.5.5	Demand analysis	73
	3.5.6	Case studies	74
3.6		Survey Detail	75
	3.6.1	Primary research: Stakeholder Questionnaire	79
	3.6.2	Supply analysis	82
	3.6.3	Demand analysis	86
	3.6.4	Case Study	89
3.7		Enhancement to existing approach and critique	90
	3.7.1	Temporal differences and data consistency	91
3.8		Conclusion	91

Chapter 4: The different domains of taxi regulation

4.1		Introduction	94
4.2		Quantity, quality and economic controls applied to taxis: an appraisal	94
	4.2.1	National and regional control	95
4.3		The structure of urban taxi markets	98
	4.3.1	Temporal markets	99
	4.3.2	Daytime policy imperatives	100
	4.3.3	Definition and response to day/night supply issues	102
	4.3.4	Spatial relationships	103
4.4		Empirical evidence	104
	4.4.1	Nature of interactions	104
	4.4.2	Nighttime transport interactions	105
	4.4.3	Daytime transport interactions	107
	4.4.4	User needs	108
4.5		Gaps in delivery	108
	4.5.1	Models used in the determination of regulatory form	109
	4.5.2	Factors in market development	111
4.6		Conclusion	112

Chapter 5: Regulatory models, a detailed analysis

5.1		Introduction	114
5.2		Defining regulatory models	114
	5.2.1	Balance and impacts between regulatory domains	117
5.3		Forms of regulatory models	117
	5.3.1	Quality control	118
	5.3.2	Linkages between quality control and analytical models	120
	5.3.3	Quantity restriction	120
	5.3.4	Linkages between quantity restrictions and analytical models	121
	5.3.5	Economic regulation	122
	5.3.6	Development of analytical cost models	123
5.4		Conclusion	124

Chapter 6: An evaluation of existing practices

6.1	Introduction	126
6.2	Case studies exemplifying key issues in taxi supply	127
	6.2.1 Structured interviews	130
	6.2.2 Key issues arising in the focus cities	130
	6.2.3 Issues specific to licensing	133
	6.2.4 Issues specific to tariff	134
6.3	Experiences in applying current assessment	135
	6.3.1 Critique of modelling practice, assumptions in SUD modelling	136
	6.3.1.1 Driver waiting conflicts	141
	6.3.1.2 Fleet composition models	141
	6.3.2 Critique of cost model components	142
	6.3.2.1 Driver wage conflicts	142
	6.3.2.2 Impacts of changing fleet sizes	145
	6.3.3 Quality control application	147
	6.3.3.1 Minimum standard and maximum age requirement	148
	6.3.3.2 Disability access impacts	149
6.4	Potential for updating model components and interaction	150
6.5	Conclusion	151

Chapter 7: Construction of a new model

7.1	Introduction	153
7.2	Technical specification	153
	7.2.1 Quantity analysis	155
7.3	Nature of relationships	156
7.4	Development of the new model	158
7.5	Technical detail of model elements	158
	7.5.1 Development from quantity models	159
	7.5.1.1 Threshold of delay	161
	7.5.1.2 Passenger delay	164
	7.5.1.3 Vehicle delay model	165
	7.5.1.4 Fleet impact sub model	166
	7.5.2 Non-licence based solutions model	169
	7.5.2.1 Stance engineering	170
	7.5.2.2 Driver perception model	172
	7.5.2.3 Time savings at stance model	172
	7.5.2.4 Engineering calculation	174
	7.5.3 Accessible vehicle model	176
	7.5.3.1 Model of proportional demand	177
	7.5.4 Linkages between quantity and other regulatory domains	180
7.6	Developing a new model of economic regulation	182
	7.6.1 Taxi cost model	184
	7.6.1.1 Vehicle purchase cost	184
	7.6.1.2 Vehicle cost, depreciation	185
	7.6.1.3 Cost of vehicle maintenance and labour	187
	7.6.1.4 Maintenance cost, labour	188
	7.6.1.5 Fuel cost	189
	7.6.2 Infrastructure cost model	190
	7.6.2.1 Insurance costs	191
	7.6.2.2 License costs	191

7.6.2.3	Other cost elements	191
7.6.3	Driver earnings model	193
7.6.3.1	Personnel cost model	194
7.6.4	Updating the taxi cost model	195
7.7	Conclusions	197

Chapter 8: Case Studies

8.1	Introduction	198
8.1.1	Primary application locations	199
8.2	West Dunbartonshire, developing a quality – quantity linkage	200
8.2.1	West Dunbartonshire, aims in taxi supply	202
8.2.2	Testing for SUD in West Dunbartonshire	203
8.2.3	Application of a new modelling framework in West Dunbartonshire	205
8.2.3.1	Enhancement of pedestrian surveys	206
8.2.3.2	Survey of individuals with special needs	213
8.2.3.3	Survey interpretation, accessibility	217
8.3	Building links to quality control	219
8.3.1	Accessible vehicle supply	220
8.3.2	Application of model and West Dunbartonshire results	223
8.4	Conclusions, lessons from West Dunbartonshire	226
8.5	Glasgow, developing quality – cost linkages	227
8.5.1	Glasgow, aims in taxi supply and costs	228
8.6	Application of the enhanced model	229
8.6.1	Cost model applications	229
8.6.2	Structure of the cost model	230
8.6.3	Review of cost model components	231
8.6.3.1	Vehicle purchase price and depreciation	231
8.6.3.2	Costs of vehicle maintenance	232
8.6.3.3	Fuel costs	233
8.6.3.4	Insurance costs	233
8.6.3.5	License and other costs	234
8.6.3.6	Driver earnings	235
8.7	Application of the cost model	235
8.7.1	Frequency of review	236
8.7.2	Applying increases to the tariff	237
8.7.3	Initiation of a tariff review	238
8.8	Application and enhancement of the SUD model in Glasgow	238
8.8.1	Building from the existing model, issues in quantity modelling	240
8.8.2	Building links to economic regulation	241
8.9	Application of an enhanced modelling structure to Glasgow	242
8.9.1	Developing a complementary user perceptions model	242
8.9.2	Driver behaviour and waiting conflicts	243
8.9.3	Conflicts arising at stance, design and stance engineering	244
8.10	Conclusions, updating taxi models, evidence from case studies	248
8.10.1	Model components	248
8.10.2	Applying links within the new modelling framework	251
8.10.3	Applying the model with specific reference to nighttime economies	252

8.11	Conclusions	253
------	-------------	-----

Chapter 9: Conclusions, taxi licensing and control: Implications of the model

9.1	Optimising taxi service delivery, licensing and control	255
9.2	Public interest	256
9.3	Implications of the new model for the different stakeholder constituencies	257
9.3.1	Application of QQE in cross regulatory analysis: enhanced modelling approach	258
9.3.1.1	Quantity regulation	258
9.3.1.2	Quality regulation	259
9.3.1.3	Economic regulation	260
9.3.2	Impacts on market participants	261
9.3.2.1	Implications for the travelling passenger: existing and latent demand	261
9.3.2.2	Implications for the taxi operator	263
9.3.2.3	Implications for the regulator: the taxi licensing authority	263
9.3.2.4	Nighttime travellers and temporal impacts	264
9.3.3	The case for regulated environments recognising local needs and priorities	265
9.4	Model structure	266
9.5	Scenario development	267
9.6	Model development	269
9.7	Policy development	270
9.8	Further research	271

Appendices

1	Metropolitan coinditions of fitness	304
2	Fare table layout, example from Edinburgh	310
3	Interactions in the Night Time Economy	311
4	Map of Edinburgh night bus routes	319
5	Calculations used in Glasgow tariff calculation	320
6	Cost mdoel components and update, Glasgow	324
7	Questionnaire Examples	242
8	Comparative data, Belfast and Edinburgh	352
9	Postscript	355

List of Tables

Table	1.1	Forms of taxi supply	19
	1.2	Market Segments with peaked demand in UK taxi industry	21
	1.3	Illustrative legislation resulting in transport regulation/reform	23
	1.4	Significant legislation affecting UK taxi industry	25
	1.5	Application of taxi regulation in US cities	27
	2.1	Application of principle regulatory structures in UK transport	36
	2.2	Approaches adopted in cost models in UK cities	53
	3.1	Principal methodologies adopted in this thesis	65
	3.2	Data collection by survey type (stakeholder)	66
	3.3	Listing of local authorities surveyed	70
	3.4	Analysis of observation method	72
	3.5	Development of primary data sets	76
	3.6	Listing of licensing authorities surveyed	81
	3.7	Standard model elements in the assessment of SUD	82
	3.8	Common model elements in the Taxi Cost Model	83
	3.9	Construction of observation surveys	84
	3.10	Construction of driver surveys	86
	3.11	Construction of pedestrian surveys	88
	4.1	Structure of UK authorities	95
	4.2	Licensing authorities applying controls by type	96
	4.3	Trip purposes, use of taxis	98
	4.4	Interactions felt significant in the use of transport	105
	4.5	Significance of issues identified specific to the nighttime economy	106
	6.1	Common issues in taxi supply	128
	6.2	Significant unmet demand model standard elements	136
	6.3	Matrix applied to identifying the presence of SUD	137
	7.1	Qualitative framework for assessing taxi stance	171
	7.2	Additional cost components applied across locations	192
	8.1	Comparative ISUD values, West Dunbartonshire	203
	8.2	Stance specific ISUD values	203
	8.3	Occurrence of excess passenger delay, West Dunbartonshire	204
	8.4	Passenger delay characteristics, West Dunbartonshire	207
	8.5	Enhanced model structure linkages in West Dunbartonshire	219
	8.6	Cost components used in the Glasgow cost model	230
	8.7	Worst performing city centre stance in Glasgow	246
	8.8	Summary of linkages to cost model	249
	8.9	Summary of linkages to SUD model	251

List of Figures

Figure 2.1	Overview of tensions within regulatory literature	35
3.1	Survey flow chart and linkages	56
3.2	Time line	57
3.3	Locations of research specific to thesis	80
4.1	Distribution of authorities applying quantity restriction in 2002	97
5.1	Regulatory and analytical models	115
6.1	Glasgow city centre stance locations	132
6.2	Typical accessible (London) taxis and saloon vehicles	133
6.3	Standard model for determining the presence of SUD	139
6.4	Comparative ISUD values	140
6.5	Standard model for determining costs	142
6.6	Interaction between fleet size and other modelling elements	145
6.7	Fleet size, cost interaction	146
6.8	Quality control interaction	147
7.1	Design specifications for the new model	154
7.2	Sub-models applied to quantity modelling	160
7.3	Threshold of delay	163
7.4	Diversion at Glasgow Gordon Street stance	175
7.5	Linkages between quantity control and other regulatory domains	181
7.6	Sub-models applied to cost modelling	183
7.7	Linkages between economic regulation and other regulatory domains	196
8.1	Maps of West Dunbartonshire – stance locations	201
8.2	Frequency of use, main modes of transport in West Dunbartonshire	207
8.3	Main trip purpose, taxi in West Dunbartonshire	207
8.4	Methods of engaging taxis in West Dunbartonshire	208
8.5	Service performance in West Dunbartonshire	209
8.6	Waiting times experienced in West Dunbartonshire	210
8.7	Acceptable waiting times - West Dunbartonshire	210
8.8	Comparative vehicle benefits in West Dunbartonshire	211
8.9	Respondents by handicap	213
8.10	Frequency of use in West Dunbartonshire	214
8.11	Main trip use in West Dunbartonshire	214
8.12	Vehicle preferences in West Dunbartonshire	215
8.13	Increased use arising from introduction of accessible taxis in West Dunbartonshire	215
8.14	Propensity to engage taxis by pre-booking in West Dunbartonshire	216
8.15	Propensity to engage taxis at stance in West Dunbartonshire	216
8.16	Propensity to engage taxis by hailing in West Dunbartonshire	216
8.17	Waiting times by location of engagement in West Dunbartonshire	217
8.18	Gordon Street taxi stance, Glasgow	240

List of Abbreviations

SUD	Significant Unmet Demand	SENG	Stance Engineering model
DRT	Demand Responsive Transport	DPM	Driver Perceptions Model
FTS	Flexible Transport Services	TSAS	Time Savings At Stance
OFT	Office of Fair Trading	AVM	Accessible Vehicle Model
DfT	Department for Transport	MPD	Model of Proportional Demand
DDA (95)	Disability Discrimination Act, 1995	TCM	Taxi Cost Model
NTE	Night Time Economy	VPC	Vehicle Purchase Cost
DOE	Department of the Environment for Northern Ireland	VCD	Vehicle Cost Depreciation
PHV	Private Hire Vehicle(s)	CVM	Cost of Vehicle Maintenance
PSV	Public Service Vehicle(s)	ICM	Infrastructure Cost Model
MCF	Metropolitan Conditions of Fitness	DEM	Driver Earnings Model
DTE	Daytime Economy	PCM	Personnel Cost Model
ODPM	Office of the Deputy Prime Minister	MPD	Model of proportional Demand
PCV	Passenger Carrying Vehicle	JP	Journey Purpose
LT	London Transport	VU	Vehicle Utilisation
DVTA	Driver and Vehicle Testing Agency	ADA	Americans with Disabilities Act
SE	Scottish Executive	QQE	Quality / Quantity / Economic regulation
LA	Licensing Authority	PSNI	Police Service of Northern Ireland
TDD	Threshold of Delay	PU	Pick-up (by taxi)
PD	Passenger Delay	CGSA	Civic Government (Scotland) Act, 1982
VDM	Vehicle Delay Model	SANDAG	San Diego Association of Governments
FISM	Fleet Impact Sub Model	CALTRANS	California Transportation (CA Department of Transportation)
EA	Extra Arrivals model		
IAA	Impact of Additional Arrivals		
ILF	Impact of a Larger Fleet		
NLSM	Non-License based Solutions Model		

Chapter 1

Introduction: the development of regulatory models applicable to urban taxi supply

1.1 The role of taxis in an urban setting: the context and identification of objectives of the thesis.

The primary objective of this thesis is to provide a new approach to optimizing the supply of taxis in UK cities. Taxis form a very distinct part of the supply of modern land based transport services, and play a role in the supply of public transport, itself a range of differing modes varying from large vehicle fixed route services, such as traditional bus and rail in the public sector (either in terms of ownership or regulation), to smaller responsive vehicles able to provide services on request. This latter mode has come to be termed Demand Responsive Transport (DRT) or Flexible Transport Services (Brake et al, 2004). Taxis are a part of this provision, contributing to a wider public transport field (Cooper, 2004), but tend to be considered separately to fixed route or other DRT services. Controls applied to taxis, and their regulation, in the UK, are functions of licensing departments in local authorities rather than that of transport departments in the respective regional authorities (White, 2002) and are more often considered in the same domain as liquor control, rather than as a part of a joined-up or integrated approach to transport. This disparity in terms of the regulatory agency as between taxis and other forms of transport is present also in the logic of regulation as applied between other forms of transport and taxis. Whereas other forms of transport have seen emerging policy logic of deregulation in favour of market approaches, in the main, the regulatory logic in respect of taxis has been a continuing, and fiercely defended, restricted market for taxis. The extent of these differences between the different modes of transport in terms of regulatory structures in respect of taxis and the important recurring transport policy discussion (OFT, 2003) that taxis could be provided differently gives rise to this thesis and its objective of investigating the potential for improvement in delivery of taxi services.

The concept that taxi regulation is intended to provide the best method of delivery to taxi passengers forms the basis of this thesis. This understanding provides us with a set of

key questions: Does the current form of regulation and methods by which regulations are determined actually help in the provision of the best service appropriate? What are the consequences of adopting a particular stance towards regulation? What guidance is available to local authorities in reaching decisions as to whether to move toward a deregulated environment, as set out in the Department for Transport Best Practice Guidance (DfT, 2006), or to maintain controls on the numbers, quality and cost of vehicles in a city fleet?

In line with these key questions, the major objective of this thesis is to analyse the regulation of taxis in UK cities and to identify the potential to optimise the supply of taxis in the context of wider transport provision. This includes the identification of existing analytical approaches to taxi services (Supply and Demand), analysis of these approaches including detailed literature review (see Chapter Two) to determine impacts and shortfalls arising from their application; and the development from this base line of revised or new approaches as appropriate to the delivery of taxis in medium sized UK cities.

A major argument of this thesis is that current forms of regulation, both those that seek to control and those that seek to follow free market principles, fail to adequately address the supply of taxis across all forms of demand. The thesis identifies three major domains of the operation of controls – Quality, Quantity and Economic Regulation (QQE) - and characterises the current patterns of regulation associated with these areas of control within the UK (see: White, 2002). In particular, the thesis finds that the separate operation of these respective types of control (QQE) affecting the industry may operate against the best interest of taxi users and, ultimately, against the interest of the operators themselves (see: Schaller, 2006).

Using survey methods and standard observation techniques, a model has been developed, specified in Chapter Seven, which identifies the nature of the demand for taxis and the impacts of the varying forms of regulation on the supply of taxis. The development of this model has been informed by spatial understandings obtained through case study and survey materials. In particular, detailed studies of Glasgow and West Dunbartonshire commissioned from the researcher by these respective local authorities provided high quality access to taxi organisations and to the array of relevant stakeholders beyond the

resources of normal research sources (see Chapter Three). In Chapter Eight, the model developed is applied to the West Dunbartonshire and Glasgow taxi environments to make the case that optimal delivery may result from a more detailed analysis of the linkages between the different regulatory domains.

The model identifies the impacts of changes in regulatory structure and allows for an assessment of optimal delivery of taxi transport in cities. The thesis contends that optimal solutions will include consideration of interaction between regulatory domains and may only be possible where the needs of both daytime and nighttime economies (NTE) are satisfied. The nighttime economy represents distinct and separate activities to those of the day (Thomas and Bromley, 2000), and that this may require a different approach to transport in general (Cooper, 2005) and taxi regulation and control in particular, compared to the extremes of regulation or de-restricted markets seen to date.

An additional dimension of the thesis considers the relationship between taxi supply, fleet composition and transport under the auspices of the Disability Discrimination Act (1995) (DDA) (HM Government, 1995), which sets out minimum levels of access required in law (DPTAC, 2001; DRD, 2005; DOE, 2006), but remain only partially applied to taxi services. This additional dimension forcefully demonstrates a neglected area of interaction between quantity and quality control. In so doing the thesis develops a methodology for assessing the performance of taxi fleets in respect of passengers with additional accessibility needs. This is then applied to establish accessibility needs in West Dunbartonshire and is described in detail in Chapter Eight.

The next section of this chapter provides key definitions and assumptions necessary to underpin a discussion of taxi provision and its regulation within the UK. It is followed by a preliminary introduction to the policy discussion of the interaction between competition and transport delivery in general. This, in turn, is followed by an identification of the differences in policy treatment as between taxi services and other forms of transport service, structure and supply. An identification of the history of the development and regulation of UK taxi delivery is then provided and a comparison made with the history of such developments in the USA. This chapter concludes with an outline of the subsequent chapters and a preliminary indication of their contribution to the overall thesis. It also provides an outline of the purpose of the thesis.

1.2 Defining a taxi service

Although the transport literature on taxi services is itself very restricted, the complexity of taxi organisation is substantial and significant. For this thesis, this means that much of the definitional work required to develop arguments around the regulation of taxis must be undertaken within the thesis itself. Adding to the complexity of assessing taxi transport is the variability and complexity of defining taxi services. Taxis are not a simple and consistent form of transport, but cover a variety of forms varying by location, in name and function. Table 1.1 sets out the four most common forms and their variants.

Table 1.1 Forms of taxi supply

Type	Characteristics	Typical Forms of Regulation
Hackney Carriage (Public Hire Vehicle)	<ul style="list-style-type: none"> • Available for hire and reward • Can pick-up on street (Hail / Cruising) • Can operate from Stance / (Ranking)³ • By pre-booking (dispatch)⁴ 	<ul style="list-style-type: none"> • Quantity Control • Quality Control • Economic Regulation
Private Hire Vehicles (PHV) (Minicab)	<ul style="list-style-type: none"> • Available for hire and reward • Ranking (Certain Locations only)⁵ • By Pre-booking (dispatch) 	<ul style="list-style-type: none"> • Quality Control • Economic Control
Taxibus ⁶ (Jitney / Paratransit)	<ul style="list-style-type: none"> • Available for restricted bus services 	<ul style="list-style-type: none"> • Quality Control • Economic Control
Limousine	<ul style="list-style-type: none"> • Available for pre-booked journeys 	<ul style="list-style-type: none"> • Quality Control

Derived from DOE, 2006

The development of taxis has led to a widely recognisable form of transport for hire and reward (see Lowe, 2002; HM Government, 1985), consistent in most cities. Visible similarities can exist in vehicle types used, often as a result of (partial) application of Metropolitan Conditions of Fitness (MCF), and in methods of allocating price to distance and time. Four categories of taxis are common: Hackney Carriage, PHV, Taxibus and

³ Differing regulations can apply at airports.

⁴ Public hire (Hackney) taxis do not always operate in the pre-booked dispatch market (street taxis)

⁵ Private Hire Vehicles (PHV) are not normally allowed to pickup in public ranks.

⁶ See: DOE, 2005; DOE, 2006

Limousine: of these the first two, are the most common in UK cities. The use of the Taxibuses and limousines is far lower although examples of Taxibuses exist in Belfast. For this reason Taxibuses and Limousines have been excluded from the main focus of this study. Similarly, the engagement of taxis at airports (see: Sims et al, 1998) represents a distinct and separate focus not included in this study.

The apparent uniformity of narratives around taxi operation may, however, impact on perceptions and range of discussion surrounding regulation (as indeed it has for the past 30 years (see Coffman, 1977; Schreiber, 1977)), effectively polarising discussion around quantity regulation of Hackney services. One pole of the ongoing discussion allows free market, liberal market access, as beneficial to the public by increasing the supply available (Buckeye, 1996; Boroski and Mildner, 1998; BSD Consultants, 1999 - where the alternative, quantity limitation, 'seriously affects peak service levels', reducing passenger benefit) and leading to effective price competition. The economic impacts of regulation are also identified as related and impacted by entry restriction (Laitila et al, 1995), suggesting deregulation brings down fares paid by the public. The other pole of the ongoing discussion provides opposing arguments which focus on the negative impacts of excesses in supply (Gilbert, 1992; Teal, 1992; Avants et al, 1996), reducing quality of service and resulting in an atomized industry incapable of appropriate control.

From the perspective of this thesis, we introduce a third strand or position in this discussion, which is that the additional impact of changes in regulation on a market that may already display distinct segments can include partial benefit in one segment whilst simultaneously producing harm in another. This thesis demonstrates that, in reality, the taxi serves a multiplicity of markets, where change in one element or market segment (see Table 1.2) will impact significantly in another. To provide an illustration, it can be seen that a change in the supply of taxis to concentrate service on particular areas – such as the city centre at night or on particular needs (including the supply of accessible vehicles) will change the circumstances of supply in other areas and for other passengers.

Table 1.2 Market Segments with peaked demand in the UK taxi industry

Market Segment	Characteristics	Times of peaked demand	Locations of peaked demand
Business Trips	Premium city centre trips, and travelling to/from airports and railways stations	Weekday daytime	Central Business District
School Trips	Transporting children as a part of local authority schools transport obligations ⁷	Weekday 08.00 – 09.00 and 15.00 – 16.30	Between School and Home
Shopping Trips	Low income trips, home from shopping	Weekday daytime	From shopping centres
Nighttime Travel Home	Returning from entertainment / revelry	Weekend nighttimes, particularly 00.00 – 04.00 Sat/Sun	From city centre (Entertainment districts)

Derived from Cooper, 2005

As we have already indicated, the development and enhancement of Nighttime Economies as a consequence of changing urban policies (including the Licensing Act (HM Government, 2003), which removed enforced pub closing times (DCMS, 2003)) and changing uses of communication technologies including for bookings (see Manganese-Bronze, 2003) have major transport consequences: these issues are well known within the trade but are often absent in mainstream policy analysis (see: Cooper, 2005). Nighttime Economies (NTE) differ substantially from Daytime Economies (DTE) (Thomas and Bromley, 2000) and have differing transport needs. Demand for transport in the nighttime economy is typified by homebound journeys from entertainment and social interaction. The need to meet demand at nighttime – a point of peak demand for taxis in the absence of other forms of public transport - receives less attention than the policy imperative of providing appropriate levels and forms of transport during the day. This aspect of taxi market organisation and segmentation needs explicit consideration within regulatory policy and requires addressing within a discussion of the tensions and disfunctionality that can be induced by the application of the different types and instruments of regulation in a complex operating structure.

This section has set out definitions and an overview of taxi services in order to identify issues pertinent to the optimal delivery of taxi transport in cities and to indicate that the

⁷ School Transport obligations are set out in Section 509 of the Education Act 1996.

policy implications of the tension between regulatory instruments and domains in respect of taxis – in a complex and as of yet inadequately researched or characterised transport structure - require careful specification and consideration. It has provided the initial ground for the key argument of this thesis; that optimal solutions are only possible where the needs of both daytime and nighttime economies are satisfied, and that this may require a differing and more nuanced approach to regulation and control than the polar extremes of fully regulated (regulated) or more free market approaches (de-regulated / de-restricted) seen as the focus of policy to date.

1.3 Competition and transport delivery

The development of public transport has, over history, migrated between the two polar approaches of: a) regulated public provision, and; b) deregulated private operation (see table 1.3) - these being the opposing concepts of *controlled* against more *free market* operation. Each approach attracts proponents and both have sometimes been viewed as allied to a political viewpoint or imperative (Beesley and Gwilliam, 1977). Similarly, the extent and force of regulation may vary (DFT, 2006), and can be applied either through a range of legislation and legislative levels; this may be through national, regional and local authorities applying statutory requirements on businesses to operate in a particular manner, or through guidance or policies stated as *best practice* that are open to local interpretation and application. As we shall see, the nature of taxi controls differs considerably between locations: at times and in different localities, this may reflect either differing markets for transport, or differences in prevailing approaches, but all can be brought into analysis within the framework of the three domains of regulation already identified within this thesis.

Along with other authors in this field we argue transport controls exist (White, 2002), in three domains: Quantity, Quality and Economic control (QQE). Characterising these broadly, *Quantity Controls* relate to barriers to market entry, and can include the requirement for a license or maximum numbers permissible in a city parc (the total number of taxis available in a fleet (see: Oxley, 1999)); *Quality Controls* include aspects of safety as well as vehicle design, and minimal service standards. *Economic Controls*

relate to fares, tariff caps and discounted travelling concessions (see: Schaller, 2006). Market approaches seek to replace many of the regulations controlling supply and market entry with an open market for competitive transport. They may also consider the impacts of economic controls on price mechanisms, but are unlikely to remove all forms of control. In practice, it should be noted, all markets retain some form of regulation (for example, the need to ensure vehicle safety through MOTs in an otherwise open market) and the concept thus relates to a less regulated environment rather than one without regulation.

Within the general discourse of transport regulation (see: Docherty et al, 2004), neither *Regulated* nor *Market* approaches have established complete dominance in the UK. Patterns of supply have fluctuated between a predominance of one or the other (see Table 1.3). Early railways, buses and trams operated in open competition with many suppliers; and have progressed through a number of different periods of regulation, including railway consolidation (Railways Act 1921 - grouping), and nationalisation (Transport Act 1947) applied to railways, buses, waterways and road haulage. Current provision in the UK reflects a more free market approach in most forms of public transport. The Transport Act 1985 and Railways Act 1993 moved bus and rail respectively from nationalised towards market provision.

Table 1.3 Illustrative legislation resulting in transport regulation /reform

Date	Legislation	Effect
1840	Act for regulating railways	Created requirement for inspectorate, and determined 'parliamentary trains' ⁸ and regulated workmen's fares
1921	Railways Act	Entry Restriction, groups rail services into four main operators
1947	Transport Act	Nationalisation, groups rail services under the British Railways Board, and bus services into regional companies (National Bus)
1985	Transport Act	Deregulates bus services, removes barriers to entry
1993	Railways Act	Liberalises Railways, creates national infrastructure company and allows entry to private operating companies.

⁸ Parliamentary trains 'parlies' were services with required schedules set down by parliament. Other services operated competitively at the discretion of the companies operating them.

The exception to this overall pattern, and most importantly for this thesis, appears to be the taxi. In the next section, we investigate the basis of this difference.

1.4 Taxi service delivery

Reviewing the field of transport regulation, a notable exception in the regulatory swings affecting other forms of public transport may be the taxi. UK Taxi services are operated privately, are treated in isolation of other modes (Hu and Saleh, 2005) and tend to receive less attention in academic literature than other forms of transport⁹. This assertion may, in part, reflect the separation of Taxi Licensing from Transport Policy in local councils (see section 4.2). It may also reflect the lack of consideration to taxis in the household assessment of transport use that is visible in Scotland, in that the Scottish Household Survey assessment of mode choice (Barker and Connolly, 2005) specifically excludes taxis from analysis (p40 sect. 4.6), making only a passing reference to the mode accounting for 2% of journeys to school, and absolutely no indication of the role of the taxi in other forms of public transport.

While many traditional transport texts, such as Cole (1986), provide a review of regulation in public transport, far fewer consider regulation applied to taxis. Similarly the interactions between modes are not broadened to include the *effects of and on taxis*, with the exception of incidental effects such as taxis being allowed to use bus lanes (DePalma and Rochat, 2000; DOE, 1995). Despite the relative proximity of the markets assessments of the relationship between income and mode choice continue to ignore taxis (see DeSalvo, 1996; Cervero and Radisch, 1996). This is not simply because of a lack of interaction, but rather due to a lack of inclusion of the mode in designing research questions.

The relative ‘positioning’ of taxis between private and public transport has tended to reduce the consideration of the mode in a wider transport framework. This said, consideration of the economic, social and transport issues do occur, with regularity, even

⁹Based on a key word search, Elsevier identified 9 journal articles within the Science Direct catalogue pertinent to Taxi Regulation in the period since 1980, compared with 148 pertinent to bus or rail regulation.

if review of the structure of the mode is rather infrequent (see Stigler, 1971; Douglas, 1972; Coffman, 1977; OFT, 2003). Indeed, despite the absence of significant deregulation in the taxi industry as compared with other modes of public transport, the arguments to deregulate transport elsewhere may apply equally in the development of optimal service delivery in the taxi industry, inviting questions as to: How can the mode be best regulated? What are public interests in relation to the mode? How can public interests be best served in the supply of taxis? To what extent do historic and current approaches deliver, or fail to deliver, appropriate services at times of peaked demand?

1.5 History of taxi supply

Taxi supply and regulation has a long and pre-motorised history. An identifiable taxi service, individual vehicles plying for custom, can be traced to the 17th century, with the initial services comprising horse drawn carts, superseded by motorised vehicles in the 20th century (see PBS, 2005). The earliest legislation still current and operating today is the 1831 Hackney Carriage Act, which defines limits on quantity licensing (see Table 1.4). This sits alongside an extensive body of licensing regulation and controls established since the 1831 Act, which is cumulative and current.

Table 1.4 Significant Legislation affecting the UK taxi industry

Legislation	Status	Description
Hackney Carriage Act 1635	No Longer in force	Sets limits in numbers of taxis
Hackney Carriage Act 1831	In force	Sets limits on the numbers of licences
Town Police Clauses Act 1847	In force	Determines responsible authorities
London Cab Order 1934	In force	Determines quality controls (Metropolitan Conditions of Fitness)
Local Government (miscellaneous provisions) Act 1976	In force	Determines the role of Local Authorities in applying regulation
Civic Government (Scotland) Act 1982	In force	Determines the role of Local Authorities in Scotland to regulate quantity and price
Transport Act 1985	In force	Permits de-restriction of quantity control at the discretion of the Local Authority

Derived from Toner, 1992

In the same way, legislation was introduced in the United States during the period from 1920 – 1940, culminating in 1937 with the Haas Act, introducing quantity restrictions to New York (Schaller and Gilbert, 1996). A further ‘tranche’ of regulatory reform occurred in US cities in the 1980s (Frankena and Pautler, 1984; Teal and Berglund, 1987), in which 21 cities chose to move from restricted entry to free access. Of these, the majority have since returned to a form of regulatory control on license numbers, an example being the regulation of taxis in San Diego; first regulated in 1928, derestricted in 1979, and re-regulated by 1996 (see Table 1.5). From this evidence, it can be readily seen that within the structure of the US licensing system there are apparent fluctuations between restricted and free market approaches over time.

The changes appear to follow distinct patterns - flurries of regulatory or deregulatory activities, with a number of authorities following the same particular policy paths at the same time. Given the grouping of changes to particular times, it is appropriate to reflect on whether there are specific external factors significant to the direction of transport. For example, changes in provision in other modes, suggesting a cross-elasticity between modes, whether these changes are to be explained in terms of factors external to transport or visible in terms of prevailing economics, social or political pressures suggesting the significance of society on the supply of transport, as policy makers follow the lead of others. This issue cannot be resolved here, but the US patterns of regulation and de-restriction suggest that an awareness of social trends and movements in policy thinking aligned to transport is appropriate in understanding the adoption or abandoning of particular regulatory logics within the transport sector.

Table 1.5 Application of Taxi Regulation in US cities

City	Number of taxis	Form of Regulation(s)
Albuquerque	133	Entry Restriction, Quality Control, Cost
Baltimore	1151	Entry Restriction, Quality Control, Cost
Charlotte	450	Entry Restriction, Quality Control, Cost
Chicago	5700	Entry Restriction, Quality Control, Cost
Columbus	500	Entry Restriction, Quality Control, Cost
Dallas	1848	Entry Restriction, Quality Control, Cost
Denver	842	Entry Restriction, Quality Control, Cost
Detroit	1310	Entry Restriction, Quality Control, Cost
El Paso	250	Entry Restriction, Quality Control, Cost
Fort Worth	170	Entry Restriction, Quality Control, Cost
Houston	2067	Entry Restriction, Quality Control, Cost
Long Beach	105	Entry Restriction, Quality Control, Cost
Los Angeles	2084	Entry Restriction, Quality Control, Cost
Milwaukee	321	Entry Restriction, Quality Control, Cost
New York	12187	Entry Restriction, Quality Control, Cost
Philadelphia	1444	Entry Restriction, Quality Control, Cost
Portland	317	Entry Restriction, Quality Control, Cost
San Antonio	590	Entry Restriction, Quality Control, Cost
San Diego	870	Entry Restriction, Quality Control, Cost
Seattle	643	Entry Restriction, Quality Control, Cost
Indianapolis	398	Quality Control, Cost
Kansas City	360	Quality Control, Cost
San Francisco	995	Quality Control, Cost
San Jose	525	Quality Control, Cost
Virginia Beach	39	Quality Control, Cost

Derived from Price Waterhouse, 1993

It should be noted that the timing of taxi regulation and deregulation cycles as between the USA and the UK is not identical. The patterns differ, with US regulation occurring in the 1920s, deregulation in the 1970s and re-regulation in the period 1990 to 2000 (Shaw et al, 1983; Leisy, 2001). In the UK, however, taxi services have moved slowly following policy pronouncement, or not at all, from a regulated industry (legislation since 1831), to a mix of regulated and partially de-restricted services – in which an element of regulation remains, following the 1985 Transport Act (see: OFT, 2003).

In practice, there is a tension between policy pronouncement and guidance and on-the-ground arrangements. Whilst the OFT concluded deregulation in UK taxi licensing would

be in the public interest (OFT, 2003), this has not occurred in many local authority areas, with distinct and observable bias toward regulated metropolitan cities, and deregulation in rural locations (see Figure 4.1). Nevertheless, more recent government guidance (DfT, 2006) includes a call to renew consideration of the desirability of quantity restriction by ‘urging’ licensing authorities to consider ‘whether the restrictions should continue at all’ (p8 sect 29). As we have already indicated and shall see in more detail in later chapters, the taxi licensing authorities in larger cities of the UK has broadly rejected this call.

1.6 Outline of thesis

This chapter has introduced the key elements necessary to begin the analysis and evaluation of taxi delivery, and its (de)regulation, within the UK. The chapter has indicated that the relationship between taxi transport, licensing and regulation in British cities is significant to the delivery and optimisation of service to the public and to the form and development of the mode itself. The potential exists for areas of control to be assessed alone and without reference to other domains, and this may lead, as an unintended outcome, to a reduction in the effectiveness of the taxi itself. That the nature of the relationship between domains may also be affected by political, as well as social and economic, factors requires consideration and needs to be discussed in terms of the way in which these relationships may also act to reduce the effectiveness of delivery.

An emerging concept, therefore, is that the current nature of taxi controls may work against the public interest. The ability of the taxi to deliver appropriate services in the urban environment may be improved by defining stronger linkages between existing models of regulation and assessment (detailed in Chapter Five) and developing new models (detailed in Chapter Six) to take fuller account of the linkages between areas of regulation, their assessment and application.

Chapter Two presents a review of existing UK and international literature specific to regulation, transport delivery and application to taxis. The chapter identifies current theories and practice in regulation, in its application to transport and to taxi services.

Chapter Three presents the research methods used in determining the application of regulation, and methodologies used and developed in the thesis.

Chapter Four sets out the institutional and temporal context in which UK taxis operate, the nature of specific city operation and the social impacts of taxi transport in those cities. The chapter concludes by presenting issues arising in the provision of taxi services, and the nature of gaps or difficulties arising from that provision.

Chapter Five provides a more general analysis of regulatory structures in respect of taxi delivery. Chapter Six details the analytical modelling tools currently adopted in UK cities to establish levels of supply and tariffs appropriate to taxi services, identifies divergence between the modelling approaches adopted and the consequences of these differences for the delivery of taxis. It provides a prelude to Chapter Seven, which constructs a new model of taxi regulation and details the relevant sub-models necessary to operationalising the tool.

Chapter Eight details UK case studies of the application of the model. It details the results of applying the new model in key case study cities. Chapter Nine provide a conclusion to the thesis, explores the wider significance of the new model, and the case study evidence, for the institutional environment, and concludes the thesis with a summary of the main findings and indicates directions for further research.

To summarise, this thesis seeks to establish the most effective form of regulation in the delivery of taxi services in any given set of circumstances. The thesis seeks to define a model of delivery on the basis of survey and case study analysis. This builds on the existing methods of analysis by suggesting a series of linkages between domains, explored in Chapter Two, that are currently underplayed or ignored as a result of the separation of cost, demand and quality models and in specific city case studies, detailed in subsequent Chapters. We now move to Chapter Two where the literature is comprehensively reviewed and subjected to critical evaluation. In addition the main methodologies used are specified.

Chapter 2

Taxi regulation: literature review

2.1 Introduction: objectives of the chapter.

The objectives of this Chapter are to provide: a) review of the literature relevant to taxi delivery and taxi regulation, including a critical evaluation of this literature which identifies current gaps; and b) description of the models and sub-models used in the assessment of taxi supply.

The use of a city, its form, interaction and economic viability depend on myriad factors. These include economic stability, resources, employment and infrastructure, including transport. The latter, transport, is directly linked to many of the former elements, contributing to the ability of the city to function (Buchanan, 1963), and its residents to gain access to employment, goods and services, (Buchanan et al, 2006). The availability of transport contributes to the functioning of the city, giving rise to community/societal benefits where individuals are able to participate (Cole, 1986). Businesses also benefit from access to resources, including workforce (McQuaid, 2004), increased accessibility to the business, and ultimately the decision to locate. The resulting impacts of transport can occur in all areas of the city, and these will differ by location, but are most heavily concentrated on city centres, their vitality and individuals' participation in activities (Thomas and Bromley, 2000, p.1404). A separate literature exists in relation to the social interaction between city form and residential location decisions (Grubb, 1982; Thomas and Bromley, 2000) including the impact of 'flight to the suburbs and consequential loss of central activities. The Civic Trust (2006) has identified a counter trend of renaissance within the city, with increased opportunity across central locations as the centre itself benefits from urban renaissance.

In addition to its positive contribution, transport will also impact negatively on the nature of city functioning as networks become intrusive (Handy, 2003; Donaldson, 2006; Thomas and Bromley, 2000), and may contribute to community separation (Clarke and

Hutton, 1991) or affect ecological and physical environments (Guilliano, 1992; Litman, 2006). The urban environment benefits, therefore, from the provision of transport, but also, paradoxically, suffers from the effects of its presence.

The desire to limit negative impacts, and enhance the positive contribution of transport to its environments, has led to the application of regulation - typically statutory controls limiting activities felt to be negative (Turnbull 1999). Regulation affects all transport provision in some respects, an obvious example being emissions standards, but tends to focus on particular aspects in differing modes. Ison and Rye (2003 p223) identify government actions aimed at reducing demand for private transport as such (DETR, 1998), whereby a private vehicle's contribution to congestion and pollution is seen as an issue requiring a 'solution'. These issues lead to specific schemes (eg: the London Congestion Charge (TfL, 2001)), and lead to the development of new policies - and technologies - including road pricing (DETR, 1998; McQuaid and Grieco, 2006). Public transport regulation is also widespread, reflecting the desire to regulate for minimum standards of safety¹⁰, and in some instances to address particular issues in market operation (White, 2002). Other forms of regulation may include price control in some forms of public transport applied to some fares (eg: Saver rail fares). Occasional instances exist where quality controls also impact directly on other forms of control and may exist as substitutes. This includes the London Taxi 'knowledge', a test of driver awareness of London streets, which may also work to reduce the numbers of drivers entering the market.

Public transport provision is identified by some authors as a method in itself of reducing impacts arising from private car use, Romilly (1999, p.109) presents public transport as a method of reducing environmental costs, whilst Davidson and Knowles (2005) suggest that increased use of public transport increases overall sustainability. The ability of transport to contribute to sustainability is addressed by a number of authors, (Daugherty et al, 1995; Sinha, 2003) including the ability of public modes to permeate locations that are (and have become) difficult to access by private transport (Jepson et al, 1999).

Buses and, to a lesser extent, rail services have provided a focus for public transport options in addressing urban accessibility, and are widely considered in current literature

¹⁰ A description of PCV taxi tests is available at: <http://www.dvlni.gov.uk/commercial/taxi/service2.htm>

(Banister, 1998; Small, 2001; Cole, 1986). The same cannot be said for taxi services: often seen as a minority mode (Hu and Saleh, 2005), with such attention as is afforded being concentrated on taxi supply at particular issues, such as the lack of taxis, their price and, somewhat less importantly, their colour. This may be due to the relatively low attention given to the mode in terms of transport policy, but it is also a consequence of a regulatory anomaly in that the taxi mode is usually operated and regulated in a different domain to other forms of public transport. In the UK taxi control is addressed as a licensing issue, considered alongside liquor control (itself regulated in supply and hours and thus impacting on the use of transport), not as a part of local public transport. Academic literature relating specifically to taxis tends to concentrate (Cains and Liston-Heyes, 1996) on the application of regulation, rather than the wider role of the taxi mode and its contribution to public transport.

2.1.1 Historical perspective on taxi supply and regulation

Taxi services are (Section 1.3) a long-standing, well-established mode of transport. The activity of characterising taxi history until the present has mainly lain with the enthusiasts¹¹, and is largely limited to the design and historical landmarks in development. More detailed discussions of the impact of past regulation on supply are scant and detailed historical materials are not in evidence. This is not to say that there are not materials available within local authority archives and elsewhere that would convert into a detailed historical perspective, but simply to indicate in terms of a literature review that these materials are not yet present within the body of taxi scholarship. Nevertheless they remain significant to the shape and future delivery of taxi services as the legacy from which present forms of taxi regulation have evolved.

¹¹ See: <http://taxiworld.home.att.net/culture.htm>

2.1.2 Nighttime and daytime: differentiated economies

Chapter One introduced the argument that there is a need to differentiate between night and daytime economies in terms of taxi supply. This section explores the position of the literature in respect of this proposition and the support that may be derived for it, and this is further explored in light of comments from key stakeholders in Section 4.4.

Contemporary city literature (Thomas and Bromley, 2000; Civic Trust, 2006) suggests that the ability of an urban society to function at night, as well as during the day, has increasingly been seen as positive. The NTE activities provide an opportunity to transport but also a challenge resulting from a concentration of demand at points of limited supply. The emergence of vibrant and successful city economies for evening and nighttime entertainment has positive impacts on economic growth, and social inclusion; but brings with it a series of questions in accommodating, catering for and encouraging appropriate access to facilities (see: Roberts, 2006). In most cases and in most cities, the city renaissance reflects a successful nighttime economy that includes entertainment, dining and the consumption of alcohol, pursued in most instances without giving rise to difficulties. Residents and visitors both participate in leisure and social activities during evening and weekend nighttimes, contributing to the economies, and vibrancy of a city.

In a small number of cases, however, participation in the nighttime economy is accompanied by conflict (Roberts and Turner, 2005) - actual or perceived increases in the level of crime, and environmental impacts including noise and litter. The parallel emergence of conflict and fear in the evening and nighttime city limits public trust, adds to perceptions of fear among individuals including taxi drivers (Gambetta and Hamill, 2005). Particular issues expressed by taxi drivers include personal safety, and passengers' avoidance of fares. (Stenning, 1996). The presence of fear reduces the attractiveness of the location as a destination, and will ultimately threaten the activity of the city centre beyond the nighttime activities that have created it.

A number of reviews (Chatterton, 2000; Heath, 1997; Hadfield et al, 2001) make comparison between the activities of the city overnight and during the day, seeking to establish the extent to which a '24hr city' exists –where the same or similar activities

occur during the night as during the day. Others identify a city never sleeping as a goal of a cosmopolitan city, even being seen as attractors for tourism (Cooper, 2005). In reality few, if any, cities actually manage to replicate daytime activities into nighttime hours, and those which do may see the development as an economic imperative, rather than a matter of social desirability. More identifiable are a range of industries and activities maintaining 24 hour presence, or presence specific to the nighttime economy, ranging from business services in US cities (e.g. FedexKinkos) to the entertainment, eating and drinking apparent in the UK.

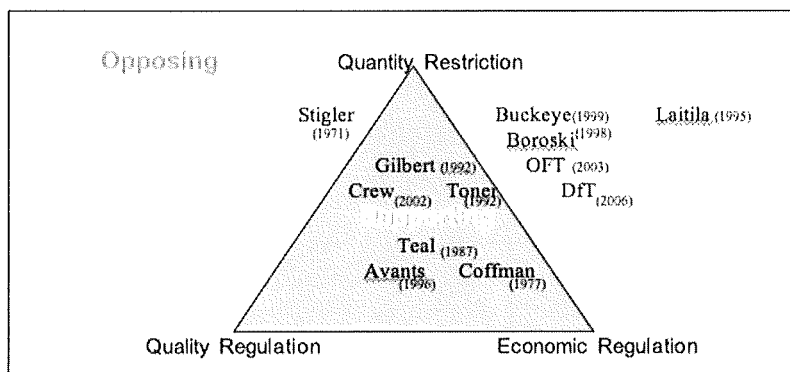
Societal constraints, most specifically the concept of 'normal behaviour', also act to reinforce a day/night split of particular activities occurring at specific times, suggesting that the concept of 24 hour office work is unlikely to be a significant part of the UK nighttime economy in the foreseeable future. This does not, however, preclude the growth of the NTE. Indeed, within the past decade or so, city centre activities have developed rapidly; increasing numbers of residential developments in city centres suggest an increased popularity of urban living (Myllyla and Kuvaja, 2005), characterised as the development of 'vibrancy' (Tallon and Bromley, 2004) in the context of 'urban renaissance'. Such vibrancy is, however, allied to new challenges – particularly related to alcohol related disorder and new policy questions in relation to strains on public services, including transport (ODPM, 2005&2005a; Myllyla and Kuvaja, 2005), and a related fear for personal security (DETR, 1998). As we shall see in later sections (see Section 4.3), the relationship between taxi use and the nighttime economy is a significant one. However, for our purpose here it is sufficient to indicate that the investigation of this relationship within the literature is scant.

To summarise, the balance of the literature in regulatory economics in relation to transport does not distinguish between daytime and nighttime activities. In pursuing this thesis we make such a distinction, and will address this more fully in respect of primary data in Chapter Four. However, for the moment, we turn to the mainstream discussion of regulatory economics as it relates to taxi functioning.

2.2 Regulatory economics

Much of the discussion surrounding taxi supply concentrates on the regulatory framework in which the mode operates, the main focus of the literature being the... *'long-standing debate...whether the [taxi] mode ought to or need be regulated by civic authority'* (Cains and Liston Hayes, 1996). As already indicated in Chapter One, it is possible to characterize the discussion in terms of two broad strands of thought - whether to regulate or deregulate taxi operation (illustrated in Figure 2.1). A detailed discussion of the literature follows from Section 2.4 of this chapter.

Figure 2.1 Overview of tensions within regulatory literature



Source: Author

Figure 2.1 illustrates graphically the separation of the regulatory domains and the cross section of support or opposition to regulation. For our purpose here we wish to note that the discussion appears polarised and can be presented in terms of all or nothing - regulated or free market supply - and, despite the simplicity of this exposition, disguises the reality that all markets operate under a level of control. At the very least, the application of regulation to the taxi trade should, therefore, address the question as to whether more regulated environments operate better or worse than less regulated ones.

Regulatory Domain / sub-domain	Application to Bus	Application to Rail	Application to Taxi
Quality / Safety / Accessibility / Appearance	PSV Testing* DDA ^{12*} DPTAC**	Railway Inspectorate* DDA* DPTAC**	PSV Testing* DDA** MCF ^{13***}
Quantity / Entry Control	(London) ¹⁴ (Northern Ireland) ¹⁵	Franchise	Restricted numbers of licenses issued in some cities
Economic Regulation		Increases in Single and Saver fare levels must be approved by Parliament	Maximum levels of Taxi Tariffs are set by all UK licensing authorities.

* Legally Enforced, ** Applied as guidance, *** Enforced in some cities

General pro-regulation arguments, as opposed to those specific to transport, suggest that regulation protects the public interest by controlling the excesses of companies in monopolistic positions, and may encourage supply at times of market failure (see: Crew and Kleindorfer, 2002; Posner, 1974). In contrast, free market proponents, such as Stigler (1971) or Baumol and Sidak, (1994) suggest that regulation works against the public interest by reducing the benefits to the consumer of a properly functioning market.

The discussion is deep rooted and has continued at regular, but infrequent, intervals. Posner (1974) suggests that taxi regulation should be instituted in the public interest. Crew and Kleindorfer (2002) go further and argue that control provides a particular form of protection of consumer interest reducing the risk of overcharging where market forces are restricted. Oversight of taxi fares, on the one hand, may, therefore, be a method of reducing overcharging – there being an implicit to trust the accuracy of fares and/or opportunity for redress. Controlled access may also represent (Niskanen, 2002) ‘a method of limiting natural monopolies in supply’. Lok Sang Ho (1993) considers the further issue that regulation is a requirement to alleviate external costs of operation, typically excess pollution, environmental or social impacts. Counter arguments relate to

¹² The DDA (1995) defines minimum vehicle accessibility standards and is applied in bus and rail transport. Taxi services are also included in the Act, but have not yet been integrated or application enforced. See: <http://www.dft.gov.uk/pgr/regional/taxis/taxiandprivatehirevehiclelic1792?page=2>

¹³ Metropolitan Conditions of Fitness (MCF) are applied in some UK

¹⁴ Entry controls exist in London in the form of additional driver testing (the knowledge).

¹⁵ Entry controls have applied in Northern Ireland.

intervention negatively impacting on the ability of the commercial concern to operate properly as a competitive entity - regulation introducing (Stigler, 1971) an 'element of political influence', expressed forcefully by Baumol and Sidak (1994) as imposing 'heavy social costs' as a result of 'governmental intrusion into pricing, investment and other such business decisions'.

In practice, intervention remains partial. The decision whether to regulate has followed prevailing economic and social policy and, in the UK, has resulted in periods favourable to regulation, and others favourable to deregulation (see table 1.3). In recent history - the period since 1980 - the UK has experienced a prolonged period of deregulation, referred to by some authors as a 'Deregulatory Movement' (Adler and Posner, 2006). The period is typified by the identification of inadequate investment and poor management in public utilities as being solvable by the introduction of private management and/or capital, and by market led competitive pressures resulting in a better service to the consumer (Glaister, 1991).

2.2.1 Market failure

Operation within a correctly operating competitive market can produce consumer price benefits but may also result in negative impacts, allied to *market failure* - a recognised concept (Lipsey, 1993; Cowan, 1992) in which the competitive market fails to allocate goods or services efficiently, and may result in their supply not fully serving the public interest. Market failure is identified in some instances of utility provision, and in the supply of transport, particularly where markets are insufficient to support commercial services, as is the case in some rural transport, or where the market is affected by other factors such as a lack of knowledge of alternatives, or an inability to choose freely at the point of use. Taxi markets can be identified as falling into the latter where a lack of ability to choose in an open market may exist at point of engagement.

Market failure is said to occur where the competitive forces do not act to ensure best value services (Bator, 1992). Aspects of market failure can be seen in transport in relation to: 1) Imperfect Knowledge, in instances where it is unlikely that a passenger has full

knowledge of prices in a competitive market, controls may be put in place to legislate for price charged at point of use. 2) In relation to: Quality and Safety, where issues of safety are taken as pre-requisites to operation, it is not appropriate to require passengers to confirm levels of safety prior to commencing journeys (Cooper, 2003). In most instances the intending passenger neither wishes, nor is competent, to assess vehicle safety. In such situations statutory levels of control are required. 3) In relation to: market entry, the perfectly competitive assumptions that entry to and exit from the market can be achieved without cost does not, in reality, hold in the supply of transport. Failures occur where entry to the market distorts supply, in both instances of oversupply and lack of supply. Regulations affecting entry can impact on ease of entry, achieving or restricting contestability. 4) In relation to: Market Sustainability, classic market economics distinguishes between the operation of a market in the short and long terms. In the short-term, market fluctuations are normal, and indeed represent a function of the market in operating to match supply to demand. Where regulations are being developed or revised, it is the long-term impacts of a change in regulation that will ultimately determine the success or otherwise of any change. This can clearly be seen inside taxi supply.

Crandall (2003), discussing market failure and commenting on deregulation in US energy supply, suggests that ‘despite its enormous success, the deregulatory movement may be stalled and even subject to reversal’. Improvement in environmental impacts may also not be fully achieved where changing external expectations impact the market in which companies operate.

At the individual level, consumer benefits, particularly those in relation to cost savings, may not be fully realised. Despite movement in privatised utilities from single tariff to a wide array of pricing structures – an early outcome of utility privatisation in the UK (Milward, 2006) – consumer choices appear to remain tied to traditional or known supply. Where customers ... *‘prefer not to choose, opening regulated markets can reduce welfare, even for some of the consumers who do switch, as the incumbent can exploit this preference by raising price above the formerly regulated level.’*

2.3 Regulation in the transport sector: setting the context for taxi services

Deregulation and liberalisation in the transport sector has followed trends in other public utility services (see: Maunder and Mbara, 1996). Airline deregulation in the USA removed many of the long standing arrangements between carriers, producing free(er) entry within the US market (Goetz, 2002; Creel and Farrell, 2001). Land based transport has also moved from controlled to more open markets, following US liberalisation of freight, and more recently deregulation in the UK Local Bus market (Transport Act 1985), and British Railway (Railways Act 1993) markets.

A review of the contemporary literature, both that proffered at the time of and post- each change in transport regulation, provides insight into the evaluations of the effectiveness of the existing structure, the factors resulting in the perceptions of the need to change, and also of the prevailing thinking of the time. Regulation was applied to the US road freight regulation under the 1935 Motor Carrier Act, as an attempt to address destructive 'ruinous' competition with the market. 45 years later the same market was deregulated under the Motor Carrier Act (1980) in an attempt (Krol and Svorny 1994) to reduce freight rates in interstate trucking. European regulations in the same area identified the same issues, 'between 1930 and 1990 [state] diagnosis of problems (impacts of competition in market failure) ... was defective and that the corrective measures applied probably did more harm than good.' (McKinnon, 1996) The European experience of regulation had, according to Adrangi (1995), stifled productivity growth, technological innovation and efficient management.

Public transport has also followed a similar path, moving in and out of regulation over time (see Table 1.3). The supply of rail services in Great Britain moved, as a result of the 1921 Railways Act (the Groupage Act), from many small operators, to a group of four mainline companies (large natural monopolies) and, following the Second World War, to a single national monopoly – British Rail.

Deregulation followed, in the US as a result of the 1980 Staggers Act, and in Great Britain as a result of the 1993 Railways Act. For a time, the presence of a large rail monopoly appeared to contradict the logic of deregulated provision in other areas of transport, most particularly local bus services which were deregulated under the 1985

Transport Act in England and Wales. Shaw et al (1998) suggest that the last stage of UK rail deregulation has only been successful in achieving a 'broadly similar organisational outcome to that intended by the 1921 Act'. Bus deregulation has also received a mixed reception (Bly, 1987). Deregulation supported on the basis of delivering lower fares and higher service frequency, may in reality impact negatively by reducing service levels away from core service areas (Brake and Nelson 2006).

2.4 Regulation in the taxi sector and the identification of issues specific to the taxi mode

The basis for regulation and its effect within the UK taxi industry reflects many of the concerns arising in other areas of transport provision. And yet the taxi mode operates under a very different set of rules and requirements than its bus and rail counterparts. This may reflect a significantly different history to the development of bus and rail transport, but may also reflect the fact that much of taxi control predates the development or widespread use of other forms of public transport, with taxi regulation dating from 1636 (see table 1.3), comparable to the first London omnibus entering service in 1829 (motor-buses from 1899, and regulatory control of buses, the London Traffic Act, from 1924). The mode also differs significantly in that its provision in the UK has never involved government directly as a transport supplier, rather as regulator of (many) private operators.

Many of the underlying issues affecting taxis do, however, mirror issues seen in other modes. The use of price control to avoid exploitation *at point of use* is applied in the taxi industry throughout the UK, and can be seen in other transport modes, most particularly in the determination of (some) rail fares – the definition of 'capped fares' is set out in the Railways Act 1993. Quantity controls exist in some taxi fleets, and reflect concerns about 'ruinous competition' also observed (McKinnon, 1996) in relation to the road freight market. Quality restrictions also exist, in taxis in terms of vehicle age and appearance, applied in some authority areas, and in terms of vehicle safety, applied in all¹⁶.

¹⁶ All authorities apply a motor vehicle test to taxis operating in their area (an example of governing legislation is set out in HM Government (1996a). Some authority areas also apply driver tests, including the London 'Knowledge' test. (See DVTA, 2007).

Identifiable taxi regulation in the UK dates from the 1636 Hackney Carriage Act, and is still controlled, in part, by the 1847 Town Police Clauses Act, a regulation specific to the application of licenses and control by local (town) police, and local authority. US taxi markets similarly reflect long-standing traditions in supply regulated on a regional basis. Early regulation appears to date from the 1886 Chicago ordinance requiring taxi bonding - a form of insurance against passenger claim, followed in many areas by requirements for taxi bonding and the display of fare tables in vehicles - an early method of reducing overcharging; culminating with the 1937 Haas Act, applied in New York. Gilbert and Samuels (1982 p66) identify consistent approaches to entry regulation in many parts of the US from the 1920s, as addressing issues of 'ruinous competition' prior to this date. Philadelphia introduced quantity restriction from 1920, in part as a method of addressing negative impacts of 'conditions caused by the Depression' ... during which time... 'cheap entry creating unstable market conditions' (Ogus, 2002 p38), a similar argument to that used in the regulation of rail services in the UK at the end of the First World War (Shaw et al, 1998, p38).

Changes in the structure followed only slowly, deregulation being introduced in a number of US cities in the 1970s and 1980s, and in the UK as a result of the 1985 Transport Act. The '85 Act being primarily intended to introduce deregulation in the English and Welsh bus industries, also allowed for the partial deregulation of entry restrictions in the taxi industry, though uptake of the de-restriction has been slow (Toner, 1992; OFT, 2003). Toner (1992) noted that by 1991 only 28% of local authorities had removed entry barriers, the figure advancing to 55% by 2003 (OFT, 2003) representing, according to the OFT a 'majority' of local authorities, despite some confusion over the definition and counting of authority areas - the OFT mistaking Northern Ireland's single taxi authority for its 26 districts (which have no taxi licensing powers), and making a similar miscalculation in London - see Figure 4.1. Although it should be noted that this description may also be misleading in the basis that the majority of metropolitan areas have maintained restrictions, with the greater extent and volume of taxi use remaining within areas applying forms of restriction to entry.

Taxi regulations and de-restriction remain controversial and polarised in practice and in assessment. The US examples, dating from the early 1980s, demonstrate the extent of the

disagreements between proponents of and opposition to regulation or regulatory reform. Reviews prior to US de-restriction tend to concentrate on the ability, or otherwise of the open market to be competitive, with Shreiber (1975) suggesting that an open market would often lack conditions approximating a competitive market. Abolition of the restricted entry requirements - Medallion Caps (see: Tiwari, 2005) would 'increase congestion and pollution and attract more passengers away from public transport'. Douglas (1972, p 127) suggested that the *cruising taxi market* - the market for taxis hailed on street - prohibited efficient comparisons of price, the result being 'that the price generated by competitive equilibrium may be inefficient...'. Proponents of deregulation suggest that the industry structure was such that there was 'little doubt that a taxi industry would approximate the characteristics of perfect competition' (Beesley, 1973), with Coffman (1977) identifying that price competition [would] exist in the deregulated taxi market, and in relation to particular market segments where, taxi ranks (stances) would benefit from price competition (Williams, 1980 p106).

Though not entirely mutually exclusive, the discussion between viewpoints became quite significant and heated, with a series of papers, reviews, comments and rejoinders appearing in the *Journal of Transport Economics and Policy* (see: Shreiber, 1977). The intensity of positions did not appear to ease post-deregulation, with continued discussion immediately following US de-restriction, and since, though many present specific issues of dispute arise within the application of the new dispensations (Choong, 1998). Teal and Burgland (1987) suggest that some level of restriction is necessary to guarantee the efficient running of the market, phrased by the UK Department for Transport (DfT, 2006 p2) as a role 'of licensing to protect the public'. Gilbert and Samuels (1982, p147) suggest that the 'process of regulation is time consuming and expensive, and therefore a cost that could and should be avoided'. This represents a level of pragmatism, combined with the, realistic concern that entry 'barriers reduce the ability to [enter freely and]... thus promote illegal operators (Buckeye, 1999). The argument is affected by the fact that some of the initial claims of open market competition were blunted by an apparent lack of price effects (Hackner and Nyberg, 1995), identified by Dempsey (1996) as a 'failure to achieve the outcomes...' or to 'match expectations established in the lead into [US] deregulation.'

Many of the differences in approach, and support for regulation or de-restriction, may actually relate more to the methods of control, rather than total support or opposition for regulation *per se*. Many of the positions adopted appear more absolute than they may in fact be. This over-identification of positions within the literature, allied to the positioning of industry and politicians to represent all or nothing formulations of options, may obscure the reality that regulation exists across differing domains, and indeed allied to the differing uses of taxis (Hu and Saleh, 2003). Apparent differences in respect of the desirability of regulation need not hold across all domains, for all uses or at all times, with apparently contradictory analysis referring to specific elements of control rather than to its entirety.

Taxi controls can, as we noted earlier, occur across three domains, Quantity, Quality and Economic regulation (QQE), and apply across a strata of different supply, including ranking (stance), cruising (hail) and pre-booked markets - with each market segment affected differently by competition (OECD, 2005) and reacting differently to regulation. Moreover, some areas of cross-over between taxi and bus, including Demand Responsive Transport (see Brake et al, 2004), and in relation to competition from unlicensed or Gypsy Cabs (see Holt and Paradise, 2000), present new challenges not fully considered within the current regulatory structure. Indeed current regulatory forms may act to limit or prevent the development of 'crossover' taxi/DRT modes, (see Scottish Executive, 2006).

2.4.1 Quality regulation

Surveying the literature, the idea of controlling vehicle quality tends to attract the least controversy, and is often included as a necessary form of control, even by those seeking wider taxi deregulation (see OfT, 2003). Quality regulation affects vehicle safety, vehicle type, and vehicle quality, and is usually argued as positive (Teal and Burgland, 1987 p37). The concept is widely applied in relation to vehicle safety in other modes, but should also be identified to include other areas of quality control in the taxi industry, including setting vehicle type and age limitations. The latter is applied differently in different locations within the UK, whereby local authorities maintain 'a wide range of

discretion' over the types of vehicles operating (DfT, 2006). In practice a wide range of standards are applied, with some authorities specifying conditions only met by purpose built vehicles, the impacts of which reach beyond the domain of quality regulation itself, and impact on the economics of the industry. Similar linkages may also exist between applications of quality controls specific to the UK Disability Discrimination Act 1995 (DDA) economic viability, given the higher price of accessible taxis, and on quantity controls, in so far as some authorities imposing quantity controls have allowed unrestricted access to DDA compliant vehicles (see: Dundee, 2003)

Accessibility (as defined in the DDA, 1995, Section 50) has also emerged as an area of interest in its own right and applies to taxis as to other forms of transport. A significant amount of literature addresses principles of accessibility; 1) in transport (Fielding, 2005; Oxley and Richards, 1995; Oxley, 1999), 2) on social inclusion (Gannon and Nolan, 2007), and 3) on wider policy issues including documents and guidance focusing on the requirements of the DDA in design and delivery of services¹⁷. The Acts seek to ensure equality of treatment, the first Act (DDA, 1995) addressing rights to access goods and services by determining access standards and the second (DDA, 2005) in removing policy and corporate barriers and making discrimination unlawful.

The impacts of (a lack of) access is addressed in a number of texts related to the personal and societal impacts where access is reduced, which can include social exclusion (see: Farrington, 2007), with links between this and the a lack of transport (Handy and Niemeier, 1997; Church et al., 2000), and by logical extension, where transport is provided, exclusion may be reduced (Lucas, 2006; Preston and Raje, 2006). This is balanced against the access needs of different groups, and in particular to those where traditional transport may pose additional difficulties (Lewis et al. 2005), which may result from changes in the levels or nature of transport provision, the availability of a particular vehicle type or a reduction in the service level to those requiring accessible vehicles resulting from changes in transport provision (see: McDonagh 2006). This raises a question of equal rights of access, both apparent and logically required to reduce discrimination and, while most locations and services can easily be made to be accessible, not all can. Policies promoting inclusive access may often lead to a discussion of costs, impacts and 'proportionality' (Oxley and Richards, 1995), with many changes to

¹⁷ See: http://www.direct.gov.uk/en/DisabledPeople/RightsAndObligations/DisabilityRights/DG_4001068

transport infrastructure limited by views as to what is practical or reasonable – a result of the use of the wording ‘reasonable adjustment; in the Act itself (Shaw Trust, 1999; OECD, 2004). This approach, which seeks to balance what is ultimately desirable against what is achievable from existing infrastructure differs significantly with approaches adopted elsewhere, most particularly in the United States of America, where access to appropriate transport is set out in the Americans with Disabilities Act (ADA, 1990). US travellers with disabilities have a right to separate accessible provision operating along the same routes as public transport, a parallel but separate service¹⁸, contrasted to the UK seeking to accommodate all users in the same vehicle.

2.4.2 Quantity regulation

Of all the forms of control, quantity regulation provokes the largest extremes of opinion. Quantity controls exist as restrictions on market entry and are common in many UK metropolitan areas, and across larger US city administrations. The presence of upper limits on the numbers of licenses issued is justified, where caps exist, on the basis of addressing market failure, see section 2.2, and in some instances on the basis of comparative quality levels in regulated vs. deregulated environments (see: Toner, 1992). Open market access had led, in some US cities, to destructive competition (Gilbert and Samuels, 1982), but is more likely to continue on the basis that its alternative, open market entry, has not delivered the range of benefits initially anticipated in deregulating US markets (Toner, 1998).

In the UK, the DfT identifies open market access as a preferred route, but also acknowledges that local factors affect the choice between controlled and open market access (DfT, 2006). The Department also sets out guidance on the justification for maintaining restricted entry, which is permissible where local authorities are able to demonstrate that no Significant Unmet Demand (SUD) exists. SUD measurement is, therefore, of major concern in authority areas choosing to maintain restriction, and of equal concern in areas where pressure exists to remove restriction (see Chapter Five). The

¹⁸ADA transit in the USA is referred to as ‘Paratransit’. See: www.fta.dot.gov/civilrights/civil_rights_2360.html

need to measure SUD has, in turn, led to the development of detailed methodologies commonly applied in UK cities.

The arguments for and against quantity regulation revolve around the ability, or otherwise, of an open market to deliver services appropriate to demand. Importantly, peaks in demand for taxis differ from other modes and, in large cities, are concentrated on return journeys from entertainment on Friday and Saturday nights (see section 4.4.2). Substantial and opposing arguments exist in relation to the ability of the market to deliver at this point, with impacts on the total market of excessive supply, and some evidence suggests increased taxi license numbers may not lead to greater cab shift availability – the observation that not all new licenses result in linear increases in vehicles plying for hire.

Regulation also appears as an issue in other European countries and elsewhere; Marell and Weston (2001) address issues of regulation in Sweden, Gaunt (1996) looks at New Zealand, and the Industry Commission (1994) at the impacts of reform in Australia. The impacts and analysis of non- UK or US regulation reflects the issues discussed in both the UK and USA. The impacts of reform being taken up in this thesis, applied in developing a new model form, extend existing concepts in British cities. In addition to the research reviewed above within the field of UK taxi studies within the UK there is a body of work undertaken by this researcher as commissioned studies. These studies provide, in part, the primary data for this thesis and can be summarised as contributing to the literature in respect of quantity, quality and economic control of taxi supply. The studies develop from an initial review of tariffs in Edinburgh (Cooper, 2003a) based on pre-existing approaches to cost models, to include more a detailed review of the regulation of taxis (Cooper, 2003). More detailed studies of the structure of regulation in the supply of taxis in Northern Ireland (Cooper, 2004a), and the impacts of supply of taxis in the Nighttime Economy (Cooper, 2005) have prompted the development of new approaches to taxi models, applied in the cases of West Dunbartonshire (Cooper, 2006) to the determination of accessibility, and in Glasgow (Cooper, 2006a) in relation to impacts of cost. Our purpose here is not to review our own work but rather to indicate that it is an existing part of the UK literature on taxi studies.

2.4.3 Economic regulation

A second area of control courting less attention than quantity controls, *economic regulation* is most commonly applied, in the UK, as a limit to the fares that may be charged for journeys. The control of fares is the most long-standing of all controls applied to taxis, being included in the Chicago statutes of 1886, and in the provision of UK taxis from the very first regulation (Hackney Carriage Act 1636), as a method of reducing the occurrence of overcharging on the part of unscrupulous taxi drivers. More recent literature relates economic control to the functioning of the market, with Schreiber (1975 p270) suggesting that 'unlike atomistic markets, a taxicab market... will seldom give rise to price competition' (Williams, 1980, p.106). Though this particular view is questioned by a number of authors (see: OFT, 2003), the need for a maximum price is advanced by many, including the OFT, who identify the control as an upper limit and not affecting the possibility of competition below the set rate. In this respect different authors identify the possibility for price competition to vary by market strata, being more possible in some circumstances than others.

In the UK, the current dispensation to regulate fares arises from the Local Government (Miscellaneous Provisions) Act 1976¹⁹ and responsibilities lie with local authorities to apply and set fares. Almost all UK authorities choose to regulate Hackney Tariffs, and many follow a consistent methodology, identified by some (including Glasgow and Edinburgh) as a taxi tariff model. As with the application of quality control, linkages do exist between the application of economic regulation and other elements of control. This indicates the necessity of considering the issue of *economic control* with other forms of control, rather than in isolation, which is, as we have noted, the current practice in most UK authority areas. Put simply controls on quality have consequences for the economics of running a taxi and these must be considered together.

Although less controversial in public discussion than quantity control, links between economic regulation and market structure are important. Economic regulatory arguments are of significance to the application of price control, and the understanding of linkages between regulatory domains important. Shreiber's view (1975, p20) that the taxi cab market rarely gives rise to price competition is appropriate to the determination of fares,

¹⁹ Mirrored in legislation in Scotland and Northern Ireland

but also significant in that it implies that a free 'open market' might not result in the accrual of benefit to the extent suggested. Unsurprisingly opposition to Shrieber's contention exists: Coffman (1977, p.289) rejects Shreiber's argument on the basis that "Schreiber's rejection of the competitive model is only a priori and is unsupported by any testing of the predictions of the competitive model' and would not be borne out in practical application. Schaller and Gilbert (1996) add further caution that price competition may not in itself suffice to ensure efficient pricing. As we shall argue in the course of the thesis the enforcement of some regulation may, indeed, benefit the public.

2.4.4 Critical appraisal of the literature

Preceding sections have summarised the main thrust of the literature as it is relevant to the major arguments of this thesis. Despite the significant impacts of taxi services on individual access, the mode appears underrepresented in the body of transport literature, and isolated in the discussions of method of control and provision applied to it vis-à-vis other transport modes. We have seen that the application of regulation affecting the taxi industry tends to be considered separately and away from the transport mainstream, which may result in a lessening of the potential benefits from regulation applied to the taxi.

The development of taxi control and licensing presents a significant history in the development of regulation. The balance between a desire to expand, and a need to control in order to mitigate harmful impacts of operation, and account for issues surrounding market failure or market exploitation have shaped the form of regulation. Although, as we shall see in subsequent chapters, there are many local interpretations of appropriate taxi regulation, taken broadly, the control of taxis in the UK appears from the literature to be well established, widely recognised, and consistent in methods of regulation. Three domains are apparent, restrictions on the numbers of vehicles, their quality, and price of use. The assessment of at least two of these areas appears, specific to the UK market, to follow consistent methodologies. The longevity and apparent consistency within the market does not, however, equate to a lack of interest in change in the application of regulations. Recently, for example, the OFT (OFT, 2003) has been

concerned about the impact of quantity controls on the interests of the travelling public and with other concerns relating to the appropriateness of existing balances between the domains of regulation.

Having reviewed both the general literature on regulation as it relates to transport and the specific literature on taxi regulation, we now turn to a preliminary evaluation of the models – and sub-models - used in the regulation of taxi delivery. This is then followed by a description and justification of the methodologies used in this thesis (Chapter Three), and followed in subsequent chapters by contextualisation (Chapter Four) current use and development potential.

2.5 Methodological literature

It is also significant to address the approaches contained within the standard ‘taxi review’ – presented as a generic name (Halcrow, 2002) for taxi assessments as required within the current legislation. Such ‘reviews’ build on standardised ‘models’, considered in detail in Chapter Four, to provide an indicative level of supply, discussed in section 2.6. While such models are common and in general use, their underlying methodologies, methods of data collection, use of observation, etc., are significant to their outcome and these should themselves be the subject of analysis.

Most current models are based on the use of an observation survey, a long standing tool (Ellwood, 1933) applied in social analysis, in transport and logistics (Lam et al, 1999), and used in the taxi review to establish delays at stance (Halcrow, 2002). Observed delays, and the gap between observed passenger demand and observed vehicle supply form the basis of the modelling tools discussed below. These do not, however, fully address all of the issues of demand, including the measurement of latent demand, discussed in Chapter Six, and the identification of linkages between regulatory domains. Indeed, many of the ‘reviews’ undertaken have failed to fully account for these and this may represent a significant gap in the current state of practice (DfT, 2006). Alternative methodologies do, however, exist, appropriate to the identification of the wider demand for taxis and include the use of questionnaire survey by various means in the identification of demand previously hidden, and in the identification of factors affecting

supply that would not be immediately apparent from observation alone. Substantial and substantive texts relate to the methods by which questionnaire surveys may be best approached (Yin, 1984), and addressing the combination of quantitative and qualitative data in a mixed methods approach (Daganzo et al., 2002). More specific approaches to stakeholder analysis - the need to determine a cross section of interest and impact (Brugha and Varvasovsky, 2000) - are also identified and applied in the development of a broader methodological approach than used thus far (and are detailed in Chapter Three).

2.6 Models and analysis pertinent to taxi regulation: assessment types and practices

This section provides a preliminary introduction to the analytical models used in the regulation of taxi delivery. The modelling of taxi services has generally emerged as a systematic approach to particular issues in supply. The SUD model, a consistent and 'standard' approach – that used by the majority of authorities – provides a methodology to determine presence of SUD. Cost models also exist and are applied to the determination of fares in some cities, however, these do not share the levels of consistency of the SUD model. While the term 'model' may also apply to identifiable forms of application, it is distinguished here to relate to analytical approaches.

To begin, two key models with their individual elements of assessment can be identified (DfT, 2006) and are applied by licensing authorities as standard practice:

- where Quantity Control is applied, the assessment of Significant Unmet Demand is utilised, and must be undertaken at frequent intervals²⁰.
- where Economic Controls are applied to fares, a cost model yielding an assessment of changes in the costs of operation is utilised (see section 6.3).

In the third regulatory domain of quality, quality controls are applied in the form of vehicle roadworthiness, although these are typically not addressed in council led review.

²⁰ The frequency of licensing reviews is open to interpretation and is based on the currency of the last model run. (See: <http://taxi-driver.co.uk/phpBB2/viewtopic.php?p=32229>)

2.6.1 Impacts of individual assessment

As we have already indicated within the UK taxi industry, the individual elements of control (QQE) tend to be assessed separately without reference to their linkages (see Halcrow, 2002). For example, SUD analysis, which comprises a number of elements specific to consumer choice, but does not take account of the effect of changes in costs of operation or the prices charged in using a taxi. Similarly, cost models, which relate to a number of factors including the effective incomes of drivers, include assumptions about numbers of vehicles without further reference to Quantity Regulation. The significance of quality regulation, beyond the implicit requirement for vehicles to be safe, is not directly addressed. However, the impact of a determined maximum age of vehicles is likely to be felt in the costs of operating a vehicle, the resale value (if any), and the method for accounting for depreciation.

The separation of the existing modelling elements by form of regulation fails to take account of the linkages between these elements, and this is likely to affect the ability of the model to deliver an optimal solution across the differing domains. Individual models may also reflect shortfalls and gaps resulting from a number of assumptions in their design, and in their application.

2.6.2 Current definition and use of the Significant Unmet Demand (SUD) Model

Under current practice, the analysis of Quantity regulation of taxis is based on models of Significant Unmet Demand (SUD), the identification of significant numbers of potential taxi trips not being met from an existing fleet (section 6.2). Guidance for the parameters of the model are included in the DfT best practice guidance (DfT, 2006), and have been traditionally based on observations of queues (Halcrow, 2002) and the interpretation of impacts on those queues of a change in the size of the taxi fleet. The existing models are limited by the assumptions they make and the extent of the measurement that is undertaken, (Chapter Six). The observation of queues is relevant to the identification of unmet demand but, most importantly, is rather limiting as it fails to address issues of suppressed or latent demand – where the production of a journey is limited by the

(perceived) lack of appropriate transport. The methods adopted are also limited by the extent of assumptions made in the behaviour of individuals at queues – which may include but not account for unruly behaviour or ‘queue creep’ (see Chapter Eight), the behaviour of taxis at stance (taxi drivers are not obliged to pick up passengers), and the pattern of arrivals in the wider city area, which may include but not account for uneven arrivals and/or favoured stances.

Existing assumptions include:

- Stochastic arrival – an assumption that vehicles arrive at stance randomly,
- limitless capacity at stance,
- even application of new taxi arrivals across all locations.

As we shall see within our case study evidence (Chapter Eight), and most particularly in the material from Glasgow, these assumptions are not borne out in reality and may have the effect of misrepresenting the extent of SUD as the measurement at some stances will be atypical of demand at others. It is further observed (Halcrow, 2002) that existing models make assumptions about what constitutes delay. Reasonable expectations of delay differ across differing time periods, although the identification of expectations, and delivery against differing expectations is not included in the existing framework.

2.6.3 Cost models

Fewer authorities adopt a consistent method of determining costs than they do a consistent SUD model (Section 3.3). This may in part be a result of the predominance of one model type (that used in SUD analysis) but also a result of differing approaches to the triggering and completion of tariff updates. Never-the-less a distinct pattern is observable in the approaches adopted across many UK cities, see Table 2.2.

Table 2.2 Approaches adopted in cost models in UK cities

Cost Component	Approximate frequency of inclusion
n=21	
Vehicle Purchase Price / Depreciation	18/21
Parts used in maintenance	16/21
Labour costs in maintenance	15/21
Fuel Costs	21/21
Cost of insurance	16/21
Subscription to Radio Ring	4/21
Consideration for 'knowledge'	1/21
Social Cost	1/21
Miscellaneous	1/21
Environmental Supplement	1/21
Specified Driver Wage	3/21
Earnings (not as wage)	5/21
Profit take	Proposed in 1

Source: Cooper (2006) Survey of 21 locations: March 2006

2.6.4 Inclusion of quality controls in taxi models

As already indicated above, within existing standard practice, in SUD and cost modelling, there is no direct consideration of the impacts of quality controls, such as determining a fixed fleet age. The effect of such stipulations is, however, pertinent to the design and accuracy of such models. As can be seen from this short review of assessment practices, there is space in modelling terms to remedy the deficiencies in existing practices and to better review and integrate the linkages between the various modes of control.

2.7 Conclusion

While taxi services are an established and consistent form of transport, the structures in which they are supplied and operate continue to cause controversy and differences in

opinion. Theoretical and practical methods of regulation, and the measurement applied to that regulation, differ between two distinct camps that can be broadly described as pro-regulatory or de-regulatory. In addition the measurement, in the UK, of a demand based threshold on which quantity control may be justified, and models applied to the determination of other forms of regulation, appear to follow isolated patterns and fail to fully identify the actual conditions in which taxis are provided.

Both the conflict and vehemence of positions taken in relation to regulatory control, and the potential need to rethink models applied in the determination of that control support a need to investigate the practical methods by which taxi services are provided in UK cities.

The following chapters outline a method by which the study objectives may be achieved, being aware of the range of literature and current state of the art in some areas of taxi supply analysis. Chapter Three sets out a detailed methodology building on the strengths of existing approaches, and in light of a significant range of stakeholder analysis as detailed and expanded upon throughout the remaining thesis, which critically assesses existing approaches building on their strengths and compensating for their existing weaknesses through the utilisation of a significant level of stakeholder analysis that is then detailed and applied throughout the thesis. Chapter Four concentrates on context and local structures, drawing out experiences described within the literature and explored in this chapter, and identifies the institutional context and local structures within which taxi regulation relating this to the existing academic literature and the pattern of existing industry practices identified above. Later chapters detail the need and potential for further model development and include, in Chapter Eight the application and testing in case study cities.

Chapter 3

Methodology

3.1 Introduction

This thesis seeks to develop a consistent approach to determining the effects of regulation on the supply of taxi services. In doing so, it makes use of multiple methods appropriate to the objectives of cross regulatory analysis (QQE) as set out in Chapter One. These include Stakeholder Analysis, a technique addressing the needs, and impacts, of a project on its stakeholders (Mitchell et al, 1997), making use of focus group and public surveys (see: Yin, 1984), and observation at stance. These approaches build, and expand, upon previous methodologies used in the supply of taxis survey – ‘taxi review’²¹ (see Lam et al, 1999 for examples of observation surveys in transport analysis). A schematic illustrating the applied methodologies is provided in Figure 3.1, below. The research methodology has followed a developmental approach, being conducted in a number of stages, but has also allowed for iteration between stages as led by the findings of the surveys and time constraints resulting from differing opportunities for data collection. Data has been collected over a number of periods within the thesis, but has sought to maintain validity and comparability by avoiding temporal differences, using a 24-hour approach to observation, and data consistency, using standard criteria in observation location selection.

The research included a range of stakeholder analyses, informed in their design by existing literature, and undertaken to identify the effectiveness of current approaches to taxi supply, its control and licensing, and shortfalls experienced by its users. Figure 3.2, and detail set out in Table 3.5, highlight the timelines of the various elements of research, and illustrate the interaction between the methods chosen. Key interactions exist between the methods chosen to establish a local authority perspective, reported practice, and a review of needs reported by passengers (and potential passengers). The thesis built on

²¹ The term taxi review is commonly used in existing practitioner literature and is referred to by respondents throughout the surveys of local authorities completed as a part of this thesis.

stated needs and gaps in the development and revision of existing practices, and was primarily focused on the operation of a ‘standard’ model, with the aim of delivering and testing enhancements to the state of the art. The final method, the case study approach, tests the new model ‘in-situ’ using live data from Glasgow and West Dunbartonshire.

The following sections of this chapter define the methods used in more detail, their contribution to achieving the research objectives, and provide a critique of their use and effectiveness.

Figure 3.1 Survey Flow chart and Linkages

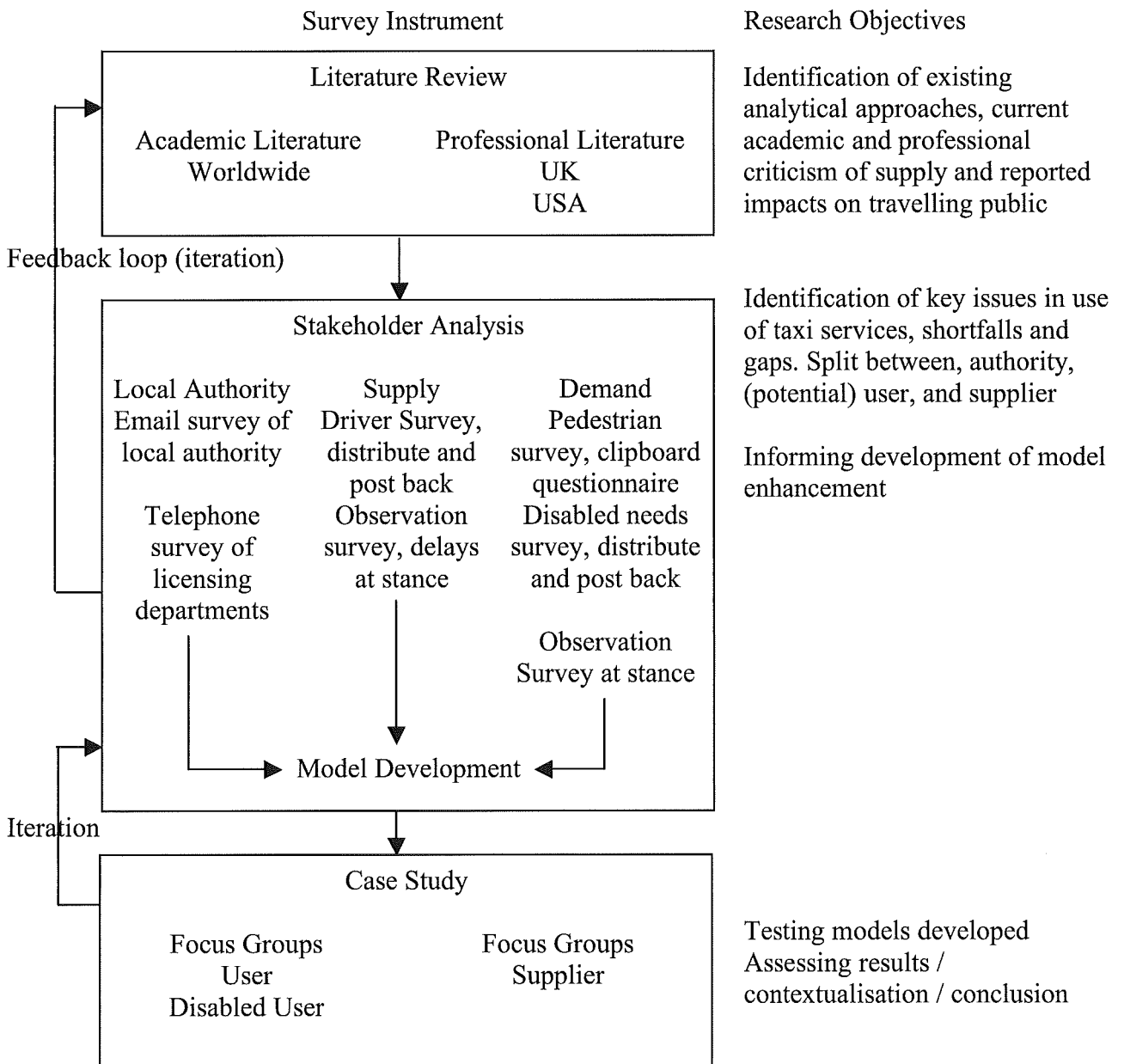
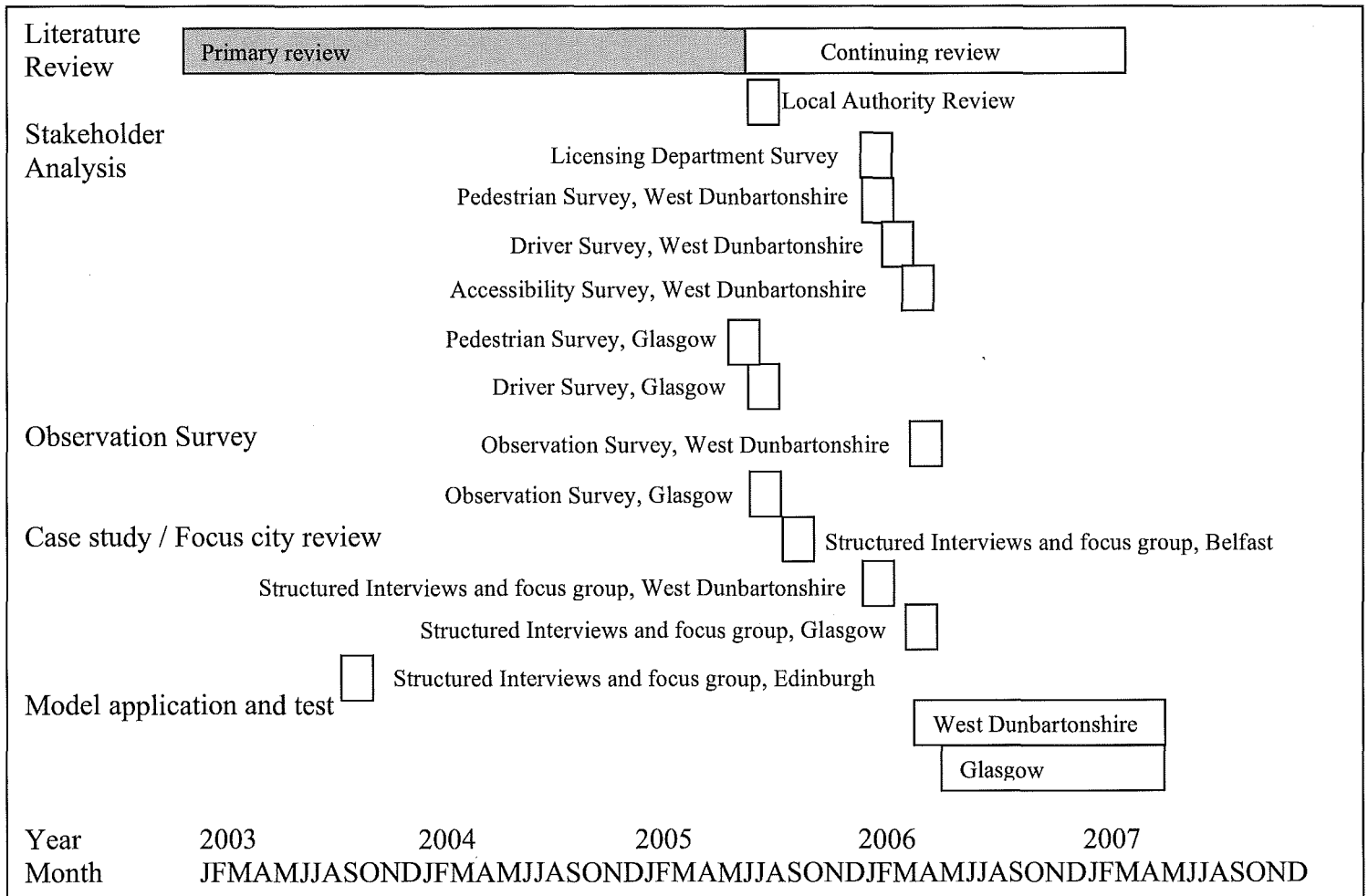


Figure 3.2 Timeline



3.2 State of the practice, building from existing study methods

The field in taxi studies has been characterised by the measurement of Significant Unmet Demand. In this context the Halcrow Model (Halcrow 2002, 2004) has come to dominate the field. An objective of this thesis is to critically evaluate this model, and revise the aligned methodologies and sub-methodologies. The standard practice in UK cities has included the Halcrow methodology in the reviews of taxi supply. These studies, which are common, seek to identify quantity levels as their objective, but may also serve the objective of simply satisfying legislated requirements, such as the Civic Government (Scotland) Act 1982 (CGSA). Primary data has tended to be collected by observation survey, an effective tool (Ellwood 1933), applied in a number of transport studies (Lam et

al 1999; Vivoda, 2007) in determining certain aspects of demand, but by no means all forms of need (DfT, 2006).

The identification of the wider range of research objectives adopted in this thesis, see Chapter One, compared to those within the traditional taxi study (Halcrow, 2002), requires a more detailed analysis which can not be limited to the impact of quantity on *queue behaviour at stance*, the primary indicator in current taxi reviews. More recent taxi reviews, completed for licensing authorities (see: Halcrow, 2004), have also included a limited amount of stakeholder analysis, based around user questionnaires, but have not fully developed this concept, nor applied it to key areas of demand such as use of taxis by disabled passengers.

As this thesis questions the underlying sustainability of conclusions drawn from data collected at stance and from minimal stakeholder analysis conducted to date, particularly in relation to latent demand (set out in Chapter Two), it appears appropriate and necessary to develop a new range of qualitative and quantitative datasets. A number of surveys have been developed which include the use of pedestrian questionnaire, completed on street using clipboard techniques, and driver surveys. These are described in more detail in the following sections of this chapter, in addition to the use of local authority reviews and case studies, used in testing of the resulting model.

3.3 Choice of methodology

The thesis sets out in Chapter One, a number of objectives, including critique of existing approaches to taxi supply, development of a new modelling structure and its application (see Table 3.1). These aims cover a wide range of resources and sources of information that might not be fully addressed by a single methodological approach. The thesis has therefore adopted a mixed methods approach, described in Section 3.4, using a variety of data collection and survey methods, outlined in this section and subject to critique from Section 3.5.

The initial objective, the identification of existing analytical approaches, is based on the use of literature reviews. Few alternatives exist to the use of existing literature, and this is discussed in detail in Section 3.5.1. The effectiveness of the literature review has been enhanced through the use of professional and technical material in addition to academic research articles.

The second objective, the identification of key issues in the use of taxis, breaks down into several key groups, including issues for users, regulators and suppliers. This required a number of approaches, collectively stakeholder analysis (see: Section 3.5.2), with differing data collection techniques employed. Local authority views were significant as they allowed for the identification of a range of issues specific to town and city centre use and its access; while the views of the licensing authority, generally the licensing department in city and districts, was significant to the identification of taxi models in current use, and issues felt to be present therein. Key objectives were to achieve a good response to questions about city use and to obtain detailed information concerning the taxi models used. A number of alternatives were considered to be useful in identifying key issues in the use of the city by residents and visitors. These included telephone interviews, structured (face-to-face) interviews and postal or email questionnaires. Given the identified need to maximise responses, neither telephone nor face-to-face interviews were felt appropriate, although structured interviews were used in a later 'focus-city' approach. An email questionnaire, described in section 3.5.3, was used to identify city authority views.

A different approach was felt appropriate for licensing authority surveys, see Chapter Four. Individual approaches to licensing vary between locations, and the exact terminology may differ, as for example between Scottish descriptions of 'stance' comparing to English use of the term 'rank'. It was also felt important to be able to explore individual issues of model use, choice of tariff model components, construction etc. These approaches, while possible within a standard form, are limited to the numbers of choices within the form, and may suffer from misinterpretation arising from differences in terminology. Instead, a telephone questionnaire was used, described in section 3.5.3, providing a more detailed response than may have been achieved using email or postal questionnaires.

Further groups impacted by taxi supply were also approached. These included the general public, and users with specific needs. Operators' views were also significant both in terms of local knowledge of difficulties in supply and in relation to driver availability.

A survey of disabled users was used to identify views specific to vehicle type, availability and propensity to use, discussed in Chapter Six. The group is significant, may be poorly served by traditional mixed fleets, and form a significant part in identifying improvements in supply – a modelling outcome of this thesis. It is, however, a challenge to obtain a full range of views of disabled needs on the basis of a survey of the general public. The objective was therefore refined to identify a full range of views specific to the needs of disabled passengers in the use of taxis, as a separate exercise to public questionnaires. A number of approaches were considered. These included the identification of individuals on street with identifiable ambulant disability, interviews at specific points of disabled need – such as old peoples' homes, and the use of support organisations to identify and distribute questionnaires. Initial consideration of separate identification on-street was considered inappropriate, mainly as a result of the need to distinguish and discriminate during the process of surveying. This was felt impractical and potentially alienating. The focusing of surveys on a particular facility, e.g. at an old peoples' home, was felt to have merit in that it would not be seen as discriminatory at point of survey. However, any focused approach based on facility is likely to have a significant bias. The alternative, a guided distribution, was adopted. The Local Access Panel, a non-statutory authority groups which represent the access needs of all disabled passengers, was approached in West Dunbartonshire. The panel agreed to distribute questionnaires on a 'distribute and post back' basis.

Driver surveys provide information on the issues in taxi supply and are significant in identifying poor stance design, particular issues in passenger behaviour, and can also provide input to the taxi model (in terms of costs associated with supply and in relation to hours worked – cab shift availability), see Chapter Eight for a description of the design and application of driver surveys in the case study locations. Surveys of drivers are, however, a significant challenge. Given the nature of the work drivers tend not to be able to answer surveys on street. Other approaches, such as focus group, would not, however, provide a large response. It was therefore decided to adopt a 'distribute and post back'

approach to driver surveys. Questionnaires were distributed at stance, and by post to taxi association members.

Surveys of the general public were completed on street using a clipboard technique (see Section 3.5.2).

The latter parts of the thesis address further objectives, the development of the model, detailed in Chapter Seven, and its application and testing in case study locations, detailed in Chapter Eight. Both development and testing required detailed data collection, much of which is based on observation surveys, and on the use of focus groups in case study locations.

Case study locations have been chosen on the basis of their representative nature, and the availability of information. Differing city forms, identified in Section 3.6.1, including compact, and conurbation peripheral location, informed the choice of location, while the ability to undertake large-scale observation surveys restricted model application to locations where operational data was measurable. Four locations were identified: Glasgow, West Dunbartonshire, Edinburgh and Belfast, and these formed the focus of detailed case study analysis. Both Glasgow and West Dunbartonshire provided an opportunity for large-scale data collection, and have thus formed the basis of model testing and application; while Belfast and Edinburgh provide the opportunity for focus group analysis. For the purpose of clarity in the thesis, Glasgow and West Dunbartonshire are set out as case study locations, while Belfast and Edinburgh are described as focus locations.

Observation surveys form the mainstay of previous modelling approaches (see: OFT, 2003; Halcrow, 2002) and are included in this thesis in testing the resulting new modelling approach. The revised approaches recommended by the thesis maintain a role for pre-existing approaches, but develop from these enhancements. Many of the existing methods of data collection were therefore appropriate, following detailed scrutiny, for inclusion in the new model.

Observation is an inherent part of the standard modelling approach. The surveys current in the standard approach identify waiting times at stance and have traditionally been

based on using an observer with clipboard. The enhanced methodology recommended by this thesis thus retains the need to obtain similar data. The methodology does, however, permit enhanced data collection, initially described in section 3.6.2, which included the possibility of using video based observation, and the potential for future application of hand held computing devices. This thesis trialled the use of video collection in Glasgow, where images were made available by the Nite-Safe partnership, but was not able to develop this technique further given the significant cost of equipment required to undertake the task independently. Additional barriers exist to video capture specific to the legal requirements for notifying the public of video surveillance, and the potential for vandalism or theft of equipment. As a result, the majority of observed data collection was undertaken on the basis of clipboard input. A detailed review of the data collection requirements is set out in Chapter Six.

Focus groups, undertaken in focus and case study locations (see above for a description of focus locations) were used to establish detailed information specific to taxi supply. Table 3.5 sets out the range of groups held and respondents, detailed in section 3.5.5. The nature of taxi supply, and the range of issues that relate to its provision vary from location to location, and are often presented as a variety of problems requiring separate solution. It was, however, apparent from the literature specific to previous model applications (such as Halcrow, 2002, see Chapter Two) that little, if any, attention was being addressed to the relationships between issues, or in the interpretation of impacts across regulatory boundaries. Lack of full awareness of issues in supply and use of taxis, or of the interaction between solutions in one domain and impacts in others, may be seen as a weakness in the previous approaches, and one that could be addressed by identifying impacts on the local level. The thesis sought to inform both design of the combined model, and the design and application of potential solutions, on the issues identified at local levels. Focus group studies provided an opportunity to identify issues across all stakeholder groups without limiting discussion to theme specific questioning (see: Wixey et al, 2007 for a description of the use of focus groups in transport analysis). A cross section of stakeholders was approached, including taxi supply, user (including disabled user) and regulator, resulting in a number of small groups (see Table 3.5).

3.4 Developing a mixed methods approach

The initial review suggested a need to move from a single data collection method to a mixed methods approach. This reflects the fact that the existing and developing models will continue to require large amounts of observed data (models, of the type used in the standard SUD approach tend to be data hungry, and often rely on high numbers of observations to increase accuracy (see: Daganzo et al, 2002)), while their development will also require a mix of other data collection methods to identify wider needs and impacts.

The thesis proposes the enhancement of taxi analysis based on a mixed methods paradigm, in line with the concepts set out in Burke-Johnson and Onwuegbuzie (2004). This acknowledges the need for high levels of observed data, but also the need to identify and fully account for the wishes of a wide cross section of stakeholders. Mixed methods allow for a combination of “techniques, approaches, concepts or languages” to be applied within a single study rather than restricting the research to a single approach, where each combination adds to the direction of the thesis. This has led to a number of different strands of research, building from the literature review into stakeholder analysis, survey and case study assessment. In line with existing methodologies (see: Denzin and Lincoln, 2002), the research continues to use observation surveys, but adds to these user surveys, of pedestrian (clipboard), of driver (distribute and post back), and of disability needs (distribute and post back). Case studies have also been used to test the models developed in the course of the study.

3.5 Critique of the methods used

Table 3.1 sets out the detail of surveys undertaken in the course of this work. Within each method, a number of underlying approaches exist, illustrated by the use of multiple surveys in the identification of stakeholder needs. A developmental element is also utilised, as the findings resulting from one method often informed the development of the next. The iterative nature of data collection, model revision, and revised data requirement can be illustrated in relation to the development of the new modelling structure, presented

in Chapter Six, and the identification of additional data needs specific to the new modelling tools developed (see Chapter Eight), an example being the need within the accessible vehicle model to identify demand that is not traditionally present in the standard approaches.

Table 3.1 Principal methodologies adopted in this thesis.

Research Element	Data collection method	Datasets achieved	Linkages
Literature Review	Focused trawl of all taxi based literature available using standard approaches, eg. ScienceDirect, British Library catalogue; review of wider sources via BTS and TRIS and the identification of consulting reports to local authorities in the UK and USA.	Detailed commentary and review, set out in Chapter Two.	Essential pre-requisite to subsequent research
Stakeholder Analysis	Local Authority Review Town Planning / Licensing	Two separate questionnaires: - phone and send back - Telephone interview	Informed Night Time Economy focus, and licensing issues focus
Supply Analysis	Observation and measurement of delay occurring at stance	Delay statistics for taxi supply at stance	Included in traditional and enhanced modelling
	Driver questionnaire	Distribute and post back Availability statistics and key indicators (qualitative) of delay points	Included in the enhanced model
Demand Analysis	Observation and measurement of delay occurring at stance	Delay statistics for passengers queuing for taxis	Included in traditional and enhanced modelling
	Pedestrian clipboard survey, public survey	Indicative statistics of experiences in using taxis, determined levels of latent demand, determined 'acceptable' delay criteria	Included in the enhanced model
	Disabled needs questionnaires	Indicative statistics of demand levels and latent demand	Included in the enhanced model, input to total supply level, and accessible taxi level calculation
Case Study	Focused application of emerging model		

Table 3.2 Data collection by survey type (Stakeholder)

Data Collection Type	Survey	Respondents*	Stakeholder Status
Email Questionnaire	Local Authority, questionnaire	52 authority responses. City and town planning, town manager, economic planning departments	Local Authority
Telephone questionnaire	Local Authority, questionnaire	21 authority responses. City and district licensing authority, taxi licensing managers	Licensing Authority
Telephone questionnaire	US Local authorities, questionnaire	11 authority responses. City licensing authority, taxi licensing managers	Licensing Authority
Postal questionnaire	Disabled access users, West Dunbartonshire. Distributed via access panel, posted back.	81 completed returned questionnaires, sample of all access related disability types	Disabled users
Postal questionnaire	Driver survey, West Dunbartonshire. Distributed via address list provided by licensing authority, posted back.	96 valid questionnaires, 2 spoilt questionnaires sample of all drivers licensed by authority.	Supplier
Postal questionnaire	Driver survey, Glasgow. Distributed on rank, and via address list provided by Glasgow Taxis Ltd.	348 valid questionnaires, no spoilt responses. Sample of drivers registered at Glasgow Taxis, and street taxis (non-association taxis).	Supplier
Pedestrian Survey	West Dunbartonshire, public clipboard survey questionnaires	350 completed on street questionnaires. Completed Feb 2006, sample of Dumbarton and Clydebank locations.	Public
Pedestrian Survey	Glasgow, public clipboard survey questionnaires	682 completed on street questionnaires. Completed May 2005, sample of city centre locations	Public
Focus Group	West Dunbartonshire	Representatives of taxi trade, Feb, 2006, 5 participants	Supplier
Focus Group	West Dunbartonshire	Licensing department and access panel, Feb 2006, 7 participants including David Rooney, Margaret Macera	Licensing Authority
Focus Group	Glasgow	Representatives of taxi trade, May, 2006, 6 participants including Bill McIntosh, Robert Dunabbie	Supplier

Focus Group	Glasgow	Licensing department, May 2006, 6 participants including Helen Welsh	Licensing Authority
Structured Interview	Belfast	Aug, 2005. Meetings with Department of the Environment, Adele Waters; PSNI, Keith Addie; Taxi Association, William McCausland, Harry Fitzsimmons	Licensing Authority / Supplier
Structured Interview	Edinburgh	Aug, 2003. Meetings with Licensing department, Peter Lang, and taxi trade, Jim Muldoon	Licensing Authority / Supplier

Source: Author

* See Table 3.5 for detail of methodologies and data detail

3.5.1 Literature Review

A comprehensive literature review was undertaken, and formed the initial base of the study. A range of literature was followed drawing both on academic and practitioner papers appropriate to taxi supply, control and regulation. Whilst there is a volume of academic scholarship, a distinct discourse continues in policy and local authority documents, and this 'grey' literature has also been reviewed (DfT, 2006; OFT, 2003). The literature review was undertaken from the outset of the work and has been continuously updated during the course of the study to identify current advances in practice. The review draws from academic and professional literature, and includes client reports completed for Licensing authorities, and previous taxi surveys.

Creswell (1994) indicates the importance and relevance of comprehensive literature analysis to the quality of research, setting out relationships between the approach taken in designing a literature review, and the outcomes appropriate for the study being undertaken. The review (Creswell) is appropriate in determining the extent of the field. Croom et al (2000) considers application in the transport domain, identifying the literature review as pertinent to classification and analysis.

This study has applied a method consistent with Creswell, and the stated approaches set out in similar literature (Hart, 1998) with an aim to 'synthesize key ideas' appropriate to

the research. The search procedures are, however, somewhat more complicated in reality than suggested in classic texts. This is a result of the nature of material available, and the fact that many of the reports pertaining to traditional taxi studies undertaken to date remain confidential within the councils for whom they were prepared. This called for an extension of the search procedure to include the academic and professional literature that may not be directly available in ScienceDirect or similar referencing systems (JSTOR etc.). Moreover, as this study identified at an early stage, much of the literature relating to taxi deregulation exists in American, rather than British local authorities.

The study expanded its search criteria to include specifically targeted libraries and referencing systems (the US Bureau of Transportation Statistics (BTS), the Transportation Research Board (TRB/TRIS), and the Department for Transport Library in Victoria, London), as well as requesting previous studies from the councils for whom they had been prepared including those in the UK and the USA (Fresno, San Diego (SANDAG), Los Angeles, and Seattle).

The result was a comprehensive source of material drawn from academic and professional literature, including over 250 journal articles, texts and practitioner papers accessed, that informed the design of subsequent areas of research, including model design and particularly the need to address the needs of all stakeholders.

3.5.2 Stakeholder Analysis

A key objective of the research was to determine the impacts of applying current taxi models on their supply and use. Impacts exist across a wide range of groups, and affect both current and potential users. Two issues were felt to be significant, the identification of the most appropriate surveys, reaching all stakeholders (including those who have not chosen to make frequent use of taxis in the past); and the opportunity to complete the surveys across a wide time frame. The study has, therefore, developed a 'suite' of surveys, collectively representing a full range of stakeholders. These included Local Authority questionnaires, public pedestrian survey, identifying public perceptions, experience and identified gaps, disability group survey; and a driver survey, key to

identifying driver perceptions, availability etc. Surveys were undertaken separately and are described in subsequent sections.

Stakeholder analysis is identified (Brugha and Varvasovszky, 2000) as providing (p. 239) a method of including stakeholders 'influence in the decision making process'. The views of all the stakeholders is critical in identifying needs, gaps, and the potential for any 'solution' that might emerge from the study. The process has significant potential but, critically, relies on the extent to which it addresses the needs of all. This suggests a need to identify a wide range of participants that, as a result of their hierarchical nature, (differences in the levels of administration, regulation and use) required several surveys, and differing formats appropriate to the circumstances of the respondents.

3.5.3 Surveys of local authorities.

Local Authorities are included in the analysis both as regulators and agencies with a responsibility for wider city and area interaction, the latter being relevant to the determination of the former, but heavily impacted upon by deficiencies in the supply and use of transport. As a result of the split between town planning and taxi licensing, two surveys were undertaken, the first addressed to town centre managers, the second to taxi licensing departments. The initial questionnaire was sent to 93 authorities with 52 responding (see Table 3.3). The survey was distributed by email, with a prior telephone call being made to identify a named individual to whom the questionnaire should be addressed. The resulting response rate was c. 55%, compared with a response rate range average of c.20% achieved in similar studies, (see: Australian Government, 2003; Perretts, 2005; Slotterback, 2004) providing an adequate basis on which to undertake the continuing analysis. Findings are of the local authority surveys are included in Chapter Four, which addresses the context and structure of taxi supply.

Table 3.3 Listing of local authorities surveyed

Local Authority Name	Removing / retaining restriction*	Local Authority Name	Removing / retaining restriction*
Basildon	Removing	Londonderry (City of Derry)	Not applied
Basingstoke	Retaining	Luton	Retaining
Bath	Retaining	Manchester	Unknown
Belfast	Not applied	Middlesbrough	Unknown
Birmingham	Unknown	Newcastle-upon-Tyne	Retaining
Blackpool	Retaining	Norwich	Unknown
Brighton	Retaining	Oxford	Retaining
Bristol	Unknown	Plymouth	Unknown
Burnley	Retaining	Reading	Retaining
Cardiff	Unknown	Rotheram	Retaining
Chester	Retaining	Salford	Retaining
Coventry	Unknown	Scarborough	Unknown
Dover	Unknown	Southampton	Unknown
Durham	Removing	Southend	Retaining
Eastbourne	Unknown	Stevenage	Unknown
Edinburgh	Retaining	Stratford upon Avon	Removing
Exeter	Unknown	Sunderland	Unknown
Glasgow	Retaining	Swansea	Unknown
Guildford	Removing	Swindon	Removing
Hastings	Unknown	Torbay	Retaining
Huntingdon	Unknown	Walsall	Removing
Inverness	Not applied	West	Retaining
Ipswich	Removing	Dunbartonshire	
Lancaster	Retaining	Woking	Removing
Leicester	Retaining	Wolverhampton	Removing
Liverpool	Retaining	Wrexham	Removing
		York	Unknown

continued, above right

* Based on DfT, 2006b

The second survey addressed a far more detailed analysis of the regulation of taxi licensing. Whereas the previous survey was completed using email, the licensing questionnaire was completed using a telephone interview technique. The choice of telephone interview based on the extent of detailed description, and possible need for explanation, specific to the choice of licensing structure, models used, and extent of

observations (with additional questions related to tariff) which could be described in a number of ways, and required detailed explanation not possible within an emailed questionnaire. 21 licensing authorities agreed to participate, of 32 asked, with all responses received providing input to the subsequent work.

3.5.4 Supply analysis

We now turn our attention to the data specific strands within involved in operating the analytical model. The principal existing methodology applied, the Halcrow model, involves the identification of supply shortfalls by comparing waiting times at stance with availability of taxis. The method utilises an observation survey undertaken at stance based on a review of (an element of) demand, and a parallel review of (an element of) supply.

With the similar objective of identifying waiting times at stance, this thesis similarly also uses observation, but builds on a more detailed survey structure in achieving a wider range of objectives. These are specific to the analysis of supply, beyond the levels achieved in stance observation alone, and seeking to achieve the broader objective of identifying issues specific to the supply that would not be revealed on the basis of stance observation, set out in this section, and of demand, set out in 3.4.4.

Measurement of delay at stance

The measurement of vehicle delay, and of passenger waiting times (which are usually bundled together in the same assessment), are clearly defined in earlier studies and widely established (see: Halcrow, 2002; 2004; TPI, 2004). The measurement seeks to identify inputs in the calculation of appropriate fleet size, and allow for conclusion of the numbers of vehicles that would reduce (observed) passenger delay at stance. The approach requires accurate measurement of delay to passengers waiting and taxis arriving, a measure based on disaggregated measurement. Observations are made (Halcrow, 2002) specific to individual hours and at individual locations. Locations are chosen on the basis of indicative demand over all stances and applied on an aggregated basis, at fleet level. The nature of the observation is common and repeated, and has achieved a level of acceptance that has led to the fact that a survey has been completed

becoming equated with the satisfaction of legal requirements set out under CGSA 1982 (Coyle v. Glasgow, Sheriff Court).

A more rigorous analysis of the method itself, derived from Gable (1994), and set out in Table 3.4, is applied to the measurement methods used, and is discussed below.

Table: 3.4 Analysis of observation method

Form	Manual entry of observed delay times, against delay on stopwatch. Field entries include: Vehicle delay, where present; Passenger delay, where present; vehicle count at five minute intervals; passenger count at five minute intervals; passenger count in departing vehicle; Special needs limited to: elderly, wheelchair, parent with child's buggy
Controllability	Variables are derived from the observation of vehicle and (intending) passenger movements. The enumerator has no control over the performance of the subjects, but must maintain sight and accurate time measurement. Controls may be in-place to ensure correct entries to data recording sheets, based on the numbers of passengers/vehicles entering a queue and leaving.
Repeatability	Each observed survey period is unique, as the patterns of demand alter over time, no single period may be repeated. However, trends are apparent which create an element of repeatability. This is significant to the direction of the study as well as to the accuracy of the data and has informed the development of the survey, see below.
Generalisability	Taxi demand is particularly location specific, the generalisability of measurement is therefore low. However, as few surveys are completed at all stances at all times some generalisation is necessary. This is achieved in determining a cross section of stances as representative of a pattern, eg: city centre, peripheral etc.

Derived from: Gable (1994)

The Gable analysis provides a number of key indicators that have fed into the construction of the observation surveys. The control of the survey relies on the accurate measurement of passenger and vehicle movements and this will often occur in poor visibility and poor weather. Control was improved by adopting a moving observer method in determining queue delay, a method of timing whereby the enumerator joins a queue to determine the length of time from entry to exit (see: Acer, 1991). The analysis also presents an issue in terms of the repeatability of the survey, and the related issue of generalisations drawn from the data. Previous analyses have limited actual observation hours and effort in the basis of costs (Halcrow, 2004), which remain an issue in large

scale studies. However, the identification of hour-by-hour changes, particularly overnight is integral and important to the study. While individual hours are not repeatable – the delay one week varies from the day the next – detailed trends over several nights and several time periods will provide recognisable validation of data accuracy. Countering this, there is also an issue in seasonal fluctuations in demand, which have led to the conclusion in this thesis that comparisons only hold true (accurate) if applied to review of similar circumstance. Thus a winter survey would not be comparable with a summer study even where all other parameters remain the same. This research comments on the need for assessment and its update at 12-month intervals.

Driver Questionnaire

A further element in the analysis of supply has been the development of a driver questionnaire. The method has a number of applications (TRL, 2006), which include assessment of driver opinion, safety and vehicle operation. A driver questionnaire was developed, in this study, to identify data specific to availability, fleet vehicle composition, and an open question response to issues affecting the delivery of taxi services.

The survey followed a ‘distribute and post-back’ methodology, a form of survey whereby forms were distributed to respondents to take away, complete and return. This was felt appropriate given the need for taxi drivers to drive away at short or no notice, which might otherwise affect the number of questionnaires completed.

3.5.5 Demand Analysis

Demand for taxis has been represented in traditional models on the basis of observed demand at stance. Much has been made (Halcrow, 2002) of the assessment of waiting times at stance as a surrogate measure for all demand which, although rejected in the thesis as an appropriate measure of all demand, has been repeated as a part of a wider framework. A description of the combined at stance observation survey measurement is set out in section 3.3, above. The observed measure does not, however, address issues of latent demand, amongst the population in general, and for the supply of disabled accessible taxis in particular. These call for additional research, and have been addressed

in this study by the use of clipboard surveys on street, looking at latent demand within the general population; and through the use of postal questionnaires addressed to individuals with disabilities, and distributed through the disability panels.

Demand surveys also provided an opportunity to address other issues in the demand for taxi services, in which personal experiences were requested, and these formed an additional element in the development of scenarios within the case studies. Furthermore, the perceptions of appropriate waiting time, an issue not covered in any detail in literature but identified as significant to the actual scoring of performance and thus outcomes of the model, were tested. The demand surveys split between information appropriate to the interpretation of existing use of taxis, and that appropriate to identifying latent demand. Questions also addressed issues of perceived delay, and sought to identify the maximum levels of delay felt acceptable.

The need to address a wide audience resulted in the use of differing questionnaires, an approach that is detailed, and justified (Johnson and Turner, 2003) who identify that “collection of multiple datasets”... by varying means ...“using different strategies, approaches, and methods”... result in a combination ...“likely to result in complementary strengths”.

An additional strand was added using focus groups, see Table 3.5, adding to and aiding the interpretation of differences between locations, and the identification of location specific factors in the completion of the study. Focus groups were an important tool, illustrated in West Dunbartonshire in the highlighting of accessible vehicles as a key issue issue.

3.5.6 Case Studies

The final research method was based on the use of case studies, designed to test the application of the new modelling structures developed in the course of the research in specific ‘live’ locations. Two case study locations were used, Glasgow and West Dunbartonshire, both locations setting quantity restrictions on the numbers of licenses issued, but also allowing for testing of differing elements within the new modelling

framework, testing disabled access requirements in West Dunbartonshire, and economic regulation in Glasgow, see Chapter Eight. A full range of modelling analysis was applied in the case study cities with the agreement of licensing authorities that maintained an interest in the results of the work, and in the application of findings in their own areas.

Case studies are widely adopted in transport analysis (New Jersey, 2007), and particularly in the testing of traffic models (MIT, 2002). In common with other traffic studies this thesis has developed case study methodology around the use of scenarios, a series of location specific 'solutions' devised for testing. The concept has been applied within this thesis to location specific 'solutions, illustrated by the testing of increased numbers of accessible vehicles in West Dunbartonshire - while Glasgow already operated a fully accessible fleet.

3.6 Survey Detail

Having established an appropriate range of surveys, this section continues to describe the design and completion of the data collection. Table 3.5 sets out the chronology, focus and response rates of individual surveys undertaken. Survey forms used are set out in the appendices.

Table 3.5 Development of primary data sets

Description	Locations (number of responses)	Primary Methodology	Response Rate	Date Completed	Data Detail	Participants in survey
Review of Nighttime Economy. – Local Authorities	93 authorities approached 52 responses received representing a cross section of UK city authorities	Email questionnaire, with phone requests	52/93	Aug, 2005	Qualitative review of issues affecting interactions in the nighttime economies	Local authority questionnaire addressed to economic development and / or city planning departments. Named respondents used where possible
Review of regulatory approach and Taxi Models used in UK Telephone Survey	30 authorities approached in telephone survey, 21 UK cities responded	Email questionnaire with phone requests	21/30	Feb, 2006	Review of methods of assessment adopted in taxi modelling	Local Authority Licensing Departments, addressed to head of licensing. Names respondents used where possible
Review of regulatory approach in USA	15 North American cities approached, 12 providing detailed responses to structured questions	Telephone Questionnaire	12/15	Sep, 2003	Qualitative experiences in taxi operation in differing forms of regulation	Licensing authority departments, contact made via taxi licensing to named respondents

Continued on next page

Detailed assessment of focus cities	Belfast: Interviews with the Department of the Environment, West Belfast Taxis Ltd., and the Police Service of Northern Ireland.	Structured Interview	N/A	Aug, 2005	Qualitative and Quantifiable experiences in applying specific taxi models	Departmental representatives including Keith Addie, PSNI,
	Focus group held with Combined Group of Belfast Taxi Proprietors Associations.	Focus Group		Aug, 2005		Group including: William McCausland, Stephen McCausland, Harry Fitzsimmons
	West Dunbartonshire: Interviews with West Dunbartonshire Council, West Dunbartonshire Access Panel.	Structured Interview		Feb, 2006		Group including David Rooney, Margaret Macera
	Focus Group with representatives of the Taxi trade	Focus Group		Feb, 2006		Group including the Alexandria taxi association, Clydebank taxis, and Dumbarton taxis
	Glasgow: Interviews with City Council Licensing Department, Glasgow Taxis Ltd., taxi supply companies	Structured Interview		May, 2006		Group including Bill McIntosh, Helen Welsh, Robert Dunabie
	Focus group with Taxi operators.	Focus Group		May, 2006		Group including Glasgow Taxis Ltd representatives
	Edinburgh: Interview with City Council, licensing.	Structured Interview		Aug, 2003		Group including
	Focus group with the taxi trade.	Focus Group		Aug, 2003		Group including Jim Muldoon

CONTINUES ON
NEXT PAGE

Model Operation* Observation and pedestrian surveys, driver surveys, focus groups	West Dunbartonshire:				Primary data for input to traditional model runs and new modelling framework
	Observation Surveys: 576 hours at stance observation over 12 stance locations.	Observation Survey	576 hrs	Feb, 2006	
	350 completed and valid pedestrian survey questionnaires.	Clipboard Survey	350 q	Feb, 2006	
	96 completed and valid driver questionnaires	Distribute and post back	96 q	Mar, 2006	
	81 completed and valid accessibility questionnaires (completed as a postal questionnaire distributed by the West Dunbartonshire Access Panel.)	Distribute and post back	81 q	April, 2006	
	Glasgow: Observation Surveys: 600 hours at stance observation over 31 stance locations.	Observation Survey	600 hrs	May, 2005	
	682 completed and valid pedestrian survey questionnaires.	Clipboard Survey	682 q	May, 2005	
	348 completed and valid driver questionnaires	Distribute and post back	348 q	June 2005	

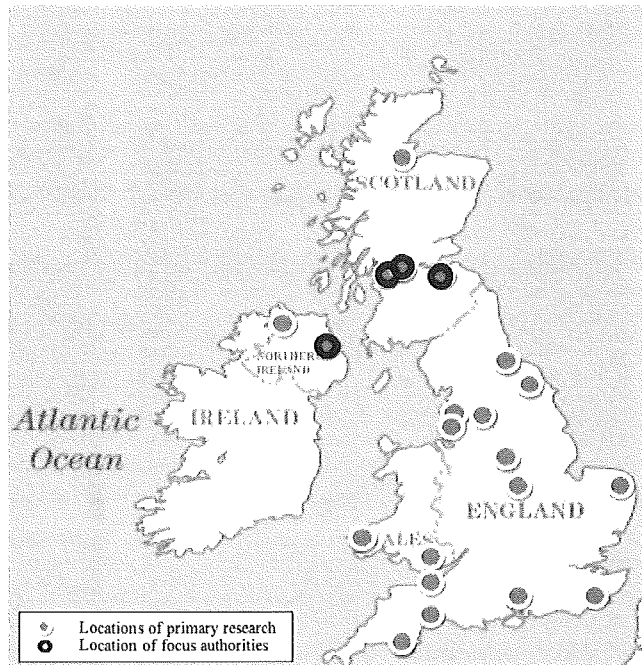
3.6.1 Primary research: Stakeholder Questionnaire

The first stage of the research focused on the interaction between taxi supply and the nighttime economy (see: Cooper, 2005) based on a survey of local authorities across the UK. An initial questionnaire, completed by 52 authorities (see Table 3.2), identified nighttime use of taxis as a point of peak demand for taxis, and a key point for interaction between travel home from entertainment. The survey also suggested a need to focus on the issues of supply of taxis at specific points of time, night time peaks related to access crowds wishing to return home, but also the need to address other peaks including access at railway stations and airports following arrival of trains and aircraft respectively.

Initial research locations were chosen to include as wide a range of authorities as possible, and the questionnaire was distributed to 93 locations, with 52 responding. A sample of 93 UK authorities was identified from a potential total of 408 UK authorities with an interest in taxi licensing (c.25%), drawn from information held at the Department for Transport Bus and Taxi division. A cross section of authority size and pre-existing taxi licensing policy was addressed. Questionnaires were sent by email in August 2005 to named individuals following a phone trawl of local authorities. This initial questionnaire, which established points of interaction between taxis in the local community, was followed by a separate stakeholder questionnaire specific to taxi regulation (see Table 3.5).

The second survey sought to identify local authority policies on taxi regulation and tariff determination providing primary data identifying the extent of 'common approach' used in the determination of regulatory structure, and in the identification of issues in the supply of taxi services.

Figure 3.3 Locations of research specific to thesis



Source: Author. Map taken from Google.

Further levels of analysis were determined in relation to focused analysis, locations in which it would be desirable and practical to seek further information specific to the operation of taxi control, and case study locations where it was desirable and possible to obtain large datasets specific to a model run. In both focus and case study the thesis makes use of a sample of cross-section of city forms which can be identified as: a) Urban Conurbation, b) Compact Urban City, and c) Urban Peripheral Authority, see Table 3.6. The key dimensions of these forms are:

- Urban Conurbation – multi-centred city location based on a central authority, and surrounded by urban development falling into other local authority areas,
- Compact Urban City – self contained authority not displaying significant urban development (sprawl), with the majority of activity contained within a single authority area, and
- Urban Peripheral Authority – authority within the peripheral conurbation of a central city.

A cross section of urban forms is appropriate to analysis within this thesis and this has been achieved, where data is available, in analysis of case study locations (Glasgow and

West Dunbartonshire), see Chapter Eight, and in other cities of focused analysis (Edinburgh and Belfast), see Table 3.6.

Table 3.6 Listing of licensing authorities surveyed

Authority Name	Authority Structure	Stakeholder Review	Focus City	Case Study
Swansea	Compact City	Yes		
Cardiff	Compact City	Yes		
Bristol	Compact City	Yes		
Exeter	Compact City	Yes		
Plymouth	Compact City	Yes		
Southampton	Compact City	Yes		
Dover	Compact City	Yes		
Norwich	Compact City	Yes		
Coventry	Conurbation	Yes		
Birmingham	Conurbation	Yes		
Manchester	Conurbation	Yes		
Liverpool	Conurbation	Yes		
Blackpool	Compact City	Yes		
Sunderland	Compact City	Yes		
Newcastle-upon-Tyne	Conurbation	Yes		
Edinburgh	Compact City	Yes	Yes	
Glasgow	Conurbation	Yes	Yes	Yes
West Dunbartonshire	Urban peripheral authority	Yes	Yes	Yes
Belfast*	Conurbation	Yes	Yes	
Londonderry (City of Derry)**	Compact City	Yes		
Inverness	Compact City	Yes		

* Belfast City council responsible for city planning, DOE for taxi licensing

**City of Derry council is responsible for city planning, DOE for taxi licensing

Moving our focus explicitly to taxi provision, there appears not to be an extensive literature on spatial factors to be consulted. However, within the body of this thesis where spatial dimensions can be identified and related to the literature this has been undertaken. The combination of reviews of city types and transport organisation with the results from the survey of taxi organisation and regulation in UK cities resulted in the choice of two case studies, being:

- Urban Conurbation - Glasgow²²
- Urban Peripheral Authority - West Dunbartonshire²³

3.6.2 Supply Analysis

The review of current practice, which emerges from both the literature and comments set out in the city responses, informed the development of surveys specific to supply, see Chapter Four for a description of this development. Tables 3.7 and 3.8 set out the most common elements used in SUD and cost models – the two regulatory domains under the control of the licensing authority pertinent to supply.

Table 3.7 Standard Model elements in the assessment of SUD

Element	Definition
ISUD Matrix	Indication of the presence of SUD on the basis of peaking and delay
ISUD Relative Value	Indication of the presence of SUD on the basis of measured comparative values
Latent Demand	Indicator for the presence of SUD and input to scenario building models
Queuing models	Method for obtaining passenger delay figures through observation or estimation
Taxi Delay Models	Method for obtaining vehicle delay figures through observation or estimation
Passenger Expectation Model	Method for defining optimal service levels as an input to scenario building models
Scenario Building: Extra Arrivals Model (EA)	Method for estimating impact of changes in license numbers, on the numbers of vehicles arriving on rank
Scenario Building: Impact of Additional Arrivals (IAA)	Method for estimating the reduction in queue length and waiting time resulting from increased on rank arrivals
Scenario Building: Impact of Larger Fleet (ILF)	Method of estimating impacts of a larger fleet on the delay experienced by taxi drivers

Table derived from Halcrow, 2002

²² Glasgow is detailed as having a metropolitan area population of 1,749,000 (Wikipedia), located within the wider conurbation area of Strathclyde. The City council taxi licensing area is set within the city boundaries – rather than those of the conurbation, and is detailed in this study as a medium sized location.

²³ Local Authority area population: 94,000

Table 3.7 illustrates the standard approach to SUD modelling. It can be identified that SUD modelling requires a significant amount of data to input and produces higher levels of accuracy with more data. An initial trawl of existing council led reviews suggested the nature of data requirements. These are summarised below, and explored in more detail in Chapter Four.

The standard SUD model includes two data collection points, stance observation and pedestrian survey. Stance observation is used to identify patterns of queuing and delays at stance, and includes both supply analysis, and that of demand. The need to combine observation of supply and demand into a single survey results from the scale of data required against the opportunity for its collection.

The second regulatory area in which consistent methodologies do exist, specific to supply, is the determination of taxi tariff. The most consistent methodology (Table 3.8) measures the change in costs of production and is known as the Taxi Cost Model.

Table 3.8 Common Model elements in the Taxi Cost Model

Element	Definition
Vehicle Cost	Purchase price by vehicle type and depreciation
Maintenance Cost	Parts and Labour or contract cost
Fuel Cost	Change in retail price DERV
Insurance Cost	Change in cost for typical driver
Licenses and Permits	Change in prevailing costs
Earnings	Comparative wage

Table derived from responses from 21 Licensing Authorities

Cost modelling inputs comprise of primary data from suppliers, and secondary data derived from published information. These are used within the model to determine changes in the costs of production to determine increases in Industry Price Inflation (IPI), although the exact nature of collection of this information differs.

The development of supply analysis builds on the approaches commonly adopted in previous studies. Revisions to existing methodologies are determined as appropriate, see Chapter Seven, and applied as set out below.

For ISUD, queue and delay (observation survey)

The method is based on the observation, at taxi stance, of waiting time between seeking and engaging a taxi, whereby the extent of waiting is used as an indicator of the occurrence and shortfall of supply. Observations were carried out in May 2005 and February 2006, and include 1176 hours of *at stance* observation, conducted by the author and a team under the direction of the author. The observation survey identified a sample of city locations based on three criteria, those representative of central, centre peripheral and suburban locations, with the majority of observations (70%) based on central locations. The sample technique is common to most SUD models (see: Halcrow, 2002) and necessitated as it is, normally, not practical to observe all stance locations.

Table 3.9: Construction of observation surveys

Data Requirement	Method of capture
Passenger queue behaviour	Entry and exit time from queue using moving passenger observation
Vehicle queue behaviour	Entry and exit time from stance using moving vehicle observation
Passenger numbers / taxi	Observation of departing taxis
Passengers with special requirements	Observation to identify: Elderly passenger, Passenger with buggy, Passenger with shopping*, Wheelchair user (* - West Dunbartonshire only)

Critique:

Observation surveys at stance can provide detailed data specific to demand, queue behaviour and supply at a specified location, but are limited as a result of the labour intensive nature of the survey. Results are also limited in that they represent a snap shot of demand at the point of survey rather than any trends or longer-term information. As a result of the high labour costs involved in the data collection at stance, some standard models choose to synthesise queue information from limited observation, which may in turn reduce the reliability of the data obtained in the survey, or limit surveys to particular stances only. Both will result in less reliable data, and may lead to over- or under-

estimation of the levels of unmet demand. The new modelling frameworks identified as a key outcome of this thesis (detailed in Chapter Five) propose a more detailed analysis of stances, and build on more detailed observed data, itself requiring a more intensive data collection exercise, but well suited to the development of technological solutions which might include automated entry and exit counts using hand-held PDA equipment at point of observation, or use of video camera surveillance allowing remote data entry.

Although it was not possible within the constraints of this thesis to adopt PDA data entry, the desirability of its use remains a conclusion of this thesis. Some limited testing was, however, possible of the use of video surveillance in the development of Glasgow's dataset, this as a result of the involvement of the Glasgow Camera Partnership, now the Nite-Safe partnership, in providing video recordings of the Gordon Street stance. The use of video based observation improves the ability to observe and enter data, not least as a result of observers not having to stand at street corners. It is, however, limited by the nature of the cameras, not being available or appropriate to all desired locations, and the reduced ability of the observer to gauge the extent of very long queues (the camera not being able to see around corners, while a present observer would be able to move position as appropriate).

For taxi fleet impact, questionnaire (driver survey)

A major drawback in the standard modelling approach has been the lack of information specific to driver behaviour or likely reaction to changes in fleet size, yet this is an inherent part of the ability of a fleet to supply services. The existing model has contained a standard element - ILF (Impact of a Larger Fleet), see Chapter Six, but this has included assumptions of even arrival rates and departures from stances, consistent physical (engineering) circumstances across all stances and unlimited capacities at stance. They have not sought to account for the behaviour of drivers in the fleet, nor have they identified shift working patterns, or factors that affect taxi drivers' willingness to work at particular times. Moreover, the absence of driver surveys from the standard modelling approach limits the opportunity to determine fleet characteristics, actual vehicle age and replacement intentions.

A survey of drivers at stance was undertaken to enhance the information specific to supply, and to reduce the need for assumed supply characteristics. Driver questionnaires

were used to establish driver perceptions toward supply, availability, concerns in providing services at particular times (see Table 3.10), and provided an indication of the effect on current supply of changes in license numbers, detailed in relation to the case study cities in Chapter Eight. Questionnaires were based on a ‘distribute and post back’ methodology, in which forms were passed to drivers at stance and via the taxi associations, and returned in pre-paid envelopes. A sample of taxi drivers was established from the information provided by local authorities. A sample size of 50% of drivers was identified, being achievable within the limitations of the research. At stance completion was felt inappropriate given the potential need for a driver to depart quickly as a passenger engaged the vehicle.

Table 3.10: Construction of driver surveys

Data Requirement	Method of capture (from Driver questionnaire)
Vehicle Types	Choice from list
Age of vehicle	Date of first registration
Replacement of vehicles	Choice from list
Shift patterns	Tick box by hour / day for two weeks
Choice of shifts	Choice from list
Willingness to work Fri/Sat night	Choice from list (graded from not at all to very willing)

The development of broader datasets, specific to the supply and use of taxis contributed to the development of enhanced methodological approaches, as well as new and updated model elements felt likely to enhance the accuracy and broaden the application of existing standard modelling approaches used in determining taxi supply.

Pedestrian surveys are also significant in the determination of SUD, but these have been limited in the standard approach (Halcrow, 2002; TPI, 2004) to a review of public perceptions, mainly in the basis of the quality of the taxi service. More detailed approaches to pedestrian surveys, one of the major suggestions of this thesis, could provide a method of validating and assessing latent demand, a major conclusion of this thesis, and determining user expectations across different time periods.

3.6.3 Demand Analysis

The second element of identifying gaps between supply and demand is the identification of a full cross section of demand for taxi use. This includes the observed use of taxis at stance, a fundamental and primary element of the standard model, included in the observation survey and detailed above. The observation survey does not, however, provide a full indication of all areas of demand and is naturally limited to those categories of use that are observable at the stance itself. The observation does not address public attitudes toward taxi use, nor does it allow for any consideration of demand that is suppressed, a trip that is not made, or latent demand, a trip that would be made if supply were more appropriate to need. Further surveys were felt appropriate to address public expectation and latent demand.

For public expectation, questionnaire (pedestrian survey)

A public attitude survey was developed and completed with the aim of determining public perceptions specific to the supply of taxis, to supplement delay data including experiences in engaging taxis in the hail and ride sector, and in relation to bookings by telephone. The survey also sought to address questions specific to service levels experienced in the use of taxis and to set thresholds of 'acceptable' and 'desirable standards'. Two paper-based pedestrian surveys were completed, the first in May 2005, returning 682 responses, the second in April 2006, returning 296 responses.

The public expectation surveys completed sought to address a shortfall in the standard model approach (Halcrow, 2002). Previous studies had, latterly, used pedestrian surveys, but these were limited to identifying views on the supply of taxi services available, including price, perceived waiting time and indicative availability (Halcrow, 2002 pp 22 – 33). This approach, though valid and appropriate, failed to fully address issues of Latent Demand, particularly in relation to accessible vehicles, or the different expectations of daytime and nighttime travellers, identified as significant new model elements in this thesis. Table 3.11 highlights the construction of the new pedestrian surveys and sets out wider data requirements specific to these additional modelling elements.

Table 3.11 Construction of pedestrian surveys

Data Requirement	Purpose	Method of capture
Respondent personal information	Stratification, validation across sample	Age, status, employment. Choice from list
Frequency of taxi use	Stratification	Choice from list
Determination of reasonable delay	As input to modelling structure	Identification of reasonable delay period and perceived actual delay for 5 time periods
Typical trip characteristics	Stratification and allocation of delay data to modelling structure	Origin and destination of last taxi trip
Development of taxi services	Input to scenario building	Choice from list, desirable / not desirable
Locations where stances should be, but are not provided	Input to scenario building and indicator of latent demand	Free entry
Locations where stances are poorly served	Input to scenario building and indicator of latent demand	Free entry
Frequency of desired use where taxi not used	Input to latent demand identification	Choice from list
Factors preventing use	Input to latent demand identification	Choice from list (ranked)

For Accessible vehicle requirements, questionnaire and focus group

An additional assessment specific to demand for accessible vehicles was undertaken as a part of informing the model structure, and application in case study locations (see section 3.6.4). The nature of demand for accessible vehicles varies by location and is dependant upon, among other factors, the vehicles used within the fleet, and the proportion of a population seeking transport by accessible taxi. This itself relates to the potential differences of urban, peri-urban and non-urban locations as 'access friendly' places, and may actually relate to the proximity of appropriate transport facilities to residential locations including nursing homes. A detailed area of research exists around accessible transport and location type, see: Bromley et al. (2007).

An accessible vehicle questionnaire was designed with the aim of determining the numbers of accessible vehicles in a mixed fleet sufficient to meet demand where this is appropriate to city circumstance. A number of locations, including Glasgow, operate a

“fully accessible” taxi fleet, and in these instances an improvement in service levels could not be achieved through a change in fleet vehicle composition. Others, including West Dunbartonshire, operate a mixed fleet, one comprising both accessible and non-accessible vehicles, and some have no accessible vehicles at all. The complexity of this mix requires a research method that can be applied seamlessly in locations where accessibility is seen to be an issue.

The accessible vehicle questionnaire was undertaken in addition to the pedestrian survey in locations with a mixed or non-accessible fleet. It was developed to establish views and potential taxi demand patterns among less able-bodied respondents. The survey took the form of a postal questionnaire, distributed to individuals with a personal experience of special needs for transport.

3.6.4 Case Study

Case studies are significant and widely used in social and transport research (see: Yin, 1984). This study uses specific locations to develop and test the modelling framework and includes the concept of scenario building in their application. The thesis considers the experiences of case study locations both in terms of primary data specific to the broad range of issues in the supply of taxis, and in terms of the detailed impacts of regulatory practices. Case study cities have also been used in the testing and validation of the emerging model, and experiences specific to these locations (set out in Chapter Eight) are considered in determining the impacts of applying a new methodology. In order to accomplish these objectives, it was necessary to collect a substantial volume of primary data. The need for and availability of primary data is identified specific to each of the case study locations, and collected following four methods, *Observation Survey*, *Pedestrian Survey*, *Telephone Survey* and *Structured Interview*. Case study locations were identified on two bases, by the representative nature of the locations, vis-à-vis other UK cities, and in relation to the availability of data and potential to undertake analysis. Glasgow and West Dunbartonshire both represent medium sized locations, but differ in structure (city and peripheral authority). The choice of these locations represents a balance between data availability and location structure. Other location forms, such as rural authorities, are not represented by this sample, nor are very large urban

conurbations (in the UK this is illustrated by London). Analysis of rural locations is appropriate, as is consideration of alternative uses of taxis in these locations, but this is not identified as a focus of this thesis. Similar argument may be applied to London, which differs in its approach to transport provision including taxi licensing to other UK authorities. While the significance of taxi supply in these locations is acknowledged, this thesis focuses on medium sized locations, excluding London and rural locations. The need to address London and rural locations separately is a conclusion of this thesis.

To summarise, within this thesis, case study data was collected in a number of waves, the first of these took place in the period from 2004-2005 and was conducted in tandem with the DfT considering interactions within the nighttime economy. The second wave was a detailed review of taxi supply in 21 UK cities in 2005. The third wave took the form of structured interviews with cities and representative groups with an interest in the supply and use of taxis, covering four UK cities. Finally the fourth wave was the completion of observation and pedestrian surveys in the case study locations. In the course of the study, 1176 hours of observation were undertaken, by the author and a team under the author's supervision.

3.7 Enhancement to existing approach and critique

Existing assessment in the UK appears to be based on a series of disconnected taxi reviews within two of the three regulatory domains, demonstrated within the case studies, detailed in Chapter Five and applied across a number of cities, see OFT, 2003. These are appropriate for consideration, with the concepts and methods used in the existing reviews forming a detailed basis for the development of a revised approach. The identification of the model elements and their enhancement forms a part of the methodology of this thesis. The standard model elements, illustrated in tables 3.7 and 3.8 are widely used and inform data requirements mainly around observation surveys.

Table 3.7 illustrates the standard approach to SUD modelling. It can be identified that SUD modelling requires a significant amount of data to input and produces higher levels of accuracy with more data. The standard SUD model includes two data collection points,

stance observation and pedestrian survey. Stance observation is used, in the standard model, to identify patterns of queuing and delays at stance.

The second regulatory area in which consistent methodologies do exist is the determination of taxi tariff. The most consistent methodology (Table 3.8) measures the change in costs of production and is known as the Taxi Cost Model.

The development of a revised modelling approach has been set out as a Technical Specification, detailed in Chapter Seven, which is applied to a series of case study scenarios, outlined in Chapter Eight, representing possible applications of quantity, quality and economic regulations in specific locations. The use of scenario analysis is a well-developed and well-established tool appropriate for this purpose.

3.7.1 Temporal differences and data consistency

An additional issue also exists in relation to the development and use of disparate datasets across differing time periods. The collection of data should, ideally, occur at a single point in time to provide a base line and subsequent comparative data, for example a summer survey in one year can be compared with summer surveys in previous years, rather than a comparison between summer operations in one year and those in a winter period of a different year. Failure to achieve 'fair' comparisons has resulted in false comparisons being made between periods particularly in the instance of tariff updates in Glasgow (see Appendix 6). Similar issues exist between time periods (night time versus daytime) with false conclusions being drawn where periods are not comparable.

The thesis has addressed a number of data collection points at differing time periods, mainly as a result of the inability to collect multiple datasets at the same time. Data consistency has been achieved by ensuring data collected in differing locations relate to the same periods of the day and days of the week. This included the identification of observation periods consistent within the case studies, on the same days (weekdays were observed Wednesday and Thursdays; weekends on a Friday night to Saturday overnight) in both Glasgow and West Dunbartonshire.

3.8 Conclusion

In the development of this thesis, to this point, we have seen that within ‘transport’ literature, regular - if infrequent - discourse has focused on the supply of taxis, and specifically on the balance between Quantity, Quality and Economic Regulation in the taxi sector. This in turn relates to the methods by which appropriate balances between these elements can be achieved, the methods by which services are defined and controls put in place. Existing taxi analysis, applied to the supply of taxis and including survey and economic analysis by city, has previously been applied to the three elements of control (Quality Quantity and Economic regulation) individually. The effect of which has been to reduce the impact of such analysis, and (negatively) polarising discussion within the individual elements rather than permitting a wider ‘optimisation of supply’ – a key aim of this thesis.

Common existing approaches, detailed in Chapter Two, include measurement for the presence of SUD and the separate assessment of changes in the costs of operation as a method of determining taxi tariffs. While it is possible to identify both elements as individual, it is also logical to suggest the presence of linkages between the two and develop analysis on this basis. Furthermore, it has been argued that neither economic regulation nor the determination of SUD models can be fully divorced from quality licensing, and the full nature of these linkages is not fully developed in the existing literature.

The development of a new methodology rests on the view that identification of a taxi service appropriate to the full needs of a city or authority area is not limited to the assessment of one element alone, and that a licensing authority should be aware of and determine the effects of changes in one domain on the operation of the others. Furthermore, it is argued that, as awareness of the needs of particular user groups becomes further developed, the need to establish tools indicating optimal balances in delivery become more acute.

This thesis sets out an analysis of the approaches common to the regulation of taxis in UK cities, identifying the elements contained within the existing ‘standard’

methodologies, and the linkages that exist between regulatory domains, to present a more detailed framework through which an optimal balance between regulation and market control may be determined. Given that the nature of controls, as well as individual city conditions, differ from location to location, it is anticipated that the resulting framework will be applied on a modular basis, this being demonstrated in the case study cities (Chapter Eight) and illustrated in the instance of a city with a mixed fleet (such as West Dunbartonshire) potentially using the accessible vehicle model developed in Chapter Seven, this not being appropriate to cities with fully accessible fleets (including Glasgow).

The nature of the interaction between taxis and the communities they serve forms a keystone in the development of this thesis and its objective of addressing the cross-section of needs as between users, suppliers and regulators. This is explored further in the context of the UK experience of taxi supply in subsequent chapters, in Chapter Five through the analysis of regulatory models and through an analysis of existing deficiencies in assessment procedures in Chapter Six. Issues arising from the balance between regulation, and the nature in which the current models are applied is further explored in Chapter Seven, where a technical specification for new modelling is built and then applied to the case study sites in Chapter Eight using a scenario building approach. This differs from the standard model in that existing studies question the impacts of changes in one domain alone. For example, the impact of changing numbers of licenses on the entirety of supply; the new modelling framework allowing for a wider range of scenarios, including the impacts of changing vehicle type, stance design and cost relationships.

The methodological approach adopted, including the consideration of cross-regulatory analysis, provides a novel approach not present in existing analysis of the taxi market. The thesis further develops an area of transport research which has remained at a distance from much of the mainstream public transport literature and should prompt and promote questions specific to the relationships between the taxi mode and other forms of public transport; as well as providing a detailed method by which existing supply can be developed and enhanced on a local basis.

Chapter 4

The different domains of taxi regulation: an examination of the institutional, temporal and social context

4.1 Introduction

This chapter develops themes introduced in Chapter Two, in light of commentary from 21 local authorities describing actual practice, institutional practices, and prevailing (social) conditions. It explores the reasoning and aims of imposing such controls and concludes that traditional methods by which an authority controls taxi services may not be entirely consistent with solving social and access issues stated as aims by those authorities.

4.2 Quantity, quality and economic controls applied to taxi services: an appraisal

In preceding chapters, we have provided a preliminary introduction to the application of taxi regulation in the UK. In this chapter we interpret primary material gathered within the UK (see Table 3.5), to assess how current forms of regulation are applied by local authority licensing departments, the structure itself being a result of a historical legacy (see section 1.5). The chapter will appraise the institutional context of taxi regulation in the UK, define the different institutional levels, agencies and authorities involved in taxi regulation in Britain, and suggest that the complexity of licensing reflects both its historical development and the complex nature of administrative structures, with a variable patterning of legal authority in different localities (see Table 4.1).

Table 4.1 Structure of UK authorities in relation to taxi services

	England	Wales	Scotland	Northern Ireland
Primary Legislation	Westminster Government	Westminster Government	Scottish Parliament	Westminster Government / Stormont Assembly ²⁴
Policy Development	Department for Transport	Department for Transport and Welsh Assembly Government	Scottish Executive	Department of the Environment
Policy Application	City and District Authorities	City and District Authorities	City and Regional Authorities	Department of the Environment

Table derived from work set out in Cooper, 2005

4.2.1 National and regional control

Regulation of taxis currently occurs across a number of administrative levels of government, set out in Chapter Two, and differs between national policies at DfT, Scotland and Northern Ireland, and local application, determined at Licensing Authority level. Analysis has, therefore, focused on the issues experienced in applying taxi policies both within the authority (issues arising at a city level include noise, availability, cost etc.) and where difficulty arises at the boundary between authority areas (which may include conflicting approaches, different fares, and difficulties in regularly accessing infrastructure in a neighbouring authority area eg, Airports).

Just over half of all UK authorities choose to limit the numbers of licenses available within their authority area (see Table 4.2) but the pattern is uneven, with a majority of metropolitan cities restricting, and a minority of rural councils. Those choosing to restrict quantity are required (Transport Act 1985; Civic Government (Scotland) Act 1982) to undertake a review of taxi supply focused on levels of demand, and the measurement of SUD, the 'standard' model (section 2.1) a common approach applied repeatedly between locations. Other controls include quality restriction, mainly imposed in relation to the types of vehicle that can be operated as a taxi; vehicle roadworthiness; and economic

²⁴ Northern Ireland legislation is set either by central (Westminster) government during periods of prorogation, or by the Northern Ireland Assembly.

controls – the definition of the tariffs that may be charged and the methods by which such tariffs are updated.

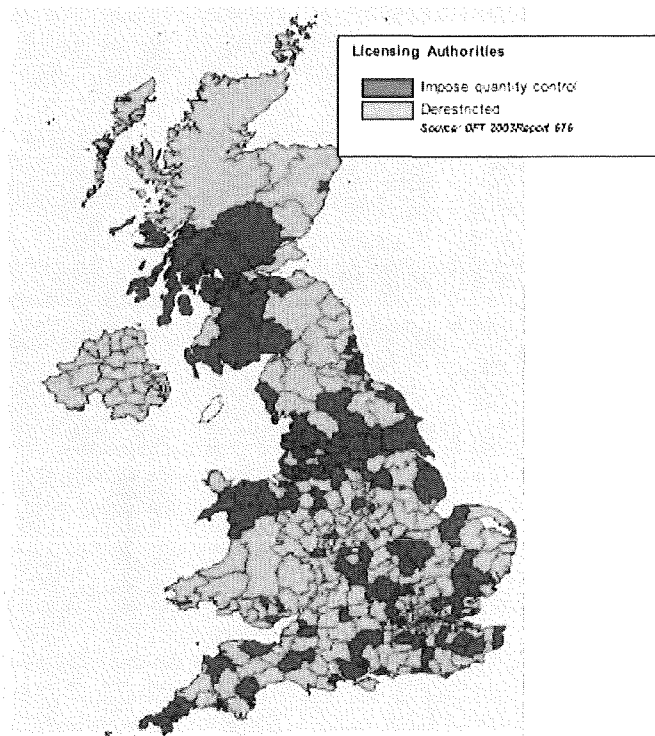
Table 4.2 Licensing authorities applying quantity controls, by type

% of authorities	Urban	Rural	Mixed	Total
Unrestricted	28	82	53	55
Restricted	72	18	47	45
Total (%)	100	100	100	100

Source: OFT Statistical Analysis (2002) Annex B

The choice between a regulated or de-restricted market for taxi licenses appears as a key issue in licensing authority decisions, and appears significantly more controversial than economic controls - where tariff reviews are comparatively routine (OFT, 2003) and consistently applied; and quality controls which are updated infrequently. The controversy surrounding quantity controls has, over time, become a source of disagreement within the cities, between the operator and the city, and between cities and central government (see: Sheriff Court, 1998; OFT, 2003; Court of Session, 2005). In part, the controversy may stem from a polarised approach – a feeling that one of the two regulatory approaches (regulated/de-restricted) is more appropriate in meeting the requirement to satisfy passenger expectations of supply than the other (see Section 2.2), but is also likely to reflect guidance at national level.

Figure 4.1 Distribution of authorities applying quantity restriction (2002)



Source: OFT, 2003

Both guidance from the Department for Transport (2006) as well as policy recommendations from the OFT (2003) identify one approach, de-restriction, as favourable, the OFT stating that Quantity Regulation limits *'the number of taxis, reduces availability and lowers the quality of service to the public'* (pp 3), though the same report indicates, in error, the extent of restriction illustrated in Figure 4.1, which is sourced from OFT, 2003. The report, and the accompanying map incorrectly determining Northern Ireland as representing 26 licensing authorities, when in reality only one exists, and in London counts each London Borough, while taxi controls are determined at London-wide authority level thus over-counting the numbers of authorities operating a deregulated policy.

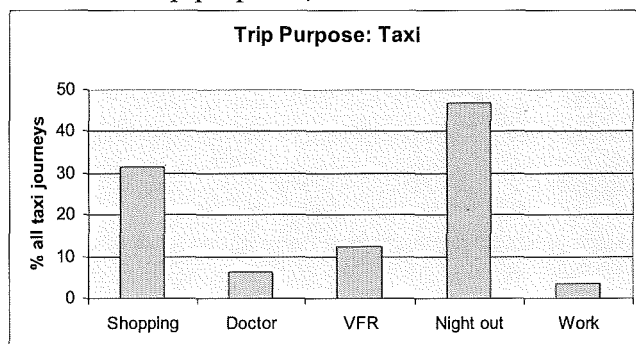
4.3 The structure of urban taxi markets

As we have seen in Chapter Two, there has been a substantial body of policy discussion as to whether taxi delivery is best serviced by regulation or de-restriction. The fact that the discussion remains unresolved and continuing may indicate the significance of a wider range of issues than regulation alone which affect the fit of policy to circumstance, borne out in the survey of 21 cities and including the needs of differing passengers at different times of the day (temporal separation), and the identification of differing needs by location (spatial separation).

Taxi use in the cities surveyed varied between business, leisure and shopping activities, illustrated in Table 4.3, although few of the existing taxi studies distinguished supply on this basis. In comparison, and surprisingly, a key document in the literature - the OFT report (OFT, 2003) provides no data on trip purpose with the exception of information on trips by Disabled Passengers. The apparent lack of detailed assessment of trip purpose, including temporal and spatial differences, has contributed to (perpetuated) the view that a single approach may be suited to all locations, and for all users in that location.

This thesis identifies a number of key underlying impacts arising from purpose of taxi use and the supply of taxis including the distinctions between needs of the daytime and nighttime economies, location in relation to taxi stance, and the functioning of particular stances including differences in the propensity to supply across differing time periods as inputs to new modelling approaches.

Table 4.3 Trip purposes, use of taxis



Source: Primary material contained in Cooper (2006) Report to West Dunbartonshire

Varying city conditions (political, economic or social) may actually result in either the fully regulated or fully de-restricted approach failing to achieve optimal delivery mechanisms that satisfy the taxi service needs of the city while the realities of taxi supply and use may reflect a number of different distinct market segments, discussed below.

4.3.1 Temporal markets

Within broad bands of time, the uses of a city alter and consequently the demand for transport fluctuates, as does its effective supply. Nighttime statistics in the UK are included in some of the reviews of taxi provision, as general indications of current use, but in most instances cities appear unable to determine the exact numbers of travellers seeking to access and travel home from city centres at night. This contrasts significantly to the observed needs of large numbers of people wishing to travel home and may lead to difficulties in accessing such transport as exists, and in the interaction between individuals and the environment (see ODPM, 2005a).

Using primary evidence obtained from the survey of 52 cities (see Section 3.5), case study evidence (Chapter Eight) and detail from existing literature (Chapter Two), it is possible to determine significant differences in the demand for and use made of taxis in daytime and nighttime use. Four periods are identified (see Chapter Two) summarised as:

- Daytime (Office Hours)
- Early Evening
- Late Evening
- Early Hours

Each period displays differing needs, and each representing differing policy imperatives.

4.3.2 Daytime policy imperatives

The current regulatory environment, particularly that applied to transport, gives little scope for temporal differences. Little if any distinction is made between transport during the day and at night, in taxi terms the balance between quantity, quality and economic controls, remain the same in their application across both time periods. It is also apparent that seasonal variations are not generally considered, or at the very least not accommodated with the exception of some cities allowing slightly higher charges to be levied at night. The current policy and assessment structures, particularly those allied to SUD, appear unable to deliver differing licensed fleet levels during daytime and nighttime periods, with a result that councils seek to encourage nighttime supply through fiscal measures (higher tariffs at night) rather than by establishing differences in licensing requirements between day and night. In response, grey markets have emerged in some cities, in which Private Hire Vehicles (PHVs) provide (semi-legal) services, particularly at night where gaps in Hackney supply, suggested by queues as stance, are apparent. In other cities, the illegal operation of pirate taxis has emerged; these vehicles are also referred to as Gypsy Taxis (see: Suzuki, 1985), and are typically involved in illegal pick-ups.

The most common city response has been to adjust levels of taxis through a single licensed-based solution, adjusting the numbers of taxis (generally upwards) across all time periods. These have a propensity to result in either excessive waiting times at night where insufficient taxis are available to meet demand; or in an excessively large fleets seeking business during the day the latter an observed result of previous changes in Glasgow.

Increased supply may, it is argued by some (OFT, 2003), solve long passenger waiting times by encouraging supply at (profitable) night-time hours, but must be considered against the impacts of fleet sizes at other times on the industry in the medium and long terms. These were felt in the taxi focus group to include a reducing return on investment, and increasing un-productive vehicle time. The alternative, satisfying daytime demand, appears more efficient in resource utilisation but fails at nighttime where demand is higher. 'Middle ground' solutions were unpopular among the 21 cities, and in reality not

particularly appropriate as these are likely to be based on compromises in which supply is set somewhere between peak night and daytime expectations, and result in a level of supply that satisfies neither taxi passenger, nor taxi driver.

National responses, expressed in terms of policy, appear to concentrate on the visible, and thus popular, issues of transport supply during the day, including single licensing solutions (DfT, 2003) or de-restriction (OFT, 2003). Transport policies focused on congestion, pollution and modal split questions all affect the visibility and operation of daytime transport, but are far less of an issue in the supply of transport at night. Nighttime transport is more heavily weighted to public transport modes, of which the taxi plays a major role, and neither receives the extent of attention or delivers the same visibility of impacts in comparison to the daytime modes. The impact of a 'natural' focus on daytime issues has been a limited consideration of the impacts of transport policy at night: too much transport (including congestion) being an issue during the day has received the greater part of attention at the expense of the policy consideration of lack of transport at night²⁵. This does, however, represent an issue in the supply of taxis commonly with highest demand on weekend nights, and raises questions on the application of a single assessment measure across all time periods.

Further difficulties were identified in the determination of what constitutes acceptable parameters in varying city conditions. Definitions of passenger delay, indeed if any delay to a passenger seeking to engage a taxi is acceptable, were not clear, with the adoption, in current model of an assumed value for minimum delay (see: Halcrow, 2002). Single values for minimum passenger delay exist regardless of trip type or time of day, with the effect of an assumed minimum service level at night which are unachievable even to significantly expanded fleets in open competition, and generally leading to the conclusion that occasional unmet demand does not equate Significant Unmet Demand, and causing difficulty in that no definition as to what constitutes 'significant' exists (Halcrow, 2002).

²⁵ Considerations of using infrastructure to capacity should indeed lead to an understanding of the deficiencies of such an approach: in the context of current concerns and road user charging policies, reducing congestion in the daytime could reasonably be connected to policies of improved use of capacity at night.

4.3.3 Definition and response to day/night supply issues

The second element of the stakeholder analysis was the identification of individual city responses to nighttime transport. Commentary from the 21 cities, reinforced by observation in the case studies (Chapter Eight) demonstrated that a private individual's use of the city varied by time of day, and seasonally. Seasonal variations may often relate to vacation patterns, climate etc., and are forcibly demonstrated in Edinburgh by a significantly higher number of taxi journeys reported by the city taxi trade as a result of the Edinburgh fringe festival. The most visible patterns of daytime commuting to city centre offices typically inbound for a 9am start, and outbound from 5pm onwards, has formed the mainstay of city transport infrastructure for many decades. Optimistic reviews of the 1980s and early 1990s visualised an alternative '24 hour' city in which time of day played a lesser role in the choice of commuting patterns or work hours (Thomas and Bromley, 2000), have failed to materialise beyond a 'spread' (ibid) of demand at commuting peaks.

More recently, the focus has moved from a 24hr city, in which the same activities were available at any time of the day or night, to a distinct nighttime economy, differing in the nature of activities available - centred on entertainment. The shift in focus has changed prevailing city authority priorities, with many in the 52 authority study seeking to encourage evening participation in leisure activities as a positive factor in promoting local economic growth and city centre revitalisation (Cooper, 2005). In parallel, anti drink-driving campaigns, which have the effect of reducing individual driving, which may logically also have the effect of reducing access to suburban leisure activities, and have encouraged the use of city centres for social purposes - a revival of inner city entertainment and entertainment districts, which may in turn reflect higher levels of public transport accessibility to and from the city centre compared to suburban locations. The counter perspective, as described in the 52 city survey, includes centrally located residents' opposition to the disturbance caused by increased night time activity relating to noise, perceived and actual violence caused by late night revellers returning home in a drunken state (see: ODPM, 2005a).

It would not, however, simply suffice to identify two markets, day and nighttime uses of the city. Few consistent definitions of a Nighttime Economy (NTE) exist (see: Thomas

and Bromley, 2000), most relating to a period after the conclusion of normal 'daytime' business, nor does the nighttime market split easily into transport by private and transport by public modes, rather it can be argued that a graduated market exists in line with the temporal markets set out in section 4.3.1.

4.3.4 Spatial relationships

In addition to the time-based issues, defined above, perception and allocation of space is key to an individual's use of the city. Common issues of sense of place, belonging, and the actual abilities to participate are, therefore, dictated by the physical and aesthetic characteristics of any one location. Facilities available will also vary, central locations differing in activity to urban and suburban locations (spatial), the availability of daytime facilities differing from those at night (temporal-spatial). As the use of the city changes, so do the apparent relationships between social interaction and space. Thus uses differ spatially, but, importantly, they also differ temporally, both affecting demand for and relative efficiencies of taxis in city centre locations.

Changes designed to address taxi supply, indeed all transport supply, must seek to include impacts and benefits but, critically, address them across all time periods. From the transport policy maker's viewpoint policies ultimately seek to serve the desire:

'to have a modern, sustainable, safe transportation system which benefits society, the economy, and the environment, and which actively contributes to social inclusion, and everyone's quality of life'

DRD (2005)

Similar high-level objectives exist in the DfT, which defines its objectives as being:

'to provide reliable, safe, secure transport for everyone which respects the environment: against which efficacy and appropriate application can be measured.'

DfT (2005)

In addition to the policies and legislation arising from the DfT, a range of policies arising from other departments of Central Government, and those arising from devolved administrations, affect the ways in which transport relates to place. These range from examples where regional legislation effectively mirrors DfT policies, as with the taxi licensing elements of the CGSA, to apparently unrelated policies which in their prosecution affect the supply of or demand for transport. An example of the latter would include the Licensing Act (2003) that, although the act itself limits discussion of transport to a minimum, abolishes fixed closing times of licensed premises, thus significantly affecting the use of the city at night and the demand for transport. Policies affecting place can thus impact on transport, and those affecting transport can impact on place.

4.4 Empirical evidence

Within the research conducted for this thesis, the perceived issues of taxi supply across a range of time periods were compared to the actual experiences of medium sized cities (see Table 3.3). A survey of 52 authorities established a range of interactions within the city that are affected by the supply of transport generally and the use of taxis in particular, detailed in section 4.4.1. Observation of peaks in demand for taxis, which occur predominantly at night (see Chapter Eight), suggested the need to identify issues in the use of transport over a full 24-hour time frame, and include issues not typically present in the daytime economy. Additional information specific to the operation of the nighttime economy was also sought from focus locations (Glasgow, Edinburgh, Belfast and West Dunbartonshire), using structured interviews and by observation of transport demand in Glasgow and West Dunbartonshire.

4.4.1 Nature of interactions

Interactions, significant to the use of transport, occurred at a number of levels (Table 4.4), including those directly associated with the use of taxis, time of activity, availability of

services and scheduled arrival/departure times. Propensity to having drink taken was identified as affecting choice of mode, and perceptions of service levels. Further interactions included relationships between retailers, commerce and the licensed trade with the suppliers of transport services; the nature of control applied to those services and factors influencing individuals' decisions whether or not to use services.

Table 4.4 Interactions felt significant in the use of transport

Focus	Interaction	Secondary Interactions
Interactions specific to transport	Private / Public transport modal split	<ul style="list-style-type: none"> • Time of activity • Public transport schedules • Drink Driving • Quality of services
	Commercial and non-commercial transport operation	<ul style="list-style-type: none"> • Assignment of resources • Involvement of retailers / licensed trade
	Supply of public transport and taxis	<ul style="list-style-type: none"> • Impact of Unmet Demand • Quality and Quantity controls of taxis • Illegal and grey markets for taxis
	Provision of adequate Security to those travelling	<ul style="list-style-type: none"> • Perception and reality of vulnerability to attack • Access to boarding and alighting points • Waiting Environment • Security on vehicles
	Role of staff	<ul style="list-style-type: none"> • Reassurance • Enforcement • Policing • Operational Control

Source: Author, survey of 52 authorities

Some of the issues including transport schedules, resource allocation, perception of adequate security, were felt to exist across all time periods, while others were more focused on the provision of transport at night, such as increased vulnerability to attack, and the potential for illegal taxi operation.

4.4.2 Night-time transport interactions

A scoring system whereby issues were ranked in order of importance highlighted that, from the 52 authorities responses, three areas of greater concern existed being: violence,

drunken behaviour (and crime arising from the consumption of alcohol) and a lack of transport.

Drunken behaviour was identified as significant both in terms of the problems arising at night, and in relation to policy application, where policies set a pattern to be followed, while enforcement actually impacted on the environment and the success (or otherwise) of the policies.

Policy effectiveness was also investigated, with Liquor Licensing policies being felt to have the greatest impact on perception of place, as well as the greatest impact on transport. Surveillance, including watch schemes, scored highly as having an impact on the level of crime, although more pro-active measures such as Anti Social Behaviour Orders (ASBOs) achieved a lower 'effectiveness' score and Acceptable behaviour contracts less still.

The apparent lack of public transport was felt to be an issue, though views of the significance of individual modes varied widely from city to city, often reflecting the differing levels of availability of transport between locations.

Table 4.5 Significance of issues identified specific to the nighttime economy

	Value (x/100)
Violence	72
Drunken behaviour	76
Lack of bus transport	71
Lack of Rail transport	51
Lack of taxi transport	60

Source: Author, based on responses of 52 cities

While availability of taxi transport was generally less of an issue than availability of bus services the extent of the gap between demand and levels of supply increased significantly through the course of the night. The issue is highlighted, for example, by Glasgow with its very sharp peaks in the demand for public transport occurring late at weekend nighttimes (see Chapter Eight).

Additional surveys completed in focus locations, reported in section 5.3, allowed further interpretation. Both Glasgow and Belfast recognised the significance of the nighttime economy to their development and image - both seeking to establish infrastructure in which nighttime activities can be enhanced, protected, and carried out with a minimum of conflict between individuals, residents and visitors²⁶.

Glasgow typifies a larger city in which a well-established daytime public transport system was accompanied by a far smaller nighttime service, and is common with Belfast in heavy reliance on the use of taxis. Belfast differs in the physical size and constraints of the city in comparison to Glasgow, and better represents the bus public transport situation in smaller medium sized cities. In Glasgow, both nighttime bus service and large taxi fleets exist in parallel. Taxi services were felt to offer a high quality vehicle, operating in a restricted environment. Overall demand for taxis is satisfied from the existing fleet, and surplus vehicles ply for trade in daytime hours. However, an insufficient supply of taxis was observed for late night transport, demonstrated a sharp peaking of demand.

In Belfast bus services stop in the late evening, and have not been successfully complemented by late night buses, although initiatives exist to re-launch a limited night link service. Taxi services are provided as a mode of choice, and differ to Glasgow in that Belfast has no policy of quantity restriction. Vehicle quality and type differ significantly to Glasgow, and Belfast suffers from large numbers of PHVs seeking to pick-up illegally (DOE, 2006).

4.4.3 Daytime transport interactions

Daytime use of transport differs significantly from its use at night. A significantly higher range of services and options are available to the potential traveller, and concerns over impacts reflect differing priorities to those present at night. A large range of literature (Chapter Two) exists specific to transport during the day and these are assumed, within the focus of thesis, to represent a good indication of current practice. In terms of taxi delivery, an area with less detailed analysis specific issues are identified as they relate to

²⁶ Including the development of safe zones (Belfast and Glasgow), and Taxi wardens (Glasgow)

the changes in model specification. Preceding sections have thus identified and 'problematized' the issues of taxi regulation vis-à-vis the importance and impact of the nighttime economy – an economy in which it appears from the evidence collected that the taxi has a key role to play – and the relationship between this role and other time periods.

4.4.4 User needs

The differing impacts of transport between day and nighttime services also reflect the differing needs of the two distinct markets. Travelling at night involves different choices to travelling during the day, as choices made progressively later through an evening rely less on private transport, and alternative modes become less available. Journey types also differ, with nighttime services more likely to involve longer trips, returning home from entertainment; rather than the shorter business-to-business or home with shopping trips during the day. Issues within the city also differ, with cities identifying differing interactions in the nighttime economy as compared to during the day. Transport is involved in some interactions, indeed many nighttime issues arise from a lack of transport, and these impact on the use of transport, and taxi in particular, setting expectations, but also reflecting concerns of the travelling public, the city authority and the drivers themselves.

Passenger concerns, which emerge from the pedestrian surveys, are often related to availability and cost; city authorities being aware of the need to prevent conflict and the impacts of liquor licensing decisions on access; taxi drivers expressing concerns regarding passenger behaviour and costs associated with cleaning or repairing vehicles.

4.5 Gaps in delivery

A further step in identifying an appropriate model for taxi delivery was to identify the relationships between concerns and gaps in taxi, and transport, delivery that may be addressed in terms of changes to supply. The relationship between an urban environment

and its transport is complex and significant. A considerable base of documented research, policy and practical applications exist demonstrating the potential for positive interactions (Grant-Muller, 2000), as well as some of the negative consequences of adopting poorly planned transport policies (ODPM, 2005). It is also observed that many current transport policies (eg: congestion charging, parking etc.) apply to the daytime economy, where impacts are visible. By comparison, consideration of nighttime policies, or the impacts of '24 hour' policies on nighttime transport and city use are less advanced. Taxis operate in both time periods, and have been observed in this research to be the majority form, and sometimes the only form, of transport available very late at night.

The split between the nature of transport at night and during the day creates strains on the concepts currently used in determining the effective forms of service by city, and is often overlooked in the development of new policies. Moreover, in the supply of taxis, the models currently employed in assessing and justifying a particular form of regulation may fail to fully account for the significant differences in the markets (day and night), take account of the wider range of interested parties, or appropriately measure location specific or time specific factors in their analysis.

4.5.1 Models used in the determination of regulatory form

The focused discussions also provided detail of the tools, use of models, and choice of regulatory structures applied in each authority area, and consistent with current legislation (Table 1.4) including maximum fares, and the need to apply taxi surveys where quantity restrictions are sought. In practice this has involved the use of SUD surveys which in turn have developed around the standard model described in Chapter Two. The approach is commonplace and supports one of two forms of quantity control: regulated or de-restricted, discussed in section 2.4.2.

The existing SUD approach incorporates a number of sub-routines (SUD, ISUD etc.) that measure particular elements of the balance between supply and demand and do not typically discriminate between day and night. The models appear to be widely applied in order to satisfy one condition alone, namely whether there is felt to be a surplus of

demand over supply across the entirety of any one city's taxi supply. This is understandable, and is commonly applied in supporting restriction, but fails to consider a significant number of elements in determining what is, and what is not the most appropriate form of regulation, a decision that appears to be more based on the political approaches or strength of lobby groups, rather than having a foundation in measured analysis.

Most SUD model application fails to identify differences between day and nighttime use of transport, differences in seasonal demand for services, or even to look at the full range of factors affecting the use of the fleet and the demand for taxis beyond that required in law - appearing to be adopted as an approach of least resistance. The simplicity of the choice between regulated and derestricted markets is a product of the simplicity of the model, but also of the avoidance of the less visible issues such as a need to fully address latent demand or need for particular vehicle types that may provide a better level of service to the travelling public.

Issues also occur specific to the application of the model itself, particularly where a standard and carbon copied methodology is being applied without due consideration of the factors affecting the particular city in which it is being applied. Local circumstances, spatial particularities, physical restrictions, and behaviours of the taxi trade can be overlooked in favour of operational simplicity, and cost reduction, preferring to assume limitless stance capacity over measured and modelled assessment by stance, stochastic arrival and absence of preferred operating patterns on the part of the drivers. Simple definitions of significant unmet demand do not exist, allowing arbitrary measures to be adopted, reducing the effective quality of conclusions based on the measurement. Furthermore, the interaction between excesses of daytime supply and a desire to meet nighttime demand appears little considered. In one instance an additional 10,000 vehicles were shown as necessary to satisfy nighttime demand²⁷, regardless of the nonsensical impact of this number of additional vehicles on the daytime market, or indeed the likelihood of such supply being forthcoming.

²⁷ The figure of 10,000 extra vehicles results from the application of the standard model to Glasgow, and is not shown as a realistic figure required to achieve supply at all times, but rather a real result demonstrating the inability of the standard model to identify impacts in one domain on others. In reality any increase of this level will have a significant and negative impact on the ability of the trade to operate, and will not result in full supply.

Widening concerns about the form and nature of the existing models do exist, and are demonstrated in the development of best practice guidelines (DfT, 2005), seeking to include assessment of Latent Demand assessment, a measure that can be achieved on the basis of observation alone, and the need to review the cruising market. Though in reality these may actually only relate to the removal of some gaps in the existing model, rather than the determination of a more appropriate approach.

4.5.2 Factors in market development

While the current market models concentrate on the needs of the passenger, they support, or at least sustain, the perception of a polarized market, one in which either passenger gains in supply are at the expense of the industry, or that restricted markets appear to protect the interest of the suppliers in a closed market, over the needs of the travelling public. It is possible that neither extreme is appropriate, nor correct. Long-term declines in vehicle quality and supply number are apparent in instances of full deregulation and were highlighted in responses from US cities. These highlighted, falling quality and price impacts are the main visible indicators of this, and can be seen in previously deregulated cities including Fresno and Seattle. Identified in our review of 15 US cities (see Table 3.5). On the other hand, restricted markets need not equate to a lack of supply. The original concepts set out and including SUD were not intended to act as a method by which market supply could be limited, merely a method by which appropriate supply could be determined, where the determination of appropriate levels of supply could inform the decision on regulation rather than be a base to justify on or other approach.

Other market participants include the regulator, being both the authority applying policy determined at national level, and arbiter of appropriate regulatory balance in an authority area. Here it is important to understand that the regulator will be adopting tools for regulation authored by experts and other higher level authorities and applying these within their area (jurisdiction). In fact, in many models and analyses the needs of the Licensing Authority are not explicitly addressed and are indeed often overlooked, including the need for the regulating authority to justify choice of restriction and its assessment in terms of best value to the public purse. The regulator, in meeting the legal

requirements set by higher-level authority, may need to demonstrate both effective provision, and a method by which costs of regulation can be covered (cost recovery).

To be successful, the development of the market needs to address the needs of the operator and of the regulator (which underwrite the supply of services in the longer term) as well as the needs of the passenger in all time periods. Improving customer service may well go beyond the existing SUD, and include, demand (SUD/ISUD), Economic Regulation, service quality, and safety. The needs of operators should also be considered in achieving a level of service that is sustainable in medium and long terms, to avoid the situation where short-term gain to the passenger (such as immediate reductions in fares) may be at the expense of longer-term sustainability.

The determination of appropriate methods of determining supply of taxis provides a key to delivering a service appropriate to the needs of the traveller. This is not a simple or polar choice between regulation or de-restriction, but an assessment of the temporal and spatial needs in order to define appropriate delivery mechanisms.

4.6 Conclusion

In conclusion, it can be seen that an appropriate alternative solution to present problems in the regulation of the taxi industry would seek a balance of regulation that satisfies the needs of the cities in differing time periods, and the needs of all market participants. The interaction between the two extremes appears not to have been fully explored in models to date, with the consequent need to include these in the development of new frameworks for regulation. Any such new model would need to include both the factors included in the existing concept of SUD, this being a widely applied and common justification for the choices between regulation types, and the wider context of taxi delivery.

But this is only a part of the development of the modelling concepts, which need also to consider the ability of the industry to satisfy the needs of the travelling public across a wider time scale, both temporally at the point of application, and in the medium, and long terms in the ability of the industry to sustain and develop. Having identified the issues in

supply at a city level and considered the relationship to existing models at a preliminary level we now move to Chapter Five which provides a description of the relationship between regulatory models and the analytical models used in the delivery, assessment and operationalisation of regulatory models. This is followed by Chapter Six, which considers existing UK practice in more detail. It considers how models are defined, both as general descriptions of the balance of QQE, and the methods in which the external factors can be accommodated. This combined with Chapter Five is a prelude to the development of the new model in Chapter Seven.

Chapter 5

Regulatory models: a detailed analysis

5.1 Introduction

This chapter defines the concepts of models of taxi delivery. It distinguishes between models of regulation, analytical and economic modelling. The chapter considers the relationship between regulatory models and the tools that have been applied in their design and justification. It concludes by indicating the extent of apparent inefficiencies in differing models of regulation in the UK and comments on the implications these may have on the delivery of appropriate taxi services in metropolitan cities in the UK.

5.2 Defining regulatory models

The term ‘model’ is often used to mean two things. Firstly, as a description of a set of factors typical in applying a range of controls; and secondly, in referring to a tool (such as ISUD) that determines the impacts of particular application, and thus informing service design or regulatory balance. This latter form can be termed an ‘analytical model’: the former, defining models of delivery - effectively the balance between controlled factors, in which an authority applies limits to activity; and/or market factors, in which the market applies limits to activity – which can be termed a ‘regulatory model’, see Figure 5.1. Analytical models have become widely used in the determination of regulation, in informing or as justification of a particular form of regulation. Figure 5.1 illustrates the relationship between regulatory models, and analytical models, and demonstrates the range of options that may be applied in the determining levels of service and control in the taxi industry and methods of determining their impacts.

Figure 5.1 Regulatory and analytical models

QUALITY CONTROL <ul style="list-style-type: none"> • Safety • Comfort • Appearance 	QUANTITY RESTRICTION <ul style="list-style-type: none"> • License Numbers 	ECONOMIC REGULATION <ul style="list-style-type: none"> • Tariff • Pick-up charge 	Regulatory Models
PSV / MOT	SUD	COST MODEL	Analytical Models

Quality controls

Quality controls can be applied in relation to safety, comfort and vehicle appearance, being forms of regulation applied to a taxi vehicle. Such controls are common and applied in terms of vehicle safety and fitness, and are regularly applied in UK cities. Quality controls may further be extended to include driver dress code etc., (eg: Highlands require collared shirt).

Analytical models may also apply to the determination of quality control, of which vehicle testing is identified a common test against which vehicle performance is tested.

Quantity restriction

Quantity restriction relates to the numbers of licenses issued by an authority, and are applied as an upper limit by some cities. The rules under which quantity restrictions are applied and enforced are significant and precise (CGSA), requiring authorities that choose to restrict to demonstrate no significant unmet demand results - a key element of analytical models applied in this domain. Authorities are prohibited from applying quantity restrictions to PHVs.

Analytical models of demand (SUD) are common, see section 2.6.2, and are required where quantity restrictions are applied. The most common (Halcrow model) appears widely accepted as satisfying legislated requirements; but fails to address the potential for more wide ranging analysis, both in terms of satisfying legislated minima and in optimising taxi services. Such developments form a significant element of this thesis, and include the identification of linkages between quality control, quantity control and economic control.

Economic regulation

Economic regulation is most commonly applied to the determination of tariffs, and may include determining the form of such charges in relation to distance, time, and how initial charges – the amount paid for engaging a taxi, booked pick-ups and/or access from prime locations (such as airports) are applied. Economic regulation is generally justified on the basis of public interest, but has been subject to significant debate (see section 2.2), argued between controls that reduce the opportunity for excessive charges and downward price competition within the market. Protection exists to the consumer in that a detailed and defined tariff structure reduces the opportunity for an unscrupulous driver to charge fares that do not relate to costs, and this is further reinforced by the common use of taximeters in the majority of cities surveyed (with the exception of Belfast).

The Taxi Tariff lies at the heart of economic regulation in the industry. The tariff is a maximum that can be charged, traditionally based on a combination of time and distance. Implementation of tariff is obligatory and charges based on it are overseen and enforced. It is a significant element in determining the shape and operation of the taxi market, and will impact both on the levels of use and the desirability of the trade to new entrants, to retaining staff, and to the provision of services at particular times. The tariff is determined against a measured cost of production, and regularly updated (the CGSA requires updates every 18 months or more frequently) through a process of taxi tariff reviews.

Analytical models exist in the determination of taxi tariff and are applied across a wide range of authorities as a part of the taxi tariff review process. These are based on comparisons of costs and are used in updating tariffs over time. Changes in the costs of production can be applied to the base tariff, while alternative scenarios are employed to determine appropriate methods of application. An increased basic tariff, for example where an Industrial Price Index (IPI) increase of 5% is determined, this can then be applied to the tariff table, the amount charged by unit distance and unit time. Here, however, another complication arises in that many tariff tables are set out in stepped units (cost per distance or cost per unit time) where either particular coinage is determined, a step of 20 pence per unit, or preset distances, where one unit value buys a determined

number of yards. The stepped nature of the tariff may in fact discriminate against particular journeys or result in uneven distribution of an increase across all taxi users.

Further issues arise in the determination of tariff in that significant linkages exist between the economic regulation of taxis and other regulatory domains that are not fully considered in an isolated tariff review. Changes in other domains, such as a change in fleet size resulting from a quantity model, directly impact on elements in the cost model but are not, currently, considered together, affecting and reducing effective balances between regulatory domains. This is a major finding of this thesis, and is included in the specification of a new modelling framework, detailed in Chapter Seven, and applied in Chapter Eight.

5.2.1 Balance and impacts between regulatory domains

The balance between regulatory domains (Section 1.1) reflects current regulation and the choices made at Licensing Authority (LA) level. The decision requiring, under the current structure, application of a differing set of analytical models. Thus *Quality* control may include testing for the safety of vehicles (PSV/MOT), typically applied by agency rather than LA. *Quantity* restriction justified on an analytical measurement of Demand (SUD), see section 2.4.2, while *economic* controls may include assessment of tariff levels.

5.3 Forms of regulatory models

As we have seen, the concept of a control or limitation placed upon taxi services is not new, the first application of regulation dating from as early as 1636 (see section 1.5) at which time a *quantity restriction* was applied to the number of taxis 'licensed' to operate in London. Tariff restrictions followed in 1654 (Poole, 1998) providing the first form of *economic regulation*, followed by the 1847 Town Police Clauses Act – still in force – requiring appropriate identification (a *quality restriction*). Restrictions being argued for,

then as now, to maintain or set into place methods of assuring a quality of service. By the time of the 1847 Act all elements of regulatory control (QQE) were set and in place, and have remained to this day.

No matter the length of regulatory history, regulation is has not remained a static choice between fully regulated and deregulated markets, with differing forms of regulation applied to differing service types, often a choice between Hackney carriages, and PHVs (see Table 1.1). Both are subject to control, but rarely on a consistent basis. Larger cities regularly restrict the numbers of black taxis permitted to operate, while none restrict the numbers of PHVs (OFT, 2003).

5.3.1 Quality control

Quality control is an overarching description applied to a variety of factors affecting the quality and safety of taxi vehicles. These include, but are not limited to, the:

- Safety, including PHV testing
- Operator and Driver Fitness
- Comfort, and appearance of licensed taxis

Vehicle safety restrictions

All cities require vehicles to fulfil vehicle safety minima, standards covering the basic road fitness of taxis (see: OFT, 2003). The concept and application of vehicle safety standards and associated testing receives little commentary, appears broadly uncontroversial, and was similar, in the 21 cities reviewed, to the standard tests set for private cars in the MOT test. The main differences relate to the frequency of testing, taxis are generally required to complete testing once a year from the date of first registration, as opposed to testing from the third year applied to private cars. In a limited number of instances older vehicles are required to be tested more often, in others an age limit is applied to the vehicle, a form of vehicle type restriction.

Operator and driver fitness

Operator and driver fitness for purpose are, similarly, suitable for objective testing, as are standards applied to operator premises. The concepts are not as widely applied as the roadworthiness tests, and have courted some controversy in instances where their application has been suggested (DOE, 2007), reported in Northern Ireland (Belfast Taxi Proprietors) where operators see the introduction of new testing as a threat or form of ‘hidden’ restriction.

Vehicle type restrictions

In some cities vehicle type restrictions exist (eg: Glasgow). This is often felt to improve the overall appearance, and in some instances performance. Most vehicle type restrictions are not mandated on the basis of legislation, but rather on the desire of a local licensing authority to ensure a standard of vehicle operating in the taxi parc. A standard for ‘black taxi’ types exists in relation to the definition of a ‘London Taxi’ (see Table 2.1), and this has been applied in relation to other cities including Edinburgh, and, as described below, in part to Glasgow. The MCF specify very strict operating parameters for vehicles including cabin space and, controversially, turning circle requirements. In practice, two types of vehicle fully comply with the MCF requirements, the Metrocab, and vehicles produced by London Taxis International – currently the TX1, TX2 and TX4. Glasgow also allows other black taxi styled vehicles that conform to the majority of the MCF requirements but fail the turning circle; these include the E7 Eurotaxi, and are permitted in a reduced number of cities. Other instances of restriction include cities allowing fleets of vehicles to a specific age, and in some instances authorities insisting on greater numbers of roadworthiness checks on older vehicles (see South Ayrshire, 2006).

Vehicle standards also affect the mobility of passengers using them. The DDA (Table 2.1) recognises and seeks to apply minimum standards to taxis as forms of public transport suited to the carriage of passengers with disabilities. Not all locations apply DDA requirements, with a number seeking exemption, allowed under Chapter 50, Section 35, for smaller locations and where application would create negative market conditions adversely affecting supply.

The effect of vehicle type controls directly impacts on the appearance and usability of the taxi fleet. Indirect impacts also exist, including impacts on the cost of operating taxis, and

where cost models include vehicle purchase costs; these relationships, this thesis argues, should be accounted for in the regulatory assessment framework.

Vehicle appearance restrictions

In addition to the types of vehicles permitted, some Licensing Authorities choose to specify appearance requirements, including bodywork colour (eg: St Albans), and in some instances restrictions on the extent of advertising and signage permitted (eg: Highlands). As the restriction is applied globally within the authority areas, it attracts little controversy, except in instances where its application is considered to be inconsistent or discriminatory. Examples of controversial sign restrictions include a current move by the DOE to remove roof top signage from PHVs, and introduce vehicle specific plates in Northern Ireland (DOE, 2002), where the same restriction can not be applied to certain vehicle types (London Taxis) where built in roof top signs are integral to the vehicle. In reviewing these restrictions and requirements it can be easily seen that these are likely to impact on the model itself, as costs of compliance influence operating costs and alter the effectiveness of cost and SUD models.

5.3.2 Linkages between quality control and analytical models

Quality controls are rarely considered in tandem with other regulatory decisions, often on the basis that their presence is necessary, does not court controversy, and these are likely to continue regardless of changes in other forms of the QQE balance. We will return to this issue later in the discussion of interactions and linkages between the different domains of regulation (see Chapter Five), for our purpose here it is sufficient to note that the analytical models relevant to regulatory controls set on quality are to be found in the requirement for mechanical testing as set out in the requirements of the PSV/MOT tests.

5.3.3 Quantity restriction

By far the most controversial element²⁸ of the balance of regulations is the restriction applied to the numbers of vehicles and licenses issued in a Licensing Authority area. Quantity controls are direct and indirect limitations placed on the numbers of vehicles effectively operating in an area. The most common form of control is a direct limit placed on the numbers of vehicles permitted to operate, usually achieved by placing an upper limit (cap) on the numbers of licenses issued.

Supply restrictions

Properly speaking supply restrictions can be identified as barriers to market entry. However, the policy of restricting license numbers differs significantly from fitness for purpose requirements identified as a quality control. Furthermore, the tests applied to restricted licenses recur, are mandated, and subject to testing on a regular basis as a result of case law (see: *Coyle v City of Glasgow: Sheriffs Court, 1998*), whereas limits on fitness for purpose tend to stand as long running, and generally uncontroversial. Restrictions on the numbers of licenses issued are normally justified against the effects of an open market in the instance of market failure. Free markets operation can result in market failure observed as excessive charging or inappropriate levels of service and the basis for restrictions applied from 1647 to the present day.

The policy of restricting entry is highly controversial, and is limited the UK to where an LA demonstrates that no negative impacts will result as a result of the policy. This is effectively construed to mean no SUD. The approach mirrors similar concepts adopted in New Zealand, which has since deregulated supply (Transport Services Licensing Act 1989)

5.3.4 Linkages between quantity restriction and analytical models

Many cities in the UK continue to apply restrictions to the numbers of licenses and, as a result, SUD testing is widely used. Surveys tend to follow similar patterns and are all designed to conform to the legislated requirements. The wording of the legislation (which is common between England, Wales and Scotland) is precise and this has led to the

²⁸ Receiving the majority of local press and trade journal coverage (based on review of *Private Hire Monthly* and a 'Google' journal search

common approach, including development of Best Practice advice by the DfT (2006). Modelling approaches to SUD assessment are not proscriptive but have become heavily weighted toward the standard approach, a *de facto* form of detailed in section 2.5. The concept can only, however, provide detailed assessment for some of the elements pertinent to supply restriction, and in some instances is limited in its application. *Latent demand*, the desire to use taxis not revealed by the action of seeking to use a taxi, is not measured in many SUD studies (see Halcrow, 2002; 2004), while the effects of other forms of transport or nature of peaking are hard to integrate. Secondary markets, including latent demand, and tertiary impacts, such as the effect of licensed taxi supply on regulator, business and other forms of transport would require additional impact assessment, and the relationship between taxis and the general supply of public transport may require a further more holistic assessment approach.

5.3.5 Economic regulation

The third element of the regulatory balance relates to economic controls and, in the case of taxi tariff, is derived from the need to protect against abuses in price setting that may arise in the absence of such control. Economic regulation itself can relate to a widespread cross section of impacts and controls arising from the application of control to an industry or company but is largely restricted, in taxi control, to the detailed examination of taxi tariffs. In this respect the term applied to the control of economic aspects of taxis should be clarified and applied in the determination of price restriction and appropriate tariffs alone.

Price restrictions

Economic regulation in the taxi industry is, where applied to price restrictions, most commonly justified on the basis of consumer protection²⁹. Limits to the level of charges that may be made for using a taxi are determined by licensing authority and applied through preset tariffs imposed as maximum charges. Price restrictions are often justified

²⁹ The absence of price controls would allow for tariff abuse and, eventually, loss of consumer confidence.

as a balanced measure against overcharging by profit maximising and unscrupulous drivers. Tariff levels can be increased, and must be reviewed at regular intervals (CGSA) to ensure tariffs accurately reflect the costs of providing services a process of review by authorities, operators or contracted consultancies. The presence of a legislation (the CGSA and Local Government Acts) to justify and review tariffs is likely to have contributed to the development of a series of common analytical approaches (cost models) used in the determination of this form of regulation.

Other controls impacting on price regulation

In addition to direct regulatory controls applied to the levels of tariff that may be charged for the use of taxis, a number of locations identify the physical conditions of taxi engagement as affecting the ability to compete openly on price (see section 2.4). This is further explored by the OFT, leading to the statement, at a meeting with the Belfast taxi trade in 2005, suggesting that ranking taxis may be more open to price competition than in hailed or pre-booked markets. This is significant, as it appears to distinguish between the economic regulations of one form of taxi use above another. This may not, in reality be possible or a realistic outcome of a single cost base approach. It does, however, confirm the linkages between controls applying in one domain, in this instance economic control, being directly linked to those in another. It may also indicate a link between the physical condition of engagement and the effectiveness of controls. The latter issue being addressed in the new modelling framework by the application of a physical engineering element, detailed in Chapter Seven, and indirectly followed by non-licensing scenarios – possible solutions to taxi supply shortfall not related to an increase in license numbers.

5.3.6 Development of analytical cost models

Tariffs can be determined using a number of tests, most identifying changes in the ambient costs associated with the provision of taxis, and applied as ‘cost models’ in some UK cities (including: Birmingham, Glasgow, and Edinburgh). Most determine changes in costs in comparison with a previously determined tariff, and apply all, or a proportion of

this change to the tariff in force. Cost based assessments tend to be more precise than inflationary testing, the former using an Industrial Price Index (IPI) based on measured inputs to production costs, the latter on general price inflation (RPI/GPI).

Differences can also exist in the manner of application. In many instances tariffs impose a financial straight jacket on the industry operating under them. No accommodation is made for increased costs of supply, except in instances where time of day differentials are included in the tariff application³⁰; and little room exists for price competition. The desire to allow for price competition while avoiding excessive charging has led many authorities to set tariffs as a maximum. In practice, the concept that price competition is possible and that charges would be made below preset maximum rates is questioned, and in some texts dismissed as impracticable (eg: Price Waterhouse, 1993; see Chapter Two).

Links do, however, exist between the most common forms of cost models and models of demand, and will represent a significant level of interdependencies where both are applied in the same location. Moreover, the need to consider impacts of one form of regulation on others remains, regardless of the extent of modelled or more arbitrary tariff determination. Price control measures are likely to impact on the ability of a market to function, and on the controls in place in other regulatory domains, and this is felt to support the need for more fully developed links to identify and take account of impacts arising in one domain affecting the operation of others.

5.4 Conclusion

This chapter provided a detailed analysis of the components involved in analytical models of taxi regulation and details precise elements within the models of Quality, Quantity and Economic Regulation, it is followed by Chapter Six which evaluates existing UK practice in respect of the analytical models and these two chapters taken

³⁰ Nighttime taxi tariffs tend to be higher than those during the day, an instance referred to by tariff number, thus Tariff 1 may apply to daytime taxi use, tariff 2 to nighttime use. Some cities, including Glasgow, apply a supplement for travelling on weekend nighttimes.

together will inform the design and construction of the new model presented in Chapter Seven.

Chapter 6

An Evaluation of Existing Practices

6.1 Introduction

This chapter builds on the Chapter Five, which set out analysis of the regulatory models available to the taxi authority, to assess their application in UK authority areas. UK taxi services operate, at present, within a complex framework of regulation and licensing based on application of controls at a city and district level. The controls distinguish and set taxis apart from other forms of public transport and have, over a significant number of years established a particular form of licensing and control pre-dating and differing from controls applied to other forms of transport. Taxis are heavily regulated and, although the subject of regular discussion (in the USA in the 1970's, and following the UK OFT report of 2003), have remained largely unchanged in structure or control. The introduction, by the Civic Government (Scotland) Act (1982) (CGSA), which applies in Scotland, and the Local Government (Miscellaneous Provisions) Act (1976), which applies to England and Wales, of a mandated review has led to the development of a series of standard analytical approaches (SUD Models). While common, the application of a regulated framework does not appear to have universal support. Moreover, the close association between SUD models and a particular – regulated – market form may also drive questions as to the appropriateness of the 'standard' approaches to determining taxi delivery.

The initial review of literature, Chapter Two, indicated and demonstrated a divergence in support between those seeking to maintain regulation, and those seeking to liberalise provision. UK literature, particularly within and arising from the Office of Fair Trading report (OFT, 2003) also discusses the methods by which regulation is applied, and methods of assessment, currently the domain of the SUD model. Chapter Four addressed the institutional, temporal and social contexts in which taxi supply takes place in the UK. It also introduced the conceptual structures within which models are used within the taxi domain. Chapter Five extended this latter understanding and prepared the ground for a detailed evaluation of the existing practices, model form and assessment of gaps in the current modelling methodologies. This chapter looks in more detail at the current

experiences of regulation, and the 'standard' models used in its assessment. In this context, 'modelling' refers to a) the existing methodological approaches to the determination of assessment measures for the presence of SUD, and b) approaches taken in determining economic regulation. The chapter also identifies issues specific to quality control, and in particular the effect of accessibility regulation, including the Disability Discrimination Act (1985), which applies to transport but has not been universally applied to taxis. The chapter also provides an introduction to the case study cities, described in Chapter Eight, and potential for model enhancements for application, described in Chapter Seven.

This chapter uses location specific materials, collected in the course of the thesis, to investigate issues identified from taxi literature, in Chapter Two, in their concrete local application, and to determine the extent to which these issues impact on the supply of taxis. The case studies also provide more detailed analysis of the operational difficulties that any one particular approach causes, and reveal faulty current practices that have not been either identified or developed particularly within the existing literature. A subset of the full range of case study locations also provide the focus for model development, for the determination and testing of new modelling approaches, and these reflect a cross section of urban forms, initially identified in Chapter Two.

6.2 Case studies exemplifying key issues in taxi supply

The major analysis of case study materials is provided in Chapter Eight. For our purpose here it is sufficient to note that a cross section of British cities have been the subject of primary data collection, used to establish the range of issues typically affecting the supply and use of taxis. In addition to the broad range of locations used to identify current issues, more detailed assessment including pedestrian survey, observation survey and structured interviews has been undertaken in a smaller number of urban locations, representative of the range of city forms identified in 3.5. Surveys occurred in a series of waves, with 52 local authorities responding to the initial survey round indicating recurring issues in the supply of taxis (see Table 6.1).

Table 6.1 Common issues in taxi supply

Issue	Definition(s)
Taxi Delay (also peaking)	Identified delays between seeking and engaging a taxi.
Peaked Demand	High levels of demand for taxis at particular times of the day, and in particular city locations. Most common in the early hours of Saturday and Sunday mornings
Interactions between city and transport supply	<p>A large number of interactions are identified, and include:</p> <ul style="list-style-type: none"> * Urban design and control * Interactions including transport and the night time economy * Interactions between individuals and groups * Interactions including licensed premises * Interactions arising from administrative and authority boundaries

Source: Author, survey of licensing authorities

Taxi delay appears as a common theme through city authorities, as does the issue of taxi peaking, either excesses of demand or excesses of supply. The nature of this split is also noticeable on a more detailed scale, both in terms of its impact on the nighttime economy and in terms of the associated control and licensing regimes identified in 21 authority areas. Delay, however, counts both as a generic issue – where an issue arises from delays within the transport network, impacting on the functioning of the city differently by time of day; and a precise location specific issue affecting the explicit spatial references connected to the analysis of each and every location. Table 6.1; above, details generic issues, expanded in the case of the nighttime economy in Appendix 3, while subsequent analysis concentrates on location specific and detailed issues of spatial context and the operation of taxis within a location.

Location specific impacts are considered in relation to a smaller number of locations, as part of the third wave of assessment, and are based on case study cities, observed and survey based data for those locations. Within our case study materials, detailed later (see Figure 6.1), we discuss the explicit patterning of delay for a number of locations, and identify conflicts in spatial resolution, a complex issue that includes interactions between authority areas (boundary impacts), legislated conflicts (including the spatial

ramifications of mixed versus single tier fleets), temporal conflicts (including spatial significance of supply in the nighttime economy) and administrative conflicts (including differences in priorities and objectives of local government / authority departments). Of these, particular emphasis arises in relation to the nighttime economy, where taxi services are often a majority form, and sometimes the only form of transport available.

Individual locations, identified from case study data, also demonstrate particular peculiarities arising from the popularity of one stance against under use of others, which has resulted in some stances being heavily used and attracting larger numbers of vehicles, while others may be underused or not used at all, become less well served by taxis, and in consequence lose regular service altogether, as may be observed in use concentrated on the Gordon Street stance in Glasgow (see Chapter Eight, Figure 8.17), in preference to nearby stances in Hope Street, or Renfield Street. Observed patterns of use highlight the need to identify the variations in the spatial and temporal supply of taxis – put simply, models of supply need to be aware and take account of the fact that taxis may be readily available in one location of a city, whilst being relatively inaccessible in others. The same is true in terms of availability by time of day.

The issues, of administrative and spatial interaction, which were identified in the initial survey round, were further explored in structured interviews of city administration and local interest groups. These were undertaken through a series of meetings held between 2005 and 2006. These structured interviews confirmed that there were major problems in accessing taxi services in city centres most particularly during the workings of the nighttime economy. The principal contributing factors can be identified as a lack of adequate supply at the nighttime point of peak demand and the nature of nighttime city use, concentrated in entertainment districts with associated problems of noise, disorder and unruly behaviour. These elements are further investigated in the next section.

6.2.1 Structured interviews

Structured interviews were undertaken in the four focus authorities, and these provided opportunities to investigate in more detail the issues faced at a local level, by taxi users and key stakeholders, including undertaking structured interviews and collecting primary data for use in modelling through observation and survey. Before discussing the results of the structured interviews, it is useful to focus upon the locations and scale of the research.

Meetings in Glasgow were held with the taxi suppliers, Glasgow Taxis Ltd., in May 2006, together with discussions with the City of Glasgow Licensing Department and the taxi committee convenor. Two meetings were also held with the managing director of Glasgow Citywatch, a combined police and city CCTV system in the same month. Interviews followed the same format allowing open discussion within the pre-determined structure of identifying issues in supply and use of taxis, issues at stake, and issues specific to the regulatory structures. Meetings in Edinburgh were held with the taxi trade and with the City of Edinburgh Licensing Department. Meetings in Belfast were held with the taxi trade, and with the Licensing Authority, the Department of the Environment (DOE). Additional meetings were held with Black Taxi associations. Meetings in West Dunbartonshire were held with the taxi trade, the authority's Licensing Department, and with the West Dunbartonshire Access Panel, a council group concerned with physical accessibility and the development of equal accessibility to all users.

6.2.2 Key issues arising in the focus cities

As already noted, the principal areas of concern within the four focus cities reflect those found within the wider set of case study locations, however these structured interviews provided a more detailed window on the patterns associated with the various particular applications of regulation as adopted as between cities.

Taxi delay was identified in three of the focus cities (Belfast, Edinburgh and Glasgow) as being of particular concern, the fourth, West Dunbartonshire, identifying delay at specific

times and in specific locations only. All four cities identified a strong link between nighttime activities and the use of taxis as a method of returning home, taxis being the predominant mode of transport returning from nighttime entertainment in all. Both the licensing convenor, interviewed in Glasgow, and DOE policy development officers (being responsible for taxi licensing in Northern Ireland) interviewed in Belfast reported a vibrant Nighttime Economy comprising entertainment and revelry³¹. Significant numbers of participants partook in activities at weekends, with some estimates as high at 70,000 individuals in Glasgow city centre. Most estimates in Belfast vary between 20,000 and 30,000 participants on any given weekend nighttime (Scotsman, 12th May 2005). Similar patterns were identified in Edinburgh, with a peak in demand for taxis in Edinburgh coinciding with the Edinburgh festivals³².

The interviewed officials³³ of Belfast, Glasgow and Edinburgh all identified well-developed systems of public transport within their cities; in Glasgow, this comprises a network of local, suburban and underground rail. Belfast has a smaller system of suburban rail routes, and a developed system of bus services referred to as the Metro. Edinburgh has an established bus service that includes a number of night bus routes along most radial corridors (see Appendix 4). Belfast and Glasgow were both identified as reflecting the national trend to close mainstream public transport services at night, typically around midnight, with the last Subway trains departing at around 11.30pm³⁴, and all local rail services in Glasgow and Belfast closing by midnight, with public transport beyond this time predominated by taxis. This perception was confirmed by direct observation within the thesis research.

We now turn to this direct observation and subsequently to the implications of what has been observed. After midnight, the key access point for public transport is the centrally located taxi stances. Using Glasgow as an example, centrally taxi stances are located in

³¹ Definitions of Nighttime 'entertainment' differed between theatre (and cinema) going, and drinking activities, loosely defined as revelry. Revelry included pub going, with a peaked demand to return home between midnight – 01.00, and club activities, with a peak in demand to return home between 03.00 – 04.00.

³² 1,531,606 tickets were sold for the 2006 Edinburgh fringe festival (source: <http://www.edfringe.com/area.html?id=48>) indicating a very significant seasonal peaking in demand for services.

³³ Convenor of Licensing Committee for Scottish Authorities and in Belfast the Transport Policy Advisor in the Department of the Environment.

³⁴ Timetables accessed on line in November 2006: www.translink.co.uk; <http://www.spt.co.uk/subway/times.html>

Gordon Street, Renfield Street, Sauchiehall Street and Buchanan Street, and these provide a focus for those wishing to travel home beyond the hours of mainstream public transport provision, see Figure 6.1. Whilst all four of these were researched, the two worst performing of these were included and tested within the new model presented in Chapter Seven – the results of this testing are provided in Chapter Eight. For the moment, and for our purpose in this chapter, it is sufficient to note that a significant and disproportionate level of demand exists in Glasgow for departures from Gordon Street, far outweighing demand for travel from other stances late at night. Similar focuses exist in Belfast for travel originating from Shaftsbury Square and Botanic Avenue, although in Belfast an additional demand is placed on the engagement of private hire vehicles from depots located in the city centre.

Figure 6.1 Glasgow city centre stance locations

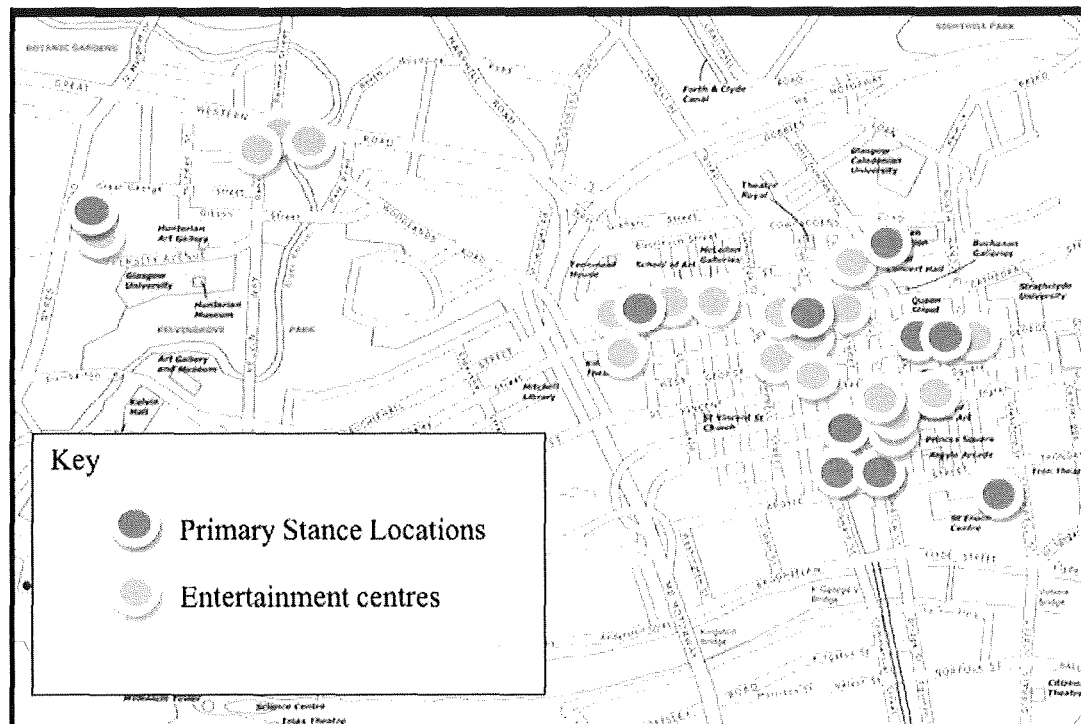


Figure based on observation surveys completed in Glasgow.

Significant queuing at the Gordon Street stance in Glasgow is observable during the nighttime peaks, with delay in engaging taxis in excess of half an hour, and in some instances in excess of 45 minutes. Conversely, for much of the daytime a significant surplus of taxis exists. In both Belfast and Glasgow illegally operating taxis form a part

of the nighttime transport, and are, in some cases, condoned by policing authorities whose priorities in relation to public order appear to be more important than the enforcement of taxi licensing requirements.

Safety issues were also felt significant, although the perception of danger applies equally to the nighttime operators as to their passengers. Limited nighttime supply in Glasgow was attributed to drivers' fear of clientele behaviour (see: Berry, 1997; Gambetta and Hamill, 2005; Vanderveen, 2006) and / or avoidance of payment for journeys (Stenning, 1996) made in the nighttime taxi environment rather than the absence of licenses. Police views in Belfast highlighted the dangers of accessing illegally operating transport, and for the personal safety of individuals congregating in known black spots where violent behaviour was felt to be common.

6.2.3 Issues specific to licensing

All four focus cities reported concerns specific to the licensing of taxis. Glasgow, Edinburgh and West Dunbartonshire all sought to establish limits to the supply of public hire vehicles appropriate to the needs of the city. West Dunbartonshire also identified a need to address disabled access within its fleet. Edinburgh and Glasgow did not have this concern in that their public hire fleets are already made up of 'accessible' vehicles (see Figure 6.2). West Dunbartonshire identified that the issue should not simply revolve around use of London taxis, and suggested at various points that some forms of disability were better served by saloon cars rather than London taxis.

Figure 6.2 Typical 'accessible' (London) taxis and saloon taxi vehicles



Black taxi image courtesy of LTI, Skoda image courtesy of Valuecabs, Belfast

Quantity control, particularly the application of restricted license numbers, was identified by some to be of significance to the numbers of vehicles available at particular times of peaked demand (OFT, 2003); while primary observation in Glasgow (which applies quantity control) identified peaks in demand at specific locations at weekend nighttimes as revellers sought to return home, with similar patterns being identified by stakeholders in Edinburgh. The PSNI also identified a nighttime peak in Belfast but identified additional issues of concern associated with the operation of illegal taxis (both unlicensed vehicles, and the use of licensed Private Hire Vehicles to pick-up illegally) in the city centre.

An opposing issue was also observed for Glasgow, and was reported on in stakeholder interviews in all three other focus cities, that away from nighttime periods of peaked demand, a significant peaking in supply exists in daytime hours. West Dunbartonshire also observed to suffer oversupply at most times. The existence of peaked demand and peaked supply at differing times of day will also represent a challenge to some approaches, typically license based solutions, aimed at increasing supply at nighttime peaks.

6.2.4 Issues specific to tariff

The third element of control, *economic regulation*, is also of significance to the development of taxi supply and will impact both on the level of demand, and also on the levels of supply. It is, however, generally considered in isolation and not as a part of a more detailed review of the taxi market. All four focus locations operate forms of cost model, as do the other licensing areas included in the survey of 21 locations, and these have been included as a subject within the structured interviews with the authorities themselves. Taxi Tariffs are revised by Licensing Authorities following one of a two possible methods, summarised here and discussed in more detail below:

- *Cost Model determination*

Cost models relate to consistent methodologies applied to determine changes in the costs of operating taxis, and the application of cost changes to the tariff charged to taxi users. Cost models are applied in a significant number of UK cities³⁵, and most often include vehicle cost, operating cost and a method of accounting for changes in wage levels.

- *Inflation based increases*

A far simpler method of allocating cost increases to tariff is based on a simple application of inflationary increases to the fares charged for using a taxi. The measure is simple and simplistic, as it tends to relate cost change to a measure of Retail Price Index (RPI) rather than the Industrial Price Index (IPI) specific to the operation of taxis.

6.3 Experiences in applying current assessment

Current practices in defining regulation revolve around the assessments of SUD and in the use of cost models. The primary method of analysis of SUD relates to a standard model widely replicated in similar studies throughout GB. The standard model appears ubiquitous in its application, and sets out to satisfy the requirements set out in governing legislation in England and Wales, and separate legislation applied in Scotland. No similar requirement exists in Northern Ireland. While commonplace, and widely accepted as a starting point, the single model approach does contain a number of limitations, including the number of assumptions of stance performance, and absence of the detailed assessments of the specific needs of users, including the needs of disabled passengers, and issues surrounding the identification of latent demand.

The 'standard' SUD model (see Table 6.2) contains a series of sub model elements allowing for the progressive testing of increased fleet sizes to establish transfer from presences of SUD, to its absence (ISUD \leq 80). The model is in widespread use, with a

³⁵ Based on the review of 21 licensing authorities.

significant number of reports adopting a 'carbon-copy' approach to similar studies (see TPI, 2004).

Table 6.2 Significant unmet demand model standard elements

Element	Definition
Queuing model	Method for obtaining passenger delay figures through observation or estimation.
Taxi Delay Model	Method for obtaining vehicle delay through observation or estimation
ISUD relative value	Indication of the presence of SUD on the basis of comparative measured values
Scenario Building Extra Arrivals Model (EA)	Method for estimating the impact of a change in license numbers on the numbers of vehicles arriving at the taxi stance
Scenario Building Impact of additional arrivals (IAA)	Method of estimating the reduction in queue length and waiting times resulting from increased arrivals at stance
Scenario Building Impact of a Larger Fleet (ILF)	Method of estimating the impact of a larger fleet on the delay experienced by taxi drivers

Table derived from Halcrow, 2002

The standard model in practice results in identification of the worst levels of performance in a city, implying a variation in the performance of stances, but continues to assume stochastic arrival on an even basis across all stances. Moreover the model does not allow for or take account of linkages between quantity control and other forms of regulation, and may in consequence fail to identify either a method an appropriate method of alleviating lack of adequate supply specific to one, but not other, stances; or be fully able to account for impacts arising in other regulatory domains, or impacting upon them.

6.3.1 Critique of modelling practice: assumptions in SUD modelling

In addition to a lack of linkages to external areas of regulation, the standard model also contains a number of assumptions that may not be borne out in reality. It is appropriate to distinguish between generic approaches, those which represent a basis on which assessment is constructed, and the determination of accurate methodologies for so doing:

the latter being dependant on site conditions where wide ranging assumptions may not be met. The base conditions of the standard model assume generic circumstances, unlimited capacity at rank and an absence of site-specific engineering conditions, such as site lines, good vehicle access and exit conditions that are not always accurate to the physical conditions of locations being investigated.

Moreover, many of the definitions surrounding the standard model are open to interpretation and misunderstanding. Given the wording of the governing legislation - there being a need to identify an absence of Significant Unmet Demand the classification as to what constitute 'significant' is vital in the assessment of supply. To this end, the majority of similar studies (see: Halcrow, 2002) highlight that no absolute definition exists.

The standard model includes two steps in the determination of presence of SUD, (see Figure 6.3), the first an observed matrix approach (Table 6.3), the second a comparative Index of SUD (ISUD). The matrix method is a relatively simple first indication of the presence of SUD. Four conditions exist, two indicators specific to peaked demand, two relating to the extent to which delays exist at specified times.

Table 6.3 Matrix applied to identifying presence of SUD

	Delays exist during peaks only	Delays exist during peak and other times
Demand is highly peaked	Not a SUD	Possibly a SUD
Demand is not highly peaked	Possibly a SUD	Probably a SUD

Derived from Halcrow, 2002

The application of a matrix assessment can, however, only provide an indication as to the presence of SUD, and is commonly seen as an initial screen. The assessment does not detail impacts in varying peaked conditions, nor is it clear as to the definition of delay, definitions of which differ across studies. In its simplest form, this might be defined as any waiting incurred in accessing a vehicle. Most studies do, however, recognise the time taken to manoeuvre a taxi within a stance area, combined with the actual delay taken in

passenger boarding as integral to the operation of taxis rather than an absence in their supply.

Many studies (Halcrow, 2002; TPI, 2004 etc.) make allowance of 1 minute to allow for access and egress, this being a grace period in which delay is counted as zero. Although common at one minute, the definition of threshold is not universal. Some studies identify delay of two minutes and in one instance 5 minutes (OFT, 2003). Moreover, the time period over which delay is identified is not common or even clearly defined between studies. As an absolute value, a single vehicle with a delay over 1 minute outside the peak would indicate a variance suggesting the presence of SUD, while at the other extreme, averages determined over a large part of a day may underplay the significance of delay in non peak periods. Lack of consistent definition of delay impacts on the perceived accuracy of the model, and may actually fail to fully assess the measure in subsequent elements.

Matrices identifying delays in peak hours alone, and where demand is strongly peaked, are identified to equate to no SUD. Those that identify possible SUD progress to a more detailed assessment based on a comparative Index of SUD (ISUD). ISUD assessment includes observation of queuing at stance occurrence of delay, and comparison across studies.

The Index of SUD (ISUD) is detailed as:

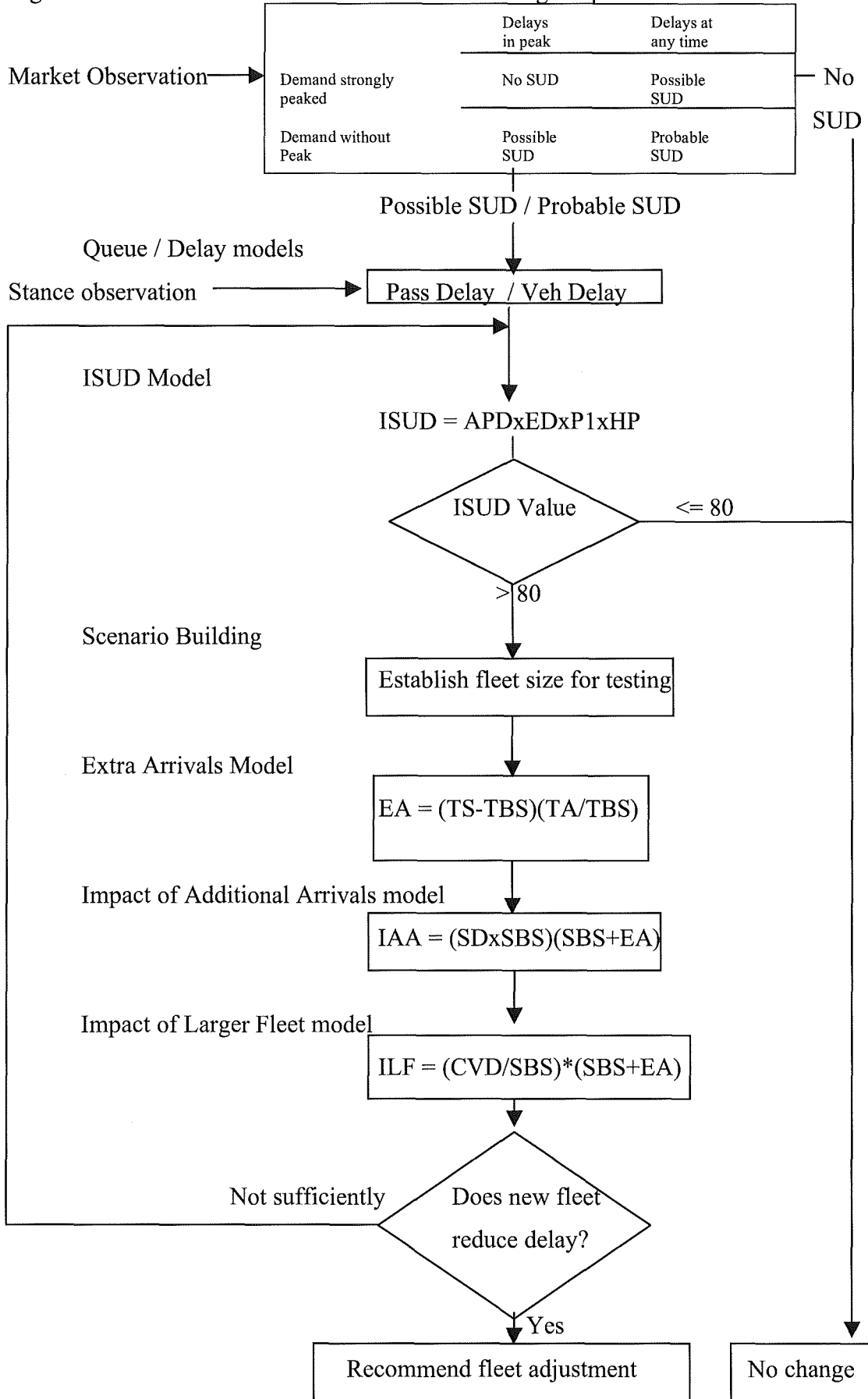
$$\text{ISUD} = \text{APD} \times \text{ED} \times \text{PI} \times \text{HP}$$

Where:

- APD Average passenger delay across all time periods
- ED Excess Demand, during the Monday to Friday daytime period
- PI The proportion of taxi users travelling in hours where the overall average delay at the stance was greater than or equal to 1 minute
- HP Adjustment factor where peaking is present (1 if no peaking; 0.5 in instances of peaked demand)

Figure 6.3

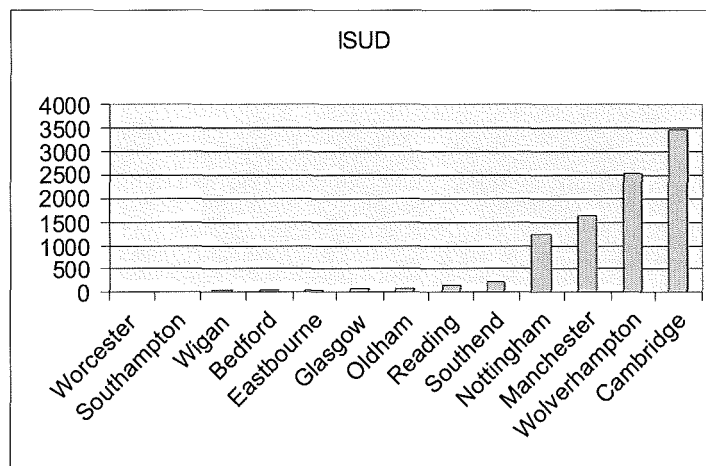
Standard model for determining the presence of SUD



Source: Based on Halcrow, 2002

The ISUD method benefits from a consistency in methodological approach, reducing the potential for interpretive errors, and thus appears stronger in its results when compared to the matrix method. Its calculation is logical, and, given its purpose of comparing the performance of one city against experience in another, useful. Resulting values (ISUD = x) provide a comparator of the effectiveness of supply in one location when compared to others. The approach does, however, pose some questions as to the basis of values used and thus accuracy of findings. The nominal value (ISUD = 80) is used as a threshold of SUD being present, appears to have limited basis other than frequency of use. Furthermore, given the levels of assumptions within the model, any threshold based on longevity of use within similar studies will also contain and possibly compound errors made in each study used in its justification. TPI (2004) add a further note that comparisons between disparate markets should be treated with some caution. Districts vary according to density, population, public transport provision, car ownership and many other socio-economic and physical characteristics.

Figure 6.4 Comparative ISUD values



Source: Previous SUD studies as detailed in Halcrow 2002

A comparative value of ISUD=80 is suggested, in the standard model, as being a lower threshold for Significant Unmet Demand. However, the range, (Figure 6.4), between authorities can be significant. Lower end values ranging in the scale 0 -100, mid ranging up to 1200, and a number in the scale range from 2000-4000.

6.3.1.1 Driver waiting conflicts

While most studies make reference to the relationship between license numbers and non-productive time - the time drivers wait for customers - few continue to fully explore the impacts of this relationship. The modelling undertaken in many studies identifies driver waiting as an impact of additional arrivals and Impact of a Larger Fleet (ILF). Impacts are felt in terms of reduced productivity or vehicle utilisation. This in turn reduces the earnings ability of the taxi driver. In classical economics approaches, the reduction results *ceteris parabis* in a move away from the industry, to added value, or to operate at times where higher incomes can be achieved.

A number of comments from suppliers highlighted this issue, indicating the difference between a desire and an ability to supply, and that the market did not work freely. Taxi trade representatives, did not consider adjustments in price to be in the control of the taxi driver, and also expressed the view that barriers to nighttime operations existed in the form of safety and in some instances availability of vehicles. Other issues arising from driver waiting conflicts arose in relation to a downward pressure on quality, and might arise in relation to upward pressure on tariffs, this arising in some cities where driver income is integral to the tariff cost model.

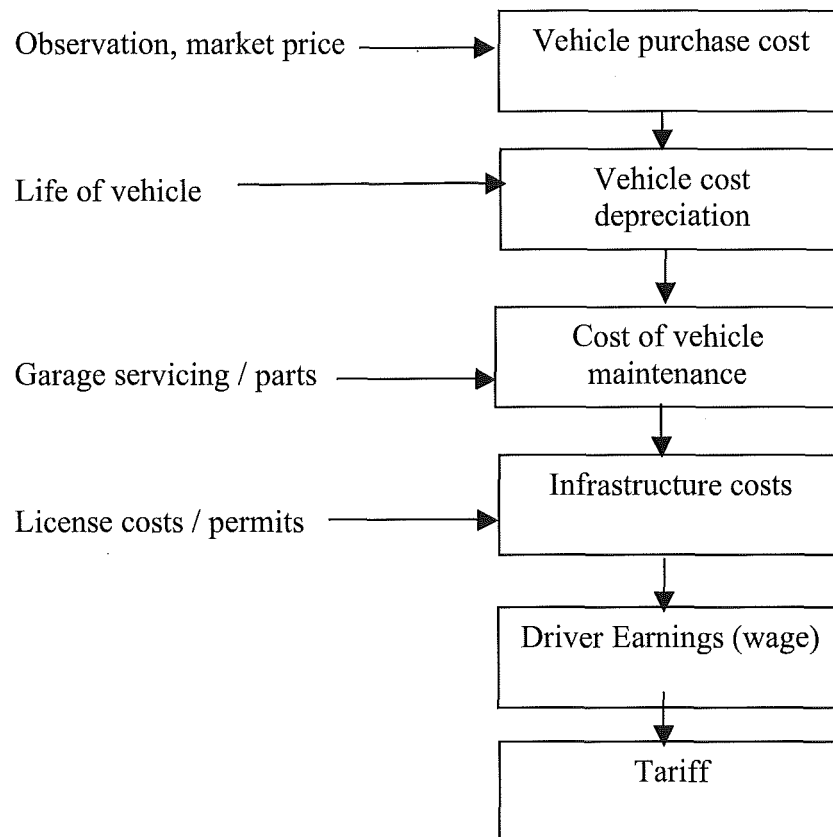
6.3.1.2 Fleet composition conflicts

Conflicts exist between the desire to achieve certain fleet specifications, such as a desire to specify an accessible fleet, and the costs of so doing. Standard application of pre-set quality controls (such as the MCF) may reduce the relative burden of this, as it is a burden to all in equal measure. However, quality issues relate not only to the initial standard detail, but also to the permitted maximum age that will also impact on other areas of regulation.

6.3.2 Critique of cost model components

Cost models represent a formal, separate, approach to establishing levels of tariff to be applied in any one licensing authority area. The approach is common and will often follow similar structures, set out in Figure 6.5. The model is not, however, as fully developed or universally accepted as those applied in 'standard' SUD approaches. The cost model discussed below represents a common approach and is adopted as standard to permit more detailed examination of linkages between regulatory elements.

Figure 6.5 Standard Model for determining cost



6.3.2.1 Driver wage conflicts

Driver wage conflicts relate to the relationship between driver wage and costs of production. The elements relates in some cost model approaches to the charges applied through the tariff to the customer, but will also have a direct link to quantity models. The inclusion of wages, earnings and or profit take varies significantly between authorities

and represents a significant element of the total costs of operating a taxi. The inclusion of compensation to drivers is consistent to cost models across authorities, although the methods of determining a cost associated differs. Two main methods of identification exist – a) a *specified wage cost* and b) a *proportionate* approach. The main differences between the two approaches being the dependency of wage determination external or internal factors. Specified wage costs determine change against changes in comparable industries wages. Proportionate wage determination sets wage increase in line with other costs applied to taxi tariffs, is thus internally determined and reflects changes in costs of production rather than costs of living.

Identification of an explicit wage within the cost model would provide a solid base for calculating changes in that cost and is recommended as a new element in the models developed in this thesis. This represents a change to current practice in the case study locations. Most significantly a local wage cost would be independent of general cost assumptions, and justifiable against the earnings of similar industries. Identification of an industry specific wage rate would also benefit the taxi trade by linking wage rates to those in similar sectors, avoiding significant disparities between earning potential in similar jobs and maintaining an incentive to remain within the taxi trade. The identification of a labour (wage) cost does, however, differ from other elements in the cost model as it relates directly to individual operators rather than to the identifiable costs of repair, parts, fuel etc., supplied by and priced by third parties. Wages within the model, therefore, relate to the amount of money paid by a driver to her/himself for the operation of the taxi, or more accurately the amount of money left as earnings when other costs have been accounted for, suggesting a direct (and potentially negative) link does exist between wages and other elements within the cost model. While the updating of earnings costs accurately will materially affect the ability of the individual to achieve a pay rise, accuracy in other model elements will also impact on the earnings received by the taxi driver.

External links between the earnings element of the cost model and other regulatory domains are also identifiable, and include the relationship between the drivers' wage and the SUD model. This relates to the impacts of changes in fleet on the basic assumptions of the availability of drivers. Increased fleet sizes may result in a reduced sustainability of supply, and changes in one impact directly on the other. There may also be a relationship

between driver income and propensity to supply. This is typically the justification used in charging a higher tariff for nighttime taxi use, as it is felt to encourage drivers to supply at anti social times. Some evidence suggests this may also relate to the availability of taxis to the driver, particularly where vehicles are shared – drivers having use of a vehicle only at particular times.

An appropriate development of the modelling framework should thus:

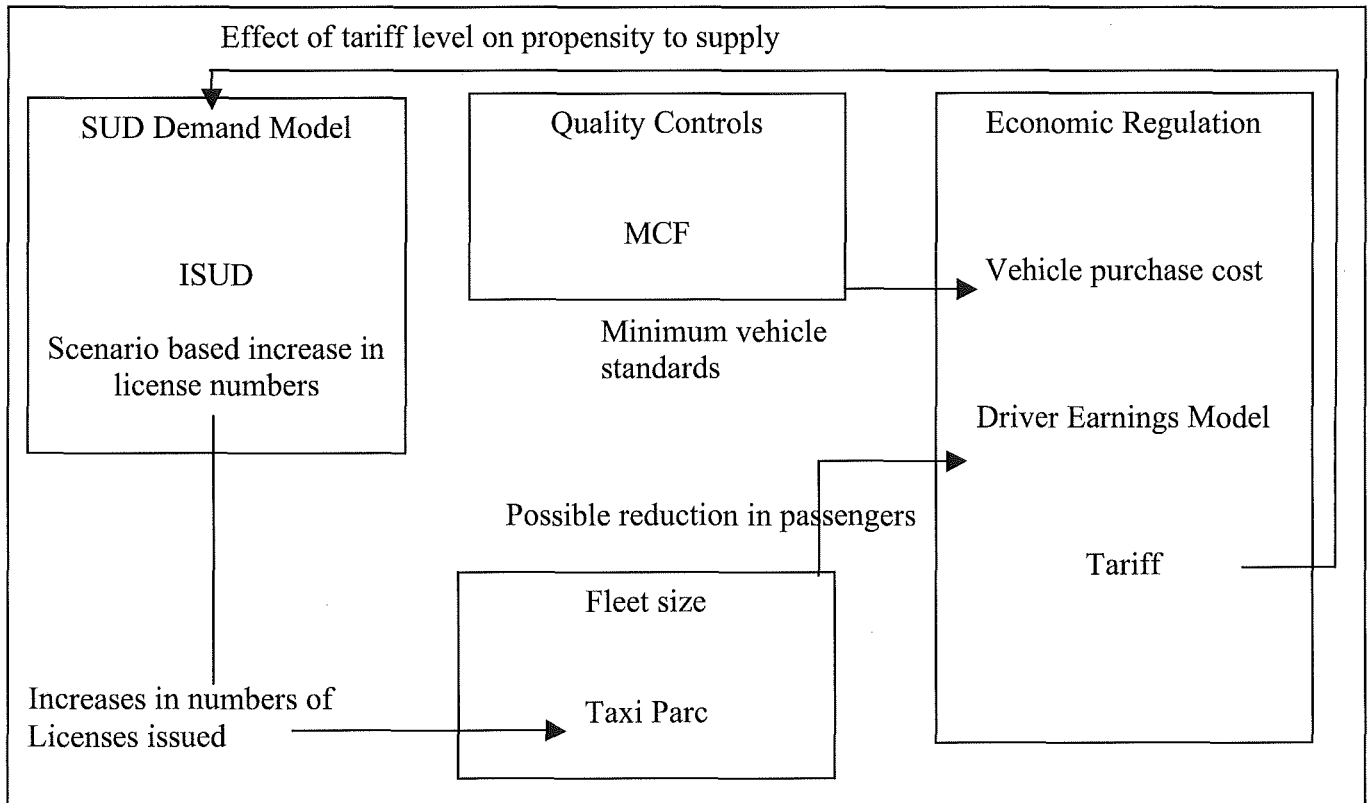
- Identify relationships between fleet size and levels of income
- Identify the effect of changes in fleet on the costs of provision
- Identify the relationship between availability of a vehicle to a driver, and the effect of changes in availability to the driver on service levels offered to the public.

Driver availability and fleet utilisation are significant to the delivery of services in response to both income, explored in the case of Glasgow in the application of combined cost and quantity models and in the delivery of accessible vehicles in the case of mixed fleets. These are set out in further sections of this chapter and further explored in relation to case study locations in Chapter Eight.

6.3.2.2 Impacts of changing fleet sizes

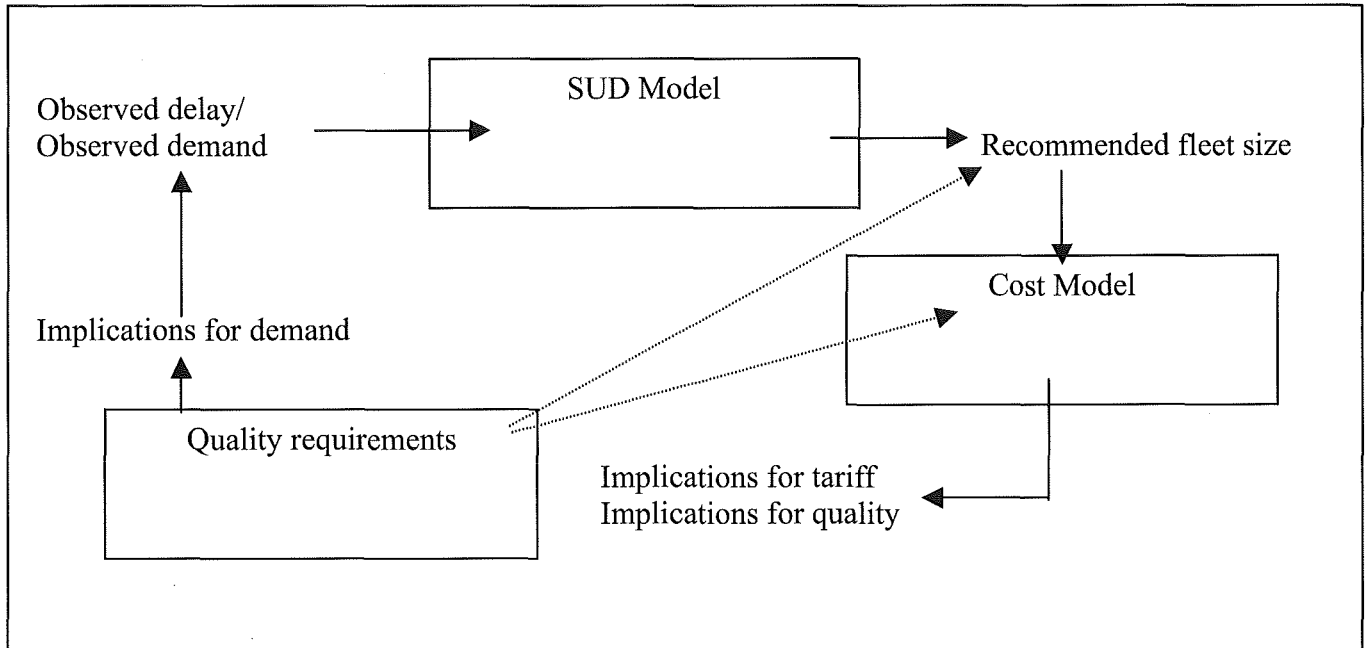
Changes in fleet size, a potential outcome (likely in the standard approach), are likely to impact directly on a number of other modelling elements, set out in Figure 6.6.

Figure 6.6 Interaction between fleet size and other modelling elements



Fleet size impacts on, and is impacted by, a large cross section of other modelling elements. The main output of the traditional model, a recommendation of changes to fleet size, can only be fully correct where the secondary and subsequent implications are fully appreciated and taken account of. Moreover feedback exists between modelling elements. As fleet size changes, for example where an increase in vehicle numbers is applied, the numbers of pick-ups per vehicle alters. Income levels change, altering the effective tariff, and altering the levels of demand on which the original SUD calculations were made. In other areas of transport modelling this would result in a feedback loop and iteration. In the existing taxi models, and because of a lack of identified linkages, such iteration has not been applied.

Figure 6.7 Fleet size, cost interaction



Larger fleet sizes do not, however, necessarily result in higher levels of service. Concerns expressed by trade representatives within the focus groups suggested that increased numbers of licenses would, counter-intuitively, reduce the level of supply at night as individual drivers are able to move from forced hours (when a shared taxis is available) to hours of choice, identified in the driver survey as during the day. The focus groups suggested evidence from Dublin to support a reducing ‘cab shift availability’ although no published document appears to provide a level of detail to allow comparisons at the level of times of day. On site factors will also impact on the ability of a particular stance to optimise benefits that might otherwise accrue from increases in the taxi fleet size. The study identifies *delay* as an appropriate measure for assessment, where it is possible to determine localised factors.

An appropriate development of the modelling framework should thus:

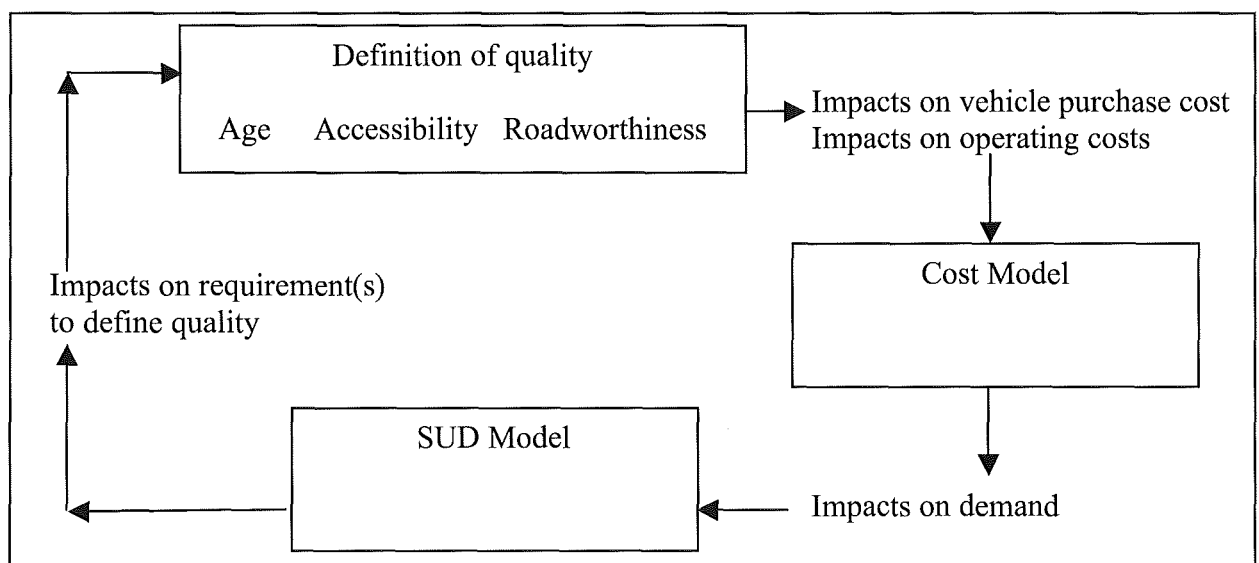
- Identify relationships increased fleet size and use of taxis
- Identify the impacts of changes in fleet size on the cost model
- Identify the impacts of changed costs on the demand for taxi use

6.3.3 Quality control application

Quality controls exist but sit apart from the discussion on taxi regulation. These do, however, form an integral part of the balance between regulations. The consequences of differing requirements are clearly felt within the use of taxis, and indeed integral to their control. Quality Controls are most often identified in relation to the physical appearance and mechanical safety of the vehicle (OFT, 2003), but will also relate to its specification, maximum age and accessibility to disabled passengers. The requirement to use accessible vehicles affects the costs of providing a service, is thus an element in cost models, and this will also impact on the demand, and is thus an element in SUD analysis.

Specifying maximum ages of vehicles also impacts on the cost of vehicles themselves, including a concern that resale values of changes will impact on the total life costs of the vehicle. At the other end of the spectrum, and identified within the OFT report, any change in potential income in the industry is likely to result in reduced maintenance and older fleets. This is evident in a number of US cities where deregulation was applied (Leisy, 2001). The OFT suggests that changes in the approaches to quantity regulation that negatively impacted on the quality of the taxi parc could be addressed by increased application of quality controls (OFT, 2003). Thus the effect of removing regulation in one domain is its introduction in another.

Figure 6.8: Quality control interaction



6.3.3.1. Minimum standard and maximum age requirement

An additional element in determining vehicle purchase and depreciation costs relates to parallel impacts of quality regulation, the controls set on the age, type and quality of vehicles in the fleet by a licensing authority. As in previous elements, links exist between the determination of standards and age controls and other elements of regulation. Quality controls materially affect the age and appearance of the fleet; and may limit the permissible age of vehicles in the fleet. The inclusion of specific requirements within the defined quality standards have a direct effect on the costs of provision, and particularly to the cost of vehicle purchase / depreciation, but tend only to be considered in relation to outcome. Given that the impacts of quality regulation affects costs of operation, and similarly decisions affecting depreciation are likely to impact on the quality of vehicles, it is appropriate for these factors to be considered together.

An appropriate development of the modelling framework should thus:

- Identify relationships between vehicle age and resale value,
- Identify the impacts of changes in age and resale values on the operation of the cost model
- Identify the interactions between average vehicle age and propensity to use taxis
- Identify the impacts of resulting changes in the cost model on the operation of the SUD model.

Chapter Seven develops a method of integrating economic and quantity elements, applied as a case study to Glasgow in Chapter Eight.

6.3.3.2 Disability access impacts

The desire to provide access to taxi services across all sections of the community reflects a wider desire to increase access to facilities and services, a right held in law and applied to transport and many other services through the Disability Discrimination Act 1995. Most models do not make specific reference to the availability of accessible vehicles within the fleet as a part of their modelling approaches, though it has become a significant issue in the delivery of services that is noted in many studies. The relationship between a legislated requirement to provide such vehicles and the development of the model is complex.

In cities where fleets are MCF compliant it is likely that the majority of vehicles would already conform to a common standard of Disabled Accessible vehicle. While costs of moving to accessible vehicles in MCF compliant fleets, such as Glasgow, may be low, the cost in non-MCF compliant fleets is significant, and as such a necessary consideration in cost models.

Other impacts of legislating for disabled vehicle provision will include a change in the numbers of passengers seeking to use taxis by vehicle type. The exact definition of these links, and their inclusion in a broadened modelling approach would appear appropriate and is undertaken in relation to West Dunbartonshire in the analysis presented in Chapter Eight.

Although comparable in stated versus observed increase, most approaches have been based on adoption of an all or nothing approach, either a fleet is fully compliant, or not at all. There appear to be no studies completed which relate the sensitivity of supply to a proportion of a fleet being provided by accessible vehicles. The need to establish vehicle fleets appropriate to use of that fleet will necessarily include consideration of the role of accessible vehicles in taxi supply. In some authority areas, the provision of access to all has been achieved through the adoption of fully accessible fleets (including Glasgow). Other authorities and jurisdictions have tended to adopt more pragmatic approaches, including partial (proportionate) fleets, in which specified numbers of fully accessible vehicles are made available. Others have adopted a gradual move to fully accessible vehicles over time.

City and large urban authorities surveyed have been more likely to adopt fully accessible fleets than rural or largely rural districts, which in turn reflects the significance of vehicle costs in the economics of vehicle supply, and the need to ensure that services are maintained as appropriate to the needs of the authority area. An expensive vehicle impacts negatively on the ability of an operator to continue to operate.

An appropriate development of the modelling framework should thus include:

- Methods of identifying the demand (including all or nothing options) for wheelchair vehicles
- An element within a supply model determining the levels of change required within the fleet to achieve current and predicted demand
- Methods of identifying the impact of a revised fleet on the total numbers of journeys demanded across all passenger groups
- Methods of identifying the effect of differing uses in peaked demand on the actual supply of vehicles to primary needs groups
- Methods of identifying the impacts of the above changes on the costs of operating taxis, and the cost implications within the tariff
- A method for iteration to allow changes that have resulted in other model elements to feed back into the SUD model.

The issues of accessibility and the nature of interactions between quantity and quality regulation are further explored in Chapter Seven, and applied to the case study Chapter Eight.

6.4 Potential for updating model components and interaction

We have now established that there is a significant need for the various elements of the existing model to extend to include effects arising in other regulatory domains (links between existing models and development of links to other external factors). The interaction between the elements will vary by city, and the strengths of linkages between

elements vary depending on local circumstance, priority etc. It is, however, appropriate to identify the nature of links, and develop a toolkit of combined model elements within a framework for application in individual cities and authority areas. Subsequent chapters set out a design specification (detailed in Chapter Seven in which linkages are set out and incorporated in to a new modelling framework) and application (detailed in Chapter Eight based on data from case studies).

6.5 Conclusion

This chapter has identified the extent of gaps in and errors of the existing models. Gaps exist in both standard demand and cost models and relate to both a lack of links between regulatory domains and a lack of detail within the model elements themselves. Assumptions, particularly in the case of the SUD model, will also affect the accuracy of the model run and reduce the potential efficacy of results and solutions based on its operation. Among these, the assumed characteristics of stance operation are particularly prone to error and are, in the main, at odds with actual practice. Significant gaps also exist in relation to the method by which latent and disabled demand are considered within the existing structures, and lack of an appropriate accessible vehicle sub-model within the demand modelling structure is visible and should be redressed. Cost models lack appropriate links between vehicle quality and purchase costs, and have not been used to inform the development of SUD models (detailed above and including iteration). Furthermore, links between the determination of taxi parcs, a result of the SUD model, and the earnings elements of cost models have not been developed, and may not have been possible in standard cost models where proportionate, rather than relative, wage costs are used.

The development of a new approach is significant and provides the opportunity for a more detailed analysis of links between and accuracy of modelling within regulatory domains to be established. Most significantly, the identification of a modelling framework addressing a full cross section of issues in the supply of taxis, identified from the views of consumers (passengers and potential passengers)³⁶ but also including views

³⁶ Based on comments in pedestrian surveys, and structured interviews of key stakeholders

of stakeholders, authorities and suppliers (detailed in Chapter Four), provides a method for wider application, and determination of services appropriate to all.

By identifying issues with the current standard models used the chapter has provided a basis for moving to the development and construction of a new model. Subsequent chapters provide a new model that corrects the deficiencies identified in this chapter (set out in Chapter Seven), and application of the new modelling framework to case study cities.

Chapter 7

Construction of a new model

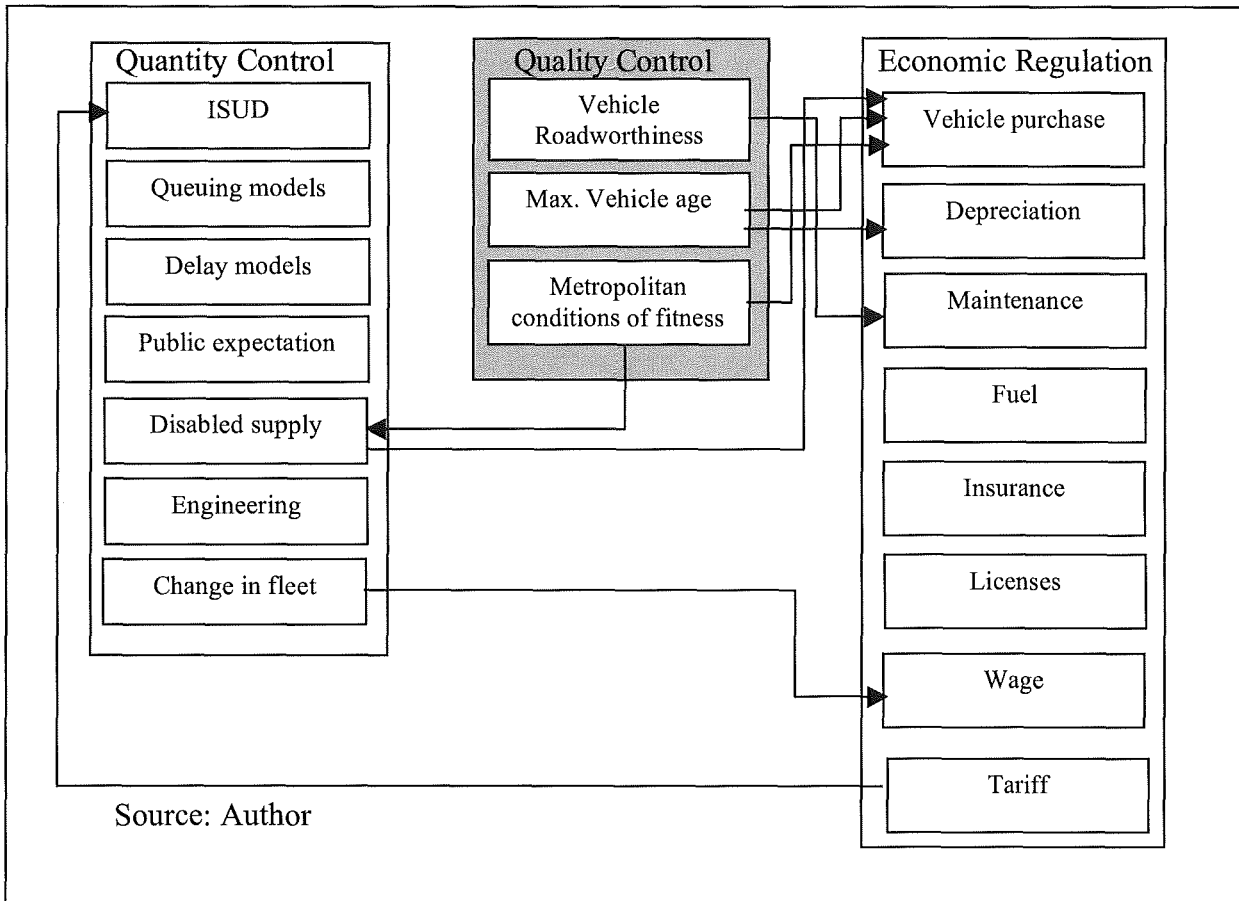
7.1 Introduction

The preceding chapters have demonstrated the deficiencies of existing models in respect of accomplishing the optimal delivery of taxi services. Standard SUD, and those used in the updating of taxi tariffs, fail to take full account of the links between regulatory domains and may apply stringent assumptions in their operation, which in turn limits the effectiveness of the models themselves in achieving conclusions appropriate for application in the locations being considered. This chapter sets out a new modelling framework that is better attuned to the institutional and market context of the UK, and to application on an authority-by-authority basis. The new modelling framework includes and builds on the individual approaches adopted in existing models, but further contributes to the effectiveness and accuracy of the model by including links between the domains of regulation. The chapter also considers the potential for application of a wider modelling framework, and makes extensive use of case study locations in order to demonstrate specific operational features. The chapter sets out the new modelling approach with a detailed sequence of appropriate sub-models specific to the issues observed and current in the provision of taxis in the UK.

7.2 Technical specification

The key properties of the new model require technical specification. Figure 7.1 provides these in diagrammatic form, and demonstrates the core elements of existing regulatory controls, and the links between these domains.

Figure 7.1 Design specifications for the new model



By setting out the core elements it is possible to identify a number of key linkages between regulatory domains in the provision of taxis. Linkages exist between the elements currently contained separately (per diagram left to right) in Quantity Control, Quality Control and Economic Regulation domains, and are indicative of impacts arising in one domain as a result of changes in another. These are explored in detail in section 7.3.

A technical specification has been derived from the identification of existing models and the need for their enhancement, and includes expansion on the linkages between set out above. As differing locations apply different levels and combinations of regulation, the new model is set out as a framework in which various elements may be applied as appropriate to the needs of the location. This has the benefit of both being aware of links between models and being able to take account of the exact circumstances appropriate to locations under consideration. The exact structure of a modelling framework will thus be specific to each location being considered. Key elements are set out below.

7.2.1 Quantity analysis

The standard SUD model seeks to identify impacts of changes in the taxi parc on the levels of supply. Three new sub models have been developed to enhance the standard model:

- **Public Expectation**
Determining and applying service levels expected and felt appropriate by time of day.
- **Disabled Supply**
Determining and applying service levels appropriate for disabled passengers
- **Engineering (at stance)**
Determining and taking account of specific stance engineering that affects the ability of individual stances to operate

In addition, four linkages have been identified between quantity and other regulatory domains:

- **Disabled supply and Metropolitan Conditions of Fitness (MCF)**
The impact of MCF requirements on the supply of accessible taxis
- **Disabled supply and vehicle purchase**
The impact of accessibility requirements on vehicle purchase price
- **Change in fleet and wage**
The impact of increased numbers of licenses on the potential earnings of drivers
- **Tariff levels and index of SUD**
The impact of changes in tariff affecting propensity to supply and levels of unmet demand

The thesis proposes a number of new modelling elements that add routines allowing for a reduction in the number of assumptions made in the standard models, a broadening of the extent of analysis contained within the standard models, and methods by which linkages may be more fully included within the modelling procedures adopted for taxi supply analysis.

7.3 Nature of relationships

In the preceding section key linkages were identified within and between standard models. This section characterises the various relationships between these elements, identifying the state of the practice existing in current models and methods of enhancement. Quantity regulation analysis is typically based on the operation of the SUD model, a full description of which is set out in Chapter Six (see: Figure 6.3). The model builds across routines (sub-models) set out as:

- Queue / Delay model
- ISUD
- Change in fleet model

Progression through the model is dependant upon the completion and results of the preceding stages and, depending on sub-model, can be dependant upon the findings of the preceding stages. The first step in the process includes an initial review of unmet demand, followed by a full ISUD model run.

Measurement of ISUD requires observation of delay at stance, and a determination of levels within the index that identify what is determined as significant unmet demand. Linkages exist between tariff (economic regulation) and determination of ISUD (quantity control), in that changes in tariff levels may affect the level of supply, in turn affecting the levels of SUD measured in the ISUD model. Additional issues exist arising from the determination of values, what is identified as significant unmet demand, and the ability of existing infrastructure to accommodate changes in supply levels. Subsequent stages are undertaken where ISUD values suggest significant unmet demand does, or probably does,

exist. This is determined in many studies as an ISUD value over 80 (see: Halcrow, 2002) - lower values do not represent significant levels of unmet demand.

New sub-modelling elements determining public expectation, as a Threshold of Desirable Delay (DTT); disabled supply; driver behaviour, a Driver Perceptions Model (DPM); stance design, including Stance Engineering (SENG) and Time Savings At Stance (TSAS); are also significant and act to realign the individual internal model linkages.

Additional linkages exist between the new sub-model elements and other regulatory domain models, between disabled supply, which may be affected by the adoption of Metropolitan Conditions of Fitness, and in turn affect vehicle purchase behaviour; between vehicle roadworthiness and maintenance patterns, and the determination of a maximum vehicle age and purchase behaviour.

Economic regulation is most commonly applied to the determination of taxi tariffs, and this uses a comparison of costs over time as a standard modelling approach. The cost model lacks an exact structure, typical of the SUD model, but contains consistent elements. Linkages between the cost model and other regulatory domains are also apparent, and include a number of links impacting on purchase behaviour, most notably links affecting the price paid for taxis, typically affected by specification of minimum standards (including disability requirements). Linkages from other regulatory domains can also be identified including quality requirements impacting on maintenance, and impacts of changes in fleet size, in turn impacting on potential incomes. External influences may also impact on the cost model and include fuel costs, costs of insurance and similar external costs.

Quality controls are directly linked to the other regulatory domains and influence the development of a more appropriate model, but are not themselves subject to the same influence from licensing authorities. These are therefore developed as internal linkages subject to development within the scenario building processes of a new modelling framework.

7.4 Development of the new model

This thesis sets out a new modelling framework addressing many of the issues present in the standard approaches to supply and control of taxi services in the UK. Analytical models are common in establishing levels of licensing and approaches to control, but are not evenly applied. Differences exist in the balances between regulation adopted by differing authorities, discussed in Chapter Six, while the adoption of a single model where one size fits all may itself present a number of challenges and introduce inaccuracies in assessment resulting in a sub-optimal level of taxi service. This raises the challenge of presenting a modelling approach that addresses the issues most commonly subject to this form of analysis, whilst being aware of differences between authorities that influence the effectiveness of such models.

The new model is therefore proposed as a structured framework comprising ‘plug-in’ sub-models appropriate for inclusion dependant on circumstance and authority priority. As an example, the development of a sub-model (plug-in) identifying numbers of disabled accessible taxis required is appropriate for inclusion in the case of West Dunbartonshire, where a mixed fleet is in operation, but not required for Glasgow, where 100% of all public hire taxis are already accessible. The structure and content of the new modelling framework is set out in the remaining sections of this chapter, and applied to real life data from case study cities in Chapter Eight.

7.5 Technical detail of model elements

This section sets out the technical content of new sub-models, and their location within the modelling framework. The section also indicates the logic in their development and the circumstances in which each sub-model may be used.

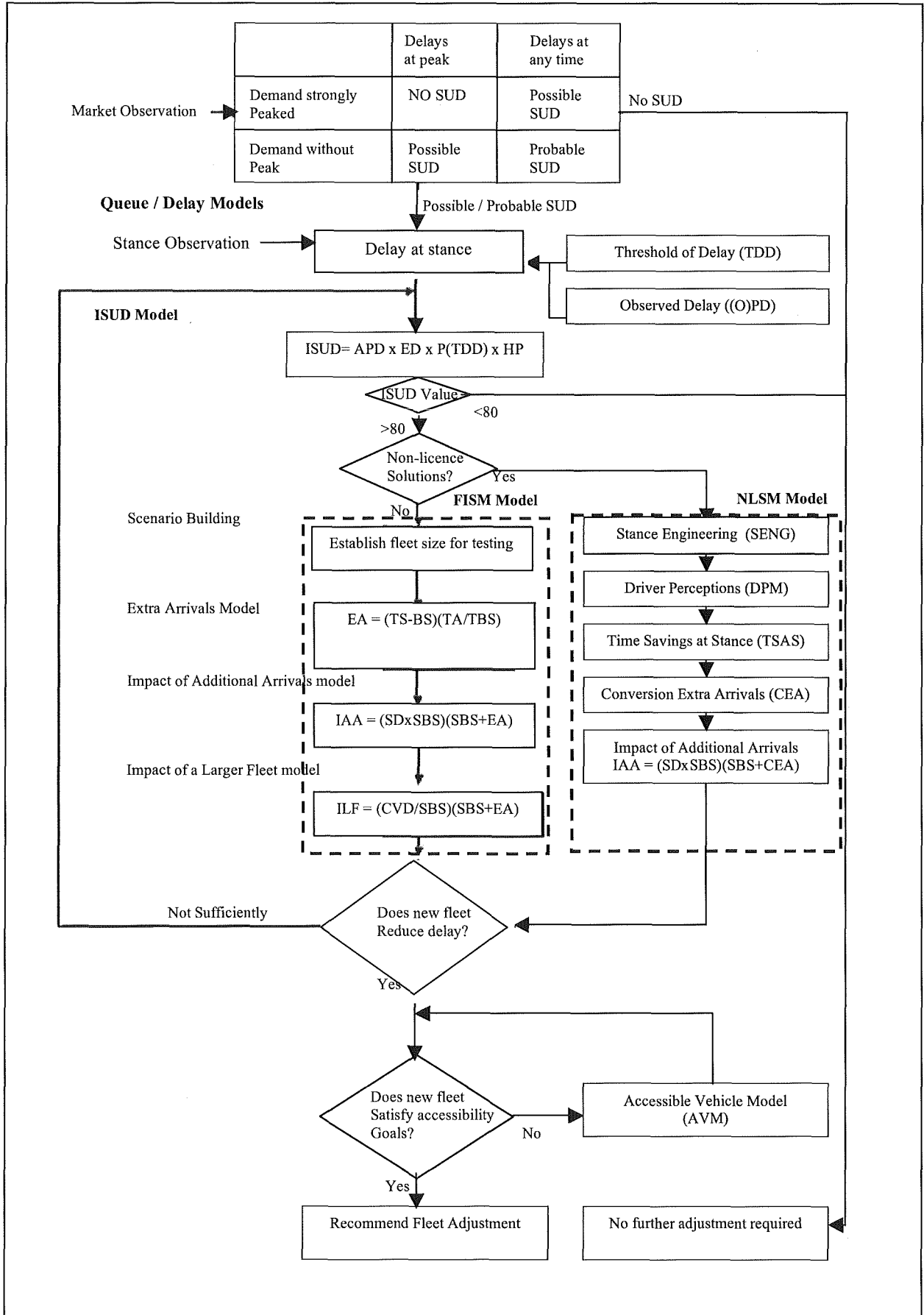
7.5.1 Development from quantity models

Existing SUD models have followed a single approach over a number of years (see Chapter Six). The model makes a number of assumptions in relation to the operation of taxis, definitions of delay and stance performance, and may also fail to account for links to other domains. Figure 7.2 illustrates both the standard approach, identified in white, and proposed new modelling elements, shaded in blue. The new elements (shaded) represent a departure from traditional modelling approach, but also build on the traditional model. These are significant enhancements to the standard model, but not its replacement.

The NLSM – Non Licensing Solutions approach is felt to be complementary to the traditional Fleet Impacts Sub Model (FISM) and permits the consideration of impacts arising from a new approach in addition, complementing, or separate approach to the traditional licensing – change in license numbers, approaches. Accessible Vehicle models complement and enhance previous approaches.

Given the desire to enhance and provide complementary modelling elements, the thesis seeks to maintain notation consistent with previous models. Subsequent sections discuss the development of an enhanced SUD model, describing and developing the existing and new modelling elements illustrated in Figure 7.2.

Figure 7.2 Sub-models applied to quantity modelling



7.5.1.1 Threshold of Delay (TDD)

Following the initial qualitative trawl, the ISUD index represents the first modelling element in quantity models. It is quantitative insofar as it uses measured assessment from observations specific to a location, according to the standard (Halcrow) formula:

$$ISUD = APD \times ED \times P1 \times HP$$

Where:

- APD Average passenger delay across all time periods
- ED Excess Demand, during the Monday to Friday daytime period
- P1 The proportion of taxi users travelling in hours where the overall average delay at the stance was greater than or equal to 1 minute
- HP Adjustment factor where peaking is present (1 if no peaking; 0.5 in instances of peaked demand)

Values attributed at P1, (1 minute – Halcrow, 2002, 5 minutes - OFT, 2003) appear to be set arbitrarily and without due consideration of either expectations on the part of the public, or the ability of the trade (regardless of fleet size) to provide sufficient vehicles to meet demand by stance. Moreover, the impacts of differing time periods are not identified or considered in the standard approach. The development of a Threshold of Delay (TDD) as a new model routine allows for the definition of values for P1 that are specific to location. It would also allow for separate analysis by time period i.e. distinguishing between daytime travel and taxi use in the nighttime economy.

The definition of a value for P1 is significant to the conclusions drawn from the operation of the model, and this is critical to the conclusions drawn. The current arbitrary nature of the value is therefore a significant concern to the construction of the new model. In the determination of the new model, a more exact definition of P1 is addressed by the addition of a sub-model to determine the actual levels of delay Acceptable in any given period - Threshold of Delay (TDD). TDD values then inform the operation of the ISUD model and are determined on the basis set out below. Wider research, beyond the scope

of this thesis, is also felt to be appropriate to the determination of a more detailed P1 value, including sensitivity to time of day, market segment and location.

The calculation of P1 value is based on a threshold of determinable delay, according to the formula:

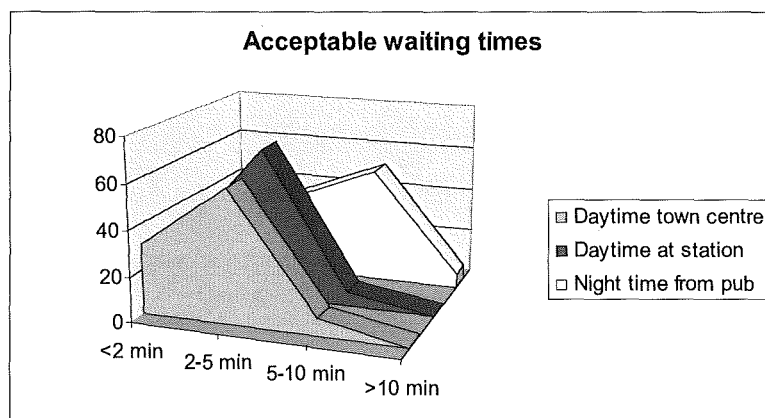
$$TDD = f(ATD_{tl})$$

Where

ATD_{tl} = Acceptable time delay by t - Time; and l - Location

ATD values have been determined from the pedestrian survey that identified both experiences of delay in engaging a taxi, and determined the maximum delays considered desirable by the public by time of day. Figure 7.3 illustrates the response Acceptable delay in engaging a taxi for returning home from a city centre on a weekend nighttime. It is apparent from the responses that Acceptable delay thresholds are not consistent across all time periods, or by location. Moreover, the attitude toward waiting at peak periods supports differing interpretations of appropriate delay, and enhancement of the methods by which it is identified, identified as areas for future research.

Figure 7.3 Threshold of delay



Source: Author

As a result of this additional routine, the ISUD model is reformulated, as set out below, to include locally set values of waiting time. The new approach can be applied in both a single time frame, in which case TDD is defined as a mean of all periods, or as specific to separate time periods identified in the questionnaire.

$$ISUD = APD \times ED \times P(TDD_t) \times HP$$

Where:

APD Average passenger delay across all time periods

ED Excess Demand, during the Monday to Friday daytime period

$P(TDD_t)$ The proportion of taxi users travelling in hours where the overall average delay at the stance was greater than or equal to the value of TDD over time period t .

HP Adjustment factor where peaking is present (1 if no peaking; 0.5 in instances of peaked demand)

The new TDD sub-model works both within the context of the original 'stand-alone' SUD analysis, and as a part of a wider framework including linkages to other regulatory domains. These are applied to real life data in Chapter Eight.

7.5.1.2 Passenger Delay (PD)

Passenger Delay (PD), shown as APD in the ISUD formula, is a sub-model within the measurement of ISUD, identified as an average across all time periods. The correct identification of passenger delay is of significance to the assessment of stance performance, and in the determination of the presence of Unmet Demand. The measure also forms a part of the building and testing. The enhanced SUD model identifies passenger delay on the basis of observed moving target measurement, and is defined as:

Observed identification of PD ((O)PD)

$$PD = ODT - OAT$$

Where

ODT = Observed Departure Time

OAT = Observed Arrival Time

The introduction of observed delay is identified in the ISUD formula as:

$$ISUD = A(O)PD \times ED \times P(TDD) \times HP$$

Where:

A(O)PD Average passenger delay across all time periods³⁷

ED Excess Demand, during the Monday to Friday daytime period

P(TDD_t) The proportion of taxi users travelling in hours where the overall average delay at the stance was greater than or equal to the value of TDD in period *t*.

HP Adjustment factor where peaking is present (1 if no peaking; 0.5 in instances of peaked demand)

³⁷ The same formula can be applied to differing time periods, in which case average values relate to the time period in consideration.

7.5.1.3 Vehicle Delay Model (VDM)

A similar approach is adopted in the identification of delays experienced by vehicles at stance (an input to ILF). In this instance the identification of delay relates to the observation of queuing taxi, and timing individual vehicles from entry to a queue to departure, and is defined as:

$$(O)VD = VDT - VAT$$

Where:

(O)VD = Observed Vehicle Delay

VDT = Vehicle Departure Time

VAT = Vehicle Arrival time

Vehicle movements are measured from point of entry to a taxi stance queue, to point of exit. Departing taxis are identified in terms of minutes delay standing at stance, and those departing empty. A further, and unexpected, issue has, however, arisen in the application of the passenger and vehicle delay models. These are implicitly mutually exclusive, passenger delay occurs in the absence of taxis, taxi delay occurs in the absence of passengers. However, an unexpected observation arose in some instances where a queue of taxis waiting for passengers and queues of passengers waiting for taxis arose in the same stance at the same time. Simultaneous and conflicting queues at stance are not identified in the standard approaches but, together with associated queue creep appear to result from behaviour at stance and are related to stance design, addressed below.

7.5.1.4 Fleet Impact Sub-Model (FISM)

Subsequent elements within the standard SUD model all seek to establish the impacts of changes in the fleet, and are collectively referred to as a fleet impact sub-model – see Figure 7.2. The FISM approach is based on the development of scenarios, identifying increases in the numbers of licenses issued – a surrogate for vehicles on road, and seeks to test the impact of ‘licensing solutions’ on waiting times at stance. FISM contains three elements:

- Extra Arrivals Model (EA)
- Impact of Additional Arrivals (IAA)
- Impact of Larger Fleet (ILF)

In developing a new approach, this thesis addresses both the existing FISM, enhancing elements within this to reduce the incidence of assumed and missing data; and by proposing a non-licensing approach – NLSM, set out in subsequent sections.

Extra Arrivals Model (EA)

The extra arrivals model is an integral part of the current standard approach. It estimates the additional numbers of vehicles arriving at a stance as a result of an increased fleet size, where increased numbers of licenses are issued, what are the impacts on the effective supply at stance. The model is simple in application and measures an even increase to all stances.

The base methodology is defined as:

$$EA = (TS - TBS)(TA/TBS)$$

Where:

TS = Total supply of licenses including any increase scenarios

TBS = Total base supply of taxi licenses before any increase

TA = Total arrivals throughout the simulation period

The model determines on a uniform basis the extent of increase throughout a simulation period, theoretically any time span on any day, but is typically applied to weekend evening periods as these represent the most acute delays observed. The model assumes uniform arrival patterns, and effectively unlimited accessibility and capacity at stance. The sub-model has the significant advantage of consistency but fails to take account of factors that may reduce its accuracy, including limitations in stance engineering that may reduce a stance's ability to accommodate more vehicles.

Impact of Additional Arrivals (IAA)

The IAA model determines the effect of a larger number of vehicles operating within a fleet on the waiting times experienced at stance. The model is calculated on the basis of selected stance data predominantly related to a particular time period. Thus most IAA calculations set out to identify reduction in peak waiting times, effectively seeking to address a weekend peaking problem.

In the standard model, IAA is calculated as:

$$IAA = (CD \times SBS) / (SBS + EA)$$

Where:

CD = Current mean passenger delay

EA = Extra Arrivals at stance in the simulate scenario

SBS = Stance base arrivals before increase in supply

This does not, however, account for stance-specific characteristics or driver behaviour that may alter the performance of a stance in accommodating new vehicles. Two alternatives exist that may address this; an additional element

within the existing IAA routine reducing stance arrivals in line with limitations to capacity and driver propensity to supply, or an alternative approach to FISM considering non-license based approaches in the first instance. The latter, non-license based approaches are set out in section 7.5.2.

This thesis proposes modification of the standard formula to take account of the limits to capacity at stance. This is identified as a limit applied to the number of vehicles that may rank at a stance. This results in a modification to the IAA routine, set out as:

$$IAA = (CD \times SBS) / (SBS + (EA - SSR))$$

Where:

CD = Current mean passenger delay

EA = Extra Arrivals at stance in the simulated scenario

SSR = Stance specific reduction

SBS = Stance base arrivals before increase in supply

Stance-specific reductions are based on the observation of numbers of current arrivals unable to enter the stance in proportion to the increased levels of arrivals determined in the EA sub-model.

Impacts of a Larger Fleet (ILF)

ILF determines, in the standard approach, the likely impact of a larger fleet on the operators within the fleet. Larger fleet sizes impact negatively on the fleet itself reducing the vehicle loadings, vehicle utilization levels, and have the potential to impact on the viability of services, particularly in relation to daytime operation. Using the standard approach it is possible to identify ILF as:

$$ILF = (CVD/SBS) * (SBS + EA)$$

Where:

CVD = Current Vehicle Delay

EA = Extra Arrivals at stance in simulated supply

SBS = Stance base arrivals before increase in supply

Driver delay differs from passenger delay, and is usually observed at times of low demand. The difference between, and accurate identification of, both passenger and driver delay is significant to the potential of the model to provide an effective solution to elements of taxi supply. Part of this is the correct identification of *driver perception* and driver behaviour rather than a reliance on the assumption of uniform availability across time periods, an element not currently included in the standard approach. Reduced availability at particular times, for example where drivers would seek not to work at night, affects the balance of new arrivals and reduces the effectiveness of increased numbers of vehicles in terms of increased levels of service to passengers and may influence other forms of regulatory control, most specifically the existence of a link between driver numbers and potential earnings. A more detailed exploration of the links between quantity and economic models is set out in section 7.5.4.

7.5.2 Non-License based Solutions Model (NLSM)

In its current application, the standard approach considers solutions to significant unmet demand as related purely to an increase in the numbers of licenses issued. A significant alternative to increasing numbers of licenses is to increase efficiencies within the operation of the existing fleet. Non license based solutions, identified as NLSM in Figure 7.2, sets out a new methodology for identifying the impacts of improving access and stance engineering prior to, and possibly avoiding, increasing numbers of licenses.

The non-licensing sub model comprises the following elements:

- Stance engineering,

- Driver perception, and
- Time Savings at stance

In the following sections, the concept of a non-licensing solution is set out in more detail. Existing terms and notation styles used in the standard approach have been followed wherever possible.

7.5.2.1 Stance Engineering (SENG)

An early observation suggested that despite considerable differences between stance design, capacity and use, the standard approach treated all stances as the same, all having unlimited capacity, and all functioning without physical restriction. In reality no single stance operated in exactly the same manner as any other. Each presented unique operational issues, and many offered opportunities for service improvement without a need to increase the size of the fleet.

On an individual, location by location basis, delays incurred at stance have a significant impact on the performance of the stance under review, and on the wider existing fleet, and these influence the levels of service experienced at particular stances, and as a result levels in the rest of the city. Three connected steps are proposed, 1) a review of stance engineering, identifying issues specific to location that may, where improved, result in better service levels; 2) a review of driver perceptions, seeking to identify propensity to supply where changes are applied; and 3) a new sub-model identifying time savings at stance resulting from changes identified in the previous two steps.

The SENNG model is derived from Transport for London best practice guidelines (TfL, 2003 p23), which sets out a qualitative assessment system for taxi stances. The TfL framework is helpful in that it allows for particular issues to be identified as appropriate to each site under consideration and this in turn allows for alternative solutions to be tested, see Table 7.1.

Table 7.1 Qualitative framework for assessing taxi stance
Indicator **Score**

SET DOWN AREA

Walking distance to facilities from set down point

Degree of comfort in set down

Efficiency in set down

Ease of taxis progressing to pick up

Carriageway markings

TAXI STANCE

Relationship with set down facilities

Interference from pedestrians

Capacity of stance

Carriageway markings and signs for drivers

PICK UP AREA

Waiting time

Accessibility for the mobility impaired

Efficiency of the passenger queue

Facilities provided at stance

Degree of comfort in queue

Capacity of passenger queue

Adequacy of loading bays

Speed of taxis exiting loading area

Accessibility of exit to highway

TOTALS

Derived from TfL (2003)

The TfL framework is appropriate as it identifies a wide range of issues that may limit the performance of a stance, and allows for a qualitative score that can be used to prioritise stance improvement. The framework does not, however, provide a means to identify the impact of a change in one or more indicator on the service levels at stance, rather a method to identify the most effective stance adaptations, measured quantitatively in terms of Time Savings at Stance, as set out in section 7.5.2.3, below.

7.5.2.2 Driver perception model (DPM)

A second input to improving performance of a stance (identified in Figure 7.2, and set out in section 7.5.2.3 as a time savings at stance approach - TSAS) relates to driver propensity to supply. This is calculated as a limit to increased supply at stance based on the availability and willingness of a driver to actually work at any given time. The majority of taxi drivers are self-employed, and therefore can choose times and days to suit within the confines of vehicle availability. It is not a clear-cut conclusion that improved capacity will lead to increased supply, and any predicted growth based on an increase in capacity must also take into account driver propensity to supply.

In order to distinguish between the desire and the ability to supply, a survey of drivers at stance is used and, in the case of Glasgow, this sought to identify issues that directly affected choice of shift. A survey of drivers is appropriate to this element of the new model, and is used to provide the proportion of the taxi parc available at any particular time. The concept is applied in the instance of Glasgow, see Chapter Eight, and summarised here.

For Glasgow taxi drivers, by far the greatest factor affecting choice was the personal desire to work at any particular time. Personal choice also reflected the perceptions expressed in three further categories: Safety, availability of vehicle, and the perception of numbers of passengers seeking transport. Personal safety was seen as the most significant external factor affecting the choice of mode (22% overall), although the figure dropped among nighttime drivers to 12%. 42% of all drivers were willing to work at night, 36% of daytime drivers were prepared to work at night. The propensity to supply is built in to the Time Savings at Stance model, described below.

7.5.2.3 Time Savings at Stance Model (TSAS)

This model element has been developed to identify the impacts of changes in stance specific factors on supply at those stances. Changes may be identified as a result of the

qualitative stance-engineering framework (see section 7.5.2.1, above) and applied where it is possible or cost effective to do so³⁸. Each change in infrastructure will represent a new calculation of time savings, with total time savings cumulative of all changes made at stance. Using traditional notation, the initial calculation is defined as:

$$TSAS = (CAD - TSE)$$

Where:

TSAS = Time Savings at Stance per vehicle

CAD = Current arrival delay

TSE = Vehicle Time savings resulting from change

As a vehicle arrives and departs more quickly from the stance, a benefit is experienced by users of the stance, and across the wider fleet, as the availability of vehicles is increased. Time savings at stance run parallel in the model to extra arrivals in the standard model and can be input in subsequent stages where time savings are converted into extra arrivals, using an approach similar to the existing Extra Arrivals (EA) determination contained in the standard approach. A conversion to extra arrivals (CEA) is applied according to the formula:

$$CEA = ((TP/(AJT-TSAS)) \times NVF) - ((TP / AJT) \times NVF)$$

Where:

TP = Time period

AJT = Average journey time

TSAS = Time Savings at Stance

NVF = Number of vehicles in fleet

Results of the conversion to extra arrivals (CEA) provides an input to the original standard model, see Figure 7.2, and can be further analysed using the same Impact of Additional Arrivals (IAA) sub-model as included in the original approach. However, as the fleet size is not affected by the improvements at stance, merely their efficiencies, it is

³⁸ Non-license based approaches are based on changes in the infrastructure available to taxis, or its use, and this implies an element of cost.

not necessary to continue to apply the Impacts of Larger Fleet (ILF) sub-model at this stage. Results from the new NLSM model are presented in the same format as those calculated in the original FISM model, and allow for conclusions to be drawn on the same basis as before.

7.5.2.4 Engineering calculations

An integral element of non-licensing approach is the identification of improvements that can be achieved in the operation of an existing fleet – time savings at stance benefit the performance of the entire fleet without a need to change the total number of vehicles, set out in section 7.5.2.3, above.

The TSAS model contains the value TSE, identifying time savings arising from specific engineering improvements, or improvements in stance use. The value is unique by location, and is calculated on a stance-by-stance basis, and explored in more detail in the case studies in subsequent chapters, but may include issues arising from traffic control, roadway width, ambient traffic or parking restriction. The case study examples include examples of the potential for time savings arising from changes in traffic signal phasing (eg, at the Gordon Street stance). A value applied to TSE in this particular instance are derived from improvements in the sequencing of the traffic lights, and follows a TRL formula (Webster et al, 1966):

$$TSE = (CAD \times EGT) / (EGT + IGP)$$

Where:

TSE = Vehicle Time savings resulting from change

CAD = Current arrival delay

EGT = Effective Green Time

IGP = Increase applied to Green Phase

Other changes in stance use may also improve stance performance, including shortened departure routes, described below and explored in detail as part of the case studies, see Chapter Eight.

TSE values arising from shortened departure routes, illustrated (Figure 7.4) in the case of departures from Glasgow Gordon Street stance, are calculated on the basis of time savings achieved by departing taxi.

Figure 7.4 Diversion at Glasgow Gordon Street stance

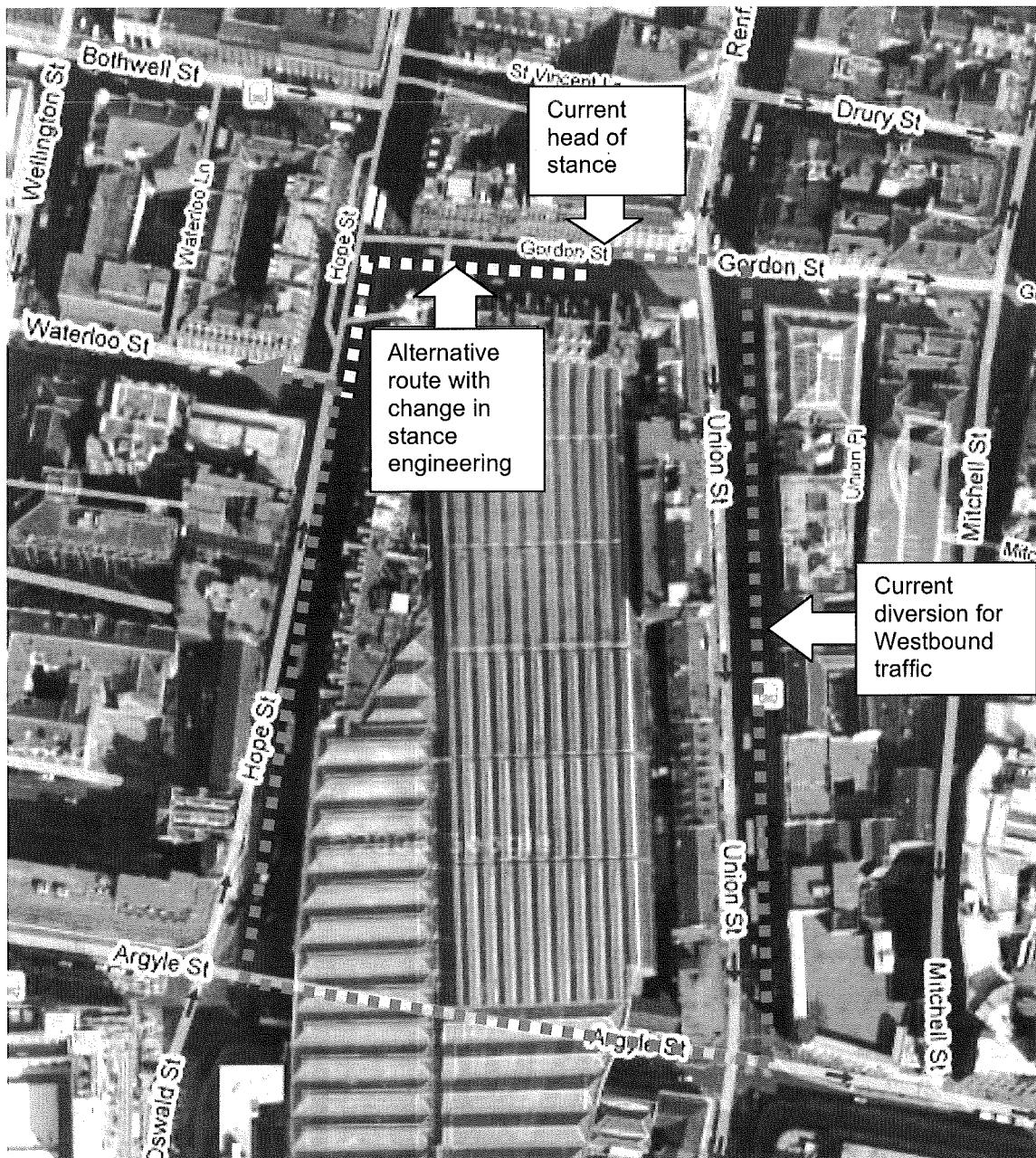


Image: Google, Route Diversion: Author

Where this diversion is followed, both journey time and tariff charged increase to the passenger whilst the effective availability of the fleet falls in proportion to the lost mileage. Realignment of the stance would, where implemented to allow for departures from both sides of the road, eliminate the need to divert to the East, and create a significant time saving at this stance. Calculation of TSE in this instance is based on the formula:

$$\text{TSE} = (\text{AJT} - \text{TS})\text{PWD}$$

Where:

TSE = Vehicle Time savings resulting from change

AJT = Average Journey Time

PWD = Proportion of Westbound Departures

7.5.3 Accessible Vehicle Model (AVM)

A further area of enhancement relates to the use of accessible vehicles, generally considered being accessible to passengers with physical disability. Authorities operating a mixed fleet (both accessible and non-accessible vehicles) and those without accessible taxis have sought to establish methods of determining appropriate levels of supply of accessible vehicles to meet demand (including West Dunbartonshire), and this represents a significant linkage between quality and quantity regulation that has does not appear within the existing standard approaches.

Two alternatives appear possible, the full adoption of an accessible fleet, where all vehicles within the parc are required to comply with DDA design standards, or the determination of numbers of taxis that would satisfy the demand identified in the authority area. The second option requires development of further model elements specific to proportional demand.

7.5.3.1 Model of Proportional Demand (MPD)

A fundamental question in adopting a proportional approach to accessible taxi supply relates to the determination of appropriate numbers of vehicles. A lack of sufficient accessible vehicles may lead to a suppression of demand not fully visible using observed behaviour models. The proposed proportional demand model seeks, therefore, to identify a level of future demand – in instances where sufficient numbers of accessible vehicles are present, and determine the potential increase in journeys resulting from an increased availability of accessible taxis. The initial calculation is based on the formula:

$$FQD = CQD + \% \Delta QD_{ij}$$

Where:

FQD = Future quantity demanded

CQD = Current quantity demanded

$\% \Delta QD$ = % change in quantity demanded for user groups *i* to *j*.

Potential change in quantity demanded is specific to location, and relates in this instance to the potential for increased demand as a result of requiring the use of accessible vehicles. Increases in demand ($\% \Delta QD$) are most likely to occur where previous use has prevented by inability to access existing vehicles – for example in the case of wheelchair users. Other increased use may also occur where parents with children in pushchairs are prevented, by previous vehicle designs, to gain easy access to vehicles. An illustration of the application of this concept in West Dunbartonshire is set out in Chapter Eight. The measurement of change in quantity demanded does, however, require further interpretation; given that not all journeys occur at the same time, or are made for the same purpose, the calculation is further developed to identify the effect of peaks in demand. Responses in the access survey also allow for identification of points of peak demand, by journey purpose and by time of day. As with the more general use of taxis, the most concentrated peak occurs in travelling home from entertainment, peaking at

weekend nighttimes (in West Dunbartonshire 30% of all demand), and is concentrated on a peak hour. Other peaks included shopping and attending doctor or hospital appointments, although these were more spread through the day.

A Journey Purpose factor has been developed and applied to determine the number of journeys requiring accessible transport likely to occur – for example demand occurring at a point of higher demand (eg. during the evening peak period) calculated on the basis of:

$$JP = QD * DP / LP$$

Where:

QD = Total journeys requiring accessible vehicles

DP = Stated demand for travel in a peak period

LP = Length (hours) of identifiable peak period³⁹

Variations in supply may also affect availability of accessible vehicles in a mixed fleet. The extent of supply available at any one time will vary by time of day, and by day of the week. There is no compulsion on a taxi driver to drive their vehicle at any particular stage of the day, and many will choose to operate at times felt convenient or attractive. Data from the Taxi Drivers Survey has been used to establish typical working patterns, and to determine which hours were driven regularly by taxi drivers.

The supply factor is included to identify, in the instance of accessible taxis being distributed uniformly across all taxi drivers, the actual number of accessible vehicles required to ensure sufficient supply at the point of peak demand. Given that the extent of a fleet available at any one point of time varies and is likely to be less than the total number of vehicles licensed with that fleet, the supply factor identifies in a given time period the proportion of the taxi parc available for engagement.

$$SF = ATF / TTF$$

Where:

³⁹ A peak period varies in length depending on local circumstance. In the instance of West Dunbartonshire this was observed as occurring over a two-hour evening period.

TTF = Total Taxi Fleet

ATF = Number of vehicles within taxi fleet available for hire

A further element is included - Vehicle utilisation (VU) measures the extent to which a single vehicle is able to complete more than one journey in a given time period⁴⁰. Travel and engagement patterns vary across a city, but observed practice suggests a pattern of taxi drivers returning to a central point on completion of a journey.

Typically a taxi leaves the available fleet as it is engaged to complete a journey, and returns to the fleet as it drops off passengers and seeks re-engagement. A taxi engaged for a 15 minute journey re-enters the fleet at the conclusion of its journey, and could in theory complete 4 such journeys in an hour. Practically, however, the vehicle concludes its journey away from the town centre or stance location, and would effectively require a similar time to return to the stance from whence its journey originated. This would suggest effective availability for 2 journeys in the hour. Journey lengths also differ depending on journey purpose, pick-up point, and the desire of the driver to return to the original pick-up point to seek re-engagement. An average journey time of 10 minutes would result in the potential for the same vehicle to operate 3 journeys within any given hour. A factor determining vehicle utilisation establishes the extent to which a vehicle is actually available, rather than being occupied, and is based on the formula:

$$VU = TP / (AJT + VRT)$$

Where:

AJT = Average Journey Time

VRT = Vehicle Return Time⁴¹

TP = Time Period

⁴⁰ A taxi is able to complete a number of journeys in any one time period, depending on the length of journey, point returned to and frequency of engagement.

⁴¹ Journey time and return time are likely to be the same where a vehicle returns to the same point from whence a journey originated.

The combination of these factors provides an estimation of the numbers of vehicles required to supply accessible taxi services to demand identified. This is summarised as a vehicle availability model (Vehicle Number - VN) as follows:

$$VN = FQD \times JP \times SF \times VU$$

Where:

FQD = Future Quantity Demanded

JP = Journey Purpose

SF = Supply Factor

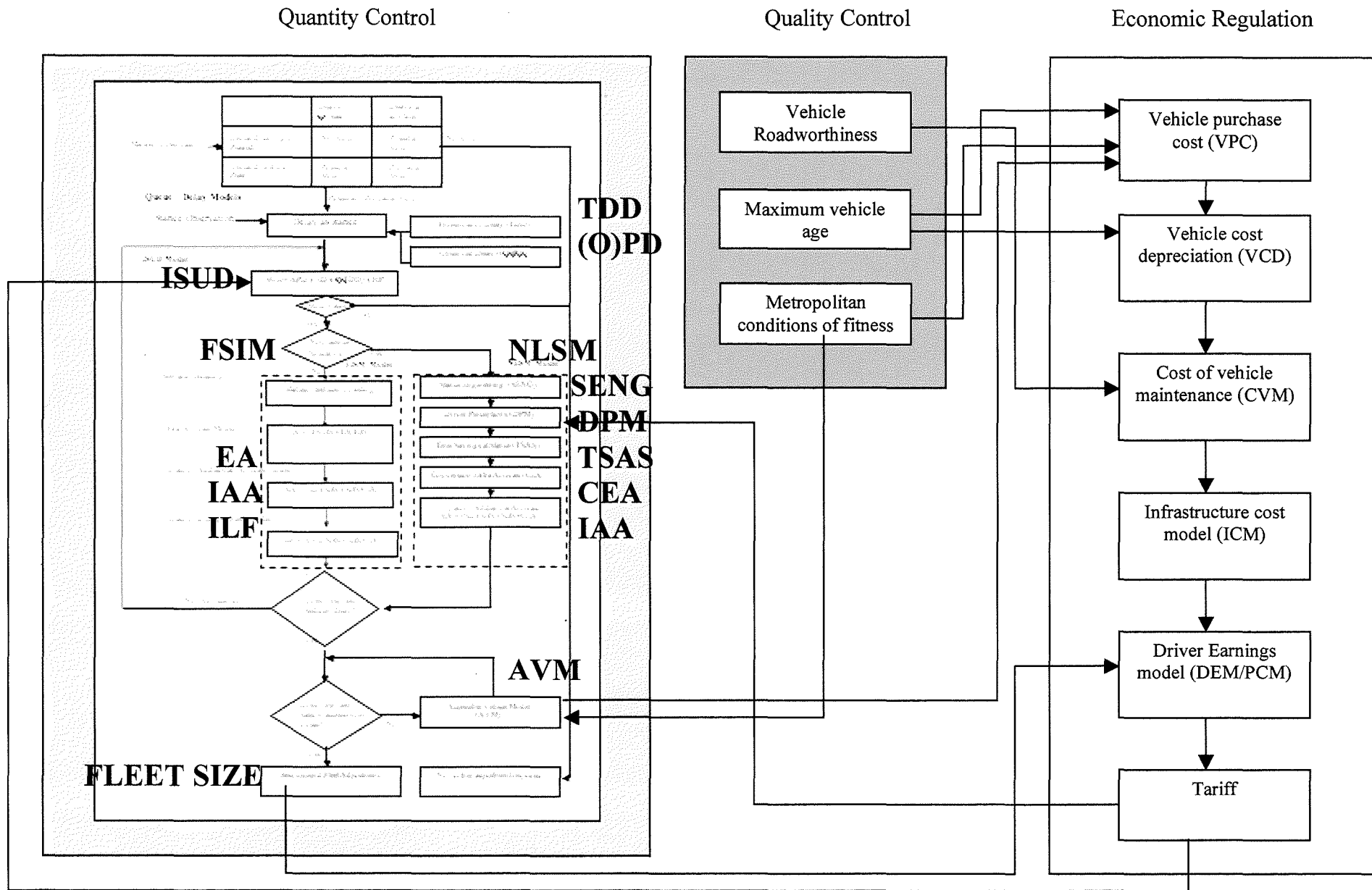
VU = Vehicle Utilisation

The number of vehicles (VN) required to supply accessible taxis to meet demand can then be applied to the fleet. An application of the Accessible Vehicle Model is set out in the case of West Dunbartonshire in Chapter Eight.

7.5.4 Linkages between Quantity and other regulatory domains

The enhancement of the existing approaches to quantity regulation allows for a more detailed assessment of links between regulatory domains, see Figure 7.5. The identification of linkages between quantity (demand) and other regulatory domains allows for a more detailed analysis of the issues in supply of taxis.

Figure 7.5 Linkages between quantity control and other regulatory domains



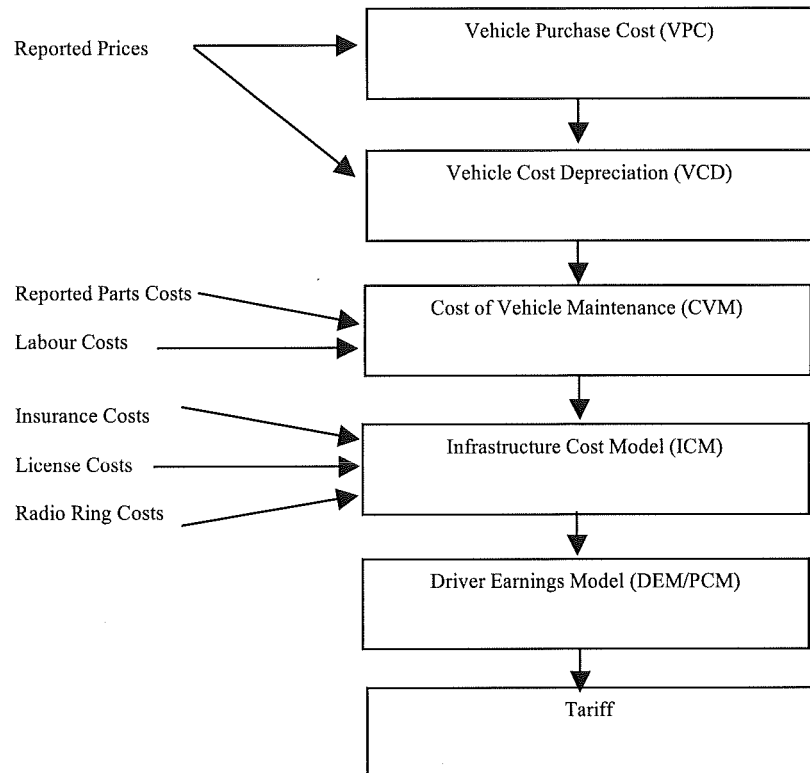
Links identified include those between quality measures, specifically Metropolitan Conditions of Fitness (MCF) and the accessible vehicle model (AVM); between AVM and economic regulation, and between fleet size recommendations and driver wage. As each city may apply a differing extent of regulation the exact nature of the links varies. However, the existence of linkages between the regulatory domains and their inclusion in analysis, allows a licensing authority to explore the potential impacts of a change in licensing action more fully. The instance of links identified within and between economic regulation and the other forms of regulatory control are explored in Section 7.6.

7.6 Developing a new model of economic regulation

In addition to the development of analytical models of quantity, the new modelling framework updates models used in economic regulation. New models of economic control may be developed to include consideration of the links identified between the regulatory domains, illustrated in Figure 7.5, above. The development of a new modelling framework and the inclusion of links between cost model and other regulatory domains does not, however, require a wholesale abandonment of previous approaches, but rather the identification of elements within the existing approach appropriate to development and updating.

The most common form of model applied to economic regulation, the cost model, provides some consistency in approach to determining fares, but does not have the formal structure observed and commonly applied in the quantity domain. Rather, represents a common form of calculation, discussed in more detail in Chapter Four. The elements within the cost model, and their structure, are set out in Figure 7.6, and discussed in detail in subsequent sections.

Figure 7.6 Sub-models applied to cost modelling



Source: Author

The primary purpose of the existing cost model, defined by authorities surveyed, is the determination of fares charged for using a taxi, or more precisely the calculation of increases to be applied to tariff, the underlying price Table on which fares are calculated. Cost model approaches are intended to identify the extent change in the costs of operating a taxi, a comparative cost rather than the absolute cost; using the level of change in costs as a base for increase (or reduction) in taxi tariff. The approach includes identification of a number of values (purchase cost, depreciation, quality, maintenance, the cost of labour in maintenance and fuel costs) that may increase at differential rates, the sum of which forms the basis of the calculation of changes in cost. Each of these is detailed in turn within the following sub-sections.

7.6.1 Taxi Cost Model (TCM)

The cost model splits into three identifiable elements, the costs of the vehicle and its operational costs, the costs of infrastructure and licenses, and additional costs. The taxi cost model (TCM) is identified as a series of sub-models, set out below, updated and developed as a part of the new model to take account of links with other regulatory domains.

7.6.1.1 Vehicle Purchase Cost (VPC)

Vehicle Purchase Price and Depreciation occur in all cost models identified – based on authorities included in the survey of regulation. The cost of a vehicle is a standard measurement, most commonly based on the list price for a new vehicle – either for a single vehicle type, typically the most common vehicle in a fleet, or as a combined cost representing two or more major vehicle types. Most of the authorities included in the survey of regulation identified the actual cost price of a 'taxi' and the change in this cost identified over the period of the review in their calculation.

The inclusion or widening of vehicle types to include primary and other major taxi types (such as the Allied E7) as a part of this calculation may be appropriate for cities with mixed fleets, or in instances where the interpretation of MCF vehicle standards allows for the operation of new vehicle types (see section 5.3.1), but will also increase the complexity and reduce reliability of data collected.

The inclusion of alternative vehicle types is based on the formula:

$$VPC = \sum_{i=1}^j (\% \Delta OPCA V_i \times PAV_i)$$

Where:

VPC = Vehicle Purchase Cost

OPC = Observed Purchase Cost for alternative vehicles *i to j*

PAV = Proportion of vehicles in fleet

The more detailed approach does, however, more fully consider the link between quality standards (represented by MCF or other minimum vehicle specification) and the elements contained within the cost model.

7.6.1.2 Vehicle Costs: Depreciation (VCD)

The second element in determining the costs of vehicle purchase relates to depreciation an accounting measure reflecting a reduction in the value of a vehicle over time. Two main measures can be applied to depreciation, straight line and reducing balance; the first a simple division of value over the life of a product, the latter recognising that higher depreciation costs occur earlier in an assets life.

Authorities included in the review all indicated that straight line depreciation is used in the calculation of costs within the taxi model, given its relatively simplicity, and the need to identify comparative, rather than absolute values between years. The method determines a straight line between value at purchase price and scrapping at the pre-determined end of service life. More complex consideration of the actual values of vehicles may also include distinction being drawn between differing patterns of vehicle ownership, to take account of different purchasing behaviour. Examples of these (TfL, 2005a) include:

- Purchasing a vehicle new, and running to scrap,
- Purchasing a vehicle new and selling at 4 years,
- Purchasing a vehicle at 4 years and selling at 8 years, or
- Purchasing a vehicle at 8 years and running to scrap.

While these may be closer to the actual behaviour, their calculation represents a significantly higher level of data required in comparison to more simplistic approaches, and this in turn may negate their benefit.

Straight-line depreciation to zero is based on the calculation:

$$\text{VCD} = \text{OVC} / \text{YSL}$$

Where:

VCD = Vehicle cost of depreciation

OVC = Observed vehicle cost

YSL = Years in service life

All authorities surveyed using a vehicle cost element apply straight-line depreciation, with the same approach being adopted in London despite the suggestion in the TfL report that alternatives be considered. The routine does, however, differ in some locations where a prediction of resale value is included (compared to other locations where depreciation runs to a zero value). This may also be informed by a link the calculation of VCD and specified maximum vehicle ages, a quality regulation. In the instance of resale values the following formula is appropriate:

$$\text{VCD} = (\text{OVC} - \text{RV}) / \text{YSL}$$

Where:

VCD = Vehicle cost of depreciation

OVC = Observed vehicle cost

RV = Predicted Resale value

YSL = Years in service life

The determination as to which form of depreciation relates to the circumstances of the location under review, a review of possible applications is set out in relation to Glasgow in Chapter Eight.

7.6.1.3 Cost of Vehicle Maintenance and labour (CVM)

A large number of the cost models reviewed included measurement of the cost of vehicle maintenance, and many additionally included cost of labour charges in maintenance. Maintaining a vehicle in a roadworthy state is both desirable and legally required. However, despite its frequency of use, the methods used to determine maintenance costs vary, as do the values identified by differing authorities. The most common measurement of maintenance costs is based on a typical basket of parts, comprising parts felt to be common in the maintenance of taxis, and the observed changes in the costs of those parts over time. The calculation, which excludes the cost of labour and is specific to one vehicle type, is based on:

$$CVM = \sum_{i=1}^j CP_i$$

Where:

CVM = Cost of vehicle maintenance

CP = Sum of costs of parts *i to j*

Costs are determined on a location specific basis, and it is inevitable that the actual content of the basket (of parts) will vary between cities as much of the actual maintenance reflects the road conditions in the city of operation, and the circumstances in which supply is provided. It should not be a surprise, therefore, that differences exist between the costs in London and those in Glasgow, rather the extent of the differences in those costs. Moreover, the issue of differences in vehicle types, which is excluded in the current approaches of the case study cities, between fleets makes actual comparison of values between cities less effective, although some indication of common trends maybe possible.

Several issues exist in relation to the basket of parts approach. The most significant is to ensure that the basket actually reflects the parts most commonly used in the maintenance of the fleet. This changes over time as the fleet itself changes, and as the technologies of the vehicles in the fleets require different, if not reduced levels, of maintenance. The

costs indicated in the current basket are applied to the cost model to identify the change in cost over a specified period. The measure is relative, and do reflect the actual costs of maintenance using the parts indicated.

7.6.1.4 Maintenance costs: labour

An additional element to the cost of vehicle maintenance is the inclusion of labour costs. Maintenance includes both the costs of parts and the cost of labour in servicing and repairing vehicles. The level of labour costs varies over time, as does the cost of parts, but is likely to vary at a differing rate – a ground for specification and identification as a separate element in the costs of maintenance. Several issues arise in the use if the current maintenance cost element, including the need for the list to represent an appropriate cross section of parts used. This need not relate to every part used in every vehicle, put should approximate the most common. As vehicle technologies, the parts used in maintenance change accordingly, and the need to update the components within the basket is heightened where the range of vehicles in the fleet increases. Where a model reflects costs for one vehicle type only, or is based on a basket that has remained unchanged for some years the model may fail to fully account for changes in the operating costs of a taxi.

The additional elements are represented in the basic approach where maintenance costs are added to cost of parts as:

$$CVM = \sum_{i=1}^j CP_{ij} + CLT$$

Where:

CVM = Cost of vehicle maintenance

CP = Sum of costs of parts

CLT = Cost of labour based on time input

and in the more detailed calculation where multiple vehicle types are used:

$$CVM = \sum_{i=1}^j (CPI_{ij} + CLT) PAV_{ij}$$

Where:

CVM = Cost of vehicle maintenance

CP = Sum of costs of parts

CLT = Cost of labour based on time input

AV = Alternative vehicle types

In addition, a number of alternative methods to identifying the costs of maintenance exist, including measurement of the direct or contract costs of maintaining a sample of vehicles over the course of a year. The approach would be best informed by seeking full costs from dealerships or individual taxi operators to establish and average cost of maintenance over a year. A sampled contract cost is identified in the Glasgow case study in Chapter Eight.

7.6.1.5 Fuel cost

Fuel costs relate directly to the operation of a taxi, and are included in the majority of models, as well as 'ad-hoc' indications of changes in cost. The concept is consistent between cities and updated in relation to the changing price of fuel. Costs are typically derived by comparing the cost of fuel in period x , to the same costs in period y . The costs include a number of variables, price of fuel at any one point in time, the assumed or comparative mileages used in the calculation, and the assumed fuel efficiencies of the vehicles in the fleet. The fuel cost can further be identified for differing distances, and differing rates of fuel consumption. The assumptions of vehicle efficiencies and driven miles are significant in that a more efficient fleet will demonstrate lower costs than a less efficient one. Fuel efficiencies also relate to the composition of the fleet with a greater

accuracy possible where a calculation models differences in fuel efficiencies between vehicle types.

Given the consistency and ease of accessing accurate fuel data, the benefits of updating the fuel cost element are limited. Vehicle fuel efficiencies appear consistent between cities⁴², while a more detailed review of fuel consumption ratings by vehicle type would be unlikely to result in a significantly more accurate measurement.

7.6.2 Infrastructure Cost Model (ICM)

The infrastructure costs model identified fixed costs, those not increasing in line with increased mileage, and also includes additional costs applied by some, but not all, authorities. Changes in infrastructure costs are determined on the basis of comparisons between costs in time period 1 against that in time period 2. This follows the formula:

$$ICM = \sum_{i=1}^j (IC_{i1} - IC_{i2})$$

Where:

ICM = Infrastructure cost change

IC = Identified cost in periods 1 and 2

Typical identified costs include:

- Insurance
- Licenses/Permits
- Radio Hire / Subscriptions

The exact nature of identified costs differs between locations, with the key elements set out below.

⁴² Based on survey of regulatory approaches.

7.6.2.1 Insurance costs

Insurance costs are seen as a necessary cost in the operation of a taxi. These costs cannot be avoided, are a legislated requirement, and common to all measured cost models. The difference in insurance costs observed in differing cities is, however, significant, and the extent of the variation between cities suggests a need for further consideration. The costs of insurance vary by individual driver, and should also be expected to vary by city, given that differences that naturally exist in the risks associated with differing locations.

7.6.2.2 License costs

The costs of licenses, driving license, operator's badges etc., are included in most models. The Glasgow tariff model currently includes costs for both elements. The actual licensing cost is highly specific to each city, which makes direct comparison difficult, and inappropriate. It is necessary to include the costs of licenses in the calculation of cost models, and these should be directly updated from city authorities.

7.6.2.3 Other cost elements

In addition to the costs detailed above, a number of additional costs are included in the cost models across authorities approached. These are summarised in Table 7.2.

Table 7.2 Additional cost components applied across locations

Cost Component

Cost of license / permits
 Subscription to Radio Ring
 Consideration for 'knowledge'
 Social Cost
 Environmental Supplement
 Specified driver wage
 Earnings (not as wage)

Subscription to radio ring

A number of cities choose to include radio dispatch costs in the cost model, identifying the costs of subscribing to or renting radios in the operation of taxi services. The costs are identifiable and readily updated from Association or Radio Ring. Arguments for inclusion of radio costs relate to providing as full a cross-section of costs as possible.

Consideration for the 'knowledge'

London includes a cost element specific to the knowledge, part of the London driver test. The element appears intended to address the significant individual costs of preparing for 'the knowledge'.

Social cost

The social cost element is included in a small number of cities (including London and Birmingham). The cost is identified differently in different reports, either as a payment for antisocial hours of operation, or in relation to the costs of additional individual social costs, holidays and pensions.

Environmental supplement

The use of costs and price mechanisms in delivering environmental benefit is desirable in many fields, and is adopted in transport to a limited extent. The inclusion of an environmental cost supplement within the tariff model would appear appropriate where the measurement is clear, and the cost actually incurred in the operation of 'greener' taxi vehicles. Where environmental costs are incurred through the production and requirement

to implement less environmentally damaging vehicles, however, as is the case in the increasing rigour of pollution controls applied to new vehicles, the costs are actually incurred by the taxi operator at the point of purchase and in the maintenance of the vehicle. These are already elements of the model, and the costs are, therefore, already included. Likewise, costs imposed through the taxation of fuels are already included in the model, and any additional element would tend to double count the cost.

The application of a separate environmental tax (as envisaged in carbon taxes) would appear to be a method of altering behaviour in driving pattern, frequency or in vehicle choice; and could thus be identified as having a potentially positive impact. It would, however, prove somewhat counterproductive to impose an environmental tax, and then provide a method of mitigating its cost, as this would effectively remove the cost and thus the incentive to move to more appropriate (compliant) vehicle types.

Driver wage

The inclusion of wages / earnings varies significantly between authorities and represents a significant element of the total costs of operating a taxi. The issues are addressed in detail in section 7.6.3.

7.6.3 Driver Earnings Model (DEM)

The inclusion of compensation to drivers is consistent in cost models across authorities, although the associated methods of determining a cost differ. Two main methods of identification exist, a specified wage cost, or a proportionate approach. The main differences between the two approaches relate to the specification of wage in relation to a measurable change in similar trades, or the generalisation of the cost against a broad increase in costs. The latter relating to updating the cost as a proportion of all costs, the former provides a method for adopting a local wage component in line with earnings and more fully justifiable to local cost of production – defined as a personnel cost model, and set out below.

7.6.3.1 Personnel Cost Model (PCM)

Identification of an explicit wage within the cost model would provide a solid base for calculating changes in that cost. Most significantly a local wage cost would be independent of cost assumptions about labour costs generally, and justifiable against the earnings of similar industries. Identification of an industry specific wage rate would also benefit the taxi trade by linking wage rates to those in similar sectors, avoiding significant disparities between earning potential in similar jobs and maintaining an incentive to remain within the taxi trade - the wage rate working through the tariff to provide a realistic income to taxi operators maintaining and reducing operating costs in other areas of operation.

The identification of an appropriate rate is taken, for the purposes of this thesis, from the Office of National Statistics Annual Survey of Hours and Earnings, and is specific to Scottish Transport and Mobile Machine operatives (ONS Sector 82). The rate is defined annually and reflects changes in transport and associated professions in Scotland. The calculation would thus be based on the concept that:

$$\text{PCM} = \text{ONS}(82)$$

Where:

PCM = Personnel Costs included in the cost model

ONS(82) = Personnel costs determined in the Scottish Transport Sector (82) of the Office of National Statistics Annual Survey of Hours and Earnings

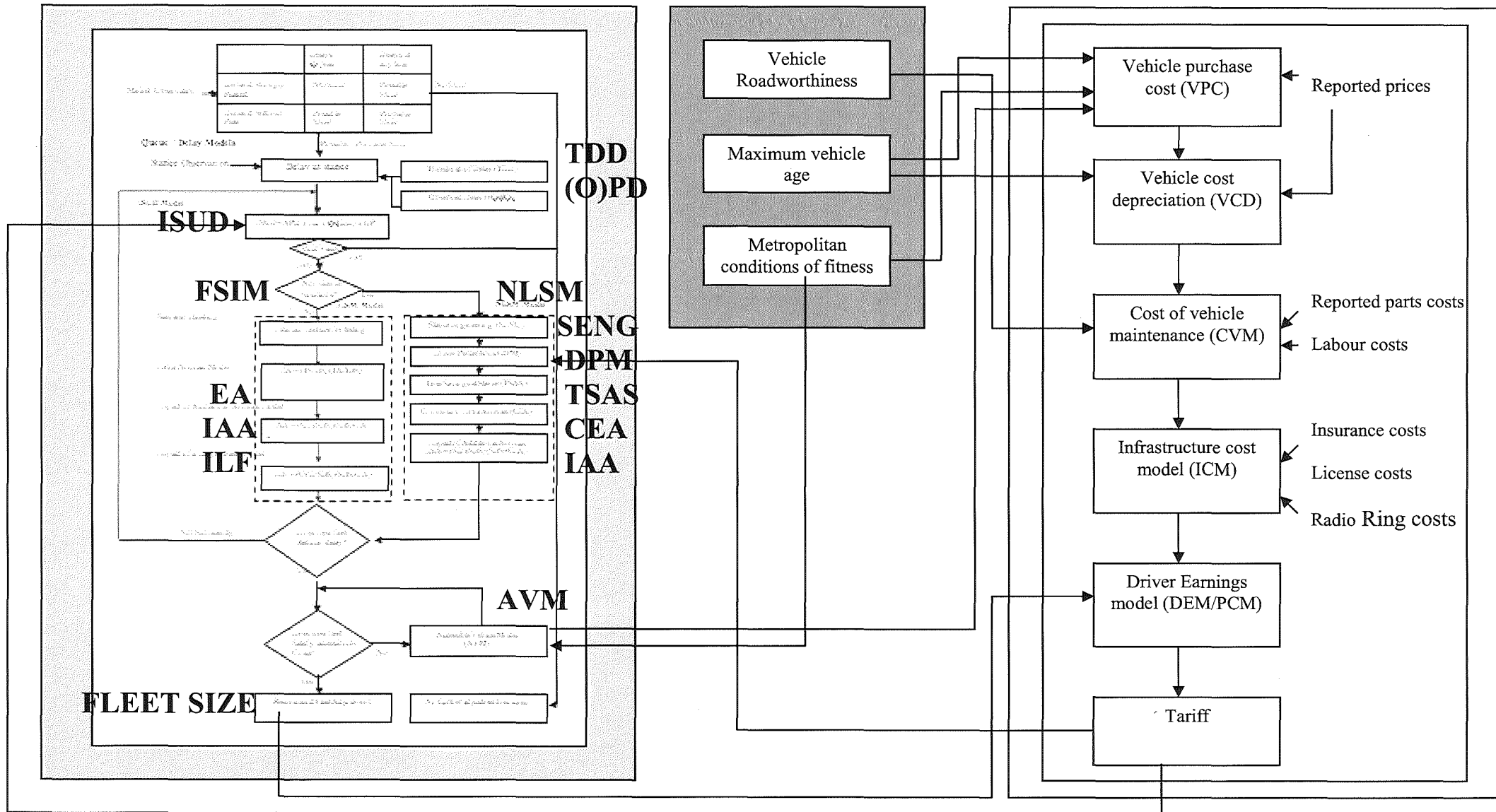
Each of the preceding elements within the Taxi Cost Model is determined on the basis of changes in costs experienced locally. It appears appropriate that the costs of labour be identified in a similar manner. The identification of a labour (wage) cost does, however, differ from other elements in the cost model as it relates directly to individual operators rather than to the identifiable costs of repair, parts, fuel etc., supplied by and priced by third parties. Wages within the model, therefore, relate to the amount of money paid by a driver to her/himself for the operation of the taxi, or more accurately the amount of money left as earnings when other costs have been accounted for. The accuracy, or otherwise, of other elements within the model impact directly on the amount of money

that may be earned, while the updating of earnings costs in an accurate fashion will materially affect the ability of the individual to achieve a pay rise or, alternatively, similar or lower incomes year on year.

7.6.4 Updating the taxi cost model

Unlike the models applied to quantity regulation, taxi cost models relate to a simple comparison of costs from period to period, wherever possible on a like-for-like basis, period x to period y. Updating the model is therefore determined more by the accuracy of the modelled elements to a location, rather than the development of new elements applicable to all. It is, however, possible to build on linkages between the cost model and other parts of the modelling framework, ensuring that these links are correctly identified and applied to and from the taxi cost model. This represents a departure from previous standard approaches, and is summarised in figure 7.7.

Figure 7.7 Linkages between economic regulation and other regulatory domains



The development of a combined modelling framework, which represents a new approach to existing taxi analysis, allows for the inclusion of a more detailed assessment of inter-working between the forms of regulatory control. Figure 7.7 extends previously defined linkages, see Figure 7.5, to demonstrate dependencies within the taxi cost model structure defined in the sections above. Application of these structures are demonstrated by using case study data in Chapter Eight. Links to and from regulation of quality (Quality Control) are demonstrated in the diagram and developed in the application of the new modelling framework. However, as analytical models applied in quality regulation fall outwith the remit of the licensing authorities their detailed construction is not developed further in this thesis.

7.7 Conclusion

This chapter has set out a new modelling approach with the detailed sequence of appropriate sub-models and linkages between regulatory domains. These have been set out as a framework for analysis, to be applied to licensing authorities as dictated by the ambient conditions, and political imperatives of those locations.

This model is now applied to two UK case study locations, to West Dunbartonshire and to Glasgow, as set out in Chapter Eight. Using the material displayed in Chapter Seven, the following chapters consider the implications of these technical additions and adjustments for the wider UK institutional environment.

Chapter 8

Case Studies

8.1 Introduction

This chapter applies the new model, developed in Chapter Seven, to specific UK case locations. Two primary locations have been used as the basis for application, West Dunbartonshire and Glasgow. The application to specific locations has allowed for detailed in-situ analysis of the issues in taxi supply, the difficulties in achieving an appropriate balance of regulation, and provided a real test of the rigidity and impacts of the new modelling framework.

The application of the new structure necessarily required large amounts of data input and this factor drove the choice of locations, both being representative of particular city types, set out in Table 3.5 and on the availability of data, or the potential for its collection.

Data collected in west Dunbartonshire, an urban peripheral authority, and in Glasgow, considered a compact city, see Chapter Three. 1176 hours of data collection were undertaken using observation survey, 1610 clipboard and emailed questionnaires completed, 33 telephone interviews, 8 face-to-face interviews and 3 focus groups undertaken, detailed in Table 3.5, including work undertaken by the researcher on the basis of commissioned research for local authorities. The commissioned character of this research provided high quality access to the range of stakeholders and afforded the opportunity to both collect high quality data and apply models developed to real life operation.

This chapter identifies the characteristics of the authority areas included in the application, the circumstances of supply in those areas and the issues identified within and by the case locations as pertinent in the development of taxi services. The chapter also sets out the extent to which the case locations have made use of standard modelling approaches and the potential and impacts of applying the new modelling framework to those locations.

8.1.1 Primary applications: the locations

In discussing primary applications we wish to identify both a) the locations in which the research was undertaken and b) the nature of the models applied within these locations. The two authority areas both operated similar policies of restriction, but operated different fleet compositions and presented differing problems in demands for taxi services, and thus potential ‘solutions’ also varied significantly. The variation in the patterns of demand between the locations highlighted differing areas of modelling within the new framework developed in Chapter Six, but also provided a basis for testing a wider ranging test of the model framework than possible in single city forms alone.

West Dunbartonshire

West Dunbartonshire is an urban peripheral authority located to the west of Glasgow within the Strathclyde metropolitan area. The council area includes two town centres, Clydebank and Dumbarton, and includes a number of semi-urban dormitory locations including Alexandria and Balloch to the North West of the authority area. The licensing authority applies quantity restrictions consistently throughout the council area, but is divided into two ‘zones’, with differing levels of accessible taxis (quality) between the zones.

Glasgow

Glasgow is a compact city at the centre of the Strathclyde metropolitan area. The city is polycentric (see: Redfearn, 2007) with a mature network of public transport services including Local Rail, Subway and Bus. The city imposes quantity restrictions and has been subject to a number of legal challenges to the validity of the restriction (Coyle v Glasgow, 1997). The city has also sought to develop separate cost models appropriate to the determination of taxi tariffs, and the combination of cost and SUD elements of assessment form the basis of this model application in Glasgow. In order to provide a preliminary indication of relevant activities in Glasgow the following actions, discussed in the later parts of this chapter, were undertaken:

- Assessment of current supply and costs
- Identification of market segments not currently served well by taxi supply
- Development of tools for resolution of problems
- Application of tools

8.2 West Dunbartonshire, developing a quantity – quality linkage

Primary issues of importance to West Dunbartonshire, identified by the council (Cooper, 2006), included the appropriateness of current limits to license numbers, a survey of taxi supply as mandated under the CGSA, but also included concerns about quality and accessibility of vehicles – not part of standard SUD analysis. Case study material was collected as part of an exercise to determine the (lack or) presence of SUD and to determine the appropriateness of taxi supply in addressing the demand for taxi transport in West Dunbartonshire –combining quantity and quality assessment.

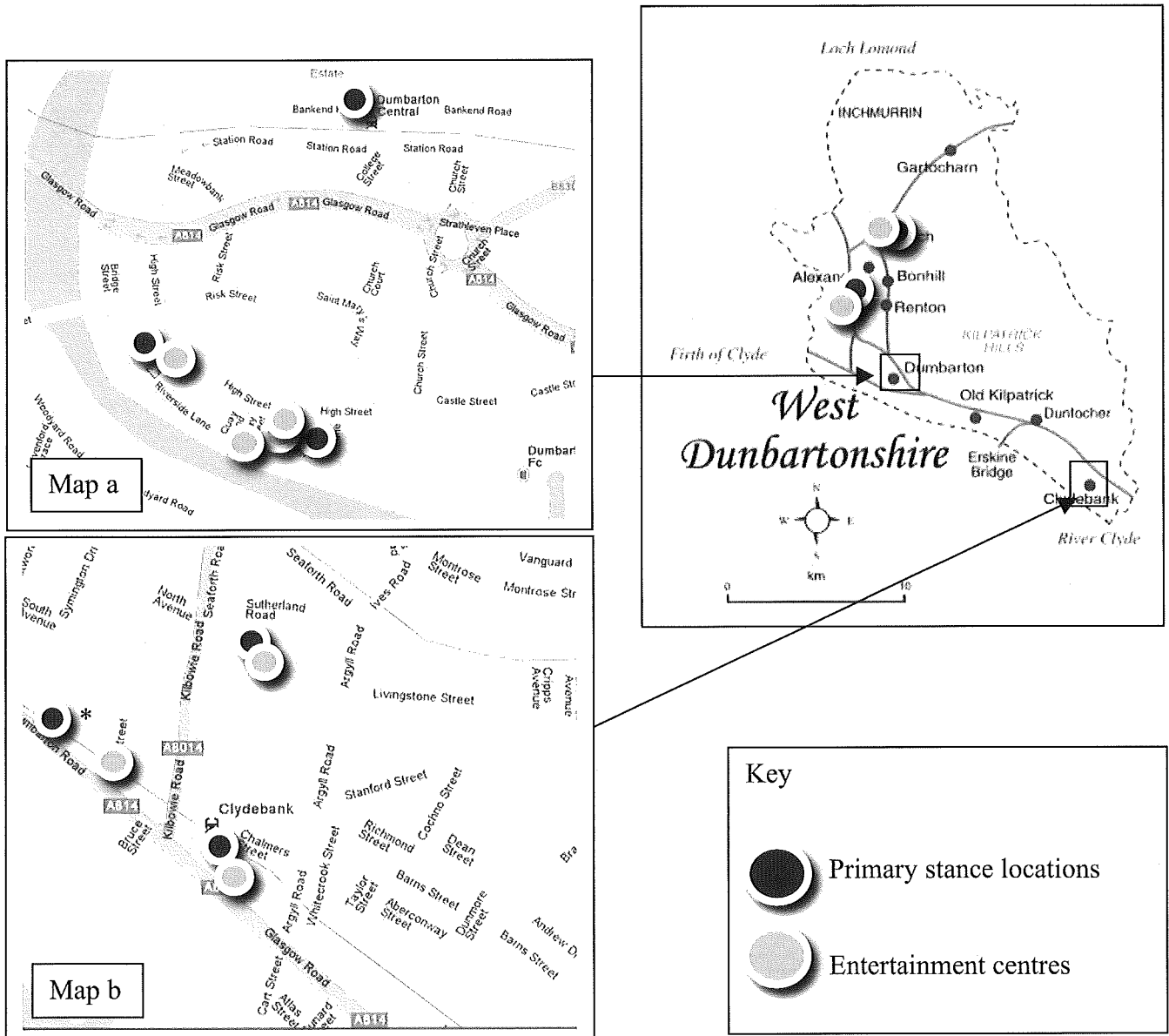
The research comprised a four-stage analysis of taxi supply comprising:

- Review of existing studies, including the assessment of the legal framework, interpretation and application to the West Dunbartonshire survey design
- Completion of observation survey at stance
- Completion of public, disabled and driver surveys
- Reporting back to the Licensing Authority and providing recommendations

The study was comprised of a series of surveys (see Table 3.5) appropriate to the determination of SUD following standard modelling approaches, and additional data collection, including driver surveys and a survey of disability access needs – specific to quantity, numbers of access vehicles, and quality regulation, overall vehicle type. Development of the quantity – quality linkage also allowed for testing of allocation concepts, methods to determine actual levels of accessible vehicles.

At stance observation surveys were completed at eight stance locations on the basis of both day and night observation (see maps in Figure 8.1) and at a number of unofficial ranking places where nighttime pick-up differed from marked ranks.

Figure 8.1 Maps of West Dunbartonshire stance locations⁴³



Stance locations: Clydebank: Alexander Street, Clyde shopping centre, Dumbarton Road; Dumbarton: Central Railway Station, Riverside lane at church, and at RBS; Alexandria Main Street; Balloch: Railway Station

⁴³ Unofficial ranking places occurred in instances where official stances appeared to be incorrectly located for nighttime demand, most common where daytime and nighttime activities differ in location. The Dumbarton Road stance at Singer is an example of this, identified by an asterisk in Figure 8.1, map (b) where nighttime demand occurs at a location to the South East of the marked stance, in this instance outside the Buddha night club, located 600 metres from the stance. Although a small distance the effects of this separation include a loss of traditional ranking patterns, uncertainty in passengers and driver behaviour, and a reduction in the validity of the standard model.

Pedestrian surveys were completed in both Dumbarton and Clydebank zones, and provide details of public attitudes and concerns in the supply of taxi services in West Dunbartonshire. An access survey, intended to provide input to the new accessibility model, was distributed with the assistance of the West Dunbartonshire Access Panel, and provides details of concerns and experiences in the supply of taxis experienced by those with specific access requirements, both those related to use of wheelchairs and other forms of physical disability. Two focus group meetings were held, the first with taxi operators, the council licensing department and the police, and the second with representatives of those with specific access requirements. Proceeding from this set of consultations and surveys, the researcher developed a combined model - already presented in Chapter Seven - that incorporated both SUD modelling and Quality Control approaches to taxi supply. The following sections detail the specific local application of the combined model.

8.2.1 West Dunbartonshire, aims in taxi supply

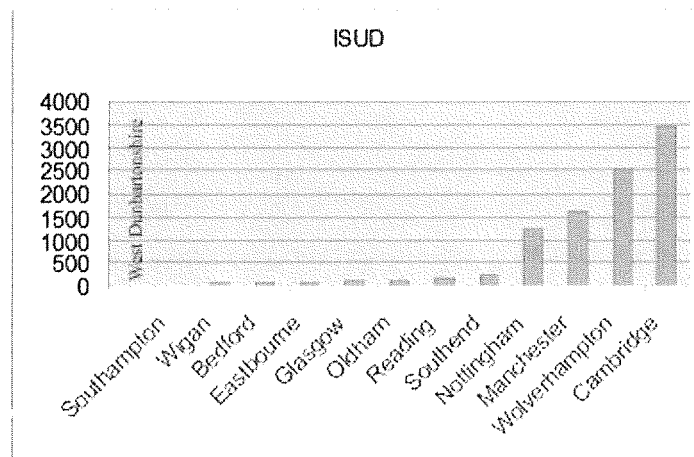
West Dunbartonshire has sought to establish appropriate levels of taxi supply to meet demand and, in common with other authorities, places a limit on the numbers of licenses issued. While the council did not feel that numbers of taxis were significantly below the level required to meet perceived demand, there were concerns that the supply of taxis was insufficient for individuals with disabilities, and this was highlighted by a split in supply between two areas within the authority: Clydebank, where MCF compliant vehicles were required, and Dumbarton operated by a mixed taxi fleet.

The authority also sought to test for unmet demand to conform to the requirements set out under the CGSA. The combination of SUD and review of accessible taxis provided an opportunity for the testing of the first stage in the new model development.

8.2.2 Testing for SUD in West Dunbartonshire

The initial element of the West Dunbartonshire case study followed a standard approach to modelling and related to the identification of SUD with reference to the waiting times experienced in taxi stances. Using the standard model, an ISUD value was calculated. West Dunbartonshire demonstrated a value of ISUD = 1.1 (see Table 8.1) which suggested that no significant levels of SUD existed.

Table 8.1 Comparative ISUD values: West Dunbartonshire



Source: Previous SUD studies

SUD calculations were based on 8 locations, see Figure 8.1, with individual stance ISUD values, output from the standard model, set out in Table 8.2.

Table 8.2 Stance specific ISUD Values

Stance Location	ISUD Value
Alexandria Main Street	0.07
Balloch Station	0.50
Clydebank Alexander Street	0.06
Clyde shopping centre	7.05
Clydebank Dumbarton Road	0.33
Dumbarton Riverside at church	0.43
Dumbarton Riverside at RBS	0.14
Dumbarton Central station	0.53

Source: Author

Additional observations were completed where late night ranking occurred in non-stance locations, typically close to nighttime activities, such as pubs and clubs. Data obtained in the observation surveys confirmed a very level of SUD and further allowed for definition of demand by stance.

Two further measures, excess delay, and passenger waiting profiles were calculated, these allowing for identification of the extent of unmet demand arising by time of day, and impacts on fleet use. At these low levels of unmet demand in the case of West Dunbartonshire, there can be no major tension between the standard model and that developed within this thesis.

Excess delay is defined as periods of the day in which either user or supplier experience delay. Observation of patterns in West Dunbartonshire identified the numbers of passengers and/or vehicles waiting and is set out in Table 8.3. Levels were observed as particularly limited.

Table 8.3 Occurrence of excess passenger delay: West Dunbartonshire

ED - Proportion of time Excess Delay Observed	Weekend Night time	Weekend daytime	Weekday night time	Weekday daytime
Alexandria Main Street	0.00	0.00	0.00	0.00
Balloch Station	2.08	1.39	1.39	0.00
Clydebank Alexander St.	4.17	0.00	0.00	1.39
Clyde Shopping Centre	2.78	0.00	1.39	2.78
Clydebank Dumbarton Rd	5.56	0.00	0.69	0.00
Dumbarton Riverside Ch	4.17	0.00	4.86	0.00
Dumbarton Riverside RBS	0.00	2.08	0.00	1.39
Dumbarton Central station	7.54	1.39	2.08	1.39
Authority wide	3.30	0.51	1.30	0.87

Source: Author

While observed delay was considerably lower than equivalent locations in Glasgow, individual delays were noted. Dumbarton Central Station experiences the highest peak in excess delay, while Dumbarton Riverside at Church experiences consistent problems at night. Passenger waiting profiles, a more detailed assessment of stance delay, were also low, and these would not in themselves suggest significant prolonged delay, see table 8.4.

Table 8.4 Passenger delay characteristics: West Dunbartonshire

PD – Average assenger waiting time (minutes)	Weekend Night time	Weekend daytime	Weekday night time	Weekday daytime
Alexandria Main Street	0.00	0.00	0.00	0.29
Balloch Station	0.82	0.21	0.50	0.05
Clydebank Alexander St.	0.11	0.00	0.00	0.11
Clyde Shopping Centre	0.36	0.18	0.36	0.27
Clydebank Dumbarton Rd	1.18	0.00	0.13	0.00
Dumbarton Riverside Ch	0.11	0.00	0.97	0.00
Dumbarton Riverside RBS	0.00	0.02	0.03	0.44
Dumbarton Central station	0.92	0.13	0.00	0.44
Authority wide	0.48	0.07	0.25	0.20

Source: Author

Passenger delay (PD), Table 8.4, illustrates an average time experienced in waiting for a taxi. Very few observed stances display any significant waiting times, with no average delay exceeding 2 minutes, suggesting in normal use taxi services were appropriate to demand. The analysis, on the basis of a standard model run, suggested that no further action was required in relation to supply. It does not, however, provide a detailed analysis appropriate to the identification of additional and suppressed demand. It was therefore felt appropriate to apply the new modelling framework to provide a more detailed analysis.

8.2.3 Application of a new modelling framework in West Dunbartonshire

Despite the very low levels of ISUD as measured by the standard model, many of the objectives stated as desirable (inclusion of latent demand and demand for accessible vehicles in the Dumbarton zone) could not be fully achieved in its operation alone. The development and application of three new elements, measurement for the presence of latent (suppressed) demand included within enhanced pedestrian surveys (see section 8.2.3.1); measurement for the demand for accessible vehicles; and a method of increasing reliability of the underlying approach were included in a more wide ranging assessment.

8.2.3.1 Enhancement of pedestrian surveys

Both standard Matrix and ISUD measurements relate to observed data. These are limited to the appearance of demand and its satisfaction at the taxi stance. Neither can, therefore, fully develop concepts of demand that is hidden, latent, and not revealed at traditional points of use. Assessment of latent or suppressed demand is not well developed in traditional models and requires an alternative point of measurement to the traditional observation survey, included in the new modelling framework, described in Chapter Seven, as an additional part of the pedestrian survey. Failure to identify and fully account for latent demand has an impact on the ability of a fleet to meet future needs and will reduce the effectiveness of solutions based on an increase in the numbers of licences issued and determined by observation.

A related area, that of determining hidden demand for the use of accessible vehicles is equally problematic on the basis of observation alone, although its solution differs by fleet composition (extent of accessible vehicles being used), and is therefore identified as a separate element in the instance of West Dunbartonshire.

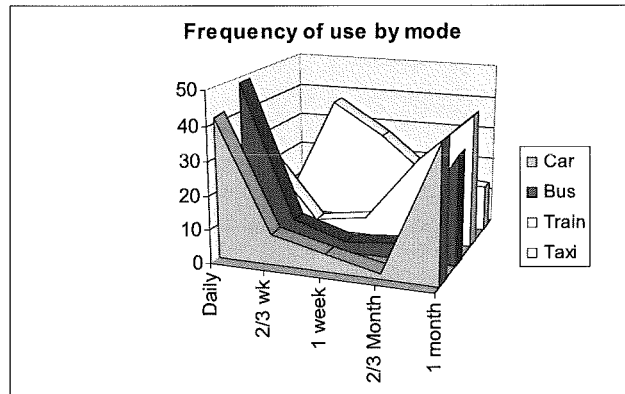
Survey design

Data collection was undertaken in 2006 (see Table 3.5) and included a pedestrian survey was primarily aimed at identifying the issues experienced in using taxis in West Dunbartonshire, common to most similar surveys; and to identify the extent, if any, of suppressed demand. The survey also established values appropriate to interpretation of modelling results, including passenger expectations, identification of waiting time sensitivity, frequency of use, purpose, methods of engagement.

Survey results: frequency and purpose

Taxis were widely used on a regular but infrequent basis. This correlated to two main uses, travel home from a night out, and in returning home from shopping. Although frequent, these represent very differing purposes, and reflect differing socio-economic groupings⁴⁴. Methods of engagement also differed between the two journey purposes.

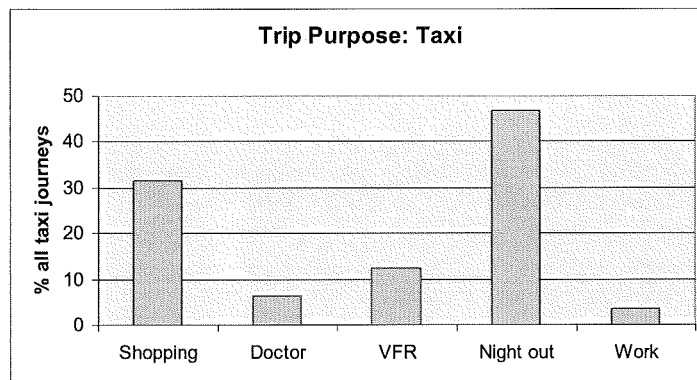
Figure 8.2: Frequency of use, main modes of transport– West Dunbartonshire



Source: Author, see Cooper (2006)

Car and bus services formed a principal mode of transport for regular daily transport, while train services were used less frequently.

Figure 8.3: Main trip purposes: Taxi– West Dunbartonshire



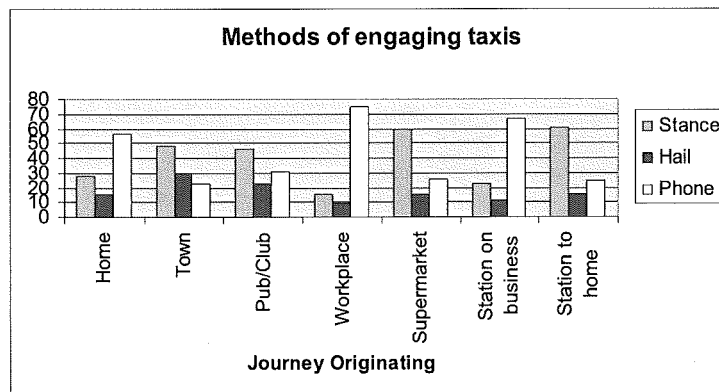
Note: VFR = Visiting Friends and Relations

Source: Author, see Cooper (2006)

⁴⁴ Socio-economic groupings were not specifically identified in the pedestrian survey. Evidence of economic status and taxi use are included in the National Transport Survey 1999-2001 (DfT, 2002a p33 Table 5.4) which suggests lower income households without car are more than twice as likely to make a journey by taxi than households with access to a car.

The principal uses of taxis split evenly between travelling home from a night out (46%), and returning home from shopping (31%). The two main uses differ significantly in the needs and demands for taxi use, and reflect an observed split in demographic groups' use of the mode. It is also observable that very few journeys are made on work business (3.4%).

Figure 8.4: Methods of engaging taxis– West Dunbartonshire



Source: Author. See Cooper (2006)

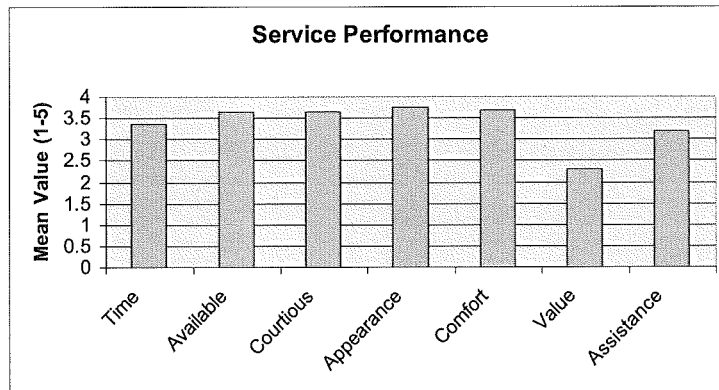
Differing uses of taxis are reflected in differing methods of engagement, but it appears that a number of trends exist. Travel on the main purpose, home from pub and club, makes use of all three methods of engagement, being engagement at stance, hailing, and telephone booking. The majority method of engagement for this use is at stance. Travel from supermarket, the second most common use of taxis, relies even more on engagement at stance, and probably reflects the availability of stances at or near to supermarkets both in Dumbarton and Clydebank. Home originating journeys have limited choice, and pre-booking is most significant. Business uses are also dominated by the pre-booked market, while travel from station on non-work journeys relies on availability at stance.

Service performance

The second element within the pedestrian survey sought to establish the perception of taxi service delivery. The questionnaire identified seven aspects of service delivery,

asking respondents to grade performance on a 5 point scale, ranging from Very Poor to Good.

Figure 8.5: Service performance– West Dunbartonshire



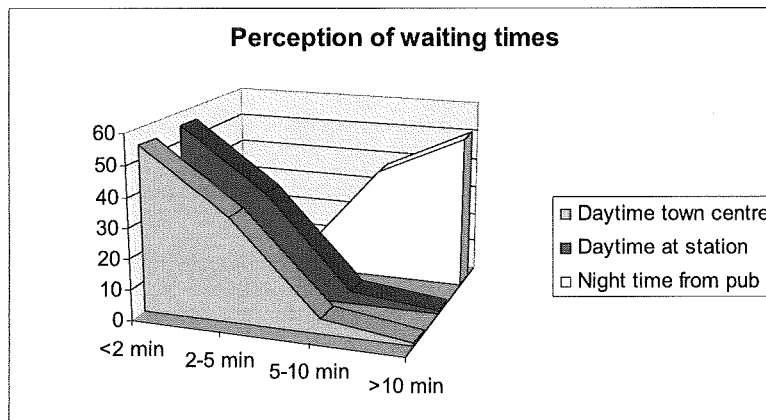
Source: Author. See Cooper (2006)

Most indicators scored well, values over 3 indicating good or very good performance, with availability, courtesy, comfort and appearance of vehicle all scoring highly. Value scored poorly, below median, indicating a low perception of value for money.

Waiting times

Waiting times are significant in that their measurement is a primary element of both questionnaire and modelled assessment. The modelled incidence, based on observation at stance, indicates a low incidence of delay and low waiting times at stance. A separate question addressed the perceived extent of delay experienced in engaging a taxi in three situations: for journeys originating on a weekday in the town centre, journeys originating on a weekday from the station, and for journeys originating on a Friday night from a pub or club.

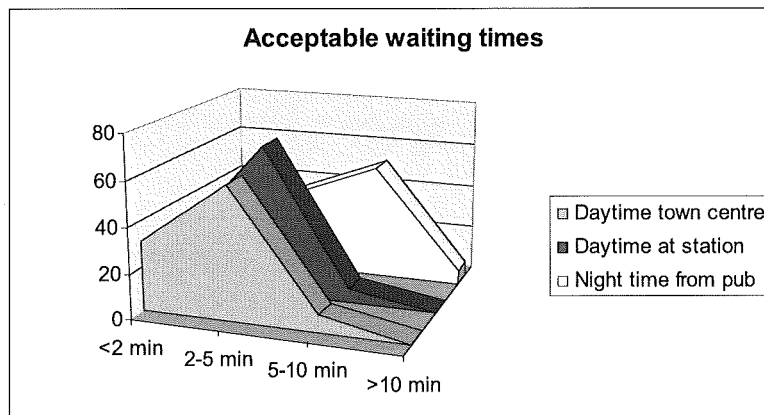
Figure 8.6: Waiting times experienced– West Dunbartonshire



Source: Author. See Cooper (2006)

Journeys in both daytime situations (travelling from the town centre and from the station) demonstrated a low value of perceived waiting times, borne out in observation, while nighttime transport home from pubs and clubs was perceived to require longer waiting times. This is also borne out in observed data, but not to the extent of perceived waiting times, with observed waiting times approximating half the wait perceived. A further question sought to identify the amount of time that would be considered Acceptable for waiting times in accessing a taxi in the same circumstances.

Figure 8.7: Acceptable waiting times– West Dunbartonshire



Source: Author. See Cooper (2006)

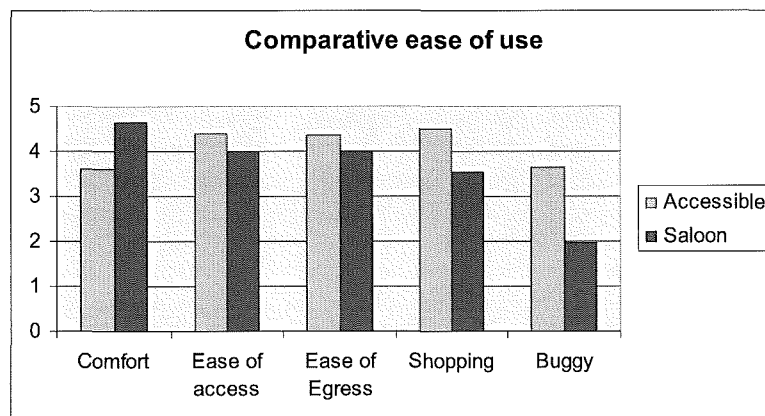
Expectation of reasonable waiting time proved positive and in line with perceived waiting time experienced for both daytime measures, but was more demanding than perceived nighttime performance. Mode average expectations for daytime delivery suggest a

waiting time between 2 and 5 minutes was Acceptable, and achieved. The mode mean suggests an Acceptable waiting time of 5 – 10 minutes at nighttime, but this was felt to be missed by just under half of all nighttime departures⁴⁵. Observation surveys do not fully support the perceived nighttime waiting times, with mean waiting times falling within the ‘Acceptable’ 5-10 minutes range. It is reasonable to expect a difference between observed and perceived waiting times, as perceived times tend to exceed measured times.

Accessible taxis

The third element addressed in the public survey relates to the use of ‘accessible taxis, generally defined as wheelchair accessible taxis and distinguished from saloon taxis. The two groups of vehicles, accessible and saloon offer differing facilities, and are likely to differ in use. The research questionnaire sought to establish perceived benefits of each vehicle against five measures, Vehicle Comfort, ease of getting in and out, ease of carrying shopping, and ease of carrying a child’s buggy.

Figure 8.8 Comparative vehicle benefit– West Dunbartonshire



Source: Author. See Cooper (2006)

A five point scale was used indicating the perceived performance from very poor to very good. A clear split exists between vehicle comfort and ease of use, with saloon taxis considered favourable for vehicle comfort. For ease of access, egress, and in carrying shopping and children’s buggies accessible taxis were considered good or very good.

⁴⁵ Perception and reality of passenger waiting times at night varied.

Pedestrian survey interpretation

The pedestrian survey provided a detailed overview of the use of taxis in West Dunbartonshire, and in common with the standard methods adopted elsewhere, allowed for detailed interpretation of the observation survey results and identification of issues arising in relation to taxi use. Taxi use was regular but infrequent, with the majority of travellers travelling once per week, either for entertainment or shopping purposes. Relatively few journeys originated for work purposes with a significant bias toward engagement at stance. The findings placed emphasis on the importance of supply at stance at times appropriate for the main journey purpose, late at night and travelling from shopping. The results are also in line with comments made within focus groups, and in relation to the location of stances in proximity to shops, especially in the Clydebank zone.

Enhancements to the survey included questions of acceptable delay, and latent demand. The overall service was considered high in quality with service performance indicators consistently good, with the exception of value for money, which scored slightly below median. Taxi delay was low. Divergence did occur between acceptable waiting times at stance and perceived delay, for nighttime travel, although actual performance at stance was better than its perception. No respondent indicated a desire to make a journey that could not be achieved (infinite delay) suggesting no presence of suppressed demand.

The pedestrian survey did not identify, and was not addressed to, travellers with special accessibility requirements, and was therefore unable to address the issues of demand for this community. A separate 'accessibility' questionnaire was devised to establish needs specific to accessible taxi supply.

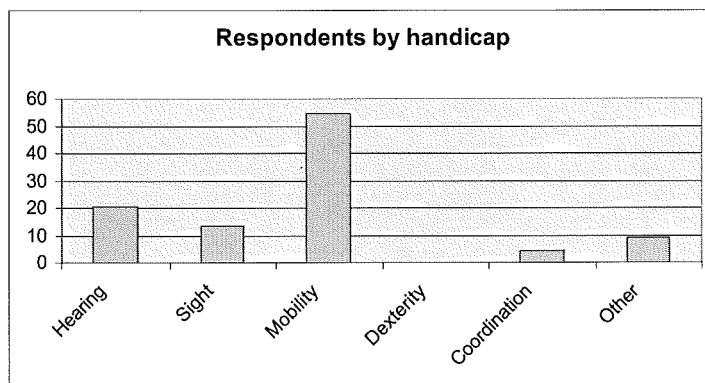
8.2.3.2 Survey of individuals with special needs

In addition to the pedestrian survey, a separate questionnaire was developed, to establish views and potential taxi demand patterns among less able bodied respondents.

The (latent) demand for taxi use, and experiences in using taxis by those with limited mobility was not considered well catered for within the pedestrian survey, but remained an issue in establishing appropriate levels of supply of accessible taxis. This position was further complicated by the nature of the fleet, split between accessible vehicles in Clydebank, and non-accessible saloon vehicles operating in the Dumbarton zone. It also represented an opportunity as the experiences of operating an accessible fleet was considered pertinent to its extension.

The survey took the form of a postal questionnaire, distributed to individuals with a personal experience of special needs for transport. A postal questionnaire was sent out with the assistance of the West Dunbartonshire Access Panel to circa 400 interested parties, and has resulted in 81 valid responses. Respondents represented a cross section of disability needs, and included those with, physical, mental or personal handicaps in access, and those providing support to such individuals. Over half of the survey respondents reported mobility handicap, but only 18% actually used a wheelchair (Figure 8.8).

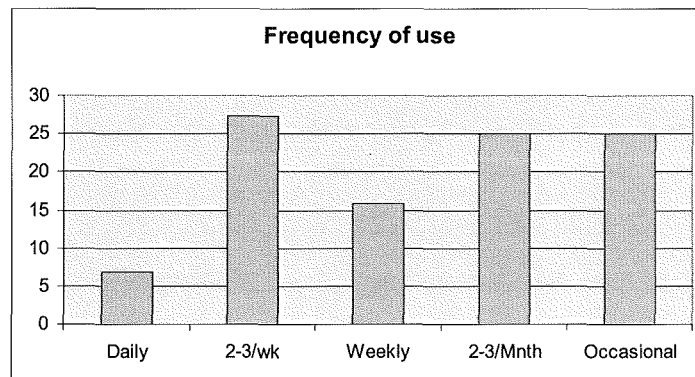
Figure 8.9 Respondents by handicap– West Dunbartonshire



Source: Author. See Cooper (2006)

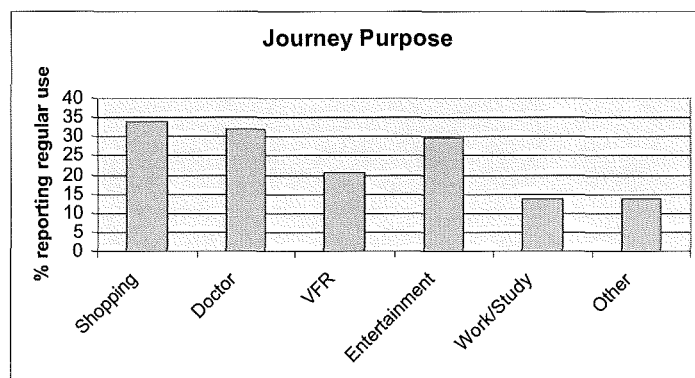
Interestingly, individuals with an access handicap tended to use taxis less often than able bodied travellers, with just over 45% using a taxi service weekly or more frequently, about half the frequency of able bodied users, an indication identified in the focus group, of a level of demand suppression. Journey purpose also differed, while shopping and travel from entertainment continue to represent high levels of use, other trip purposes also scored highly for those with access needs.

Figure 8.10 Frequency of use– West Dunbartonshire



Source: Author. See Cooper (2006)

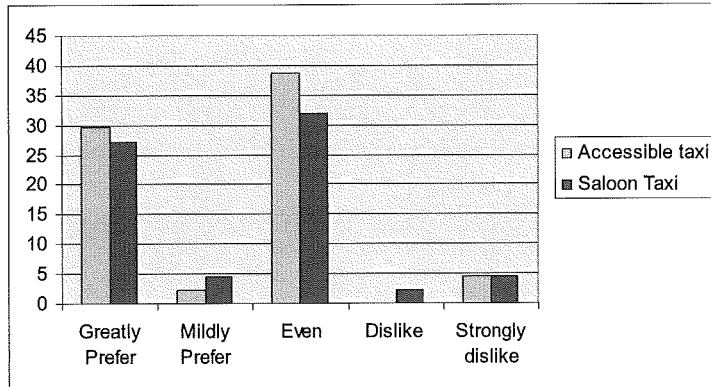
Figure 8.11 Main trip use– West Dunbartonshire



Source: Author. See Cooper (2006)

The second element of the survey sought to establish preferences for particular types of taxis, and issues in using either saloon or accessible taxis. Both wheelchair accessible and saloon taxis were felt to offer particular benefits to users, either in terms of comfort, seen as a benefit in saloon taxis, or ease of access, a benefit in accessible vehicles. The study sought to identify vehicle preferences on the basis of a five point scale ranging from greatly prefer to greatly dislike by vehicle type.

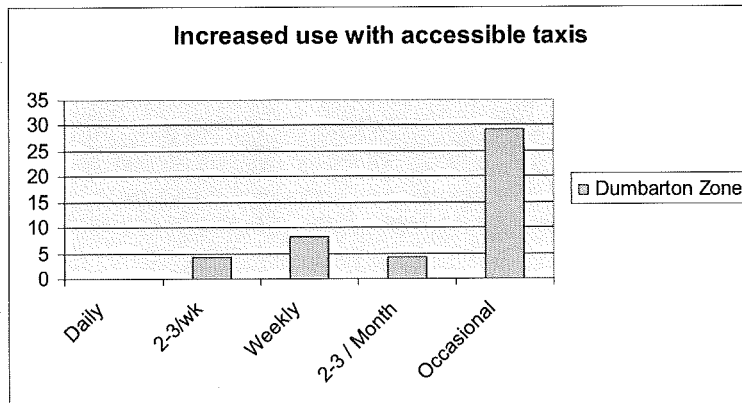
Figure 8.12 Vehicle Preferences– West Dunbartonshire



Source: Author. See Cooper (2006)

A similar and small number of respondents reported strong dislike for both saloon and accessible vehicles, while a higher number of respondents preferred accessible vehicles to saloon type taxis.

Figure 8.13 Increased use arising from introduction of accessible taxis– West Dunbartonshire

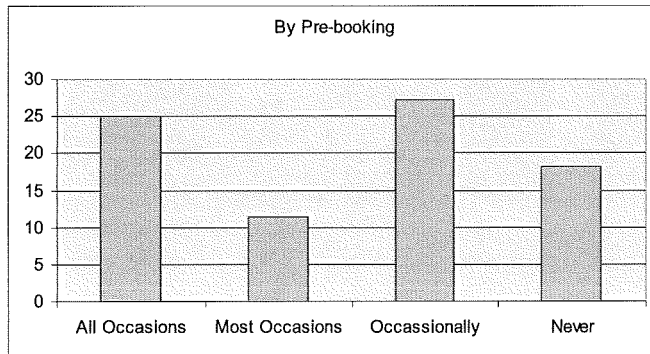


Source: Author. See Cooper (2006)

Respondents living in Dumbarton zone indicated only a small propensity to increase use as a result of a change to MCF vehicles. A combined increase in 2 to 3 weekly journeys and more frequent use of about 15% would result from such a change. An additional 29% indicated occasional use arising from the change.

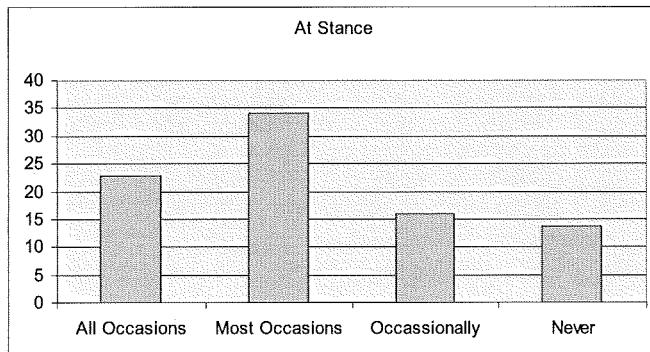
In addition to the issue of most appropriate vehicle type, a number of other barriers were felt to exist in the provision of a fully accessible taxi service. These include the ability to access taxis at stance, by hailing or by pre-booking.

Figure 8.14 Propensity to engage taxi by pre-booking– West Dunbartonshire



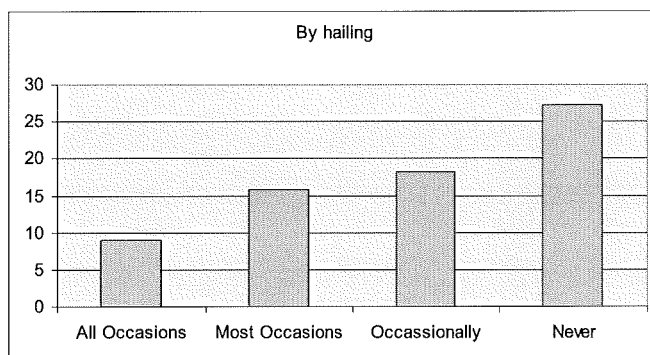
Source: Author. See Cooper (2006)

Figure 8.15 Propensity to engage taxi at stance– West Dunbartonshire



Source: Author. See Cooper (2006)

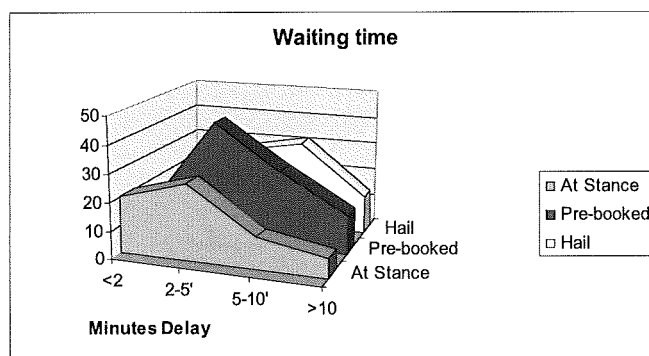
Figure 8.16 Propensity to engage taxi by hailing– West Dunbartonshire



Source: Author. See Cooper (2006)

The greatest number of respondents indicated their highest preference was to engage taxis by pre-booking, though combined first and second preferences would indicate engagement at stance to be preferred to other forms of engagement. The hail and ride sector resulted in the highest level of non-use, 27% never engaging a taxi in this manner. Waiting times at the three locations indicates an extended waiting time experienced in engagement away from home or stance locations.

Figure 8.17 Waiting times by location of engagement – West Dunbartonshire



Source: Author. See Cooper (2006)

8.2.3.3 Survey interpretation – accessibility

Taxis performed well in carrying able bodied passengers in both zones, and few delays were experienced in engaging taxis by this group. The needs of passengers with specific accessibility needs were well catered for in the Clydebank zone but not so well in Dumbarton zone, and the researcher observed few instances of significant delay in making use of accessible taxi types. Observed use and reported issues in the use of saloon vehicles suggests this type of taxi less favourable to those with specific access needs.

On the basis of stated responses, there appears to be a desire for an increase in the numbers of accessible vehicles that are available to those in the Dumbarton zone. Figure 8.13, which relates to the Dumbarton zone alone, suggests that a wider availability of accessible vehicles would result in an increased use of taxi services of c. 15% increase in

use on a regular basis (2-3 times per month and greater) resulting from the availability of accessible vehicles, and a further 29% take up in occasional usage. This figure being, notably, similar to the experience documented in three Spanish municipalities where accessible taxis were introduced, which identified:

- 18.6% of users increased their use significantly
- 21.6% of disabled users 'often' increased their use of taxis
- 20.4% of disabled users 'sometimes' increased their use of taxis
- 14.3% of disabled users 'scarcely' increased their use of taxis
- 22.9% of disabled users 'did not change' their use of taxis

Source: ECMT 2001

Although comparable in stated versus observed increase, most commentary is based on adoption of an all or nothing approach, either a fleet is fully compliant, or not at all. Little work has been completed to relate to the sensitivity of supply to a proportion of a fleet being provided by accessible vehicles. Furthermore, some criticism does exist as to the appropriateness of particular vehicle types to the needs of disabled passengers. Respondents in the West Dunbartonshire focus groups identified that even taxis identified as 'accessible' need not be accessible to all disabled passengers. The issue of the cost of accessible taxis is also identified, and appears consistently through discussion in West Dunbartonshire with taxi drivers. Costs of new vehicles differ significantly between new saloon vehicles appropriate for use as taxis, and the cost of purpose built taxis.

The accessibility survey appears to highlight the presence of suppressed demand for the use of accessible taxis and therefore confirms a link between vehicle type (quality) and vehicle use (demand). It also highlights a need to establish supply levels appropriate to ensure no significant unmet demand outside the traditional measures of able-bodied passengers, whose needs appear well catered for by the current fleet. The survey also poses difficult questions specific to the levels of supply by vehicle type in a mixed fleet.

The 'solution' to ensuring appropriate levels of supply in West Dunbartonshire, was felt to involve building linkages between the previous approaches to demand (quantity), and new approaches to establishing vehicle type (quality), see section 8.3 with conclusions appropriate to meeting the needs established in the surveys set out in section.

8.3 Building links to quality control

The key contribution of this thesis lies in the specification of links between model areas that have not been previously applied in UK. The West Dunbartonshire case study sets out a specification for developing links between model areas not previously been applied. The results of surveys in West Dunbartonshire illustrate that while demand for taxis based on the needs of able-bodied passengers is well accommodated within the existing taxi parc, the same needs for those requiring accessible vehicles is not. Vehicle specification falls within the traditional areas of quality regulation, but clearly links also to the numbers (quantity) of vehicles available. The development of combined or linked models thus led to an enhanced methodology, identified in Table 8.5, below.

Table 8.5 Enhanced model structure linkage – West Dunbartonshire

Element	Definition	Extent of application	
		This study	Preceding Studies
ISUD Matrix	Indication of the presence of SUD on the basis of peaking and delay	Yes	Most
ISUD relative value	Indication of the presence of SUD on the basis of measured comparative values	Yes	Many
Queuing models	Method for obtaining passenger delay figures through observation or estimation	Based on observed delay	Mainly based on synthetic delay estimation
Taxi Delay models	Method for obtaining vehicle delay figures through observation or estimation	Based on observed delay	Mainly based on synthetic delay estimation
Public expectation model	Method for defining optimal service levels for public access. Allows for determination of latent demand	Yes	Not Included
Disabled supply requirement	Method for defining optimal service levels for disabled accessible vehicles. Allows for determination of latent demand.	Yes	Not included

Derived from Cooper (2006)

Table 8.5 identifies linkages between modelling elements. The initial elements of the

West Dunbartonshire study follow the approach applied in other locations, consistent with the standard model. These are supplemented by enhancements to SUD to include quality controls – a key consideration in ensuring increased access to all users, and based on the determination the appropriate number of accessible vehicles to ensure that the likely demand for such vehicles is satisfied. Factors identified used in determination included:

- Supply of accessible taxis should be sufficient to cover periods of peak demand
- Supply should take account of driver availability, and likelihood of a number of vehicles being unavailable at any given time
- Consideration should be given to suppressed demand as well as current (observed) use.

The new elements of the West Dunbartonshire model, therefore, set levels of supply within the fleet to the extent that supply matches the demands for taxi transport, including latent demand. Model enhancements applied are set out below.

8.3.1 Accessible vehicle supply

The new supply model was developed to take account of current demand for accessible transport, and likely future demand in light of changes to the fleet composition. At the core of this enhancement is the question whether a fleet sufficiently satisfies demand for accessible transport by taxi. This is not an issue in instances where a fleet comprises 100% accessible vehicles (as is the case in Glasgow), however a significant number of LAs continue to operate a mixed fleet or a non-accessible fleet. The research sought, therefore, to identify the numbers of accessible vehicles appropriate to meet demand for accessible transport, in addition to the numbers appropriate to meet other demands for taxi services.

The application of a model of proportional demand (MPD), first discussed in Chapter Seven, has been defined to identify numbers of accessible vehicles required in a fleet to

satisfy demand. The following sections relate to the application of these enhancements to the case study.

Model of Proportional Demand (MPD)

The extent of increased demand was determined from responses to the access survey, using the concept of future demand (FQD), as set out in section 7.5.3.1. An increase of 14% in demand for taxi use results was determined on the basis of answers within the access survey. For 100 individuals currently identified as having accessibility needs when accessing taxi services, 114 journeys would result from provision of an accessible fleet (FQD = 114).

Journey Purpose factor (JP)

The second element of MPD derives from the fact that not all journeys occur at the same time, or are made for the same purpose, the calculation is further developed to identify the effect of peaks in demand. Responses in the access survey also allow for identification of points of peak demand, by journey purpose and by time of day. The Journey Purpose factor was applied to determine the number of journeys requiring accessible transport that are likely to occur during the evening peak period. This is illustrated:

$$JP = (114 * 0.33) / 2$$

$$JP = 37.62 \text{ journeys in the peak period for every 100 current journeys}$$

$$JP = 0.38 / LP$$

$$JP = 0.19$$

Supply Factor (SF)

SF, defined in section 7.5.3.1, is applied to establish the proportion of drivers that would be available at peak times. Of the responses received, 52% of taxi drivers would choose to drive during the peak period of weekend nighttimes. Of the total fleet, the actual number of accessible vehicles available at point of peak demand is reduced by the proportion of vehicles not available. The Supply factor increases supply to ensure that the numbers of vehicles available at point of peak demand is sufficient to meet the demand for accessible taxi transport. Where a reduced number of vehicles are available the actual numbers of accessible vehicles would need to be increased by an amount equivalent to this shortfall. In the case of West Dunbartonshire a factor of 1.923 is applied to the required accessible vehicle fleet.

Vehicle Utilisation (VU)

A further measure has been applied to reflect the availability and utilisation of vehicles within the fleet to provide accessible vehicle required journeys alongside general (any vehicle required) journeys. VU measures the extent to which a single vehicle is able to complete multiple journeys. Typically a taxi leaves the available fleet as it is engaged to complete a journey, and returns to the fleet as it drops off passengers and seeks re-engagement. A taxi engaged for a 15 minute journey re-enters the fleet at the conclusion of its journey and could, in theory, complete 4 such journeys in an hour. Practically, however, the vehicle concludes its journey away from town centre or stance location, and would effectively require a similar time to return to the stance from whence its journey originated. This would suggest effective availability for 2 journeys in the hour.

Journey lengths also differ dependant on journey purpose, pick-up point, and the desire of the driver to return to the original pick-up point to seek re-engagement. An average journey time of 10 minutes would result in a potential for the same vehicle to operate 3 journeys within any given hour. In the case of West Dunbartonshire current utilisation permits a single vehicle to complete 3.75 trips over an average distance where returning to the same central stance. Calculation of journey times is determined in relation to stated journey distance specific to passengers travelling within the Dumbarton zone, and calculated on the basis of driven miles. The calculation does not take into account delays

experienced at rank in boarding a vehicle, or at destination in alighting. Vehicle return time is based on returning to the same point at the same driven speed.

Vehicle number calculation

The final application of the accessible vehicle model is the combination of separate elements to identify the numbers of additional accessible vehicles required within the West Dunbartonshire fleet to achieve appropriate access to demand. This is calculated to identify increased demand for every 100 current disabled passenger journeys and is illustrated:

$$\text{Vehicle Number (VN)} = \text{FQD} \times \text{JP} \times \text{SF} \times \text{VU}$$

Per 100 pass journeys =

$$\text{VN} = 114 \times 0.19 \times 1.92 \times 0.27$$

$$\text{VN} = 11.22$$

To achieve an appropriate level of supply, an additional 12 accessible vehicles to the fleet is required for every 100 current disabled passenger journeys.

8.3.2 Application of model and West Dunbartonshire results

Having established both a need for additional accessible vehicles, section 8.2.3, and a method by which additional numbers required in a mixed fleet can be established, the new modelling elements were then applied in West Dunbartonshire. Appropriate numbers of new accessible vehicles required to serve the Dumbarton zone was determined on the basis of potential numbers of passengers travelling with ambulant impairment. Within the Dumbarton and Vale of Leven zones, a total of 97 journeys were observed at stance for individuals with a discernable level of ambulant impairment. This figure was increased to include demand for taxis engaged using other methods, such as engagement by pre-booking or by hailing, where observations are not possible on the basis of method of

engagement figures derived in the accessibility survey and illustrated in section 8.2.3. Responses within the access study indicated that 48% of engagement occurs at stance, 31% by pre-booking, with 21% of vehicles engaged by hailing. Where applied to observed engagement at stance, this suggests a total current demand for 202 journeys by passengers with ambulant access needs. The likely numbers of accessible vehicles required within the Dumbarton zone using the proportional method is equal to 23 vehicles (22.66 rounded up).

Critique of proportional approach

The adoption of the proportional model relates to a method of satisfying peak demand, and is likely to represent the highest number of additional vehicles required on the basis of a proportional fleet approach. The factor appears similar, to proportions adopted in other EU countries adopting this approach. (Finland = 15% accessible taxis (ECMT, 2001)). Stated increase in taxi use (access survey) may also appear low in comparison to the actual effects experienced in locations which have adopted fully accessible taxis (Dumbarton estimate = 14% increase in all journeys, compares to 18.6% of users 'significantly increasing journeys' in Spain (ibid)).

The proportional approach does, however, have a number of significant drawbacks, not least that any vehicle, once engaged, is removed from the fleet for the duration of the journey being undertaken. Where a particular user is reliant on that vehicle type, the removal of a vehicle from the fleet effectively limits that individual's ability to travel to an extent not experienced by able-bodied passengers for whom any taxi is appropriate.

The fact that some vehicles would be accessible and others not, may lead to confusion in engagement on stance with individuals seeking accessible taxis choosing to look further back in a queue of vehicles to choose a vehicle type felt appropriate to need. This may extend to include passengers without ambulant impairment but with a preference for an accessible vehicle, for example those carrying shopping, or those with a child's buggy.

Direct introduction of a fully accessible fleet

An alternative to the proportional approach in providing accessible taxis is to move to a fully accessible fleet, in which all taxis can be defined as accessible to all users. The aim to provide a fully accessible fleet is included in the DDA, as applied to England and Wales, and identified south of the border as appropriate in larger towns and locations with tourist attractions where an additional level of access may be appropriate to accommodate the needs of visitors. Scottish legislation applied to the supply of particular taxi types may appear more pragmatic, with decisions specific to local areas resting with district and city licensing authorities.

Within the West Dunbartonshire area, taxi services operating within the Clydebank zone are already operated by a fully accessible fleet, and the extension of accessible vehicles to Dumbarton is likely to provide significant benefits in passenger access to and use of taxis. A direct and full move to a fully accessible fleet offers the quickest method of achieving equal access to all users, but may also impact in the economic equilibrium of the market for the supply of taxi services. The primary arguments forwarded against the move to a fully accessible fleet relate to the initial costs of accessible vehicles compared to saloon vehicles. Accessible vehicles can cost more than saloons, and the effect of an increased capital cost can, it is argued, impact on the numbers of vehicles available in a fleet. This argument is taken further in relation to the DDA application in England and Wales, where authorities may apply for exemption from the requirement to provide a fully accessible fleet by 2012, by demonstrating (DDA: Chapter 50, Section 35) that a move to a fully accessible fleet would result 'in an unacceptable reduction in the number of taxis'. The argument of an excessive initial cost of vehicles, and the demonstration of unacceptable reduction in fleet availability actually relates to the same concept, and suggests a further link between regulatory domains, that being the relationship between quantity/quality and economic regulation, set out in detail and applied to Glasgow, see below.

Staged Introduction of a fully accessible fleet

While it is likely that an immediate move to a fully accessible fleet would cause financial pressures within the existing provision, and that this may impact negatively on the numbers of vehicles available within the fleet, it is also noted that the ultimate provision of a fully accessible fleet offers a number of advantages that can not be achieved through the proportional approach to such supply. A fully accessible fleet offers a higher level of service to those with ambulant impairment seeking taxi transport in that it does not necessitate identification of particular vehicle types within a taxi rank, treating all passengers on an equal basis. Staged introduction, for example where replacement over a set time period, would ultimately result in a fully accessible fleet, but also highlights the link between supply and cost elements in taxi supply.

8.4 Conclusion; lessons from West Dunbartonshire

Application of the existing standard and new modelling frameworks in West Dunbartonshire provided a significant opportunity to test the new modelling framework and compare results from a standard model against those from the new framework. The research resulted in a set of recommendations that were adopted by West Dunbartonshire, including the adoption of increased numbers of accessible vehicles. The testing also revealed a divergence between the results of a standard model, from which no change in fleet composition would be identified to a more detailed assessment leading to identification of the appropriate numbers of accessible vehicles required within a mixed fleet. The adoption of a proportional fleet, where a specified number of accessible taxis are required in the Dumbarton and Vale of Leven areas, offered an appropriate method of achieving increased access with immediate effect.

The application also highlighted and confirmed that a necessary link existed between the quantity elements of regulation and economic regulations. These have been further developed within the thesis and are detailed in relation to their development, testing and application in Glasgow. By combining both quantity and quality elements, the West Dunbartonshire research demonstrated effects and links between two of the three

regulatory domains, and showed where links may also exist between these and the third. Having presented the application of the new model to West Dunbartonshire, we now turn to the implications of the application of this model for taxi supply and regulation in Glasgow. Whereas the key focus in the case of West Dunbartonshire was on quality control, the key focus in Glasgow is upon developing quantity-cost linkages.

8.5 Glasgow, developing quantity – cost linkages

Taxi supply in Glasgow differs from that in West Dunbartonshire, in that it operates a fully accessible fleet of black London style hackney carriages. The city has, over many years, limited numbers of licenses issued and had, as a result, completed a number of SUD. Evidence had, however, suggested that despite previous council led reviews concluding that no significant unmet demand was present, an underlying belief existed in some users that taxi supply was, in fact, not sufficient (see *Coyle v Glasgow*, 1999). Parallel evidence in other cities (see *Dundee Taxi Cab Company v Dundee City Council and Dundee taxi association* 2005) suggested concerns about validity of surveys over time, and the city itself identified⁴⁶ an issue arising in the development of cost models in parallel with supply.

Both supply and cost model studies were undertaken by the researcher and provided an opportunity, in their combination, to consider the nature of these two elements, quantity and economic control together.

The researcher completed detailed analysis comprising:

- Review of existing studies, identification of assumptions used and evaluating appropriateness in application in Glasgow
- Completion of observation survey at stance
- Completion of public and driver surveys
- Identification of Cost model elements

⁴⁶ Glasgow City Council commissioned specific research to review the structure and application of the city taxi cost models in 2006.

- Identification of updates in costs and impacts of changes
- Reporting back to the Licensing Authority and providing recommendations

The ability to undertake large scale data collection was possible at two points, collecting information allied to the measurement of SUD in May 2005 (see Cooper, 2005c) and in relation to the Glasgow cost model in May 2006 (Cooper, 2006a).

8.5.1 Glasgow, aims in taxi supply and costs

The stated aims of the city are to encourage a continuation of a high quality taxi service⁴⁷ in parallel to identifying issues that affect the operational effectiveness of taxi services in the city. Previous studies completed for the city included standard SUD and separate cost modelling, undertaken on an 'as needed' basis irregularly. These had not, however, considered the effective linkages between economic and quantity regulation. It was also apparent that traditional SUD models undertaken by the city had not accounted for issues of stance design, not traditionally included in the SUD model. Other concerns expressed by the city, in discussion with the researcher, related to the design of the cost model, the method used by Glasgow in determining appropriate levels of fares for taxi use. The cost model had existed and been developed overtime and is consistent in approach to that adopted by other cities in the UK. The model did not, however, appear to fully represent the cost structures of the industry currently, nor take account of the interactions between levels of supply and costs of production.

The enhanced modelling structure, developed in previous chapters, was felt appropriate for application in Glasgow, bringing together the elements of quantity and economic regulation.

⁴⁷ Based on comments in interviews with the city

8.6 Application of the enhanced model

The Glasgow case study provided an opportunity to link two significant elements of analysis, contained within the new modelling framework, economic regulation and quantity control. This differs from the application of the model in West Dunbartonshire, which considered quantity and quality regulation, and provides a useful comparison in the wider utility of the model in differing local conditions.

In order to achieve an appropriate test of the new modelling framework, and to provide appropriate comparisons, the research ran both existing and new modelling frameworks, identifying impacts of cost levels in each of the measured areas, and the use of measurement linked to other regulatory domains. This has been completed in four stages. The first stage sought to identify the pattern of night-time interactions in relation to taxis; the second stage sought to identify the methods of determining taxi tariffs that are possible and common in application in the UK. The first stage and second stages were based on published literature, and on primary surveys of Licensing Authorities in other. The third element in our work included a detailed appraisal of the elements currently included within the Glasgow Taxi Cost Model, and a final element allowing for combination of existing and new methodologies in updating tariff, and in the determination of quantity.

8.6.1 Cost Model Application

Taxi cost models are common in many cities in the UK. Such models provide a consistent method of determining changes in the costs of production, and are often measured using typical operating criteria such as an assumed mileage, or typical operating patterns. Models relate to relative costs, the differences in measured costs year on year. Elements included in the model do vary between authority areas, but most have common strands including:

- Vehicle Costs, purchase and operation,
- Infrastructure Costs, licenses and permits, and
- Personnel Costs, cost of living and wages.

Model elements have been determined as a part of this thesis in relation to Glasgow, these are set out in summary in sections 8.6.1 – 8.7, with full detail of calculation included in Appendix 6.

8.6.2 Structure of the Cost Model

The Glasgow cost model follows a similar structure to that applied in other UK cities, illustrated in Table 8.6, which includes reference values for changes in costs in the period 2002 – 2003.

Table 8.6: Cost components used in the Glasgow Cost Model

Cost Component	Value (£ Mar 2003)	Percentage increase 2002 – 2003
-----------------------	-----------------------------------	--

Vehicle cost	28600	0.4
Component parts	6438	2.9
Hourly maintenance costs (labour)	36	0
Fuel cost (gallon Diesel)	3.47	-7
Insurance cost	3845	13
Operators License	330	0
Drivers Badge	134	0
National Insurance	390	9
Earnings Component	N/A	3.3

Source: Glasgow City Licensing Committee

The research continued to investigate in detail the construction of each of the component elements, set out in Appendix 6.1, testing the validity of the assumptions made in their analysis, and their validity in a combined model on the basis of evidence in real life use. An additional element related to the validity of their application over differing periods of time, as permitted in the guiding legislation (CGSA), the review of tariffs, however, need not be applied every year, and may often not reflect a regular period of elapsed time between reviews. The result of either not choosing to apply a tariff increase – or where an uneven delay between reviews occurs - is increasing divergence between actual and relative costs.

Relative change between reviews will not equate actual change year on year in instances of increased elapsed time between review, or a decision not to apply change for any reason. The result of this divergence may be a difficulty in perceptions of fairness, and a requirement to re-determine base lines within the relative cost model from time to time.

8.6.3 Review of cost model components

Existing cost model elements were included in the in the testing of the standard model run, but were also expanded to reflect links to other regulatory domains detailed below and set out in Appendix 6.

8.6.3.1 Vehicle purchase price and depreciation

Vehicle purchase price and depreciation is common to all authority approaches reported in the survey. The element is a significant part of operational cost, and is typically calculated from the actual cost price change over time, with additional calculations of depreciation (Appendix 6.1, Tables A6.1 and A6.2). Some differences exist between vehicle type, and in the length of time over which a vehicle is depreciated. The standard cost model allows for both cost and depreciation in all of the cities surveyed, but none identified quality regulation as impacting on the vehicle purchase price or explicitly on the resale or depreciation values chosen. A number of alternatives were also considered, including (TfL, 2005) the consideration of Alternative Vehicle ownership patterns (AV) (Appendix 6.1 Table A6.3) and a number of variations to vehicle type and depreciation period.

The current Glasgow cost model, in common with all reported current approaches, identifies a straight line depreciation from retail cost at purchase new to a zero resale value applied, in Glasgow, over a period of eight years. The method is simple to determine and requires an identification of end point, the point at which a vehicle is said to have no value. Despite the potential for simplistic representation of actual change in

value, the fact that the model does not fully recognise the complexities of vehicle resale value or the interaction between vehicle costs and quality regulations, the calculation has merit in providing (comparable) relative cost change consistently over time.

The application of vehicle cost does not however, account for the linkage between cost and quality regulation. This related to the impacts that a change in quality standard requirements would have on the costs of a vehicle. An additional routine has therefore been applied to the cost model, devised as a plug-in element of the new modelling framework that takes account of the impacts of changing quality regulation on the fleet. This has been developed on the basis of scenarios, described in Appendix 6.1, to identify approaches possible, which will vary by city, and that most appropriate to Glasgow, which resulted in the application of a lengthened period of depreciation (12 rather than 8 years) reflecting the realities of vehicle use rather than an arbitrary point of scrapping, and justified on the basis of vehicle age data collected in the driver survey.

8.6.3.2 Costs of vehicle maintenance

The second element within the cost model referred to the costs of vehicle maintenance. A large number of the councils surveyed, included maintenance costs, applying parts and labour to their calculation. The cost relates to maintaining a vehicle in a roadworthy state and is identified, in our discussions, as both desirable and legally required. However, and despite its frequency of use, the methods used to determine the value of this cost varies significantly, and subsequently a wide variation in levels can be observed between cities (see Appendix 6.1, Table A6.4).

This thesis contends that in reality a number of issues exist do exist in relation to the most common (basket of parts) approach. The most significant is the requirement that the basket actually reflects the parts most commonly used in the maintenance of the fleet. Similarly, the maintenance requirements, in terms of labour (time) involved in the repair and servicing of vehicles changes with the technologies of the vehicles themselves. Time costs can be significant and it is appropriate to continue to represent these in the model,

based on a realistic indication of their levels, including changes in the time input with changing technologies.

A number of options have been considered in the updating of the element, set out in Appendix 6.2. These are based on the premise that the measurement should ideally remain consistent from year to year, allowing comparison of the same factors between reviews, but should be updated in line with changes in vehicle technology and fleet composition and to reflect changes in the cost of maintaining a vehicle. An additional routine has been developed (Appendix 6.2, Table A6.7), that allows for revision to the basket of parts and (Table A6.8) to the costs associated with maintenance.

8.6.3.3 Fuel costs

Fuel costs relate directly to the operation of a taxi, and are included in the majority of models, as well as 'ad-hoc' indications of changes in cost. The concept is consistent between cities and updated in relation to the changing price of fuel (see Appendix 6.3). Given the consistency and ease of accessing accurate fuel data, the benefits of updating the fuel cost element are limited. Vehicle fuel efficiencies appear consistent with those used in other cities⁴⁸, while a more detailed review of fuel consumption ratings by vehicle type would be unlikely to result in a significantly more accurate measurement where change in comparative costs, rather than recorded actual costs, are the main input to the cost model. The researcher does not, therefore, feel there to be benefit from changing this element of the cost model.

8.6.3.4 Insurance costs

Insurance is a necessary cost in the operation of a taxi that cannot be avoided. The cost is applied across all of the authorities surveyed, and its inclusion in the cost model consistent and unsurprising. There are, however, significant differences in level of costs

⁴⁸ London Fuel Efficiency: 23 mpg, Glasgow Fuel Efficiency: 25 mpg.

between cities, to the extent that suggests a need for further consideration (see Appendix 6.4).

Differences exist between cities as a result of the varying levels of costs experienced by individual drivers and given that differences naturally exist in the risks associated with differing locations. This, in itself, does not explain the extent of the differences, which can vary between £1,500, in London, to a rate of £3,900 in Glasgow (see Appendix 6.4, Table A6.11), a significant difference resulting more from the method of updating, and the definition of 'typical driver', than the underlying costs themselves.

The insurance element of the Glasgow cost model was felt to require an updated approach that would appear consistent in scale when compared to other similar cities and be readily justifiable on the basis of costs quoted from insurance companies. It was also felt desirable that the measure to be easily updated for the purposes of tariff review. On this basis the measure was updated from the maximum cost concept used previously to a typical cost approach. The approach is illustrated in Appendix 6.4 (Table A6.12) and applied to a typical driver, identified as a 27 year old with 4 years no claims bonus.

8.6.3.5 License and other costs

The costs of licenses, driving license, operator's badges etc., are included in most models. The Glasgow tariff model currently includes costs for both license and badge elements. However, the actual licensing cost is highly specific to each city, which makes direct comparison difficult, and inappropriate. The cost is included in the development of the new model as it is pertinent to the measurement of costs in Glasgow. Its application elsewhere should be made in light of circumstances in other locations. Some other locations demonstrate a broader range of similar costs, and some have included testing fees in this element. In addition, a number of further costs are included in the cost models of other cities (see Appendix 6.5).

A number of additional elements were identified as appropriate indicators of costs, including the potential for environmental cost inclusion, but were not fully developed in

the wider transport arena to a sufficient level to merit inclusion to the model at this point. Moreover, some conflicts existed between the potential for environmental taxes on vehicles, and their inclusion within the cost model, effectively mitigating the potential benefit of the tax. The model has therefore maintained the existing approaches to licensing costs, updated to reflect actual changes in the cost without expansion to include other factors not previously present.

8.6.3.6 Driver earnings

A further, and potentially significant, element in cost determination relates to driver earnings. Previous Glasgow models have tended to calculate drivers earnings purely as a proportion of total costs, rather than as a separate element in their own right – the two main methods of identification. The main differences between these approaches being that the specification of wage as a separate element allows for a comparative measurement against costs in similar trades rather than its generalisation as proportionate to other (non-wage) taxi model cost components. The existing approach, that of identifying wages purely as a proportion of other costs, does not appear to allow for consideration of the factors that are most likely to impact on local wage levels, including costs of living etc. (see annex 8.6). The new modelling approach sought, therefore, to identify a local wage component appropriate to the actual costs incurred in Glasgow

8.7 Application of the cost model

The development of an enhanced cost model is a significant element in developing a more appropriate balance between regulatory domains but cannot, in itself, provide a full interpretation of the QQE balance without developing appropriate linkages in its operation to the other forms of control. Moreover, the application of the model, interpreting and applying changes resulting from the operation of the model to the tariffs experienced in use remains problematic. Any change in the overall production costs, determined by the model, forms the basis for a change in the amount charged to users, but

does not, in itself, necessitate an increase in tariffs. Nor does it dictate the manner in which any such increase be applied to the cost of using a taxi, which may in reality reflect political rather than financial imperatives.

The researcher sought to identify issues in relation to the application of cost model to tariff, and the impacts of various approaches to updating the taxi tariff in Glasgow. Three significant elements appear common in updating tariffs: the timescale elapsed between changes in the tariff, the method by which increases are applied to the cost of using a taxi, and the incidence of charges within the tariff itself. A number of individual comments were made in the course of stakeholder interviews in relation to the frequency of tariff review, which the researcher felt appropriate for consideration, these being: the impact of irregular reviews on the perceived accuracy of any tariff model and the need to accommodate large fluctuations in costs that would not be observed where reviews were completed on a more regular basis. The method of applying cost increases to the tariff was also considered a significant issue. Differences appear to exist as to the method by which the tariff should be updated. Additional comments were also made to the researcher regarding the nature of charges within the tariff. Most particularly the use of increments in charges, see below.

8.7.1 Frequency of review

The formal process of reviewing taxi fares occurs on a mandated basis under the Civic Government (Scotland) Act 1982 (CGSA). The CGSA determines a maximum period between reviews, but is not proscriptive within this period. There is also no requirement for a review to result in a change in the taxi tariff, merely to update the base on which the tariff is set. There is, however, a potential for conflict between irregular or longer intervals, and public perception of level of tariff change. Irregular reviews result in varying and confusing levels of tariff change and may result in a headline figure greater than that anticipated in light of annual inflation. Other issues exist where a review is completed but does not result in changes in the tariff level, most specifically that expectations within the tend to relate to changes since the last increase in tariff rather than the last review.

A revised approach has been developed within this thesis, which seeks to present additional transparency compared to the original approaches, and are based on the adoption a review, undertaken every 12 months. Changes arising in the review that relate to the period of the last 12 months avoid confusion and false comparisons with annual inflation but also require that tariff reviews be implemented even where change is minimal or where changes in operating costs result in a zero change to the cost of using a taxi.

8.7.2 Applying increases to the taxi tariff

In addition to the complexities of deriving a measure of changes in the cost of operating a taxi, a significant issue relates to the application of any resulting increase to the Taxi Tariff itself. Increases can be applied in a variety of means, across a range of charges within the tariff, and the manner by which an increase is applied will alter the levels of fares paid by passengers for any taxi journey, which will, in turn, result in differing increases being experienced by passengers undertaking different journeys (see Appendix 6.7). Tariff increases can be applied to any combination of flag charge (initial charge) time and distance element, as well as to the additional charges relating to booking, multiple occupancy etc., further complicated by pre-existing steps in tariff, fares divisible by identified coins (currently 20 pence).

It is, however, also important be aware of impacts of changes on the ability of the trade to operate within the costs defined within the cost model. The changes required resulting in a fair distribution charges, not a misapplication of costs.

An additional routine has been developed, within the new modelling framework, to establish the impact of differing approaches to applying increases to the tariff table, based on the consideration of five scenarios (Appendix 6.7) seeking to apply increases on the basis of either reducing time/distance or increasing unit cost. The method of applying tariff increases to the tariff table, and the basis of calculation of fares chargeable by initial charge, time and distance, and the use of steps in these charges has in the past resulted in an uneven effective increase inappropriate to application. The resulting methodology

applied within the model, therefore, related to the removal of stepped tariff related to single coins, and a flexible yard based or identifiable smaller distance charge base.

8.7.3 Initiation of a tariff review

Further issues exist were expressed in Glasgow concerning the highly complex relationships between tariff review, other areas of regulation, and the most appropriate point of application. Stakeholders raised a further question of timescale and initiation of review – by whom and when.

Where a review is undertaken only when requested (initiated by council, operator or outside party) distortion may result from the extended periods between reviews. These may in turn impact on the perceived 'fairness' of resulting changes in tariffs. Reviews completed on a regular basis may, however, result in small changes or no identifiable change being required which may also reflect on the perceived wisdom of a model run that does not provide for an increase in tariff.

The most appropriate testing period may, in reality, actually be best determined in relation to other factors, availability of data, and the relationships between the cost model and other forms of regulatory impact assessment. The Glasgow model, where completed on a regular 12 monthly cycle, could be designed to coincide with natural reporting periods for the measures included within the review, including earnings statistics from Office of National Statistics Earnings Data. The reporting period would also then match the desirable period for identification of SUD (Quantity Modelling), and optimise linkages between these elements.

8.8 Application and enhancement of the SUD model in Glasgow

In addition to the direct update of cost model, a separate but linked model of unmet demand has been completed. The existing Glasgow SUD model had followed the

framework defined and originally undertaken in West Dunbartonshire, discussed in relation to links to Quality in section 8.2, above. While similar in design, differing priorities between the locations (Glasgow and West Dunbartonshire) dictated the development of differing links within the new modelling framework. The Glasgow fleet being fully accessible does not have the same quality imperatives as those in West Dunbartonshire, but does demonstrate a close link between license issuance and costs (Quantity and Economic controls).

The application of the standard methodology to SUD represented a number of new elements within the Glasgow model. As with the West Dunbartonshire analysis, and consistent with similar studies completed elsewhere, the work developed from the standard model, as its central core, the design and completion of three survey exercises as detailed below:

- At Rank Observation, sufficient to identify peak trends and seasonal fluctuation
- Pedestrian Survey
- Driver Survey

The elements of the traditional model are contained within the 'at stance' observation, and the pedestrian survey; new modelling elements required a survey of drivers behaviour and additional elements within the observation and pedestrian analysis. A cross section of city locations was observed. At each location the study included core observation during the daytime, with further observation on Friday and Saturday evenings and weekend daytimes for key locations, including 24-hour observation at stances with both day and nighttime patronage, see Table 3.5. For each location, the Total Numbers of Passengers travelling, total number of Taxis departing with passengers (empty departures were not included) and a sample of waiting times were taken. Passengers and intending passengers were identified individually on a sample basis. A passenger is followed through the queue from time of arrival to time of departure, including cases where they leave the queue by foot (indefinite delay). On departure the next entrant to the queue is observed. A passenger arriving where there is no queue will be counted with zero delay.

A paper-based survey of 3 sides was undertaken on the street, covering the attitudes and perceptions of the general public, and achieved 682 responses. The 'at stance' observation followed the same methodological approach adopted in the West Dunbartonshire using observed queue, passenger and vehicle identification. The approach being consistent with current best practice and with similar studies elsewhere in the UK, but also allowing for an enhanced methodology, set out in Chapter Seven and summarised below.

The stance Survey Requirements were:

- City Centre and Key peripheral location survey.
- Weekday daytime observations.
- Weekday Nighttime observations.
- Weekend daytime observations.
- Weekend Nighttime observations.

For each location the survey identified the total Numbers of passengers travelling, the total number of taxis departing with passenger and a sample of waiting times. The researcher designed a detailed analysis to include:

- 24 hour observation per survey location, except in instances where nighttime use is not apparent.
- Weekday surveys to occur on Wednesday and Thursday
- Weekend surveys to occur for the period from 22.00 Friday Night to 06:00 Sunday morning.

8.8.1 Building from the existing model - issues in quantity modelling

The existing SUD models provided a firm base for the assessment of SUD in Glasgow, but following initial review it became clear that within this a number of assumptions could not be directly held appropriate for the circumstances in Glasgow. Site design patterns were not consistent with the stated assumption of Stochastic (random) arrival, while observed driver behaviour could further reduce the effectiveness of the standard

models, and prompted the development of driver surveys. Driver surveys were used, in part, to identify which stances would be favoured – an observed pattern – identifying the reasoning why some locations were well served in the nighttime market, and others were not; but also to determine the propensity to supply in a number of given circumstances, a key failing of the standard model.

Vehicular patterns of access within the city were observed to be affected by particular stance circumstance including, in Glasgow, an impact arising from delays at traffic signals preventing entry to the Gordon Street taxi stance, located in the city centre. A similar issue was observed related to the pattern of behaviour of drivers on departing from the Gordon Street stance, which faces Glasgow Central Station, which appeared to perform significantly better when served by LTI vehicles than when served by other black taxi types (notably the E7, which failed to perform turning manoeuvres within the confines of the Gordon Street stance without causing delay to other vehicles). The observation of differing operational capabilities prompted development of links between the initial model and quality standards on an individual stance level. A wider ranging question, within the authority, whether to further focus on a definition of quality requirements also raised issues of links to the economic cost model, initially identified as a part of the SUD study, and presented in more detail in the subsequent development of a revised cost model.

8.8.2 Building links to economic regulation

Assessment of economic regulation is most typically addressed separately to quantity analysis, initially undertaken separately in Glasgow. There are, however, obvious links between the two. The issues of vehicle cost and impact on supply were considered and this applied in more detail with the development of the cost model. Moreover, the Glasgow case study strongly suggested the need for iteration of both cost and quantity models, although the opportunity to demonstrate this in practice was more limited, the need for this iterative link is, itself, a major conclusion of this thesis.

8.9 Application of an enhanced modelling structure to Glasgow

Case study data from Glasgow collected at the time of the initial Glasgow SUD assessment (see Table 3.5) provided a significant base from which to test some of the sub-model concepts developed within this thesis. These have, in part, been developed and applied within the Glasgow study, including the development of Driver Perception and Stance Engineering elements, and these have since been accepted and applied in practice. Other sub-models have emerged following and as a result of the SUD and cost modelling exercises completed in Glasgow. These are tested in this thesis on the basis of data collected in the Glasgow study, and that collected in the West Dunbartonshire study (see Section 8.1 – 8.5), and these form the basis of a wider conclusion. Both the Glasgow and West Dunbartonshire case studies allowed for the application of some of the elements proposed in this thesis as a new model. These elements revised, rather than replaced, the existing models and have built a number of new sub-models or elements connecting the existing standard model of SUD to include quality controls, new elements linking quantity and economic as well as quantity and quality domains. The following sections detail the new elements used in the Glasgow case study and forming a part of the recommendations to the city at that time.

8.9.1 Developing a complementary users perceptions model

A significant drawback within the standard SUD model related to the assumption that expectations for taxi services were the same at night as they were during the day. The ability to solve a lack of transport at night would, following this line, be the same and as achievable at night as during the day. In reality, however, nighttime transport provision is significantly different as are the perceptions of those using nighttime transport, and the propensity to supply differs and in turn is identified as an issue of driver perception. A daytime model of increased supply would not, therefore apply at night, nor would the results of such a model apply fully to its application at night. Most significantly and by following the standard model in a nighttime situation in Glasgow an additional requirement of 10,000 taxis was identified as appropriate to reducing waiting times to an 'Acceptable level' of under two minutes. The result appeared to be unachievable in any

licensing scenario, but more significantly failed to account for the impacts of such a large increase on all other areas of demand. Moreover, the identified level of 'Acceptable' waiting time appeared to be at odds with the expectations of 'reasonable' waiting times expressed by travellers at night. Identification of an appropriate level of service, measured as an Acceptable waiting time dependant on time of day would allow for a calibration of the standard approaches differently by day and nighttime demand.

Pedestrian Survey

The developments of the pedestrian survey, a clipboard survey of the public on street, included identification of the length of time considered appropriate in accessing a taxi – the threshold of delay (TD), see Chapter Seven. A sharply differing pattern emerged in what was identified as an Acceptable waiting time in accessing a taxi. Central locations, and at stations, a maximum wait of 5 minutes or less was considered appropriate, while a waiting time of up to 10 minutes was felt Acceptable in returning home at night.

8.9.2 Driver behaviour and waiting conflicts

A counterpoint to users expectations informing the operation of the model relates to the behaviour of taxi drivers in given situations. The operation of a standard model assumes both desire and ability of an expanding fleet to increase supply at any time period and in any location of the city. Observation suggested, however, that the patterns of arrivals within the city were not equal across all stances, and prompted a more detailed assessment of the actions of drivers. The driver survey, see Table 3.5, was undertaken to establish driver perception toward supply, availability concerns in providing services at particular times, and provided an indication of the effect on current supply of changes in license numbers. The survey has also sought to identify the structure of the Glasgow Taxi fleet age of vehicle, and provide opportunity for drivers to comment on specific issues in the supply of taxis, or in the stances served.

The survey suggested that a majority of Glasgow Taxi drivers (95%) followed regular

shift patterns operating at the same or similar times of the day and over similar days of the week. The appearance of regular shift patterns suggests a consistency in factors influencing supply, ranging from market forces - certainty in market, and in the decisions made by taxi drivers in making choice of supply. It may also reflect the nature of the availability of vehicles, double as opposed to single shifted vehicles only being available for a proportion of the day. The appearance of regular shift patterns also suggested that the underlying factors influencing supply were consistent, and that the results were more likely to provide valid indication of genuine barriers to supply, than in the instance of erratic or largely irregular shifts.

In order to distinguish between a desire and the ability to supply the survey sought to identify issues that directly affected choice of shift. Multiple answers were allowed. By far the greatest factor affecting choice was the personal desire to work at any particular time. The majority of Glasgow taxi drivers were self-employed, and therefore could choose times and days to suit themselves subject to vehicles being available. Personal choice also reflected the choices expressed in three further categories: Safety, availability of vehicles, and the perception of numbers of passengers seeking transport. Personal safety was seen as the most significant external factor affecting the choice of operating at night (22% overall), although the figure dropped among nighttime drivers to 12%. It is likely that differences existed in perception of personal safety between those regularly operating at night - with some knowledge of actual risk, and those operating during the day whose perception of risk in nighttime operation is heightened, through media, or just simply personal interpretation.

8.9.3 Conflicts arising at stance – design and stance engineering

In an earlier section of the thesis, we made use of detailed Glasgow stance engineering materials to indicate a number of issues specific to the use of the taxi stance (taxi rank)⁴⁹ and the complexity of this issue that is routinely excluded from consideration in terms of standard approaches. We saw that the design of the stance could have considerable consequences in terms of delay and supply and indeed in the failure to match demand and

⁴⁹ Including unlimited capacity, regular and even accessibility and departure patterns

supply, and that the determination of actual effectiveness relied on a case-by-case consideration of individual stances. The assessment of stances at a detailed engineering level could not, however, provide a global solution to increasing supply, but rather inform the interpretation of results including identification of instances where increases in supply in the fleet would not have the desired impacts of reducing demand at a given location, see below, which might reduce effective delay and thus impact on the availability of the fleet. The stance review has also informed a number of approaches where supply has been improved without changing license numbers (non-licensing solutions).

Gordon Street stance, Glasgow

Whilst a change in the absolute numbers of taxis remains the most common method of increasing taxi supply a number of alternatives exist and can effectively reduce the reliance of standard models on assumed patterns of movement at specific stances. These include:

- Improvement of engineering factors on site, and
- Improvements in the performance of stances.

During the observation surveys in the Glasgow application it became apparent that the restrictions imposed by capacity and priority limitations have an impact on the ability of a stance to operate to its full capacity, or within the assumed parameters applied in the standard model. In some instances it was observed that the throughput of stances was further limited by misunderstandings on the part of users failing to identify queue etiquette. Individual stance performance may thus be enhanced by measures that encourage appropriate movement through the stance itself.

The City of Glasgow displayed significantly increased levels of demand at city centre stances at weekend nighttimes, and this is identified in Table 8.7 in terms of waiting times at city centre stances.

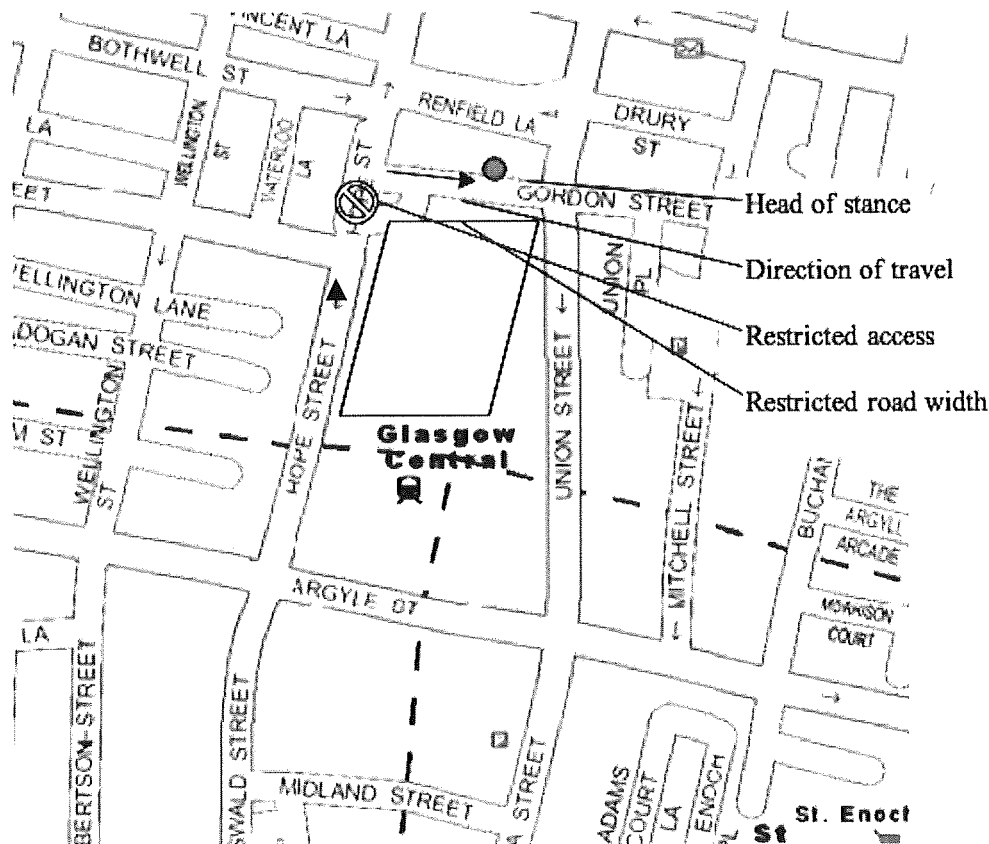
Table 8.7 Worst performing city centre stances: Glasgow

Delay (Minutes)	Weekend Daytime	Weekend nighttime	Weekday Daytime	Weekday nighttime
Renfield Street	0.25	6.05	0.41	0.61
Gordon Street	0.12	8.81	0.12	0.27
Sauchihall Street	0.35	5.16	0.20	0.97
Dundas Street	0.97	1.14	0.70	2.08

Source: observation survey

Of the selected city centre stances, Gordon Street (an average of 8.81 minutes delay at weekend night) displayed the worst performance, and was further investigated to determine engineering issues in the delivery of taxi services. The stance (see figure 9.1) displayed two major concerns, traffic direction/passenger conflict and ease of access. Particular issues arose at weekend nighttimes with a mean waiting value of 8.81 minutes, and a peak of 19.52 minutes.

Figure 8.17 Gordon Street Taxi Stance, Glasgow



Mapping: Multimap

Issues in gaining access to taxis turning at traffic signals into the Gordon Street stance from Hope Street restricted the numbers of vehicles entering the stance and reduced the effectiveness of the modelled solution using the standard model. The effect of any increase in vehicles in the fleet would be limited by the numbers of vehicles able to travel out of Hope Street. The stance appeared further complicated by the direction of travel from West to East, causing taxis to stand at the north pavement and requiring rail passengers to cross in front of vehicles in order to access the stance. Furthermore, although Gordon Street is a two way access street, non-LTI taxis were unable to successfully turn to exit to the west as a result of the restricted road width at the entrance to the station.

Engineering solutions

The impact of the signal delay at Gordon Street has been to reduce the ability of vehicles from within the current fleet to access the stance, and this in turn reduces the ability of existing vehicles to serve waiting passengers. Vehicle movements, based on the effective green phase, can be optimised to achieve better accessibility at this point (see: Webster et al, 1966), and these have been calculated in relation to Glasgow's Gordon Street stance, see Appendix 6.8.

Gordon Street also displayed engineering restrictions in layout limitations. Specifically that departing traffic is focused in an easterly direction; with many taxis unable to complete a U turn in the available road space to depart in a westerly direction. Passengers seeking to travel West and North were required to divert in their journey to the East, travel from the Gordon Street stance to the West and North encountering an additional 439 metres (measured at centre line) as a result of the directional nature of the stance. Where this diversion is followed, both journey time within the fleet is increased, and passengers experience higher fares than strictly appropriate to their journey.

An alternative, where developing a stance location on the southern pavement in Gordon Street facilitates westbound departures, reduces the extent of diversion and effectively increases supply as time taken in travel is reduced. The savings based on a typical journey, determined from pedestrian surveys resulted in time-savings of 0.67 minutes per

vehicle movement (see Appendix 6.8), applied across the entire fleet as CEA, described in Chapter Seven.

8.10 Updating taxi models, evidence from case studies

Taxi models, those which seek to predict and optimise the delivery of taxi services, have become common in application in UK cities, are common in approach and will often adopt similar methodologies in application. The use of models can, where appropriately designed and applied, contribute to the delivery of taxi services, as seen in the historical information from the case study cities. The potential is, however, reduced by the inappropriate use of a single approach and in instances where the completion of a study is more important than the actual results, an outcome appropriate to satisfying legislation rather than improving supply. The opportunities for optimal delivery of taxis may be threatened where the models fail to take account of a full range of issues in delivery, or of linkages between the elements of control.

8.10.1 Model components

Existing model components, both SUD and cost model approaches, have provided an effective method of determining supply and tariff in isolation, but failed to fully account for the needs identified in the case study locations. Analysis in Glasgow suggests, in relation to cost modelling, that changes in the cost of production are, by their nature, comparative rather than absolute, given that no one taxi will incur the same costs as any other. It does, however, provide a detailed method by which an indication of cost changes may be determined. The more accurate the elements within the tariff, the closer an approximation of costs will be achieved. The Glasgow cost model had developed over a period of time and appeared not to include updates to structure or content appropriate to the development of the Glasgow taxi parc over time. Most particularly the model had not taken account of the diversification of vehicle types operating in the fleet. In addition, many of the modelling elements identified in isolation in the cost model were, in reality,

closely linked to other areas of regulatory control. The new model runs provided an opportunity both to consider the nature of existing standard models in application and to establish the nature of linkages between models. These were immediately apparent in the use of the same base information across models, and the relationships identified in cost elements and supply.

This is not, however, an appropriate ending point. In Chapter Six, Table 6.1 demonstrated, that in the case of taxi supply, three models needed to operate in parallel to achieve full consideration of the impacts of taxi regulation. Links were identified (see Table 8.8) and these are significant in achieving full operation of the new modelling framework, and have been applied in the case study cities as appropriate to local circumstance.

Table 8.8 Summary of linkages to cost model

Link between	Description
Authority requirements for disabled vehicles and vehicle purchase price	Impact of a change in minimum standards of vehicles on the market price of vehicles
Enforcement of MCF and disabled accessibility	Impact of enforcing MCF standard on the accessibility of vehicles to encourage use (demand) by potential travellers
Enforcement of MCF and vehicle purchase price	Impact of enforcing MCF standard on the purchase and resale values of a vehicle
Determination of maximum vehicle age and vehicle purchase price	Impact of enforcing a maximum vehicle age on the resale value of a vehicle
Standards set for roadworthiness and maintenance costs	Impact of changes in vehicle fitness standards and the costs of maintenance
Numbers of vehicles in operation and driver income	Impact of changes in the fleet size and ability of drivers to earn; and (where applied) on the income element of a cost model.

Source: Author

The identification and consideration of impacts in other regulatory domains on the operation of the cost model is significant as it permits calculation of effects of external impacts with a direct impact on operational cost. Thus imposition of a minimum vehicle standard requiring additional investment, can be properly accounted for in prices charged to taxi users.

As with the cost model, SUD elements had failed to account for a full cross section of factors impacting on supply. The model contained a large number of assumptions, visible in both Glasgow and West Dunbartonshire case study areas, and the updating of components as well as removal of assumptions was felt appropriate for both areas. A summary of elements updated includes:

- Identification of observed waiting time at stance
- Identification of stance specific factors reducing effectiveness of modelled increases to achieve improved services, removal of standard assumptions of stance capacity
- Separation of day and nighttime waiting times and identification of thresholds appropriate to passenger needs, removal of standard assumption of two minute delay
- Identification of driver behaviour including new measures of propensity to supply
- Identification of physical (non-licensing) measures appropriate to the development of supply including, in the case of West Dunbartonshire, measures to ensure appropriate levels of accessible vehicles

In common with the determination of linkages to the cost model, links also exist between SUD models and other areas of regulatory control. A number of specific links between the model and other forms of regulation exist and are identified in Table 8.9.

Table 8.9 Summary of linkages to SUD model

Link between	Description
Enforcement of MCF and vehicle purchase price	Impact of a change in minimum standards and operational cost on numbers of operators in market
Determination of maximum vehicle age and vehicle price	Impact of a change in maximum age and operational cost on numbers of operators entering market
Determination of tariffs and driver income	Impact of change in income on numbers of operators entering market, remaining in market, and operating at specific times of day
Standards set for vehicle roadworthiness and maintenance costs	Impact of changes in fitness requirements and costs of operation on the numbers of operators entering and remaining in market
Determination of waiting times and numbers of vehicles required in fleet	Impacts of change in acceptable waiting time on the nature of supply and numbers of vehicles within the fleet required to meet minimum service levels

Source: Author

The development of links to the SUD model within a new modelling framework allows for impacts occurring in other regulatory domains to be considered in terms of their impacts on unmet demand, an example being the impact of a change in income on the numbers of vehicles operating taxis at any given time.

8.10.2 Applying links within new modelling framework

An update to existing taxi models was completed, taking account of both improvements to the elements in isolation and in the development of links between the models and other regulatory elements identified in tables 8.8 and 8.9, above. The nature of implementing updates varied between the case study locations, with common approaches in the removal of assumptions from models previously applied, and the development of new elements determining actual values for passenger expectations, driver propensity to supply and links between supply and quality, and supply and cost models. The West Dunbartonshire application further developed elements addressing the need for transport for those with

specific accessibility requirements, while Glasgow models built on the links between supply and costs. An additional element highlighted in the Glasgow case study addressed engineering issues at stance. The Glasgow case study also identified a strong correlation between efficiencies in supply and the need to serve nighttime economies. Services at night were identified as particularly critical, and less well served than those in the day.

8.10.3 Applying the model with specific reference to Nighttime economies

The nighttime economy emerged as a focus in the supply of taxi services, particularly in Glasgow, and is critical insofar as a majority of passengers sought to use taxis in preference to other modes of transport late at night, in part due to the lower number of alternatives. Transport services in the nighttime city differ from those used during the day in the propensity to use and availability of particular modes, modal split between public and private transport, and the nature and quality of services provided. The environment in which transport is provided effectively differs between the two time periods, with the differences being extenuated at weekend nights.

The needs of the nighttime taxi user in Glasgow differed from those during the day and are more significantly based on travel home from entertainment. The extent of issues in accessing transport was also identified in relation to personal safety, accessibility and waiting environments. Demand was peaked significantly as individuals returned home and was not sufficiently catered for from the existing parc. The daytime economy, however, was typified by a surplus of vehicles seeking engagement, with a similar pattern visible in West Dunbartonshire. Any significant increase in the total fleet size, the likely recommendation resulting from the standard model operation, would in reality harm the operation of the daytime service by producing excessive numbers of vehicles, yet fail to sufficiently serve the nighttime market without a level of increase in numbers of vehicles that affects the costs of operations as to make continued supply unsustainable.

The application of the revised model, and in particular the use of non-licensing solutions, including the determination of a separate values for waiting delay by time of day and adoption of physical rather than license based solutions suggested that, in reality, a wider

framework was able to provide a better solution than adopting standard model based increases in fleet size, visible in Glasgow by the improvement of access at stance, including the introduction of taxi marshals, and in West Dunbartonshire in relation to the make up of the fleet (increased numbers of disabled vehicles).

8.11 Conclusions

This chapter has detailed the application of the new model to two specific case study locations. In both instances, the needs of the authorities to provide appropriate taxi services have been limited by the extent to which existing tools have been able to identify need and determine quantity – quality and quantity – cost relationships. Existing taxi models have tended to be completed in isolation, and have not provided for a full analysis of the needs of a location.

The application of an expanded analysis in both West Dunbartonshire and Glasgow has allowed for consideration of wider relationships in the supply of taxis, and in the provision of a service appropriate to the wider community. West Dunbartonshire provided a detailed illustration of the application of combined quantity and quality goals and provided a method of linking a need for accessible taxis to a quantifiable determination of the levels of supply appropriate to need. In the case of Glasgow, which already operated a fully accessible hackney fleet, the study provided a method of combining quantity analysis with determination of cost changes – economic control.

While the geographies, social activities and licensing priorities of locations will differ; the underlying need to provide appropriate taxi transport remains constant. The need to identify and deliver a control mechanism and methods of supporting and updating that control is also a constant between locations, and will continue as a requirement regardless of the choice of entry restriction (regulated v deregulated approaches). Moreover, the need to assess the levels of delivery and appropriateness of controls is likely to become more acute as the issues of controls applied is maintained and expanded in the public domain.

The identification and application of appropriate tools is an essential part of improving provision. The new modelling framework developed in previous chapters and applied in relation to two Scottish authorities can provide direction in developing taxi services locally, and has developed solutions accepted and applied in practice as practice by two Scottish local authorities. The next chapter draws conclusions specific to the application of the model, considers the implications of the case study evidence for the wider institutional context of taxi supply and regulation, and is followed by wider conclusions and recommendation for future research.

Chapter 9

Conclusions, taxi licensing and control: implications of the model

9.1 Optimising taxi service delivery, licensing and control

This thesis concludes that taxi licensing represents both an established and mature system of control developed primarily as a method of ensuring delivery of taxi services in the interest of the public, intended to reduce levels of market failure and market exploitation. The approach to licensing has developed over time and follows similar patterns in most countries. Controls in the UK have been in place since the Hackney Carriage Act of 1635, with parts of the Hackney Carriage Act of 1831 remaining in force to this day (see Chapter One). Controls are justified as a protection of passenger interests, but have, in more recent history, been subject to discussion regarding liberalisation of markets, set out in Chapter Two. Taxi regulation has been subject to increased scrutiny, both in terms of its justification per se and of the methodological approaches taken in supporting particular forms of regulation, which include Quantity, Quality and/or Economic controls (QQE). Recent legislation (the Civic Government (Scotland) Act 1982 (CGSA) which applies in Scotland, and the Local Government (Miscellaneous Provisions) Act 1976 which applies to England and Wales) sets out a requirement to establish levels of demand, and review prices within a regulatory structure on a frequent basis, and these requirements have led to defined quantifiable approaches to demand analysis and cost determination often referred to as Demand (SUD) and Cost models. The development of both forms of modelling, and the extent of regulation applied as a result of their application has formed a central focus in this thesis; and has led to the conclusion that further improvements can be made based on the measured deficiencies in the appropriateness of the existing approaches in delivering optimal taxi services in UK cities.

9.2 Public interest

This thesis concludes, that to achieve best service and public interest in taxi delivery, regulation must be an informed balance between safety, industry security, price and quantity. Allied to this, an ongoing discussion arises around regulation and liberalisation, which appears to locate public interest in either one camp or the other. Both positions appear well supported through literature and logical arguments but, this thesis concludes, represent a less dichotomous position as may first appear. Both argue for a balance of regulation, and both identify that regulation does not disappear in the de-restriction of transport modes but may become focussed on issues pertinent to the political, economic and social desires around the transport mode - the issue of increasing accessibility requirements accompanying pressures for de-restriction in the taxi sector provides one such example.

In this thesis, we have investigated the context of taxi regulation in the UK. The thesis concluding that the best interest of passengers exists between, rather than at, one of two polar extremes of regulation (fully regulated or fully deregulated taxis). This in turn supports and requires (CGSA) analytical approaches to regulation appropriate to optimising regulation, and particularly the balances between regulatory domains that appear to be missing in current 'standard' approaches.

The thesis has investigated the operation of existing models, both in terms of the approaches and outcomes in a large number of cities and in relation to the detailed operation in focus and case study cities. Two detailed case studies have been provided where the researcher operated in an advisory role to two licensing authorities and within this context developed a new modelling approach to taxi supply and regulation. The application of the model produced a set of recommendations detailed within the thesis and now applied by the two licensing authorities concerned. Models remain separate and operated in isolation and it is concluded that this, in addition to a number of shortfalls within the models themselves, forms a fundamental barrier to the accuracy of the models, limits the potential of solutions based on their outputs, and may contribute to the view that existing controls are not acting in the best interest of the public.

The thesis concludes that the separation of the existing modelling elements in taxi supply by form of regulation (QQE) fails to take account of the linkages between these elements,

and this is likely to affect the ability of the existing standard models to deliver an optimal solution across these differing domains. Individual models, it has been demonstrated in detail, also reflect shortfalls and gaps resulting from a number of assumptions in their design, and in their application, having impacts on the accuracy of results in the location under review, but also perpetuating errors in operation and, as a result of a comparative variable within the standard demand model (ISUD), contributing to inaccuracy and a compound error across a large number of other reviews. Failure to fully account for links between regulatory domains, or to reduce to a minimum the number of assumptions within the models will reduce the effectiveness of the modelling process.

9.3 Implications of the new model for the different stakeholder constituencies

This thesis has demonstrated that there is a need to adjust and refine the existing models of taxi regulation as they are applied in the UK. The thesis, taken as a whole, offers a revised modelling approach in the context of a relatively weak and underdeveloped literature and a set of practices that have been subject to minimal scrutiny. The findings relate both a) to the methods by which taxi services are supplied in UK cities, and b) the approaches taken in assessing the various elements of supply. The findings also relate to the appropriateness of regulation and are consistent with the legislative frameworks defined separately for Scotland, England and Wales, and Northern Ireland. Application of the new modelling approaches that form the thrust and conclusion of this thesis provide methods of optimising supply in relation to controls placed on quantity, quality and price. The application of the models impact on the taxi user, including the intending or potential user (latent demand); on the supplier, including owner-driver and larger company operators; and on the regulator, typically the local licensing authority, but they also impact upon regional policy makers. The revised modelling approach also adds to the literature and discussion of theoretical approaches to regulation in the taxi industry, approaches to delivering services appropriate to need, and highlights methods of updating and adding to existing approaches that better reflect the demand and circumstances of provision in UK cities.

Here, then, we look at the impact of the new modelling approach detailed to this point, with reference to the implications of each development to the user, the operator and the legislator. We then look at the impacts of these changes on each of the groups identified, and on the direction of theoretical studies.

9.3.1 Application of QQE in cross regulatory analysis: an enhanced modelling approach

In Chapter Seven we set out methods by which existing approaches used in determining Significant Unmet Demand (SUD), and charges applied for taxi use (collectively analytical ‘taxi models’) could be enhanced to better reflect the actual needs of the travelling passenger and potential passenger. Not all elements of all models would be appropriate for application in every city seeking to improve taxi services, but a broader combination of models across the differing regulatory domains would reflect a more realistic approach to analysis than their identification in isolation. We also considered the impacts of additional elements not commonly addressed in council led taxi reviews, that of accessible vehicle supply, and set out methods of incorporating this into the modelling approach. As a result of this analysis, the thesis sets out a framework of tools appropriate for the optimisation of taxi services in UK cities. The elements of which are discussed below specific to the dominant regulatory domain in which they sit.

9.3.1.1 Quantity regulation

Restriction of license numbers remains a controversial element with proponents both for and against. Where it is adopted as policy an authority is required to demonstrate a lack of SUD in order to continue to apply restrictions. The models used in this determination have been systematic and consistent between authorities, but are felt to contain large numbers of assumptions in their use that are hard to justify as realistic. This thesis considered the extent of assumptions common in these models as contributing to less than ideal conclusions. Furthermore, the traditional SUD model did not recognise the impacts of changes in other regulatory domains on the presence of SUD, did not commonly

address the issue of accessible vehicle supply, nor fully take account of the levels of latent demand.

The thesis addressed the levels of assumptions by developing enhancements to the methodologies within the existing models to take account of:

- Stance Engineering
- Passenger behaviour, and the desires of potential passengers
- Driver behaviour and potential driver behaviour
- The impacts of changes in quality and cost requirements on the SUD model
- The impact of increasing use of accessible vehicles in a fleet

The enhanced model elements, detailed in Chapter Seven, were tested in two case study locations, West Dunbartonshire and Glasgow, being locations where data could be collected in sufficient quantity to allow for such an assessment.

The adoption of the new modelling approach as set out in Chapter Seven, and detailed in case studies in Chapter Eight, has the benefit of reducing the levels of assumptions within the SUD modelling process and incorporating into the assessment linkages from other regulatory domains, tested to include impacts of accessible vehicles in the case of West Dunbartonshire, and impacts of costs, tested in the case of Glasgow. The impacts of the new methodology on the SUD modelling process include a reduction in the levels of assumptions used in council led reviews, and more sustainable and justifiable conclusions.

9.3.1.2 Quality regulation

The current approach to quality regulation, control of vehicle safety, appearance, and age, receives significantly less attention than do the other forms of regulation. This is largely due to the broad acceptance of safety regulation as a necessary element in the control of taxis, and the widespread adoption of similar approaches. This said, an actual relationship

between quality controls and the other elements of taxi supply does exist, and includes the impacts of quality controls on the costs of vehicle operation, the approaches to fleet replacement, and the make up the fleet including the decisions to operate accessible vehicles. These are directly related to both cost and SUD models, to cost as a consequence of the need to invest in vehicle type and achieve maintenance standards, and to SUD directly in relation to the numbers of particular vehicles operating and indirectly through the relationships between cost and supply.

The new modelling approach, detailed in Chapter Seven, sets out the nature of the relationships between quality controls and other regulatory elements, and proposes methods by which controls specific to vehicle quality may be applied to other elements of regulatory control.

The impact of linking quality controls to other elements in taxi modelling relate to increased accuracy of assessment, and can be directly linked to achieving more appropriate delivery. The addition of quality control elements to the modelling framework is also appropriate in developing both cost levels and quantity levels correctly. Without a direct link between quality and quantity, the impacts of a change in, for example, Metropolitan Conditions of Fitness, remain arbitrary or not considered within the SUD model. Furthermore, as the relationship between costs and vehicle quality requirements are developed, direct impacts on cost model, and indirect impacts of the cost model on supply can be fully assessed.

9.3.1.3 Economic regulation

The most common approach to Economic Regulation has been the control of fares (tariffs) chargeable to the user. Fares are most commonly determined through a variety of measured changes sometimes identified as cost models. Cost models identify changes in the nature of operating costs, and these can then be applied to the tariff tables against which fares are calculated. Vehicle operating costs are clearly affected by changes in the base costs of the constituent elements in taxi service, which include the costs of vehicles,

fuel and maintenance, but may also include methods of updating an earning element, the likely take home pay of the taxi driver based on typical work patterns.

The relationship between quality controls and the inputs used in cost modelling may appear straightforward, that a requirement to use a particular vehicle type affects the costs of purchasing and updating that vehicle, but also should include less apparent relationships including the relationship between numbers of vehicles and earnings levels, cab-shift availability and propensity to provide services at particular times of the day.

The impacts of the new modelling framework include the ability to determine and ‘plug-in’ quality control impacts (tested in terms of vehicle age), the ability to identify wage impacts arising from SUD, and the relationships between the costs of production in a given set of circumstances and the ability to supply. As with previous modelling elements, the actual benefits and main impacts of the new approach relate to the accuracy of the predicted scenarios, and the identification of their impacts across all market participants.

9.3.2 Impacts on market participants

The development of the new modelling framework will have impacts on current users, in terms of achieving better and more appropriate service levels, but also across a wider number of market participants, including potential passengers (latent demand), those wishing to travel by taxi but currently discouraged from so doing.

9.3.2.1 Implications for the travelling passenger: existing and latent demand

The basis for much of the discussion over taxi supply, licensing and control has been to identify and maximise services to the consumer. The OFT report (OFT, 2003) concentrates on identifying the best approaches to maximise customer benefit, and similar issues are raised in the DfT best practice guidance (DfT, 2006). None of the

existing literature seeks to identify services that are less good to the consumer, though many differ in their interpretation of the method of achieving positive benefit. Likewise, the general approaches to assessment and taxi modelling should also seek to maximise benefit to the consumer and consumer protection from exploitation as a fundamental outcome. While all of the existing modelling approaches implicitly seek to do this, the actual range of assessment in current models may actually result in a less good solution than would be ideal or possible where more detailed assessments completed,

The impacts of the new modelling framework, set out in the preceding chapters, are likely to include a more appropriate determination of supply levels to meet passengers needs. The identification of driver propensity to supply within the model avoids an incorrect allocation of new supply to stances that are, in reality, unlikely to be well served, and provides the base for focused approaches or actions on the part of the licensing authorities to ensure appropriate supply at a stance level. The adoption of a site engineering plug-in, detailed in both Glasgow and West Dunbartonshire, is also appropriate in identifying stance specific issues, the identification of *queue creep* in Glasgow, and the avoidance of incorrect turning and stance capacity assumptions, allows focused solutions at a stance level and impacts positively on the users of taxi services as a result.

Impacts also accrue in relation to the carriage of passengers with particular accessibility requirements. While a number of larger cities already require use of accessible taxis, including Glasgow, the practice is not universal or particularly widespread in other authority areas. The new modelling framework set out methods to assess the impacts of moving toward accessible vehicles, tested in West Dunbartonshire. The implications of developing plug in model components allow for local authorities to determine the appropriate methods of moving to accessible vehicles, and include within this assessment testing methods including staged introduction of these vehicles.

9.3.2.1 Implications for the taxi operator

While many of the benefits of an improved and more accurate modelling framework relate to ensuring the best levels of service for the passenger, it is also appropriate to address the impacts of modelling approaches on the taxi supplier. Taxi drivers operate within a privately owned controlled market place and are potentially highly affected by changes in the controls applied to their industry. A modelling framework that seeks to optimise supply to the passenger need not result in a reduction in the ability to supply, indeed where a long term impact of changes in supply reduces the ability of the supplier to operate sustainably the same loss will impact on passengers. The objective should therefore be to ensure a long-term level of supply appropriate to the needs of consumers, rather than immediate benefit to one party.

The new modelling framework contains an approach to ensure that the full impacts of changes in one domain may be identified in terms of its effect in another. Changes in the numbers of licenses impacts on the actual income made by each driver. This is a linkage between the SUD and cost models. Similar links exist between quality and cost, and quality and SUD. The impact of identifying these links is likely to include the ability to test for longer-term impacts of scenarios.

9.3.2.2 Implications for the regulator: the taxi licensing authority

Licensing authorities are also impacted upon by the development of a new modelling framework. Positive impacts relate to the reduction in assumption and incorrect calculations contained in the previous modelling approaches, mainly in SUD assessment, but also in the benefits of a robust model drawing across regulatory domains. In the traditional SUD model potential for error lies in the use of relative values as an index of SUD. The relative value approach may result in compound errors in practice where all values have been established through the use of the same erroneous model. As we have already seen, the extremities observed within this index suggest that there is reason for caution in its application. The consequences of making use of this measure are many and

include potential vulnerability to challenge, and the significant impact of adopting a particular approach to satisfy legislated requirement rather than the best interest of the travelling public.

The major implications of this thesis for taxi licensing authorities in the UK is that there is good reason to re-assess their methods of evaluation and assessment in determining the appropriate level of taxi supply. The accuracy of the assumptions of standard methodologies require detailed review by individual licensing authorities and such review must take place in the context of detailed knowledge and observation of local specificities. We have seen within the thesis how issues such as stance infrastructure can have major implications for the operation and continuity of taxi supply yet receives no recognition within the standard model. For the regulators, the Licensing Authorities, there is a need to identify what elements in the local environment impact on taxi supply and to ensure that appropriate methodologies are developed to address these. In the cases of Glasgow and West Dunbartonshire, we had an overview of two licensing authorities which have taken steps in this direction – and these experiences indicate a way forward for other UK Licensing Authorities.

The preceding chapters have demonstrated that issues of QQE need to be considered within an interactive and interlinked framework. The preceding chapter provided a demonstration of such an approach. It is important that Licensing Authorities be made aware of the better guidance needed about these inter-linkages and inter-actions in the regulation of taxi supply.

9.3.2.3 Implications for nighttime travellers and temporal impacts

This thesis has addressed taxi regulation across all of its spheres and, as with other authors, identified issues across all time periods. The effect of taxi regulation has, however, continually appeared more severe, urgent, or to have greater impacts on passengers travelling at night than in other periods of the day. Demand patterns are most distinct in the nighttime periods of Friday and Saturday nights than during daylight hours. These are identified as the worst performing times, and more precisely affected the most

significantly in the journey home from entertainment. Existing modelling approaches, however, do not determine effects specific to any one time of day, and will often result in applications that are inappropriate either to daytime or nighttime taxi use.

The new modelling framework allows for the consideration of factors that may only be identified as pertinent to one particular period, such as the identification of stance characteristics and use at night, and that passenger expectations differ between times of day and between differing uses of taxis. No published model had previously addressed assumptions of expectation, or focused study to a sufficiently localised level to identify individual stance issues at night. The development of the fleet, and individual stance specific actions need to be appropriate to both day and nighttime economies, and address the needs of one without negatively impacting on service levels in the other.

The application of the new modelling framework at a stance level, as discussed in Chapter Eight, allows for identification of appropriate action, illustrated at the Gordon Street and Sauchihall Street stances in Glasgow, that benefit use and patterns of operation at any specified stance across any specified time period.

9.3.3 The case for regulated environments recognising local needs and priorities

The application of regulation to the taxi trade in any one location must address the question as to whether more regulated environments operate better or worse than less regulated ones. The divergence of theoretical opinion into regulated and deregulated camps highlights a fundamental difference in approach to achieving optimality in taxi delivery. Application of services in real life also reflect this difference, and this is maintained throughout the strata of policy and application right up to Department for Transport, Office of Fair Trading and devolved government level, and the underlying observation that different locations choose to apply differing forms of control (suggesting preferences equivalent to regulated or deregulated environments). Metropolitan urban authorities (representing a larger number of taxis) tend to support regulation to a greater extent than rural communities or smaller city locations. Non-metropolitan authorities (which outnumber metropolitan ones) are more likely to follow open market entry.

The implications of the evidence presented in this thesis are that regulated environments given specific circumstances do indeed operate better than less regulated ones. These are the circumstances found in the UK that are specific to metropolitan areas and tend to relate to the significance of, and potential for, market failure. Open market supply may not, in itself, provide the market led benefits of free market competition given the need to control for price competition, and may further be influenced by an inability of the passenger to negotiate, compare or make informed choice at the point of engagement. Moreover, the view of the Office of Fair Trading (OFT, 2003) that reductions in quality resulting from deregulation may be resolved by increased quality controls – introducing new regulation – does not allow for the conclusion that de-restriction results in improved services, merely that it results in a move from one form of regulation to another.

Regulation, therefore, must depend on circumstance and specific local condition. In this respect the conclusion of the Parliamentary Select Committee on Transport (HM Government, 2004) that decision on supply is a matter for licensing authority appears appropriate and sustainable. Moreover, the need to address issues of cost, quality and quantity remain significant regardless of the decision whether to regulate market entry or not. As each is dependent on elements of the others, the nature of quantity limitation (market or regulation driven) does not negate the need to assess and react to it. The modelling framework thus is both appropriate and necessary to deliver a formal process for identifying and optimising taxi services recognising that in reality the best form of regulatory controls must actually reflect the needs and priorities of the locations themselves.

9.4 Model structure: the implications for UK practice

Within the UK it is common practice that individual elements of control are assessed separately without reference to their linkages. For example, demand models, which comprise a number of elements specific to consumer choice, do not take account of the effect of changes in costs of operation or the prices charged in using a taxi, an element in cost modelling. Similarly, cost models, which relate to a number of factors including the

effective incomes of drivers, include assumptions about numbers of vehicles without further reference to Quantity Regulation. Gaps in the assessment of links between regulatory domains are significant in that their absence reduces the effectiveness of analysis and their future inclusion should, in conclusion, be a major part in developing and updating modelling approaches.

Modelling structures have also failed to account for differences in the physical conditions of the locations under review, and appear to frequently apply the same assumed characteristics on the basis of one-size fits all. A difficulty arises in a need to produce consistent and justifiable methodologies while accounting for, sometimes significant, differences in local conditions. The models currently applied, and reviewed within this thesis, all appear to have followed the same approach to determining stance and operational characteristics, none deviating from assumed capacity or arrival rates. This is, it is concluded, a fundamental error in their application. Moreover, it would appear that the current modelling structure is incapable of distinguishing between the most significant differences in location characteristics without significant additional effort on the part of the organisation(s) undertaking the review and may not, it is concluded, be the most appropriate models for continued application.

The development of a new model, set out in detail in Chapter Seven, therefore seeks to identify an appropriate and consistent approach to analysis within the structures defined in current legislation and appropriate to application in a variety of differing locations. The thesis concludes that a single one size fits all approach is not appropriate to needs, but rather a framework comprising standard elements for inclusion and plug in permits the widest application across a range of pre-existing regulatory conditions. A variety of possible 'solutions' should be able to be tested, in the new modelling framework as a variety of scenarios developed on a location-by-location basis.

9.5 Scenario development

Scenarios are common in the development and application of many models in transport and have been used in the case study locations, detailed in Chapter Eight. A scenario sets

out a range of possible options that may be applied in the delivery of transport services and these are applied to testing through the modelling process prior to application to services themselves. The existing standard models contain within their structure, a limited potential for scenario building, best illustrated by the adjustment of taxi supply numbers in the SUD model. The existing models do not account for cross domain linkages and are therefore not capable, it is concluded, to accommodate scenarios across multiple domains.

The development of a new modelling framework, as set out in Chapter Seven, and applied in Chapter Eight, has developed and tested links between regulatory domains and is, therefore, appropriate for scenario building across differing elements of taxi regulation. Policies are not limited in scope to particular forms of control, but are more likely to follow political and social pressures focused on particular issues of delivery, as demonstrated in the demand for accessible taxis in West Dunbartonshire. This example applies to the supply of taxis in one domain of regulation but also impacts in the costs of operation, affecting the operation of another. Equally cities may seek to address a combination of pricing and supply policies, building scenarios in combination between cost and quantity in response to particular issues in supply, or in combination with quality controls.

The development of a modelling framework allows for a broad cross section of analysis appropriate to differing regulatory application, but allowing focused and detailed analysis through the use of plug-in sub-models as illustrated in Chapter Seven. The new modelling framework allows for development of new and more detailed taxi policies without an implied need to focus on one form of regulated or deregulated supply.

9.6 Model development

Current standard models serve a purpose in satisfying the legislated requirements to test for unmet demand and to determine price structures. These requirements are satisfied on conclusion of the current modelling 'suite'. Models are operated independently of each other, and this limits their application beyond the immediate legislated goals.

This thesis has set out a new modelling framework that builds on the existing structures to include links between regulatory domains and provides methods of removing the extent of assumption within the modelling elements themselves. The standard demand model currently makes assumptions specific to the nature of delay and stance operational characteristics that do not appear appropriate or accurate reflections of existing conditions. Moreover, the model does not appear to account for alternative methods of attributing time savings to stance locations or account for demands for accessible vehicles. Assumptions of accepted delay appear to be based on arbitrary values without reference to time period or circumstance of engagement and this, we conclude, is not sustainable or appropriate. In its place, the model proposed and tested a test to determine thresholds of delay and this formed the basis for subsequent revisions in the model. The thesis also demonstrates a lack of consideration of stance specific characteristics (stance vehicle delay), set out in more detail below and concludes that assumed operational characteristics, alone and in combination, detract from the accuracy of the model and conclusions based upon it. Section 7.5 sets out more detailed revised modelling approaches that take account of locational characteristics and these are tested in Chapter Eight.

The contribution of the revisions to the demand model are likely, it is concluded, to form a more appropriate base for future demand modelling. Cost models also appeared to operate in isolation of other regulatory domains and, in the instance of Glasgow, had failed to account for changes in the levels of costs of living in the determination of earnings levels to taxi drivers. In Section 7.6, the thesis set out methods by which cost models could be updated, and brought together the various forms of regulation into a single structure. The combined modelling framework set out an approach to detailed

modelling across regulatory domains, and appropriate for the testing of multiple scenarios more closely allied to need than specific form of control.

The new modelling framework was tested using live data obtained in case study locations, and is based on a significant dataset (a summary of data collection and the extensive nature of data collected is set out in Chapter Three). Application of the framework identified, and allows for conclusion that, a menu based approach of plug-in models and sub models is most appropriate where locations differ in physical characteristics. Fleet characteristics also differ, and this is catered for within the framework by use of specific elements appropriate to specific fleet types. Thus the plug-in model specific to proportion of fleet comprised of accessible vehicles was demonstrated as appropriate to West Dunbartonshire, but would not be included in similar modelling in Glasgow.

The absence from standard models of stance specific engineering factors (stance vehicle delay) also affected the accuracy of the previous approaches. The absence of accurate at stance measurement is, it is concluded, of particular relevance in the development of alternative approaches to increasing taxi supply, and this is highlighted in the case of poor performing stances and where demand levels are comparatively high. Chapter Seven developed a stance engineering model which has been tested in Chapter Eight, providing a method to account for stance characteristics. This also allows for the first time, for solutions based on improvements at stance to be fully recognised and included in the development of policy scenarios for future taxi supply.

9.7 Policy development

It was argued that the policy and practitioner literature has been characterised by a polarisation of positions in respect of regulation – those who advocate regulation and those who advocate de-restriction. From the perspective of this thesis, we introduce a third strand to or position in this discussion which is that the additional impact of changes in regulation on a market that may already display distinct segments can include partial benefit in one segment whilst simultaneously producing harm in another. Moreover,

issues affecting subsets of the taxi market, including those travelling with particular accessibility requirements, and those travelling at night may not fit well into a structure dictated by application of a single regulatory model. This thesis contends that the taxi market is just such a market, displaying internal conflict between users of differing types and travelling at differing times. Taxi delivery is, it is concluded, a balance between regulation, not an absolute application of one form of regulation or another.

Nighttime economy and specified user requirements have emerged as particularly significant and may reflect the actual difficulties in satisfying demand for taxi transport to these groups. The focus on the nighttime economy within this thesis is explained by the importance of nighttime taxi supply as a test of the optimality of the balance within and across the specified three forms of regulation – the ability to satisfy demand at its most extreme is the test most commonly identified in reviews of unmet demand. Nighttime demand poses significant challenges to the industry and its regulation, while similar challenges exist in carriage of those with accessibility needs in locations operating a mixed fleet. Both challenges (nighttime transport and demand for accessible taxis) represent similar issues of insufficient supply within a fleet to meet a specific demand, and both are poorly addressed within the standard modelling structure. This is a major gap in the existing set of provisions, which continues to pose difficulties in urban space, access to and use of central facilities, and will ultimately affect the attractiveness of a location.

Policy development requires knowledge of and full interaction between the uses and demands for taxis, while the analytical tools (taxi models) used to inform policy decisions need to be capable of accounting for a wider set of interactions than currently included in standard approaches.

9.8 Further research

The lengthy history of taxi regulation may be viewed as explaining its integration into licensing rather transport authority control: the legacy, and the development of institutional interests around this legacy, has served to prevent the rationalisation of taxi governance into transport governance. The benefits of a combination of taxis into

mainstream transport supply are, on the face of it, apparent, but are not widely called for in existing literature. Research investigating the impact of developing a more integrated approach to taxis as a part of a wider public transport sector appears current if not overdue.

The discussions of the impact of past regulation on supply are scant beyond the opposing literature supporting either regulation or liberalisation at specific points in time. Detailed historical materials are not in evidence. This is not to say that there are not materials available within local authority archives and elsewhere in the UK that would convert into a detailed historical perspective but simply to indicate in terms of a literature review that these materials are not yet present within the body of taxi scholarship. A more detailed review of the historical context and implications would, it is concluded, add to the subject area, and further research should be undertaken to investigate the implications of the legacy of historic taxi regulation for present practice. This could be undertaken in conjunction with a thorough investigation of local historical detail.

Further research will also be appropriate where the new modelling framework is applied to continue to update and validate its findings across a wider range of regulatory structures. Of particular interest, in this respect, would be the application of the model to a differing form of governance, for example its application to US cities where regulatory reforms have occurred within an alternative structure of transport supply.

Bibliography

Acer (1991) A120 Strategic East West Route, preliminary report. Completed by Acer consultants, Cambridge, for the Department of Transport, Eastern Division.

ADA (1990) Americans with Disabilities Act, US Department of Justice

Adler, M.D., and Posner, E. A. (2006) *New foundations of Cost-Benefit Analysis*. Harvard University Press, Cambridge, MA.

Adrangi, B., Chow, C. and Raffiee, K. (1995) Analysis of deregulation of the US trucking industry. In *Journal of Transport Economics and Policy*, Vol 29 No 3 pp 233-247

Atkins, P. J. (1993), How the west was won: the struggle to remove street barriers in Victorian London. In *Journal of Historical Geography*, July 1993, Vol 19, No. 3, pp265-277

Australian Government (2003) Transport Industry Safety Survey. National Statistical Service. Available at www.nss.gov.au/nss/home.NSF/surveylookup/Transport+Industry+Safety+survey

Avants, S., Gorman, G., and Lupro, B. (1996) Peer review of Seattle taxicab regulations. Report for the City of Seattle.

Banister, D. (1998) Barriers to the implementation of urban sustainability. In *International Journal of Environment and Pollution*, Volume 10, Issue 1 pp65-83

Barker, L. and Connolly, D. (2005) Scottish Household Survey Analytical Topic Report: Mode Choice. Scottish Executive Transport Research Series. Available at <http://www.scotland.gov.uk/Publications/2005/10/10154637/46577>

Bator, A. (1992) The anatomy of market failure. In *Public Goods and Market Failures* (Cowen, T. (Ed.)), Transaction Publishers, pp35-68.

Batty, M. (2002), Thinking about cities as spatial events, in *Environment and Planning B: Planning and Design*, Vol 29 No 1

Baumol, W. J. and Sidak, J. G. (1994) Toward Competition in Local Telephony

Beesley, M. E. and Gwilliam, K. (1977) Transport Policy in the United Kingdom. In *Journal of Transport Economics and Policy*, Vol XI, No 5

Beesley, M. E. (1979), Competition and Supply in London Taxis, *Journal of Transport Economics and Policy* January 1979, Vol. 13, No. 1, Page 102.

Berry, K. (1997) The experience and expression of gender among women taxi drivers. St. Mary's University, Nova Scotia

Bianchini, F. (1995) Night cultures, night economies, in *Planning Practice and Research*, Vol 10 No. 2, pp 121-126

Bianco, M., and Lawson, C. (1996) Trip Chaining, Childcare, and Personal Safety", *Women's Travel Issues, Proceedings from the Second National Conference, October 1996*

Bly, P. (1987) Managing public transport: commercial profitability and social service. In *Transportation Research Part A*, Volume 21 Issue 2 pp109-125

Bonaiuto, M., Fornara, F., Bonnes, M. (2003). Indexes of perceived residential environment quality and neighbourhood attachment in urban environments: a confirmation study on the city of Rome. *Landscape and Urban Planning*, 65, 41-52.

Boroski, J. and Mildner, G. (1996) Taxi Regulation in Portland. – an economic analysis of taxicab regulation in Portland, Oregon. Report to Portland Council, 1996

Braeutigam, R. R. (1999) Learning about Transport Costs *in Essays in Transportation Economics and Policy* (Jose A Gomez-Ibanez and Clifford Winston Eds) pp57-98

Brand, C., Raje, F., Preston., J., and Grieco, M., Transport and Access to Health Care: The Potential of New Information Technology. Oxford University working Paper Series, No. 968

Brake, J., Nelson, J., and Wright, S. (2004) Demand responsive transport: toward s the emergence of a new market segment. In *Journal of Transport Geography*, Volume 12, Issue 4, pp 323-337

Brake J., and Nelson, J. (2006) A case study of flexible solutions to transport demand in a deregulated environment. In *Journal of Transport Geography*, In Press.

British Rail (1989) British Railways Board, National Fares Manual, Eastern Region. Not Published

British Transport Police (2005), Annual Report, 2004/5, British Transport Police, HQ, London

British Transport Police (2005a), Statistical Bulletin 2004-2005, British Transport Police, HQ, London

BRTF (2004) Better Regulation Task Force, Imaginative Thinking for Better Regulation

BRTF (2004a), Improving the quality of regulatory impact assessment, BRTF 05/10/2004

BRTF (2005) Better Regulation Task Force, Regulation - Less is More Reducing Burdens, Improving Outcomes A BRTF report to the Prime Minister March 2005

Bromley, R. D. F., Matthews, D.L., and Thomas, C.J. (2007) City centre accessibility for wheelchair users: The consumer perspective and the planning implications. In *Cities*, Volume 24, Issue 3, pp 229 - 241

Brugha R., and Varvasovszky, Z. (2000) Stakeholder analysis: a review. In *Health and Policy Planning*, Volume 15, Issue 3, pp 239-246

Brunton, C. (2003) 2002 National Taxi Users Survey Report. Prepared for the Department for Planning and Infrastructure, Government of Western Australia

BSD Consultants (1999) Review of the Western Australian Taxi Industry, report for the Department of Transport, Western Australia

Buchanan, C. (1963) *Traffic in Towns – A study of the long term problems in traffic in Urban areas*, HMSO 1963

Buchanan, N., Barnett, R., Kingham, S., and Johnston, D. (2006) The effect of urban growth on commuting patterns in Christchurch, New Zealand. In *Journal of Transport Geography* Volume 14, Issue 5 , pp342-354

Buckeye Institute (1996) *Taxicab Regulation in Ohio's Largest Cities. Policy Report.* The Buckeye Institute for Public Policy Solutions, Dayton, OH.

Burke-Johnson, R., and A.J. Onwuegbuzie (2004) Mixed methods research: a research paradigm whose time has come. In *Educational Researcher* Vol 33, No 7, pp 14-26

Cairns, R. D., and Liston-Heyes, C. (1996), 'Competition and regulation in the taxi industry', *Journal of Public Economics* 59:1-15, 1996

Camagni, R.I., Gibelli, M.C., and Rigamonti, P. (2002) Urban mobility and urban form: the social and environmental costs of different patterns of urban expansion: *Ecological Economics*, February 2002, vol. 40, no. 2, pp. 199-216

Carr, D. (1997) *Putting Customers First: Taxicab reform in the greater Toronto area.* Report for the Urban Renaissance Institute, March 1997

Cervero, R. (1992) Stimulating Transportation Alternatives in Response to Congestion Pricing, FHWA Congestion Pricing Symposium, Washington, D.C., 1992.

Cervero, R. and Radisch, C. (1996) Travel Choices in Pedestrian versus automobile oriented neighborhoods. In *Transport Policy*, Vol 3 No. 3. pp127-141

CfIT (2005) Commission for Integrated Transport, Final Report on World Cities.

CfIT London. Available at:

<http://www.cfit.gov.uk/docs/2005/worldcities/worldcities/pdf/worldcitiesfinalreport.pdf>

Chatterton, P. (2000) Will the real creative city please stand up? In *City*, Volume 4 Issue 3 pp 390-397

Choong-Ho Kang (1998) Taxi deregulation: international comparison. Institute for transport studies, University of Leeds 1998.

Church, A., Frost, M. and Sullivan, K. (2000), Transport and Social Exclusion in London, *Journal of Transport Policy*, Vol 7, No 3. pp 195 – 205.

Civic Trust (2006) First National Survey Evening and Night-time activities in England. Civic Trust, London

Clarke, J.M., and Hutton, B.J. (1991) The appraisal of community severance. Transport Research Laboratory Report 135, Crowthorne

Crew, M.A., Kleindorfer, P. (2002) Regulatory Economics: Twenty Years of Progress? *Journal of Regulatory Economics*, January 2002, vol. 21, no. 1, pp. 5-22

Coffman, R. B. (1977) The Economic Reasons for Price and Entry Regulations of Taxicabs. A Comment. *Journal of Transport Economics and Policy*, September 1977, Vol. 11, No. 3, Page 288.

Cole, S. (1986) et seq. Applied Transport Economics, Cogan Page, London

Commission for Taxi Regulation (2006), ROADMAP, towards a new national code of regulation for taxis, hackneys and limousines in Ireland. Commission for Taxi Regulation, Dublin

Contursi, V.M. (2002) An example of integrated Transport Policy at local level: the city of Genoa. Presentation given at the Sustainable Transport conference, Brussels, 13 June 2002. EU DGTREN

Cooper, J. (2002) Edinburgh Taxi Review: Technical Report. Prepared for the City of Edinburgh Council, April 2002

Cooper, J. (2003) Response to the Office of Fair Trading Report The Regulation of Licensed Taxi and PHV Services in the UK. Report to the Scottish Taxi Federation

Cooper, J. (2003a) Edinburgh taxi tariff review: Final Report. Completed for the City of Edinburgh Council.

Cooper, J. (2004) STAR Conference Paper, presented at PTRC Conference: Scottish Transport Applications in Research. Glasgow

Cooper, J. (2004a) Issues Paper, pertaining to taxi regulation in Northern Ireland. Prepared for the combined group of Belfast taxi proprietors Associations, August 2004, Belfast. Available at: <http://taxi-reg.home.att.net/prop.pdf>

Cooper J. (2005) Policy and Planning for City Centre Evening, Nighttime and Weekend Economies, Entertainment and Transport Needs. Report to the Department for Transport

Cooper, J. (2006) Taxi market regulation, industry employment and the identification of data toward informed policy decisions. Research completed for Scotecon, Jan 2006. Unpublished.

Cooper, J., Nelson, J. D., McKay, S., Molina, A. and McCleery, A. (2005b) Ground transportation, airports and external regulation conflict: a worldwide question. Paper for 84th Transportation Research Board Annual Meeting, USA, January.

Cooper, J. (2005c) Glasgow Taxi Supply. Glasgow Taxis. Report on the presence of SUD. August 2005

Cooper, J. (2006) West Dunbartonshire Taxi Study. Report completed for West Dunbartonshire Council, June 2006

Cooper, J. (2006a) Review of the components and structure applied to updating City of Glasgow taxi tariffs. Report for the city of Glasgow Council, August 2006.

Cordato, R. E. (1980). The Austrian Theory of Efficiency and the Role of Government. In the Journal of Libertarian Studies, Issue 4 No 4. pp: 393-403.

Costa, A. (1996), The organisation of Urban Public Transport Systems in Western European Metropolitan Areas, in Transport Research A, Vol 30, No. 5 pp349-359

Court of Session (2005), Opinion of the Court in the case of the Dundee Taxi cab company ltd. V. Dundee City Council and Dundee taxi association. Court of Session, extra division, inner house. Determination XA35/03 2005 CSIH30

Cowan, T. (1992) Public Goods and Market Failures, Transaction Publishers

Crandall, R. W. (2003) An End to Economic Regulation? Working Paper, The Brookings Institution. *Accepted for publication in Competition and Regulation in Utility Markets (Colin Robinson ed), Edward Elgar 2003*

Creel, M., and Farrell, M. (2001) Economies of scale in the US airline industry after deregulation: a Fourier series approximation. In Transportation Research Part E, Volume 37, Issue 5, pp321-336

Creswell, J. R. (1994) *Research design: qualitative and quantitative approaches*. Sage, Thousand Oaks CA

Crime Concern (2004) *Reduction of crime and fear of crime on and around public transport*. Presentation by Alison Mather, Crime Concern

Crime Reduction (2005) *Tackling Crime on Public Transport*. Taken from the government Crime reduction website: www.crimereduction.gov.uk

Croom, S., Romano, P., and Giannakis, M. (2000) *Supply chain management, an analytical framework for critical literature review*. In *European Journal of Purchasing and Supply*, Vol 6 pp 67 – 83

Daganzo, C.F., Laval, J., and Munoz, JC (2002) *Ten strategies for freeway congestion mitigation with advanced technologies*. California PATH Research Report UCB-ITS-PRR-2002-3

Darbera, R. (2005) *Technologie et regulation des taxis*. In *RTS Recherche Transport Securite*, Issue 87 pp 109-127

Daugherty, G.C., Alstrop, A.J., Balcombe, R.J., 1999. *A Comparative Assessment of Major Bus Priority Schemes in Great Britain*. TRL

Davison, L., and Knowles, R. (2005) *Bus quality partnerships, modal shift and traffic decongestion*. In *Journal of Transport Geography*, Vol 14, Issue 3, pp 177 - 194

Denzin, N and Lincoln, Y (2002) *Handbook of Qualitative Research*. New York, Sage

DePalma, A. and Rochat, D. (2000) *Mode choices for trips to work in Geneva: an empirical analysis*. In *Journal of Transport Geography*, Vol. 8 pp43-51

DeSalvo, J. S. (1996) *Income, Residential Location, and Mode Choice*. In *Journal of Urban Economics* Vol. 40, pp84-99

Dempsey, P. S. (1996) Taxi Industry regulation, deregulation and re-regulation: the paradox of market failure. In *Transportation Law Journal*, Vol 24 Issue 1 pp73-120

Djankov, S., La Porta, R., Lopez-de-Silanes, F., and Shleifer, A. (2002) The regulation of entry. In the *Quarterly Journal of Economics*, Vol CVXII, Issue 1, Feb 2002. Pp1 - 37

Dobbs, I.M., (2003) Inter-temporal price cap regulation under Uncertainty. Working paper, The Business School, University of Newcastle upon Tyne

Docherty, I., Shaw, J., and Gather, M. (2004) State intervention in contemporary transport. In *Journal of Transport Geography*, Volume 12, Issue 4, pp 257-264

Donaldson, R. (2006) Mass rapid rail development in South Africa's metropolitan core: Towards a new urban form? In *Land Use Policy* Volume 23, Issue 3 , pp 344-352

Douglas, G. W. (1972). "Price Regulation and Optimal Service Standards: The Taxicab Industry", *Journal of Transport Economics and Policy*, vol. 4, no. 2 pp. 116-127

Dundee (2003) Dundee Council, Taxi Liaison Group report. Depute Chief Executive, Dundee Council 2003

DCMS (2003) Department for Culture Media and Sport. Licensing Act 2003, Explanatory notes. Available at:
<http://www.opsi.gov.uk/ACTS/en2003/2003en17.htm>

DCMS (2005) Department for Culture, Media and Sport, Drinking Responsibly: The Government's Proposals. Consultation document. Joint publication of Department for Culture Media and Sport; Home Office, Office of the Deputy Prime Minister. January 2005

DETR (1998) Department of the Environment, Transport and the Regions, A New deal for Transport: Better for Everyone, The Government's White Paper on the Future of Transport, Cm 3950, The Stationery Office, London.

DfT (1997) Department for Transport, The Disability Discrimination Act 1995: The Government's proposals for taxis. Department for Transport, London

DfT (2002) Department for Transport, Get on Board: An Agenda for improving personal security Guidance, 22nd April 2002, DfT, London

DfT (2002a) Department for Transport, National Transport survey 1999 – 2001.

Available at:

<http://www.dft.gov.uk/pgr/statistics/datatablespublications/personal/mainresults/nts19992001/5otherfactorsaffectingtravel>

DfT (2003) Department for Transport, Protecting Bus and Coach Crews, A practical guide for bus and coach operators and staff, DfT, London, December 2003

DfT (2003a) Department for Transport, Safer Travel on Buses and Coaches Panel (STOP). Available at:

http://www.dft.gov.uk/stellent/groups/dft_localtrans/documents/page/dft_localtrans_023555.hcsp

DfT (2004a) Department for Transport, Accessibility Planning Guidance: Summary, 8 December 2004.

DfT (2004b) Department for Transport, Procedures for dealing with optimism bias in Transport Planning: Guidance Document, June 2004

DfT (2004c) Department for Transport, Links between bus-related crime and other crimes: Briefing Paper, Department for Transport, London 2004

DfT (2004d) Department for Transport, Registration of Flexible Local Bus Services and Related BSOG Regulations, Regulatory Impact Assessment

DfT (2004 e), Department for Transport, Tackling Crime on Public Transport

DfT (2004 f), Department for Transport, The Public Service Vehicles (Registration of Local Services) (Amendment) (England and Wales) Regulations 2004

DfT (2004g), Department for Transport, The Bus Service Operators Grant (Amendment) (England) Regulations 2004, DfT London

DfT (2005), Department for Transport, Taxis and Private Hire Vehicles – consultation on draft best practice guidance. DfT Consultation document. October 2005

DfT (2006), Department for Transport, Taxis and Private Hire Vehicles, Licensing: Best Practice Guide. DfT

DfT (2006a) Department for Transport, Transport Trends, 2006 Edition. Available at: http://www.dft.gov.uk/162259/162469/190425/Trends_2006_FINAL_v5.pdf

DfT (2006b) Department for Transport, Taxi Licensing: Review of Local Authority Quantity Control Policies, DfT

DOE (1995) Department of the Environment for Northern Ireland. Transportation in Northern Ireland, the way forward. DOE, Belfast.

DOE (2004) Department of the Environment for Northern Ireland, Review of Taxi Regulation in Northern Ireland. DOE, Belfast

DOE (2005) Department of the Environment for Northern Ireland, The regulation of Taxis and Private Hire Vehicles, proposals for public consultation. DOE, Belfast

DOE (2006) Department of the Environment for Northern Ireland, The regulation of taxis and private hire vehicles: consultation report and summary of responses

DOE (2007) Department of the Environment for Northern Ireland, Driver and Vehicle Testing Agency, Reintroduction of the taxi driving test and periodic training for taxi driving license holders. DVTA, Belfast, January 2007

DPTAC (2001) Disabled Passenger Transport Advisory Committee, Minutes of the Main Committee Meeting, 12/June/2001

DRD (2005) Department for Regional Development, An accessible transport strategy for Northern Ireland, DRD, Belfast April 2005

DVTA (2007) Driver and Vehicle Testing Agency, Reintroduction of the taxi driving test and periodic training for taxi driving license holders. DVTA / DOE 2007

Eckert, R. D. (1973) On the incentives of regulators: The case of Taxicabs. *Public Choice* Vol. XIV pp98-99

ECMT (2001) European Conference of Ministers of Transport, Economic Aspects of Taxi Accessibility. OECD Paris

Ehrlich, J. (1998) Public Convenience and Necessity Hearing Report for Taxicab Medallions to the Police Commission City and County of San Francisco. Available at: <http://taxi-reg.home.att.net/sf-pcn98.htm>

Ekelund, R.B. (1998) *The Foundations of Regulatory Economics* (International Library of Critical Writings in Economics. Edward Elgar.

Ellwood, C. A. (1933) *Methods in Sociology: A Critical Study*. Durham, NC: Duke University Press

Etheridge, Z. (2003), *The Licensing Act and Local Authorities: Knock-on effects*. IHPC, In House Policy Consultancy, Office of the Deputy Prime Minister, the Department for Transport and DCMS

Farrington, J. (2007) The new narrative of accessibility: its potential contribution to discourses in (transport) geography. In *Journal of Transport Geography*, Volume 15, Issues 5, pp 319 – 330

Farris, M. T. (1969) Transportation Regulation and Economic Efficiency. In the *American Economic Review*, Vol 59 No 2 pp 244 – 250

Fielding, C. (2005) Implementation of research-based UK regulations for public transport vehicles with particular reference to contrast in bus and rail vehicles. In *International Congress Science*, Vol. 1282 pp 1007- 1010

Flath, D. (2002), Taxicab regulation in Japan, Columbia University, unpublished

Frankena, M. and Pautler, P. (1984). An Economic Analysis of Taxicab Regulation. Staff Report of the Bureau of Economics of the Federal Trade Commission. Washington D.C. 1984

Gable, G. (1994) Integrating case study and survey methods: an example in information systems. In *European Journal of information systems*, Volume 3, No 2, pp112-126

Gaffron, P., Hine, J., and Mitchell, F. (2001), The role of transport in social exclusion in urban Scotland. Central Research Unit, Scottish Executive. At: www.scotland.gov.uk/cru/kd01/blue/rtseuc_00.htm

Gambetta, D. and Hamill, H. (2005) *Streetwise: how taxi drivers establish customer's trustworthiness*. Russell Sage 2005

Gannon, B. and Nolan, B. (2007) The impact of disability transitions on social inclusion. In *Social science and medicine* Volume 64, Issue 7 pp 1425 -1437

Gaunt, C. (1996), The impact of taxi deregulation on small urban areas: some New Zealand evidence. In *Transport Policy*, Vol 2 No. 4 pp257-262

Gelb, P. (1988) Taxi Regulation revision in Portland. In *Urban Mass Transportation Administration*. Sept 1980

Gilbert, G. and Samuels R.E. (1982) *The Taxicab: an urban transportation survivor*, University of North Carolina Press

Gilbert, G. (1992), How to make regulation work. *Presentation to the International Conference on Taxi Regulation*, Montreal

Giuliano, G. (1992) An assessment of the political acceptability of congestion pricing. In *Transportation*, Volume 19, Issue 4, pp335-358

Glaister, S. (1991) UK bus deregulation: the reasons and the experience. In: *Investigaciones Economicas* Vol 15, Issue 2, pp285-308

Goetz, A.R. (2002) Deregulation, competition, and antitrust implications in the US airline industry. *Journal of Transport Geography*, Volume 10, Issue 1, pp1-19

Goodwin, P., Hallett, S., Kenny, F., and Stokes G., (1991), *Transport: the new realism*. Report to the Rees Jeffreys Road Fund. Transport Studies Unit, University of Oxford.

Grant-Muller, S. (2000) *Assessing the impact of local transport policy instruments*. University of Leeds, ITS working paper no 549, April 2000

Granville, S., and Campbell-Jack, D. (2005), *Anti-social Behaviour on Buses*, Scottish Executive, Social Research Unit, Research Findings Report 196/2005

Grubb, W.N. (1982) The flight to the suburbs of population and employment 1960 – 1970. In *Journal of Urban Economics*, Volume 11, Issue 3, pp348-367

Hackner J. and Nyberg, S. (1995), *Deregulating Taxi Services: A Word of Caution*. *Journal of Transport Economics and Policy*, May 1995, Vol. 29, No. 2, Page 195.

- Hadfield, P., Lister, S., Hobbs, D., and Winlow, S. (2001) The '24-hour city': condition critical. In *Town and Country Planning* 70 pp300-302
- Haider, M. (2002), *Travel Plans: Mobility Management, the Nottingham Experience*, presentation given at the Sustainable Transport conference, Brussels, 13 June 2002.
EU DGTREN
- Halcrow Group (2002) *Dundee Taxi Study 2002*, report prepared for Dundee City Council
- Han, S. (2003), Dynamic traffic modelling and dynamic stochastic user equilibrium assignment for general road networks. In *Transportation Research B*, Vol 37, No. 3, pp225-249
- Handy, S. (2003) *Amenity and Severance*. In the *Handbook of Transport and the Environment*, Elsevier. Pp117 - 140
- Handy, S.L., and Niemeier, D.A., 1997. Measuring accessibility: an exploration of issues and alternatives. *Environment and Planning A* 29, 1175–1194.
- Hart, C. J. (1998) *Doing a literature review, releasing the Social Science Research*. Sage, Thousand Oaks, CA
- Heath, T. (1997) The twenty-four hour city concept – a review of initiatives in British cities, In *Journal of Urban Design*, Number 2, pp193-204
- Hensher, D.A., and Puckett, S. M. (2007) *Congestion and variable user charging as effective travel demand management instrument*. *Transportation Research Part A* (In Press)
- Hillier, B. (2005), *Can Streets be made safe?*, Bartlett School of Graduate Studies
- Hillman, J., and Braeutigam, R.R. (1989). *Price Level Regulation for Diversified Public Utilities: an Assessment*. Kluwer.

Hine, J., and Russel, J. (1993) Traffic barriers and pedestrian crossing behavior. In Journal of Transport Geography. Volume 1, Issue 4 pp230-239

Home Office (2004) Violence in the night-time economy: key findings from the research. Report by Andrea Finney, Findings 214/04, Home Office, London

Home Office (2004) Crime and Disorder Reduction Strategies 2005-2008, negotiating crime and disorder reduction targets and guidance for crime and disorder reduction / community safety partnerships, Home Office, London

House of Commons Transport Committee (2006) How fair are the fares? Train fares and ticketing: government response to the committee's sixth report of the session 2005-06. Thirteenth special report of session 2005-06. House of Commons, London, 11th October 2006

House of Commons Environmental Audit Committee (2005), Reducing Carbon Emissions from Transport. Ninth Report of Session 2005-06, House of Commons Library, London

HM Government (1635) Hackney Carriage Act

HM Government (1831) Hackney Carriage Act

HM Government (1847) Town Police Clauses Act

HM Government (1921) Railways Act

HM Government (1924) London Traffic Act

HM Government (1933) London Passenger Transport Act

HM Government (1934) London Cab Order

HM Government (1947) Transport Act

HM Government (1976) Local Government (Miscellaneous Provisions) Act

HM Government (1982) Civic Government (Scotland) Act

HM Government (1985) Transport Act

HM Government (1993) Railways Act

HM Government (1995) Disability Discrimination Act

HM Government (1995a) Road Traffic Order (Northern Ireland)

HM Government (1996) Education Act

HM Government (1996a) Motor Vehicle Testing (Amendment) Regulations
(Northern Ireland)

HM Government (1998) Crime and Disorder Act

HM Government (2001) Transport Scotland Act

HM Government (2002) Care of Substances Hazardous to Health Regulations SI 2002
No. 2677

HM Government (2003) Licensing Act

HM Government (2005) The Regulatory Reform (Public Service Vehicles) Order

HM Government (2005a) Disability Discrimination Act

HM Government (2006) The Local Government (Boundaries) (Northern Ireland)
Order 2006

HM Government (2007) Draft Taxis (Northern Ireland) Order 2007

HM Treasury (2003) The Green Book: Appraisal and Evaluation in Central Government

HM Treasury (2005) Managing Risks to the Public: appraisal guidance, June 2005

Holt, D.W.E., and Paradise, J. (2000) Sub-contracting in the New York taxi industry. Report to the National Employment Law Project. Available at:
<http://www.nelp.org/docUploads/holt.pdf>

Hu, S. and Saleh, W. (2005) Impacts of congestion charging on shopping trips in Edinburgh. Transport Policy, Volume 12, Issue 5. Pp 443-450

Huisman, T. and Boucherie, R (2001), Running times on railway sections with heterogenous train traffic. In Transportation Research B, Vol 35, No. 3, pp271-292

Ison, S., and Rye, T. (2003) Lessons from travel planning and road user charging for policy making, in Transport Policy 10, pp 223-233

Industry Commission (1994) Urban Transport, Volume 1 Report, No 37, Commonwealth of Australia

Jacobs Consultancy (2005) Survey of Taxi Provision in the City of Edinburgh, Final Report. Prepared for the City of Edinburgh Council, July 2005

James, L. (1980) The Law of the Railway. Barry Rose Publishers, London.

Jepson, D., and Ferreira, L. (1999) Assessing travel time impacts of measures to enhance bus operations. In Road and Transport Research, Dec 1999

Johnson, R. B. and L. A. Turner (2003) Data collection strategies in mixed methods research. In Tahakkori and Teddlie (eds) Handbook of mixed research methods in social and behavioural research, pp 297-319 Sage, Thousand Oaks, CA.

Kennedy, D. (1997) Regulating access to the railway network. In Utilities Policy, Volume 6, Issue 1, March 1997, Pages 57-65

Krol, R., and Svorny, S. (1994) Regulation and Economic Performance: Lessons from the States. *The Kato Journal*, Vol 14, No.1

Krizek, K. A. (2005) Household Lifestyles and Their Relationship to Land-Use and Transportation Planning. Cura Reporter Series, University of Minnesota, Minneapolis

Krozner, R. (2001) The motivations behind banking reform. In Regulation, Summer 2001, pp 36-41

Laitila, T., Marell, A., and Westin, K. (1995) A note on the short-term effects of deregulation of the Swedish taxicab industry. *Journal of Transport Economics and Policy*, 24, pp 209-214.

Lam, W. H. K., Chung-Yu Cheung and C. F. Lam (1999) A study of crowding effects at the Hong Kong light rail stations. In Transportation Research Part A, Policy and Practice, Volume 33, Issue, pp 401-415

Leisy, C. (2001), Taxicab regulation in Seattle, Lessons Learned, Document produced for the City of Seattle

Lephardt, G.P and Bast, J.L. (1985) The economics of taxicab deregulation. Heartland Policy Study, No. 3 March 11th 1985, The Heartland Institute, Chicago.

Lewis, C., McQuade, J., and Thomas, C. (2005) Measuring physical access barriers to services: 'Snapshot' research in 4 town/city centres in Britain. In International Congress Series, Volume 1282, pp 1034 -1037

Liman, T. (2006) London Congestion Charging, implications for other cities, Victoria Transport Policy Institute, January 2006

Lipsey, R. (1993) Economics. Harper Collins

Llewelyn-Davies (2004), With Professor David Bannister and Professor Sir Peter Hall, Bartlett School of Planning, University College London, Transport and City Competitiveness, A literature Review. Completed for the ODPM January 2004.

Lok Sang Ho (1993) An optimal regulatory Framework for the Taxicab Industry, Unpublished. Centre for Environmental Studies, Chinese University of Hong Kong

Lowe, D. (2002) The dictionary of Transport and Logistics, Kogan Page, p116

Lucas, K. (2006) Providing transport for social inclusion within a framework for environmental justice in the UK. In Transportation Research Part A, Volume 40, Issue 10 pp 801 – 809

McKinnon, A. C. (1996) Privatisation and Regulation of Road Freight Transport. Report to the European Conference of Ministers of transport ECMT/CEMT, Paris, 5th September 1996

McQuaid, R., Greig, M., Smyth, A., and Cooper, J. (2004) The importance of transport in business location decisions. Report to the Department for Transport, January 2004. Available at:
http://www.dft.gov.uk/162259/163944/The_Importance_of_Transport1.pdf

McQuaid, R., and Grieco, M. (2006) Edinburgh and the politics of congestion charging: Negotiating road user charging with affected publics. In Transport Policy, Volume 12, Issue 5, September 2005, pp 475-476

McNeill, D., and While, A. (2001) The new urban economies, in Handbook of Urban Studies, R Paddison (Editor), Sage, London pp 296-307

McDonagh, J. (2006) Transport policy instruments and transport-related social exclusion in rural Republic of Ireland. In *Journal of Transport Geography*, Volume 14, Issue 5, pp 355-366

Manganese Bronze (2003) Press Release: Launch of Zingo – mobile phone taxi Hailing service. 8th January 2003

Mageean J.F., Nelson J.D. (2003) The Evaluation of Demand Responsive Transport Services in Europe *Journal of Transport Geography* Vol. 11 Issue 4 pp255-270

Marell, A., and Westin, K. (2001), The effects of taxicab deregulation in rural areas of Sweden. In *Journal of Transport Geography*, No 10, pp135-144

Maunder, D.A.C., and Mbara, T.C. (1996) Liberalisation of urban public transport services: what are the implications. In *Indian Journal of Transport Management*, Volume 20, Issue 2 pp 16-23

MIT (2002) Massachusetts Institute of Technology, Urban Transportation, Land Use, and the Environment. Available at: <http://ocw.mit.edu/OcwWeb/Urban-Studies-and-Planning/11-943JUrban-Transportation--Land-Use--and-the-EnvironmentSpring2002/CourseHome/>

Michaud, V. (1998) *Coopération Taxi Transport Public, Mode d'emploi, Guide Pratique 1998*, FNAT, GART, UTP, Paris, May 1998

Millward, R. (2006) The British privatization programme, a long term perspective. Milan European Economy Workshops. Working paper 2006-07, Università degli studi di Milano

Mitchell, R.K., Agle, B.R., and Wood, D.J. (1997) Toward a Theory of Stakeholder Identification and Salience: Defining the Principle of Who and What Really Counts. In *The Academy of Management Review*, Vol. 22, No. 4, pp. 853-886

Montgomery, J. (2004) Born to Binge?, in Town and Country Planning, 3/1/2004

Myllyla, S., and Kuvaja, K. (2005), Societal premises for sustainable development in large southern cities. In Global Environmental Change, No 15., pp 224-237

MVA (1999) Edinburgh Taxi Tariff Review, report completed for City of Edinburgh Council, MVA consultants.

Nagel, T. (1986) The view from nowhere. Oxford University Press.

New Jersey (2007) New Jersey FIT: Future In Transportation, Case Studies: Evidence of Progress. Available at: <http://www.nj.gov/transportation/works/njfit/case/>

New Zealand (2005) Office of the Auditor General, Effectiveness of controls over the taxi industry. Report dated June 2005

Niskanen, W. A.(2002) A Retrospective, *Regulation* Summer 2002 pp4-5

NTA (1992) National Transportation Agency Review Commission, Competition in Transportation: Policy and Legislation in Review, Ottawa, Canada

ODPM (2005) Office of the Deputy Prime Minister, How to manage town centres. Cleaner Safer Greener communities series. ODPM London

ODPM (2002) Living Places, Cleaner Safer Greener

ODPM (2005) How to manage Town Centres, Cleaner Safer Greener Communities series

ODPM (2005a) Office of the Deputy Prime Minister, Together tackling anti-social behaviour: managing the nighttime economy. Cleaner Safer Greener communities series. ODPM London

ODPM (2005b) Planning Policy Statement 6 (PPS6) Planning for Town Centres

ODPM (2005c) Planning Policy Statement 1 (PPS1) Delivering Sustainable Development

ODPM / Home Office (2005) Cleaner Safer Greener: Managing the Nighttime Economy

OECD (2001) Organization for Economic Cooperation and Development, Glossary of Statistical Terms, June 2002. Available at:

<http://stats.oecd.org/glossary/detail.asp?ID=4047>

OECD / ECMT (2005) Organization for Economic Cooperation and Development / European Conference of Ministers of Transport, (De-)Regulation of the taxi industry. Conclusions of round Table 133, Paris 14-15 April 2005.

OECD (2004) Organization for Economic Cooperation and Development / European Conference of Ministers of Transport, Economic Aspects of Taxi Accessibility. OECD, Paris

OFT (2002) Office of Fair Trading, Investigation in to UK taxi services. Issues Paper. OFT London, 21st August 2002

OFT (2003), Office of Fair Trading, The regulation of Licensed Taxi and PHV services in the UK. Report No.676

Ogus, A. (2002) Comparing Regulatory Systems: Institutions, Processes and Legal Forms in Industrialised Countries, University of Manchester Working Paper Series No 35, December 2002

ORR (2005) Office of the Rail Regulator, Structure of Costs and Charges Review – Environmental Costs of Rail Transport. August 2005

Orr, D. (1969) The Taxicab problem, a proposed solution. In the Journal of Political Economy, Volume 77 Issue 1, pp141-147

- Otuzar, J. and Willumsen, L.G. (2004) *Modelling Transport*, Third Edition. John Wiley, Chichester.
- Oxley, P. R. (1999) Review of taxi accessibility regulations effects of compliance. Cranfield Centre for Logistics and Transport, Feb 1999
- Oxley, P. R., and Richards, M. J. (1995) A review of the personal costs of disability in relation to transport. In *Transport Policy*. Volume 2, Issue 1 pp 57 - 65
- Pagano, A. M., and McKnight, C. E. (1983), Economies of Scale in the Taxicab Industry. Some Empirical Evidence from the United States. *Journal of Transport Economics and Policy*. September 1983, Vol. 17, No. 3, Page 299.
- PBS (2005) Taxi History. Available at:
<http://www.pbs.org/wnet/taxidreams/history/index.html>
- Peltzman, S. (1976) Toward a More General Theory of Regulation. In *Journal of Law and Economics* 19 pp 211-40.
- Perretts (2005) Transport Survey Response 2005. Internal report, Perretts Coach Service, Quirindi
- Peterson, B. (1995) Demand Responsive Public Transport. In *Public Transport International*, Volume 44, Issue 1 pp 6 - 10
- Poole, F. (1998) House of Commons Research Paper, Private Hire Vehicles (London), Paper 98/14, House of Commons Library, 20th January 1998
- Pooley, C.G., and Turnbull, J. (2005) Coping with congestion: responses to urban traffic problems in British cities c.1920–1960. In *Journal of Historical Geography* Volume 31, Issue 1 , pp78-93

Posner, R. A. (1974). "Theories of economic regulation," *Bell Journal of Economics and Management Science*, 5, pp. 335-58.

Preston, J. and Raje, F. (2006) Accessibility, mobility and transport-related social exclusion. *Journal of Transport Geography*. In Press.

Price Waterhouse (1993) Analysis of taxicab de-regulation. Consultants report to the Taxicab, Limousine and Paratransit Association

Raux, C. and Odile (2002), How can road tolls serve urban policy, in *Recherche Transports Securite*, No. 75, pp115-130

Redfearn, C. L. (2007) The topography of metropolitan employment: identifying centers of employment in a polycentric urban area. In *Journal of Urban Economics*, No 61, pp 519-541

Revill, G. (2001), An Historical Geography of railways in Britain and Ireland & Railways and the Victorian imagination. In *Journal of Historical Geography*, April 2001, Vol 27, No. 2 pp291 – 293

Roberts, M. (2004) Good Practice in Managing the Evening and Late Night Economy: A literature Review from an Environmental point of view. Report to ODPM, September 2004

Roberts, M. (2006) From 'creative city' to 'no-go areas' – The expansion of the nighttime economy in British town and city centres. In *Cities*, Vol.23, Issue 5 pp331-338

Roberts, M. and Turner, C. (2005) Conflicts of liveability in the 24-hour city: learning from 48 hours in the life of London's Soho. In *Journal of Urban Design*, Volume 10, Issue 2 pp 171-193

Romilly, P. (1999) Substitution of bus for car travel in urban Britain: an economic evaluation of bus and car exhaust emission and other costs: *Transportation Research Part D: Transport and Environment*, March 1999, vol. 4, no. 2, pp. 109-125

Rosenbloom, S. (1978) Case studies of taxicab regulation in the United States. In *Transportation Research Board Special Report No. 181* pp97-101

Rothbard, M. (2004) *Man, Economy, and State: A Treatise on Economic Principles*. Ludwig von Mises Institute, second edition

Rufolo, A. (1998) Low-Cost Solutions to Portland's Traffic Problems: Congestion Pricing and Free-Market Transit, *Policy Insight* 105 May 1998 pp 4 -21

Sayer, A. (2000) Are taxi services ready to become a real part of the public transport chain? In *Local Transport Today*, 26th October 2000

Scottish Executive (2005), *Review of the Licensing of Taxi and Private Hire Car Booking Offices*, Consultation Paper, Scottish Executive, Edinburgh. June 2005

Scottish Executive (2005a) *Scotland's Transport Future: Guidance on Local Transport Strategies*, February 2005, Scottish Executive, Edinburgh

Scottish Executive (2005b) *Scottish Household Survey Analytical Topic Report: Mode Choice*. Completed by L. Barker and D. Connolly for the Scottish Executive Social Research Unit.

Scottish Executive (2006) *Review of demand responsive transport in Scotland*. Completed by the Derek Halden Consultancy for Scottish Executive Social Research

Schaller, B. (1993) *The New York City for hire vehicle fact book*. New York City taxi and limousine commission

Schaller, B., and Gilbert, G. (1995) Factors of production in a regulated industry: New York taxi drivers and the price for better service. In *Transportation Quarterly*, Volume 48 Issue 4

Schaller, B. (1998) Issues of fare policy: case of the New York taxi industry, in *Transportation Research Record* No. 1618

Schaller, B., and Gilbert, G. (1996) Villain or Bogeyman? New York's Taxi Medallion System. *Transportation Quarterly*, Vol 50, No 1.

Schaller, B. (2006) The New York City taxicab factbook. Schaller Consulting, New York. March 2006

Schaller, B. (2007) Entry controls in Taxi regulation, regulatory policy implications of U.S. and Canadian Experiences. Schaller Consulting, New York

Shaw, L. C., Gilbert, G., Bishop, C., and Pruitt, E. (1983), Taxicab regulation in U.S. Cities, Volume 2, Case Studies, US DOT, National Transportation Library

Shaw, J., Charlton, C., and Gibb, R. (1998) The competitive spirit re-awakens the ghost of railway monopoly, in *Transport Policy*, Volume 5, Issue 1, January 1998, Pages 37-49

Shaw Trust (1999) Ability at work. Disability Discrimination Act: Your obligation as an employer. Available at: <http://www.shaw-trust.org.uk/page/6/92/>

Sheriff Court (1998) Coyle v City of Glasgow. SLT 453

Shreiber, C. (1975) The Economic Reasons for Price and Entry Regulations of Taxicabs, *Journal of Transport Economics and Policy*, 21, pp 37-56

Shreiber, C (1977) A Rejoinder. *Journal of Transport Economics and Policy*, September 1977, Vol. 11, No. 3, pp298-304.

Sims, D., Hesselborn, O, and Ng, H (1998) Winnipeg international airport ground transportation management system. Transport Canada

Sinha, K.C. (2003) Sustainability and Urban Public Transportation. In Journal of Transportation Engineering. Volume 129 Issue 4, pp331-341

Slotterback, B. (2004) Transportation Survey Part 1, Minesotta Daily, Minneapolis, MN

Small, K. A. (2001) Urban Transportation Economics. Harwood fundamentals of pure and applied economics series. Routledge

Snortum, J.R. (1990) Drinking-driving compliance in Great Britain: the role of the law as a threat and as a moral eye opener. In Journal of Criminal Justice, Volume 18, Issue 6 pp 479-499

South Ayrshire (2006) Development, safety and fleet management regulation. Policy, guidelines and code of conduct applicable to the licensing, operation and testing of taxis and private hire vehicles. Set out as draft policy, Ayr, August 2006.

Spencer, A. H., and Andong, W. (1996), Light Rail or Busway? A comparative evaluation for a corridor in Beijing. In *Journal of Transport Geography*, Vol 4. No. 4, Dec 1996, pp239-251

Stagecoach (2005) Yellow Taxibus, a new cost-effective model for demand responsive transport. Stagecoach Group

Stalians, G. (1988) Regulatory Revision and the taxicab industry: what we have learned. Paper presented to the 50th Annual Convention of the New Zealand Taxi Proprietors' Federation. Auckland, 30th Aug 1988

Stenning, P. (1996) Fare Game Fare Cop, Victimization of and policing by taxi drivers in three Canadian cities. Technical Report for the Canadian Department of Justice. Canada. Available at: <http://taxi-world.home.att.net/faregame.pdf>

Stigler, G. J. (1971) The Theory for Economic Regulation. *The Bell Journal of Economics and Management Science* Vol 2 pp 3-21

Suzuki, P. T. (1985) Vernacular cabs: Jitneys and gypsies in five cities. In *Transportation Research Part A: General*, Volume 19, Issue 4, July 1985, pp 337-347

Tallon, A., and Bromley R.D.F. (2004), Exploring the attractions of city centre living: evidence and policy implications in British cities. In *Geoforum*, No 35, pp 771-787

Teal, R. (1992) An overview of the American experience with taxi deregulation. Presentation to the International Conference on Taxi Regulation, Montreal

Teal, R., and Berglund, M. (1987), 'The Impacts of Taxicab Deregulation in the USA', *Journal of Transport Economics and Policy*, pp37-56

TfL (2001) Transport for London, The Greater London (Central Zone) Congestion Charging Order

TfL (2002) Transport for London, Report to the Mayor of London: The Greater London (Central Zone) Congestion Charging Order 2001, TfL, London

TfL (2003) Transport for London, Taxi Ranks at Major Interchanges. Best Practice Guidance, TfL, March 2003

Transport Canada (2004) Case Studies in Sustainable Transportation, Case Study 6 - Taxibus: public transportation for smaller cities. Rimouski, Quebec. Transport Canada, Ottawa, July 2004.

Thomas, C. J. and Bromley, R. D. F. (2000) City Centre Revitalisation: Problems of fragmentation and fear in the evening and nighttime economy. In *Urban Studies*, Vol 37 No. 8 pp 1403 – 1429

Tiwari, G. (2005) A multi-city analysis of the taxicab industry's regulatory structure and market models in the United States. Paper submitted to the MTC Fall Student Conference. Centre for Transportation Studies, University of Missouri-St Louis

Toner, J., and Mackie, P., The Economics of Taxicab Regulation: A Welfare Assessment. Paper presented at 6th World Conference on Transport Research, Lyon, 1992

Toner, J.P. (1992) Regulation in the taxi industry. Working paper No. 381, Institute for Transport Studies, Leeds.

Toner, J. (1998) A review of regulation in the taxi industry. Report to the University of Leeds

Toronto Taxi Task Force (1998) Review of the Toronto Taxi Industry, City of Toronto, Canada

TPI (2004) Transport Planning International, Aberdeen City Council Taxi Demand Study. Report to Aberdeen City Council Legal and Democratic Service (Licensing) December 2004

Turnbull, P. (1999) Regulation, de-regulation or re-regulation of transport? Paper presented to the Symposium on the Social and Labour Consequences of Technological Developments, Deregulation and Privatization of Transport, International Labour Office, Geneva 1999

Tretheway, M. W., and Waters, W. G. (1991) US Railroad productivity after Staggers. Proceedings of the 33rd Annual Meeting of the Transportation Research Forum 6, pp 119-130

TRL (2001) Monitoring the effects of accessibility regulations. Report by TRL for the Department for Transport.

TRL (2006) Urban Safety Management Project. Study 106, TRL Crowthorne

Vanderveen, G. (2006) Interpreting fear, crime, risk and unsafety. BJU Legal Publishers, Den Haag.

Vivoda, J.M., Eby, D., St Louis, R.M., and Kostyniuk, L.P. (2007) A direct observation study of nighttime safetybelt use in Indiana. In *Journal of Safety Research*, Volume 38, Issue 4, pp 423-429

Webster, F., and Cobbe, B. (1966) Traffic signals. Road Research Technical Paper No 56. London.

White, P. (2002) Public transport: its planning, management and operation, Routledge

Williams, D. J. (1980), The Economic Reasons for Price and Entry Regulation of Taxicabs. A Comment. *Journal of Transport Economics and Policy* January 1980, Vol. 14, No. 1, Page 105.

Williams, D. J. (1981), Labour Costs and Taxi Supply in Melbourne. *Journal of Transport Economics and Policy*. May 1981, Vol. 15, No. 2, Page 179.

Wixey, S., Titheridge, H., Jones, P., and Christodolou, G. (2007) Measuring accessibility as experienced by young people. Presentation to Destinations conference, University of Minnesota, 24.08.07

Yin, R. K. (1984) Case study research, design and methods. Sage, Thousand Oaks, CA.

Appendix 1. Metropolitan Conditions of Fitness (Abridged)

METROPOLITAN POLICE SERVICE

**CONSTRUCTION AND LICENSING OF
MOTOR CABS IN LONDON
CONDITIONS OF FITNESS**

(with amendments to August 1997)

PART 1

**PROCEDURE TO BE FOLLOWED BY MANUFACTURERS AND OWNERS OF MOTOR
CABS FOR USE IN LONDON**

1 New types of motor cab (1) Before constructing any new type of motor cab, manufacturers are advised to study the Conditions of Fitness set out in Part 2 of this booklet and to send to the Chief Inspecting Officer, Public Carriage Office, 15 Penton Street, N1 9PU, dimensioned drawings or blueprints, together with detailed specifications of the proposed vehicle, for advice as to its general suitability for public service in London. It is also advisable to arrange for a preliminary inspection of the vehicle either with or without the body.

(2) In any case, application for the approval of a cab chassis or body must be made in writing to the Public Carriage Office, and must be accompanied by dimensioned drawings or blueprints, together with detailed specifications and any particulars required by the Chief Inspecting Officer.

(3) Arrangements must then be made to present the completed chassis, body or vehicle for inspection at the Public Carriage Office. When presented, every facility must be given for the inspection and testing of the vehicle, and a declaration by the manufacturer or other authorised person that the vehicle conforms to the law and is safe for use as a public carriage must be produced, together with a certificate of registration.

(4) Any proposed alterations to the original specification must be submitted to the Public Carriage Office for approval.

2 Cabs of approved types - Cabs of an approved type offered for licensing for the first time must be presented for inspection, by appointment, at the Public Carriage Office. If the vehicle conforms to the approved type, a Certificate of Approval will be issued by the Licensing Authority.

3 Presentation for renewal of licence (1) Before a cab licence can be renewed, the vehicle must be presented at the Public Carriage Office with the Certificate of Approval issued at the initial inspection. If any alterations have been carried out since the last inspection, a

statement giving full details of the alterations must be submitted and an appointment must be made for the vehicle to be specially inspected.

(2) Every cab which is in service from 1st January 2000 must be equipped to approved standards in order that wheelchair passengers may be carried.

4 General (1) It must be understood that, although the conditions set out in this booklet have been complied with, approval will be withheld if the Assistant Commissioner is of the opinion that a vehicle is unsuitable for public use. (2) Although the Assistant Commissioner may extend his approval of any particular type of cab to all other cabs conforming to the design of that type, it must be understood that he may withdraw such general approval if, in his opinion, any unsuitable features arise.

PART 2

CONDITIONS OF FITNESS

N.B.: The following requirements apply to all vehicles licensed in London, including those which have been modified after first registration.

5 General construction (1) Every new type of cab must comply in all respects with the requirements of The Motor Vehicle (Type Approval) Regulations 1980 and The Motor Vehicle (Type Approval) Regulations (Great Britain) 1984, and in use must comply with The Road Vehicles (Construction and Use) Regulations 1986 (C&U). These regulations are amended from time to time and from the 1st January 1993 cover the requirements for EC Whole Vehicle Type Approval (ECWVTA).

(2) Cabs offered for type approval must be so constructed as to facilitate the carriage of disabled persons and be capable of accommodating a disabled person in a wheelchair in the passenger compartment, provided the wheelchair fits within the dimensions specified in paragraph 16.

(3) No fittings, other than those approved, may be attached to or carried on the inside or outside of the vehicle.

6 Steering (1) The steering wheel must be on the offside of the vehicle.

(2) The steering mechanism must comply with the requirements of C&U Regulation 29.

7 Turning circle (1) The vehicle must be capable of being turned on either lock so as to proceed in the opposite direction without reversing between two vertical parallel planes not more than 8.535 metres apart.

(2) The wheel turning circle kerb to kerb on either lock must be not less than 7.62 metres in diameter.

N.B.: These requirements are essential to ensure the manoeuvrability necessary for a cab in London, e.g. where ranks may be sited in the centre of the road, at hotels and other restricted sites and where passengers hail the cab from the opposite side of the roadway.

8 Tyres (1) All tyres must comply with the requirements of C & U Regulation 24-27, and be marked "TAXI". Retread tyres must also comply with the British Standards Institution

requirement BS.AU144C.

(2) All tyres must have an effective circumference not less than the size marked on the taximeter and will undergo rolling circumference tests to determine their compatibility.

9 Brakes All braking systems must comply with the requirements of C & U Regulation 15-18.

10 Interior lighting Adequate lighting must be provided for the driver and passengers. Separate lighting controls for both passenger and driver must be provided. In the case of the passenger compartment, an illuminated control switch must be fitted in an approved position. Lighting must also be provided at floor level to each passenger door and be actuated by the opening of the doors.

11 Electrical equipment Any additional electrical installation to the original equipment must be adequately insulated and be protected by suitable fuses.

12 Fire appliances An appliance for extinguishing fire must be carried in such a position as to be readily available for use and such appliances must be independently certified that they are manufactured to meet the requirements of BS EN3 1996 and have a minimum fire rating of 5a and 34b.

Any Public Carriage Office approved appliance which meets BS 5423 1997 may continue to be carried until its expiry date has elapsed.

13 Fuel Systems A device must be provided whereby the supply of fuel to the engine may be immediately cut off. Its situation together with the means of operation and "off" position must be clearly marked on the outside of the vehicle. In the case of an engine powered by LPG or petrol, the device must be visible and readily accessible at all times from outside the vehicle.

14 Exhaust systems All exhaust systems must comply with the requirements of C & U Regulation 54.

15 Body The body must be of the fixed head type with a partially glazed partition separating the passenger from the driver.

The overall width of the vehicle exclusive of driving mirrors must not exceed 1.755 metres.

The overall length must not exceed 4.575 metres.

N.B.: These overall dimensions are essential for determining the size of taxi ranks, other pick-up points and for the free access and flow for other vehicles in London's congested streets.

16 Facilities for the disabled (1) Every cab which is in service from 1st January 2000 must be equipped to approved standards in order that wheelchair passengers may be carried.

(2) Approved anchorages must be provided for the wheelchair and chairbound disabled person. These anchorages must be either chassis or floor linked and capable of withstanding approved dynamic or static tests. Restraints for wheelchair and occupant must be independent of each other. Anchorages must also be provided for the safe stowage of a wheelchair when not in use, whether folded or otherwise, if carried within the passenger compartment. All anchorages and restraints must be so designed that they do not cause any danger to other passengers.

(3) The door and doorway must be so constructed as to permit an unrestricted opening

across the doorway of at least 75cm. The minimum angle of the door when opened must be 90 degrees.

(4) The clear height of the doorway must be not less than 120cm.

(5) Grab handles must be placed at door entrances to assist the elderly and disabled.

(6) The top of the tread for any entrance must be at floor level of the passenger compartment and must not exceed 38cm above ground level when the vehicle is unladen. The outer edge of the floor at each entrance must be fitted with non-slip treads.

(7) The vertical distance between the highest part of the floor and the roof in the passenger compartment must be not less than 1.3 metres.

(8) Where seats are placed facing each other, there must be a minimum space of 42.5cm between any part of the front of a seat and any part of any other seat which faces it, provided adequate foot room is maintained at floor level. Where all seats are placed facing to the front of the vehicle, there must be clear space of at least 66cm in front of every part of each seat squab.

(9) A ramp or ramps for the loading of a wheelchair and occupant must be available at all times for use at the nearside rear passenger door. An adequate locating device must be fitted to ensure that the ramp/ramps do not slip or tilt when in use. Provision must be made for the ramps to be stowed safely when not in use.

17 Passenger capacity (1) The occasional seats must be at least 40cm in width and the minimum distance from the back of the upholstery to the front edge of the seat must be 35.5cm.

(2) The occasional seats must be so arranged as to rise automatically when not in use. They must be symmetrically placed and at least 4cm apart. When not in use, front seats must not obstruct doorways.

(3) The rear seat dimensions must be adequate to carry two or three adult passengers comfortably in vehicles licensed to carry four or five passengers respectively.

(4) Suitable means must be provided to assist persons to rise from the rear seat with particular attention to the needs of the elderly and disabled.

18 Driver's compartment (1) The driver's compartment must be so designed that the driver has adequate room, can easily reach and quickly operate the controls and give hand signals on the offside of the vehicle.

(2) The controls must be so placed as to allow reasonable access to the driver's seat and, when centrally placed, must be properly protected from contact with luggage.

(3) A serviceable device for demisting the windscreen must be fitted.

(4) Every vehicle must be provided with an approved means of communication between the passenger and the driver. When a sliding window is fitted on the glazed partition, the maximum width of the opening must not exceed 11.5cm.

19 Windows (1) Windows must be provided at the sides and at the rear.

(2) Passenger door windows must be capable of being opened easily by passengers when seated. The control for opening a door window must be clearly identified to prevent being mistaken for any other control.

20 Heating and ventilation An adequate heating and ventilation system must be provided for the driver and passengers and means provided for independent control by the driver and passengers.

21 Door fittings An approved type of automatic door locking device must be fitted to passenger doors. When the vehicle is stationary, the passenger doors must be capable of being readily opened from the inside and outside of the vehicle by one operation of the latch mechanism. The interior door handle must be clearly identified to prevent being mistaken for any other control.

22 Fare Table and number plate A frame must be provided for the fare Table and interior number plate and affixed in an approved position. The words "The number of this cab is..." are to be shown above the position of the plate.

23 Floor covering The flooring of the passenger compartment must be covered with a non-slip material which can easily be cleaned.

24 Luggage Provision must be made for the carrying of luggage.

25 Taximeter A taximeter of an approved type must be fitted in an approved position.

26 "Taxi" sign A "Taxi" sign of an approved pattern, clearly visible both by day and night when the cab is available for hire, must be fitted.

27 Radio apparatus (1) Where apparatus for the operation of a two-way radio system is fitted to a cab, no part of the apparatus may be fixed in the passenger compartment or in the rear boot compartment if LPG tanks or equipment are situated therein.

(2) Any other radio equipment, either in the passenger or driver compartment, must be approved.

28 Maintenance Vehicles, including all fittings, advertisements, etc., must be maintained to approved standards. The vehicles should always be kept clean and in good working order. Vehicles will at all times be subjected to test and inspection and should it be found that a vehicle is not being properly maintained or kept in good working order, a notice will be served on the owner prohibiting him/her from using the vehicle until the defect has been rectified.

29 Certificate of Insurance and form of holder A current certificate of insurance as required by any Acts or Regulations relating to motor vehicles must be carried in a holder securely affixed to the cab in an approved position. The certificate must also state that the policy complies with the requirements of the London Cab Order, 1934.

PART 3 – DIRECTIONS

30 ADVERTISEMENTS

(1) Suitable advertisements may be allowed on the exterior or interior of the cab subject to the approval of the Assistant Commissioner.

(2) **Exterior Advertising** Advertising on the exterior of the cab can be either full livery i.e. use of the complete exterior body shell, except the boot lid, as the advertising medium; or the

lower panels of the front doors only.

(3) **Interior Advertising** Advertisements may only be displayed within the passenger compartment on the base of the occasional seats and along the bulkhead above the passenger/driver partition.

Occasional seat advertisements must be encapsulated in clear non-flammable plastic and bulkhead advertisements must be manufactured in an approved material. (see para. 30(4)). A bulkhead advertisement may incorporate a dispenser for leaflets directly related to it.

No material may be placed on the passenger driver partition other than notices which may be approved from time to time. (see para. 30(6)).

(4) Advertisements must be of a form that does not become easily soiled or detached.

(5) All materials used in the manufacture of, and for the purpose of affixing, advertisements to the cab must be approved (see note (ii) on page 1).

(6) Applications for approval of advertisements must be made in writing to the Assistant Commissioner of Police, Public Carriage Office, 15 Penton Street, London N1 9PU.

(7) Further information and guidance on advertising matters can be obtained from the Cab Advertising Approval Committee at the Public Carriage Office.

31 Badges/Emblems (1) In addition to advertisements displayed in accordance with paragraph 30 above, the official badge or emblem of a motoring organisation which provides genuine round the clock emergency vehicle and recovery services on a London-wide basis may be affixed to the radiator grille. Only one such badge or emblem may be so displayed.

(2) No advertisement, badge or emblem, including the stick-on type, is to be exhibited other than is provided for in the directions contained in this paragraph or paragraph 30.

Appendix 2. Fare Table Layout, example from Edinburgh

THE CITY OF EDINBURGH COUNCIL
FARE TABLE FOR TAXIS

(OPERATIVE FROM 28th May 2006)

FOR UP TO 2 PASSENGERS

TARIFF 1 Monday - Friday 6am – 6pm	TARIFF 2 Monday – Friday 6pm – 6am the following day And at weekends from 6am on Saturday – 6am Monday
TARIFF 3 Monday - Friday 6am – 6pm during Christmas and New Year	TARIFF 4 Monday – Friday 6pm – 6am the following day And at weekends from 6am on Saturday – 6am Monday during Christmas and New Year
CHRISTMAS AND NEW YEAR Between 6pm on 24 December until 6am on 27 December and between 6pm on 31 December until 6am on 3 January	

CHARGES	TARIFF 1	TARIFF 2	TARIFF 3	TARIFF 4
<ul style="list-style-type: none"> • Initial hire not exceeding 450m • Initial 90 seconds of waiting time • Combination of initial time and distance 	£1.50	£2.50	£2.50	£3.40
<ul style="list-style-type: none"> • Each additional 225m up until 2250m and thereafter each additional 260m • Each additional 45 seconds of waiting time • Combination of additional time and distance 	£0.25	£0.25	£0.35	£0.40

EXTRA PAYMENTS

When more than 2 passengers	Each	£0.20
Note: Only 2 children under 12 years will be reckoned as one passenger. No extra fare will be charged for one child under 6 years of age.		
Each Passenger must be properly seated		
Call Out Charge Applicable when pre-booked, or hired from Edinburgh Airport	£0.60	Cleaning Fee Applicable when taxi is soiled (by travel sickness)
Cancellation Fee Applicable when taxi is pre-booked but not used	£2.00	Payment Of Fare By Credit/Debit Card Extra applicable when fare paid by the above means
Administrative Charges Applicable in some cases when a taxi is supplied under a contract with a radio booking office.		5.0 %

- NOTES**
- (1) The above Tariff is applicable only within the City of Edinburgh.
 - (2) Any hire which terminates outside the City of Edinburgh area – FARE MUST BE NEGOTIATED AND AGREED WITH DRIVER BEFORE THE JOURNEY COMMENCES.
 - (3) A copy of the Licensing Conditions for Taxis, Private Hire Cars, Taxi Drivers and Private Hire Car Drivers may be inspected either at the Taxi Examination Centre, 33 Murrayburn Road, or the Licensing Section Public Counter, 343 High Street, Edinburgh (also at www.edinburgh.gov.uk/licensing).

APPROVED by THE CITY OF EDINBURGH COUNCIL on 30th MARCH 2006

Any hirer aggrieved at the level of the fare charged for any hire or for any other reason may discuss the matter with the Taxi Licensing Officer (0131 629 4250). Any complaint must be made in writing and addressed to the Complaints Officer, Licensing Section, The City of Edinburgh Council, 343 High Street, Edinburgh EH1 1PW, and should include the vehicle's licence number and time and date of the incident.

Appendix 3 Interactions in the Nighttime economy

<i>Area of Interaction</i>	<i>Issues: General / Generic</i>	<i>Issues: Specific / Local</i>	<i>Local Initiatives</i>
<u>Interactions including urban design, control and access to Night Time Economy</u>			
Urban Structure	The design and layout of the city can contribute to the extent of its use, the avoidance or the encouragement of conflict.	Physical design impacts at point of access, ease of movement Road Design and Layout affects the suitability of access points, parking and public transport use Designs for Safety, sight line and lighting affect the perception and performance of risk	At grade access to vehicles Night time pedestrianisation Lighting schemes
Monocentric, polycentric and district economies	The impact of differing locations for activities will impact on the use of the city. In larger cities districts or specific streets may become synonymous with particular activities (Theatreland etc.). Suburban centres may also play a role in the use of the city, the development of a central economy having an impact on suburban development and vice versa. Polycentric patterns may also emerge on a day and night split, where facilities used at night differ in location, and require differing design and infrastructure to the daytime city.	The infrastructure required to facilitate day and night time activities, their location and support. Differences in transport needs and other infrastructure in suburban as opposed to urban activities	The emergence of café culture need not be specific to a central location. However, a majority of activity is concentrated on the city centre (Belfast, Glasgow). At such points where travel home may be easier using public transport and taxis rather than using private cars. City periphery and rural communities may differ. Large out of town activities (including raves) differ and are almost exclusively based on private transport.
Cluster of facilities	Clusters of facilities occur in two primary fields, a cluster of associated interests, where differing but associated businesses locate in proximity, for example where hot food stands locate near to public houses or transport facilities, to attract trade as customers move from one activity to the next; and activity clusters, where groups of the same trade locate in proximity, for example an area known for restaurants, or for pubs and clubs.	A series of differing views exist specific to the desirability or otherwise of clusters occurring. Distinct activity areas or districts have a level of popularity, particularly in terms of public use of 'Theatreland' 'Chinatown' etc. Such clusters limit revelry to particular areas, and may allow for boundary policing to promote an effective sanitary barrier. Wider concerns exist in terms of the potential for conflict being higher at clusters, drunken people congregating in larger numbers giving rise to inter-personal violence. A particular issue is raised in terms of clusters around (limited) transport facilities, such as taxi ranks, and this particularly at times of high demand and limited supply.	Districts are more common in larger cities where demand merits supply of multiple activities. Examples of good practice exist (Manchester: Chinatown; London: Leicester Square), where effective policing exists within the district. Conflict, particularly drunken behaviour, is significant in late night queues for taxis. Taxi Marshals (Manchester, London) may reduce the potential for conflict. Bus Marshals (policing) may also discourage such activities in bus transport (Belfast).

<i>Area of Interaction</i>	<i>Issues: General / Generic</i>	<i>Issues: Specific / Local</i>	<i>Local Initiatives</i>
Sector Development	<p>Changes in the extent and reach of retail sectors can impact on the structure and use of the urban environment. Particular sectors, such as retail banking, have declined, and this has led to a closure of 'traditional' community based bank branches. Other instances include a merging of places of religion and sale of surplus real estate. Pubs and Clubs have sought to establish in vacant city centre premises, former banking and retail facilities, and have tended to encourage involvement from a younger drinking public. Older established local pubs with an older audience have not grown to the extent of younger drinking establishments, giving the impression of a predominance of a youth and young persons drinking culture.</p>	<p>Planning laws require consideration of the impacts of developments including licensed premises on the surrounding communities. However, development of new retail activities tends to be seen as positive where alternatives may include economic decline and closure of high street facilities.</p>	
Selling of fast foods	<p>The sale of food to a late night audience is considered to have particular issues that would not arise in the daytime city.</p>	<p>The licensing and control of vendors is more sporadic than in day. Food outlets can be seen as sources of unwanted noise, litter and pollution, and may act to encourage congregation of noisy and unruly crowds. However, where properly provided, late night food outlets can provide a diversion from violent activities.</p>	<p>Environmental Health and local authority licensing clamp down on illegal and unsafe premises.</p>
Time specific peaks in demand	<p>Use of city centre night time activities peak with weekend use being higher than during the week. Friday and Saturday nights are typified by a significant peak in the demand for entertainment and transport home. In some instances the supply of transport, suited and appropriate for most times of the week is unable to meet the extent of weekend demand, resulting in significant queues for taxis.</p>	<p>Some additional peaking may occur on Thursday nights particularly in proximity to student populations.</p>	<p>Predominantly transport initiatives in getting home safely campaigns.</p>

Area of Interaction	Issues: General / Generic	Issues: Specific / Local	Local Initiatives
<u>Interactions including Transport and the Night Time Economy</u>			
Access to car and non car use	<p>Night time access and travel home is less inclined to the use of private transport than in the daytime city. Previous (successful) anti drink-driving campaigns have largely encouraged the use of collective and public transport in journeys that include consumption of alcohol.</p> <p>Differing markets and location specific issues arise in the range of modes and use of private transport.</p>	<p>Distinct and time based differences are observable in the night time economy.</p> <ol style="list-style-type: none"> 1) Early evening activity, cinema and restaurant, similar modal split to daytime city. Good availability of public transport, low likelihood of heavy drinking. 2) Mid evening activity, restaurant, some early drinkers returning home, theatre and cinema departures, Limited availability of last bus and last train, including metro and subway. Higher tendency to drink taken, peaking to catch last train. Individual car use still high from theatre and cinema. 3) Late evening activity, heavy drinking predominant, returning from pub, lower rates of individual car use, some use of last trains and night buses where available, but mainly taxi based and collective or prearranged group transport. First peak at taxi stances, higher waiting times for taxis. 4) Late night travel, exclusively heavy drinking, and partygoers. Very low rates of private car use, except for workers returning home. Second peak at taxi stances. High waiting times for taxis, some dissipation with commencement of early shift taxi drivers and daytime bus services. Some conflict between last journeys home and first workers journeys. 	<p>Progressive and mainly successful campaigns discouraging drink driving.</p> <p>Emergence of evening quality bus services.</p> <p>Later trains and later daytime bus services, including concept of extending tube and subway operating hours.</p> <p>Safe Home, safer streets and think twice campaigns encourage use of registered vehicles.</p> <p>Licensed taxi campaigns</p> <p>Local initiatives by publicans to ensure avoidance of drunk drivers.</p>
Commercial Provision of services	<p>Provision of public transport services based on commercial operation (Transport Act 1985), with the provision for support where felt appropriate / affordable by Local Authorities.</p> <p>The DfT were noted to have only a limited role in the delivery of services, this limited to best practice guidelines.</p>	<p>Conflict may arise in the use of scarce resources in the provision of transport services between the desire to support non-commercial bus services outside of city centres, and the desire to promote appropriate transport services in the night time economy. Additional costs may accrue in the operation of night time bus services, specific to the costs of providing additional security measures, also the case in the instance of taxi stances, and in higher staff wage rates.</p>	<p>Involvement of the licensed trade in supporting (cost of) night time bus services (Belfast)</p> <p>Licensed trade and voluntary groups supporting in the policing of night transport facilities.</p>

<i>Area of Interaction</i>	<i>Issues: General / Generic</i>	<i>Issues: Specific / Local</i>	<i>Local Initiatives</i>
Public transport frequency, reduced and night services, and the availability of taxis	<p>Bus and Rail public transport services operate at a reduced frequency, if at all, during night time hours, reflecting the commercial pressures on the service providers to ensure a profitable operation. The reverse is true of taxi supply, in circumstances where night time demand offers a high level of opportunity. Never-the-less, supply of taxis late at night and at weekend nights, often falls below the extent of demand, witnessed by long queues and high waiting times at taxi stances.</p> <p>The issue of excessive demand for taxis results from two elements, the existence of dual-market, where hackney (public hire) taxis co-exist with private hire (minicabs). Public hire vehicles being permitted to pick up on street. Secondly, many urban areas regulate absolute numbers of vehicles licensed for operation, based on the determination of the presence or otherwise of significant unmet demand over the city at all time frames.</p>	<p>Regulation and licensing of taxi services can include:</p> <ol style="list-style-type: none"> 1) Quantity control, limit placed on the numbers of licences issued to operate mainly Hackney vehicles in a Licensing Authority Area 2) Quality Controls, vehicle types, including compliance with European, UK and Metropolitan Conditions of Fitness, local standards, and accessibility requirements 3) The operation of a dual system of public and private hire restricts absolute numbers of vehicles able to pick up at taxi stances <p>Also considered an issue in specific circumstances, the illegal operation of unlicensed, incorrectly licensed or vehicles licensed by a neighbouring authority.</p> <p>Illegal ranking of private hire vehicles</p>	<p>Local agreement for specified pick up points, such as city centre taxi offices, allowing for public and private hire operation.</p> <p>Licensed premises agreement to allow for private hire pick up</p> <p>Accommodation of additional night time stances and pick ups in locations specific to night time only use.</p>
Provision of adequate security to those travelling	<p>The perception of vulnerability is seen by many respondents as a negative factor in promoting public transport use at night. This included more elements of the journey than just the vehicle itself. Fear of travel appeared to affect some user groups more than others and this was particularly noted in reference to the elderly and lone females.</p> <p>The provision of security did, however, raise a number of conflicts in itself, particularly in that the security environment may become sterile or even oppressing in its own right, reducing the propensity to travel.</p>	<ol style="list-style-type: none"> 1) The access within the city centre to the mode of transport, particularly the walk to a bus stop. This was considered a heightened issue in the instance of disabled passengers. 2) The waiting environment at and around the point of boarding. Waiting areas were felt to be more threatening than the vehicle itself. Additional concerns are raised in a lack of certainty specific to vehicle arrival times and reliability. Post-deregulation (TA 1985) bus services were felt to be most susceptible to a lack of information, or inaccurate information. 3) The presence of appropriate security measures on vehicles, proactive measures including staff (one respondent noted a difference between the numbers of staff and the authority of the staff members present), panic alarm button and intercom (rail) points; active and monitored CCTV; passive measures including the use of recording CCTV, and warning notices. 4) Security environment at alighting point 	<p>Many initiatives based on the use of CCTV, including the Glasgow Streetwatch project, a joint initiative between city and police force, with active monitoring and direct link to police force personnel.</p> <p>Better design at bus and taxi stances is limited to issues of lighting and CCTV observation. Other initiatives include the development of Taxi Marshal schemes (London), and increased on the street 'in your face' police measures (Glasgow)</p> <p>CCTV seen as a more common solution than increased personnel involvement. In some instances the staff are advised to avoid involvement.</p> <p>Some questions raised specific to the use of warning posters, and the effect of these in working to increase a perception of the likelihood of attack.</p>

<i>Area of Interaction</i>	<i>Issues: General / Generic</i>	<i>Issues: Specific / Local</i>	<i>Local Initiatives</i>
Lack of appropriate transport	A lack of appropriate transport also resulted in a series of impacts within the night time economy. These reflected the effective role of transport in the avoidance or reduction of opportunity for conflict and affray.	Lack of appropriate transport promoted the use of illegal vehicles, mainly pirate taxis. The suggestion was made that a black market in taxi services is indicative in a insufficient number of legal taxis, although this measure is not typically included in the measurement of Significant Unmet Demand. Lack of appropriate vehicles also referred to an absence of vehicles appropriate to particular user groups, including low floor and DDA compliant vehicles. A lack of vehicles or unreliability in their supply also reduces the effective attractiveness and trust in a mode. Violent behaviour and interpersonal affray was observed to occur in accessing (limited) taxis	Wider interpretation of the issues in the supply of transport services (Glasgow seeking to adopt a Holistic approach)
Staffing of Transport	An emphasis was placed on the role of staff in the reassurance and reduction in conflict throughout the night time economy. Equally, lack of staff, even where transport is provided, worked to increase the fear for personal safety of intending passengers.	A range of influences were identified, including: 1) Reassurance of authority figure present in vehicle, at station or other boarding point, on the perceptions of the public 2) The ability (or otherwise) of a member of staff to intervene and control a situation, or to seek backup 3) The influence of official staff at taxi stances in improving perception of safety to drivers and (Glasgow) increasing level of supply at night time The absolute number of staff was considered as important (BTP) as the role played.	Safer Stations Campaign Nightline bus staff and supporting policing (Belfast) Taxi Marshals (London, Manchester)
Drink Driving	The success of previous campaigns was noted in the reduction of drink driving. Driving where alcohol or drugs taken represented a small part of the night time economy. Nevertheless, the issue would remain as an ongoing requirement to enforce and reinforce.	The issue of drink driving increases in run up to Christmas, and in certain periods of the Summer, associated with attendance at private parties. Rural communities and in suburban and urban periphery more likely to suffer from drunk driving than urban centres.	Government, DOE and police campaigns to reinforce and enforce
Mobility Inclusion, transport mode, accessibility	Mobility inclusion is a central element of the DfT range of policies specific to improving access to the full community. Many issues are addressed specific to the day time city, with many of the same issues in the transport needs of night time travellers, although there are few explicit references to differing approaches appropriate to the night time economy.	Reduce the occurrence of suppressed or avoided journeys that are prevented on the basis of lack of appropriate transport, or issues in the supply of existing modes. Improve access to Jobs, Health Care, Learning and food shopping	Application of DDA to transport vehicles (currently excluding taxis)

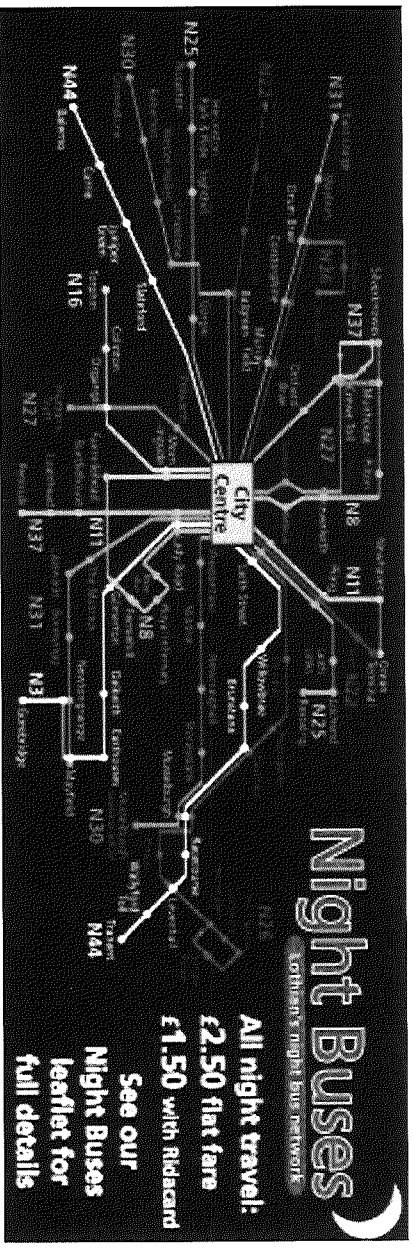
Area of Interaction	Issues: General / Generic	Issues: Specific / Local	Local Initiatives
<u>Interactions specific to Individuals / Groups and the Night Time Economy</u>			
Exclusion	<p>The late night city represents an environment specific to or favourable toward specific groups, in the main youth and young adult activities, social and drinking cultures predominantly used by 18 – 24 year old age range. Larger cities and earlier evening activities attract a wider audience, and in the case of theatre entertainment, the age range can be significant.</p> <p>Exclusion can occur on a voluntary basis, individuals or groups of people avoiding accessing a market felt not be appropriate to their age etc. Exclusion can also occur where facilities, transport vehicles or infrastructure represent a barrier to movement and inclusion.</p>	<p>Avoidance on the basis of age group may reflect a change in cultural focus or a reduction in the provision of particular activities. Licensed premises may seek to move to a different audience, or the increasing numbers of younger establishments effectively reduce the perception of inclusive facilities.</p> <p>Avoidance or inability to participate also arise as a result of inappropriate vehicles being provided in the night time economy, a lack of trust in the provision or safety in using transport facilities, or a fear of the potential for conflict to arise.</p>	Initiatives affecting exclusion are considered below.
Gender	<p>The role of gender in the interactions of the NTE is borne out in documented evidence suggesting a majority of assailants (85% - Scottish Executive Research) are male, and that the majority of victims of assault are also male.</p> <p>The involvement of males protagonists is further complicated by a desire among younger men to establish posture (see age related factors), and the related self esteem.</p> <p>Female participants, particularly lone females report a heightened perception of fear of attack.</p>	Highly publicised incidences of attacks on females by illegal taxi drivers have acted to increase fears in use of taxis.	<p>Initiatives involved at reducing fear of crime having a positive effect on female participants, including the use of panic alarms and city based help points.</p> <p>Safer Streets campaign in Belfast includes the issuance of 'Personal Identification Numbers' to taxi North and West Belfast taxi drivers and their passengers to reduce illegal taxi pick up.</p>
Elderly	The elderly report the highest (Scotland) fear of attack in the night time economy, but equally have the lowest reported rate of incidence. Few are involved in late night activities in city centre.	Localised issues exist in the interaction between other groups travelling home from entertainment and elderly residents in central, centre periphery and suburban locations. Issues of noise and attack to property are reported in some instances, and include 'fads' – crimes involving specific anti social behaviour including removal of vehicle wing mirrors.	
Ethnic Groups	Cultural barriers exist in relation to transport, including a reticence in travelling with males, access to information regarding the operation of services, and the languages in which information is presented. Other issues include parental and peer group pressure in setting expectations		

<i>Area of Interaction</i>	<i>Issues: General / Generic</i>	<i>Issues: Specific / Local</i>	<i>Local Initiatives</i>
Disabled People	<p>Access to transport vehicles and the access to boarding and alighting points form a barrier to the inclusion of disabled people.</p> <p>The Disability Discrimination Acts (DDA) 1995, and 2005, address the desire for equitable access, but the definitions and interpretation of reasonable accommodation may lead to differences on the ground.</p>	<p>The requirement to provide DDA compliant vehicles includes a test of the reasonableness of so doing. In the night time city issues of personal safety of the driver of DDA compliant vehicles may preclude the operation of access ramps, effectively precluding wheelchair users from that vehicle.</p> <p>Taxi services, where disability access standards apply only to a limited proportion of the fleet, will not always be able to offer appropriate vehicle to passenger need.</p> <p>Some respondents also reported instances where taxis do not stop where a disabled passenger is seeking transport. The same applies to taxis avoiding a member of the public hailing them where disputes are occurring, or even in the instance of feeling uncertain of a potential passenger's behaviour.</p> <p>Addressing individual modes may also avoid addressing interfaces between modes, or the pedestrian element of a journey</p>	DOE NI, propose addressing need for disabled taxi transport on a pro-rata basis
Young people	<p>Particularly young male 'posture'</p> <p>A majority of alcohol related violence (PSNI) related to 18-24 year old age group</p>		Homesafe campaign
<u>Interaction between Licensing and the Night Time Economy</u>			
Opening Hours	<p>Licensing for night time activities applies predominantly to the issuance and control of liquor licenses, and in a different context to the control and licensing of taxis.</p> <p>The control of licensed opening hours is raised in a number of responses as specific to the interaction, particularly the time of leaving licensed establishments to return home.</p>	<p>Preset closing times currently in force in licensed premises have resulted in the peaking of demand for transport to coincide with the closure of licensed establishments. Closing times differ in the devolved countries of the United Kingdom, but the same pattern is visible of peaks of demand for transport following closing time of pubs, and a later peak coinciding with the closing times of clubs and dancing establishments.</p> <p>Highly spiked peaks in the demand for transport home, most often for taxi services, has resulted in instances of significant delay, congregating of those seeking to get home at taxi stances in most metropolitan cities.</p>	The Licensing Act (2003), sets out changes in the requirements for opening times in England, and with regional application and devolved bills effecting similar changes.

<i>Area of Interaction</i>	<i>Issues: General / Generic</i>	<i>Issues: Specific / Local</i>	<i>Local Initiatives</i>
Involvement of Licensees	Participation of publicans and pub groups in the delivery of solutions to negative interaction is prompted as the most effective method of addressing some late night issues.	<p>The application of drinking and food promotions by publicans and pub chains in an effort to attract custom has been cited as providing mixed messages, or encouraging excessive drinking.</p> <p>Dispersal is seen as an issue in which publicans may be able to play a role, including a desire to establish dispersal policies.</p> <p>The role of door supervisors in the enforcement of appropriate behaviour in and in the immediate vicinity of licensed premises.</p> <p>The development of pub watch and similar information sharing schemes</p> <p>Establishing links to police and enforcement agencies</p>	<p>Application of bottle banks for empty drinks bottles and glasses located and enforced at the exit from licensed premises.</p> <p>Compulsory licensing and training for door staff.</p> <p>Pubwatch: Manchester, Cardiff etc.</p> <p>Streetwatch: Glasgow</p>
<u>Interactions arising from differences in Administrative and authority boundaries</u>			
Communication between authorities	<p>Issues arise in the communication and interactions between differing administrative and authorities in the design, licensing, enforcement and policing of the night time economy. Most administrative interactions have developed over time, and function well.</p> <p>Some instances noted in the interface between authority responsibilities, and physical / spatial boundaries.</p>	<p>Transport authorities differ, as do the administrative units charged with their control. National and GB wide administration applies to the railway industry, while bus and DRT transport is administered at a county and UA level. Taxis re licensed at a district or city level.</p> <ol style="list-style-type: none"> 1) Taxi control is based on a significantly lower spatial scale to many local transport authorities, and has effectively developed as a separate mode of transport 2) Where city authorities represent smaller geographic areas than their conurbation, neighbouring licensing areas may conflict, both in the licensing of premises, and in the licensing of taxi services. (Glasgow) 3) Policing and enforcement authorities have traditionally established good inter-working relationships, including between the (GB) British Transport Police, and the Home Office controlled local forces. Some issues arise in the relationship between private security agencies, door supervisors and the authority / interface with the police. 	NI Department run

<i>Area of Interaction</i>	<i>Issues: General / Generic</i>	<i>Issues: Specific / Local</i>	<i>Local Initiatives</i>
Communication with Central Government departments	Most central government departments are charged with developing and applying appropriate policies and setting frameworks in which regional and local applications are possible and optimal. The relationship between the policy making and application authority is significant in the observation of issues arising in policy application. The relationship between the department and the end consumer is also significant.	<p>Policies are applied either as statutory instruments or as Best Practice guidance.</p> <p>Better Regulation task force sets out the development of policies and methods by which companies are able to address issues seen as affecting their operation.</p> <p>Regulatory Impact Assessment allows for consideration of impacts prior to a policy being applied.</p>	
Communication with other Whitehall departments	Between Whitehall Between Whitehall and devolved executives	How to only applies to England	ODPM Together campaign brought cross departmental input including HO, ASB
Level of decision making	District / City / County Interactions between UK policy and EU directive	Barriers to trade as outlined in article 30 of the treaty of rome	

Appendix 4. Map of Edinburgh Night Bus Routes



Appendix 5. Calculations used in Glasgow Tariff application

Table A1:

Distance based calculation, Table 19, 2005 tariff with 5% increase applied, scenarios 1 - 5

	¼ Mile cost	½ Mile cost	1 Mile cost	2 Mile cost
Base Cost (2005 rate)	2.00	2.00	2.40	3.80
Scenario 1	2.10	2.10	2.73	4.21
Scenario 2	2.00	2.00	2.80	4.20
Scenario 3	1.59	2.01	2.64	3.90
Scenario 4	1.51	1.91	2.51	3.71
Scenario 5	1.72	2.05	2.72	4.07
Scenario 5a	1.92	2.15	2.92	4.27

Table A2:

Impacts of scenarios 1,2 and 5 on fare levels over time

Applying a 5% increase pa to the cost of a 1 mile journey

\Year Scenario	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
S1	£2.40	£2.73	£2.87	£3.01	£3.16	£3.31
S2	£2.40	£2.80	£2.80	£3.00	£3.00	£3.00
S5	£2.40	£2.72	£2.86	£3.00	£3.15	£3.31

Table A3:

Calculation by distance / cost over time, scenarios 1,2 and 5

Applying a 5% increase pa

\Scenario 1 Yards	Year 1	Year 2	Year 3	Year 4	Year 5
1 – 940	£2.10	£2.05	£2.32	£2.44	£2.56
941 – 1216	£2.31	£2.43	£2.55	£2.68	£2.81
1217 – 1491	£2.51	£2.65	£2.78	£2.92	£3.06
1492 – 1766	£2.73	£2.87	£3.01	£3.16	£3.31
1760yds (1 MI)	£2.73	£2.87	£3.01	£3.16	£3.31

\Scenario 2 Cost	Year 1 Yards purchased	Year 2	Year 3	Year 4	Year 5
£2.00	1- 895	1 – 850	1 – 807	1 – 767	1 – 729
£2.20	896 – 1158	851 – 1099	808 – 1044	768 – 992	730 – 943
£2.40	1159 – 1420	1100 – 1348	1045 – 1281	993 – 1217	944 – 1157
£2.60	1421 – 1682	1349 – 1597	1282 – 1518	1218 – 1442	1158 – 1371
£2.80	1683 – 1944	1598 – 1846	1519 – 1755	1443 – 1667	1372 – 1585
£3.00			1756 – 1992	1668 – 1892	1585 – 1799
1760yds (1 MI)	£2.80	£2.80	£3.00	£3.00	£3.00

\ Scenario	Year 1	Year 2	Year 3	Year 4	Year 5
5 Yards					
500	£1.76	£1.85	£1.94	£2.04	£2.14
750	£1.95	£2.05	£2.15	£2.26	£2.38
1000	£2.14	£2.25	£2.36	£2.48	£2.61
1250	£2.33	£2.45	£2.57	£2.70	£2.84
1500	£2.52	£2.65	£2.78	£2.92	£3.07
1760Yds (1 MI)	£2.72	£2.86	£3.00	£3.15	£3.31

Table A4:
Comparison of income Scenarios 1, 2 and 5 by distance in year 1

Year 1 charges for Yards	Scenario 1	Scenario 2	Scenario 5
500	£2.10	£2.00	£1.76
750	£2.10	£2.00	£1.95
1000	£2.31	£2.20	£2.14
1250	£2.51	£2.40	£2.33
1500	£2.73	£2.60	£2.52
1760Yds (1 MI)	£2.73	£2.80	£2.72

Scenario 1: Increased Costs only

¼ Mile Cost:

Flag Drop =	2.10	Includes <= 940 yards
Distance charge =	0	0 yards
Total Cost =	2.10	

½ Mile Cost:

Flag Drop =	2.10
Distance charge =	0
Total Cost =	2.10

1 Mile Cost:

Flag Drop =	2.10	
Distance Charge =	.63	1760 Yards – Inclusive distance = 820 Yards (Dist charge * Rounded Upper Integer of 820 / 275)
Total Cost =	2.73	

2 Mile Cost:

Flag Drop =	2.10	
Distance Charge =	2.11	3520 Yards – Inclusive distance = 2580 Yards
Total Cost =	4.21	

Scenario 2: Reduced Distance / Time only

¼ Mile Cost:

Flag Drop =	2.00	Includes <= 895 yards
Distance charge =	0	0 yards
Total Cost =	2.00	

½ Mile Cost:

Flag Drop =	2.00
Distance charge =	0
Total Cost =	2.00

1 Mile Cost:
Flag Drop = 2.00
Distance Charge = .80
Total Cost = 2.80
1760 Yards – Inclusive distance = 865 Yards
(Dist charge * Rounded Upper Integer of 865 / 262)

2 Mile Cost:
Flag Drop = 2.00
Distance Charge = 2.20
Total Cost = 4.20
3520 Yards – Inclusive distance = 2655 Yards

Scenario 3: Increased cost / Removal of distance included in flag drop

¼ Mile Cost:
Flag Drop = 1.38
Distance charge = .21
Total Cost = 1.59
Base Flag Drop (2.00 + 5% = 2.10) – Actual cost of inclusive
Distance (940 yards * 0.0763 pence)
440 yards

½ Mile Cost:
Flag Drop = 1.38
Distance charge = .63
Total Cost = 2.01
880 Yards

1 Mile Cost:
Flag Drop = 1.38
Distance Charge = 1.26
Total Cost = 2.64
1760 Yards

2 Mile Cost:
Flag Drop = 1.38
Distance Charge = 2.52
Total Cost = 3.90
3520 Yards

Scenario 4: Reduced Distance / Removal of distance included in flag drop

¼ Mile Cost:
Flag Drop = 1.31
Distance charge = .20
Total Cost = 1.51
Base Flag Drop – Inclusive Distance (2.00/2.10 * 940 yd)
(895 yards * 0.0766)
440 yards / 262 yard unit

½ Mile Cost:
Flag Drop = 1.31
Distance charge = .60
Total Cost = 1.91
880 Yards

1 Mile Cost:
Flag Drop = 1.31
Distance Charge = 1.20
Total Cost = 2.51
1760 Yards

2 Mile Cost:
Flag Drop = 1.31
Distance Charge = 2.40
Total Cost = 3.71
3520 Yards

Scenario 5a: Increased cost / Removal of distance included in flag drop / Calculation by actual yards

¼ Mile Cost:		
Flag Drop =	1.58	Base Flag Drop (2.00 + 5% = 2.10) – Actual cost of
	inclusive	Distance (940 yards * 0.0763 pence)+1 additional
		unit in transitional year
Distance charge =	.34	440 yards @ 0.0763 pence / yard
Total Cost =	1.92	
½ Mile Cost:		
Flag Drop =	1.58	
Distance charge =	.67	880 Yards
Total Cost =	2.25	
1 Mile Cost:		
Flag Drop =	1.58	
Distance Charge =	1.34	1760 Yards
Total Cost =	2.92	
2 Mile Cost:		
Flag Drop =	1.58	
Distance Charge =	2.69	3520 Yards
Total Cost =	4.27	

Annex 6: Cost model components and updates: Glasgow Case Study

The development, in Glasgow, of a new cost model structure is based on the calculation of costs across a range of indicators, described in detail in this section.

A6.1 Vehicle Purchase price and depreciation

Vehicle price and depreciation are a common element in the construction of existing cost models. Table A6.1 illustrates the vehicle cost element applied in Glasgow in the period 2004 – 2005. Vehicle purchase costs for the city are currently based on the retail costs of LTI vehicles (TXII), and these did not change over the period identified.

TXII Purchase, Year x	TXII purchase, year y	% change in cost	Cost in pence per mile, year x	Cost in pence per mile, year y
28995	28995	0	18.01	18.01

Source: Author

The price changes identified for period year x to year y (2005 – 2006) were zero, the same vehicle was available to purchase at the same cost as 1 year previous. Consequently no additional cost was being occurred, in the standard modelling approach, in the purchase costs of a vehicle. Alternative approaches include consideration of Alternative Vehicles (AV), and alternatives to the measurement of vehicle age and lifespan. The impacts of identifying costs in a mixed fleet are detailed in terms of the London model (TfL 2005), which concludes that consideration of alternative vehicles is appropriate, and that measurements should be determined against basic specification vehicles, more luxurious models being optional and not key to the operation of a vehicle as a taxi. Table A6.2 indicates the effects of incorporating differing vehicle types into the Glasgow cost model. Two options are tested, scenario 1 providing a base line for a single vehicle type, scenario 2 testing the impact of including E7 vehicles in the Glasgow cost model.

	Purchase price, year x	Purchase price, year y	% change	Indicative cost per mile
Scenario 1: TXII	28995	28995	0	18.01
Scenario 2: Mixed TXII	28995	28995	0	
E7	21915	21915	0	18.01

Data sources: John Patton, Glasgow; Cabdirect, Allied Vehicles

In the instance of the Glasgow taxi fleet in the period 2005 - 2006, both TXII and E7 vehicles have remained constant in price, making for a simple calculation, with a more detailed calculation required based on the proportion of each vehicle type in the fleet.

The second element in determining the costs of vehicle purchase relates to depreciation. Depreciation is the loss of value of a vehicle and, as with private cars, reflects the fact that the retail value of a second hand vehicle declines over time. A variety of methods exist for the treatment of declining resale values, and these are informed, in part, by the expected life of a vehicle as well as its conditions at the point of resale. Two primary options are commonly applied to the taxi fleet, the first based on the assumption that a vehicle declines in value on an equal base over the estimated life of that vehicle (Straight Line Depreciation); or alternatively that values alter, with the rate of decline dependant upon the age and standard of vehicle (Varying Depreciation). The former method is relatively simple as it determines a straight line between value at purchase price and scrapping at the pre-determined end of service life, and is adopted by all authorities asked an applying depreciation as a cost. The latter requires a more detailed observation of market values, which results in a more accurate indication of residual value over time where such observations can be accurately made.

It may also be possible to distinguish between differing patterns of vehicle ownership, to take account of different purchasing behaviour. Examples of these (TfL, 2005) include:

Table A6.3

Options in purchase	Description
1	Purchasing a vehicle new, and running to scrap
2	Purchasing a vehicle new and selling at 4 years,
3	Purchasing a vehicle at 4 years and selling at 8 years
4	Purchasing a vehicle at 8 years and running to scrap.

A number of options were tested in updating the model:

Option One *Do Minimum*

- Maintain current vehicle cost measurements based on a single (majority) vehicle type
- Maintain current vehicle depreciation patterns, straight line over 8 years

Option Two: *Do Something*

- Update current vehicle cost measurements to include a mix of vehicle types
- Update current vehicle depreciation pattern, straight line over 12 years

Option Three: *Do Maximum*

- Update current vehicle cost measurement to include all possible vehicle types/models

- Update current vehicle depreciation to reflect differing ownership patterns
- Identify link between quality control and vehicle age profile

The first option effectively maintained the status-quo in measuring vehicle purchase and depreciation costs, and thus could be seen as the simplest of the options. Inconsistencies arose, however, in Glasgow as the fleet itself has changed from a single vehicle type to an increasingly mixed fleet comprising, LTI, Eurotaxi and other vehicle type. The impact of adopting *Option One* would be to maintain a measurement based on part of the fleet, rather than representing a cross section of the fleet. It was also observed¹ that while the TXII remains the majority vehicle this type of taxi has a higher retail price than other vehicles available and allowed for use in the fleet. Any significant increase in the numbers of non-TXII vehicles may effectively overstate the costs associated with vehicle purchase, and may result in a higher cost of operation than actually justified.

The second option increases the types of vehicles included in the determination of purchase cost, and also addresses the issue of an extended life span for vehicles operating in the fleet. The option maintains the concept of straight-line depreciation, but identifies a 12-year life rather than 8 years as previously identified. Evidence drawn from other cities, including the recommendations of the TfL report (ibid) suggest that most taxi vehicles are maintained in service beyond an eight year life, and that the majority also identify a resale value for vehicles of 8 years and older. The measurement of vehicle resale values at year 8 and beyond may, however, vary significantly, reducing the effectiveness of straight-line depreciation to residual value methods of assessment. The choice of a 12 year depreciation, which is consistent with approaches adopted since the TfL report, also match stated maximum vehicle age identified in our survey of authorities.

The third option adopts a wider interpretation of fleet age, mix and ownership patterns, and is likely to be the most accurate where a full range of information is available. The option seeks to identify purchase price and depreciation for all vehicle types used in the Glasgow fleet, and identifies change in value in each of four purchase / resale patterns. The option represents the most detailed assessment, but is also requires the most data to complete.

Critique of cost element update

The changes in the Glasgow Taxi fleet over time have reduced the effectiveness of a single vehicle type measurement to fully reflect the costs incurred in the operation of taxis in the city. For this reason a more detailed assessment appeared appropriate. The counter argument that, as the extent of data required increases, so does the complexity of obtaining accurate information is accurate, but was not considered a significant barrier in the case of Glasgow where two main vehicle types exist and thus did not require unduly complicated data collection.

¹ Based on interviews with taxi trade suppliers

The second (do something) and third (do maximum) options both involved the collection of greater amounts of information, and are thus more complicated than the first option, but also allowed for a more accurate cost to be determined. Option two provided a cross section of differing vehicle types, and is illustrated in relation to the two most common taxis in operation in the city. The second option also addressed an observed tendency for vehicles to be operated for extended lives within the fleet². The choice of a twelve-year depreciation period appears consistent with observed patterns both in Glasgow, and elsewhere. The option is, however, limited to a straight line approach to depreciation, and does not account for changes in ownership during the life of a vehicle.

With an observed increased mix of vehicles within the fleet it is likely that the single vehicle calculation (option one) will become unsustainable over time, and its continued use as part of the standard model is likely to result in a mis-measurement of the actual costs incurred, and may overstate costs within the model over time. The more detailed measure, assessment of multiple vehicle types, is, however, more data intensive than the single type measurement. To accommodate differences in fleet composition and to be accurate the measurement needs to include a weighting reflecting the numbers of vehicles of each type in the fleet, achieved in Glasgow through the inclusion of fleet characteristics questions in the driver survey, but equally possible through observation of vehicle operation. The choice of calculation for depreciation also differed between the options. The standard model was based on a straight line depreciation over a life of 8 years, and benefits from the simplicity of calculation. However, as many vehicles survive beyond 8 years, indeed many retain a reasonable resale value at this age, the choice of an eight-year life appeared unrealistic. The second option adopted a 12-year life span. The effect of adopting this value was to reflect more fully the length of service achieved in the fleet. This element is also allied to the issue of quality regulation, and could be amended accordingly in light of any maximum vehicle age imposed in quality controls.

The third option adopted a more detailed review of the patterns of ownership over the life of a vehicle, and sought to represent ownership patterns in respect to one of four groups. Vehicles do not, in the option, decline on a straight line basis over time, but are identified according to market value in relation to ownership over four year blocks. The option is likely to be the most accurate of the three scenarios, but also the most data intensive. Full assessment requiring observation of actual purchasing and resale behaviour across the fleet, as well as the identification of resale values at one the end of each identified block. It would also be possible to allocate a greater number of (shorter) blocks eg, ownership over two years, but this would also demand more data, and require a greater number of possible patterns. While desirable in terms of accuracy, the benefits of adopting the third option were felt not to reflect the additional difficulty in data collection. At the other end of the spectrum, option one was significantly restricted by measuring only one vehicle type, and was considered insufficient to the reported increasing mix of vehicles in the Glasgow fleet.

In light of the limitations of both 1st and 3rd options, a new modelling approach was adopted in line with option two. This increased the measurement to include multiple

²

Based on observation at stance

vehicle types, and extended vehicle depreciation over a 12-year period, while retaining the straight-line approach to depreciation.

A6.2 Vehicle Maintenance

The difference in costs is significant, appears excessive, and probably reflects differing approaches to updating costs over time. The extent of the differences between the two cities does, however, give cause for concern, as the significant difference between costs for maintaining the same vehicle in the two locations may suggest that one of the two figures does not reflect current costs.

Table A6.4 Differing values of maintenance components.

Value of cost components	London	Glasgow
Parts	£1754	£4677
Derived from previous reports		

Table A6.4 highlights a significant difference in measured costs of maintenance between London and Glasgow despite the fact that the construction of the cost in both cities. It is based on a typical basket of parts, comprising parts felt to be common in the maintenance of taxis, and the observed changes in the costs of those parts over time. The actual content of the basket is likely (and probably inevitable) to vary between cities as much of the actual maintenance reflects the road conditions in the city of operation, and the circumstances in which supply is provided. It should not be a surprise, therefore, that differences exist between the costs in London and those in Glasgow, rather the extent of the differences in those costs. Moreover, the issue of differences in vehicle types between fleets makes actual comparison of values between cities less effective, although some indication of common trends maybe possible.

Table A6.5 sets out the current basket of parts used in the Glasgow cost model, and their values in 2006. The parts represent a significant cost but do not in themselves represent the exact or full range of parts used by all operators in the course of the year rather a cross section of parts typical in the maintenance of LTI vehicles in the Glasgow fleet. The existing Glasgow models had further interpreted costs within the basket by calculating a propensity to use parts indicated, reducing the total cost of the basket by a percentage representing likelihood of use – previously on the basis that 60% of the basket maybe used in any one year. Both assumptions, that of a single vehicle type being typical of the entire fleet, and that 60% of listed costs will be used, may be questioned, and not be fully appropriate to the current fleet, or to the measurement of the cost in the longer term.

Table A6.5 Components within the current maintenance calculations

Component	Cost (£ 2006)
Clutch Assembly	160
Rear Spring	65
Rear shock absorber	35
Exhaust assembly (complete)	320
Dunlop Tyre	98
Radiator assembly	111
Brake servo pump	143
Brake master cylinder	140
Engine assembly	3800
Gearbox assembly	950
Front Shock Absorber	33
Front Brake pads	41
Rear Brake pads	54
Front Brake disk	48
Starter Motor	254
Tail Lamp assembly	50
Rear Wing	112
Front Wing (complete)	88
Front Bumper	340
Boot door assembly	176
TOTAL	£7016.00

Source: Component suppliers

Costs of maintenance applied to the Glasgow cost model would, over time, identify the change in cost over a specified period. The measure is relative, and does not reflect the actual costs of maintenance using the parts indicated but rather an indicative value over time. Table 9.6 indicates the measurement of change in costs in the period from 2005 – 2006.

Table A6.6 Costs changes for maintenance 2005 – 2006

	2005 Cost (x)	2005 Value (x * 60%)	2006 Cost (y)	2006 Value (y * 60%)	% change in cost
Parts	£6788.00	£4072.80	£7016.00	£4209.60	3.35%

Source: Author

Costs identified over time and applied in the previous modelling approaches (see Table A6.6) are weighted at 60% of measured value as a 'likelihood to use' reduction, and had then been measured in terms of change over time. The measurement applies only to identified components and do not include costs of labour which have been accounted for separately.

Maintenance costs: labour

In addition to a direct measurement of costs, the original Glasgow model included an element for labour, an additional cost in maintaining a vehicle within the fleet. Maintenance includes both the costs of parts and the cost of labour in servicing and repairing vehicles. The level of labour costs varies over time, as does the cost of parts, but is likely to vary at a differing rate – a ground for specification and identification as a separate element in the costs of maintenance. The researcher consulted two main dealerships, John Paton and Sons, and Allied (Cab Direct) to elicit costs and changes in costs as appropriate to the two main vehicle types in the fleet. The inclusion of both labour rates, identified by and weighted in accordance with the numbers of vehicles by type in the fleet, appears an appropriate method of establishing labour costs.

The inclusion of maintenance costs is a significant element in determining full costs of operation. The Glasgow model reflects an approach widely adopted in the determination of this cost in other licensing authority areas, and in other disciplines where comparative baskets of goods are also common. Several issues arise in the use of the current maintenance cost element, including the need for the list to represent an appropriate cross section of parts used. This need not relate to every part used in every vehicle, but should approximate the most common. As vehicle technologies, the parts used in maintenance change accordingly, and the need to update the components within the basket is heightened where the range of vehicles in the fleet increases.

The existing Glasgow models reflected costs for one vehicle type only, and had been based on a basket that had remained unchanged for some years. The accuracy and effectiveness of the measure was reduced by the extent of historic data used, and this prompted a series of questions about the sustainability and continuing validity of the calculation in current modelling, or its defence against future challenge. The development of an updated structure therefore must also consider options in updating the costs of maintenance. The study has identified three possible approaches to updating this element of the cost model, set out below:

Option One: Do Minimum
Update Basket of parts to reflect parts currently used by LTI vehicle

Option Two: Do Something
Recast Basket of parts to include 'typical' vehicle components

Option Three: Do Maximum
Recast Basket of parts to include 'whole fleet' vehicle components

The first option continues to identify the costs of maintaining LTI vehicles alone, and seeks to ensure that the basket of goods most accurately reflects the maintenance costs of that vehicle as possible. It was felt important that the basket need to reflect the components actually required within the current fleet, rather than reflecting the upkeep of previous taxi types, as vehicle models change, so should the content of the basket. Given that the current basket of parts had remained unchanged over a number of years, and that despite a change in taxi model sold, the contents appeared not to

have been updated, it was felt desirable to consider the appropriate of the components in the basket. A new basket, set out in Table A6.7, proposes revisions to the original content, from which Engine and Gearbox assemblies have been removed, as have front bumper and boot door assemblies. The former being large components, replaced infrequently, the latter components that are replaced mainly as a result of driver behaviour, eg, following a road traffic accident. This does not suggest that the components are not replaced, but rather that the cost of repairing damage resulting from accidents should be the domain of insurers, and such costs are already included elsewhere in the cost model.

Table A6.7 Revised basket of parts

Component	Cost (£ 2006)
Clutch Assembly	160
Rear Spring	65
Rear shock absorber	35
Exhaust assembly (complete)	320
Dunlop Tyre	98
Radiator assembly	111
Brake servo pump	143
Brake master cylinder	140
Front Shock Absorber	33
Front Brake pads	41
Rear Brake pads	54
Front Brake disk	48
Starter Motor	254
Tail Lamp assembly	50
TOTAL	£1550.00

Source: Component suppliers

The effect of applying the first option to the costs of parts is illustrated in Table A6.8

Table A6.8 Costs changes for maintenance 2005 – 2006

	2005 cost (x)	2006 cost (y)	% change in cost
Option 1	£1512	£1550	2.51%

Source: Author

Table A6.8 demonstrates changes in costs for the revised basket, and should be compared directly with Table 9.6 (changes derived using the previous methodologies).

A second option sought to reflect a wider range of vehicle types within the basket of component approach. In this scenario the same approach as in the first option, most commonly needed components, was also used, but updated to include the costs of components of differing vehicle types. The actual content of the basket of

components was therefore reliant on the make up of the fleet, and required an additional review as to which components are most commonly required for differing vehicle types.

The third option sought to identify more fully the parts used by all vehicle types in the fleet. The scenario represents the most data intensive of the three options considered, but is also the most accurate. Differing vehicle types display different servicing requirements, with an accurate estimate only fully achieved by separate consideration of each vehicle type. The scenario also benefits in that the proportion of vehicle types in the fleet can be adjusted to reflect its actual composition. The scenario does, however, suffer from the complexity of the task of data collection. To achieve a fully accurate picture the scenario requires detailed information for multiple vehicle types, and this to be updated with any change in the composition of the fleet type. The requirement to collect large amounts of information may reduce the effectiveness of this option.

An alternative method, differing from a 'basket approach' was also been considered. The alternative approach sought to identify the full costs of maintaining a sample of vehicles over the course of a year. The approach is best informed by seeking full costs from dealership or individual taxi operators to establish and average cost of maintenance over a year. Table A6.9 indicates anonymous data from John Paton and Son for the average maintenance costs of taxis.

Table A6.9 Cost level for total maintenance cost versus basket of parts cost

2006	Dealership Annual Cost	Basket Cost (Option 1)
Maintenance Costs	£1562	£1550

Source: John Patton and Son

The alternative, Table A6.9, provides a strikingly similar cost to that identified in the revised basket of goods approach, and this suggests that the revisions in the basket are realistic when compared to the costs of actual repair. The alternative approach does, however, require a more detailed assessment of actual costs, and this itself may be difficult in light of the numbers of vehicles being repaired, and the need to obtain accurate anonymous information on an ongoing basis.

A6.3 Fuel Costs

The fuel costs included in a cost model are typically derived by comparing the price per typical quantity in period x, to the same costs in period y. The costs include a number of variables, the cost of fuel at any one point in time, the assumed or comparative mileages used in the calculation, and the assumed fuel efficiencies of the vehicles in the fleet. Table A6.10 compares fuel costs specific to operating a diesel vehicle in Scotland.

Table A6.10 Costs changes for diesel 2005 – 2006 (pence / Litre)

Pence / litre	2005 Cost (x)	2006 Cost (y)	% change in cost
Diesel	93.1	99.3	6.65%

Source: Automobile Association

Fuel costs can further be identified for differing distances, and differing vehicle fuel consumption. The assumptions of vehicle efficiencies and driven miles are significant in that a more efficient fleet will demonstrate lower costs than a less efficient one. Fuel efficiencies also relate to the composition of the fleet with a greater accuracy possible where a calculation models differences in fuel efficiencies between vehicle types.

A6.4 Insurance costs

Insurance costs in Glasgow (Table 9.11) appear significantly higher than the equivalent costs in London.

Table A6.11 Differing values of insurance

	London	Glasgow
Cost of Insurance	£1567	£3922

Source: Westminster Insurance

The current Glasgow insurance cost figure relates to a maximum insurance cost sourced from a national underwriter for operation in the city. This is therefore felt to be higher than the actual costs of insuring the 'typical' taxi, the base by which London's costs are identified, see Table A6.11. Countering this, the definition of 'typical' driver is highly subjective, and will not itself provide a consistent cost that can be applied to the entire fleet or the entire parc of taxi drivers. The nature of the industry suggests a level of change in average driver, age, driving record etc., that limits the possibility of defining an average (mean) driver description. An alternative approach, illustrated in Table A6.12, would be to adopt a specified driver cost, a consistent driver approach comparing like for like costs over specified time periods.

Table A6.12 Specified driver insurance

	2005 Cost (x)	2006 Cost (y)	% change in cost
Insurance	1094.08	1132.82	3.54%

Source: Westminster Insurance

A6.5 License and other costs

Additional cost elements (Table A6.13) relate to a wider range of costs incurred in the operation of a taxi, and highlight the differences in approach adopted in differing cities that seek to apply the same principles of analysis. There are a number of additional cost elements that may be applied, set out below

Table A6.13 Additional cost components applied across other models

Cost Component N = 21	Approximate frequency of inclusion	Used in Glasgow?	Comments
Cost of licenses / permits	Varies significantly	Yes	Costs are city specific
Subscription to radio ring	3	No	
Consideration for 'knowledge'	1	No	
Social cost	1	No	
Miscellaneous	1	No	
Environmental supplement	1	No	
Specified driver wage	1	No	
Earnings (not as wage)	3	Yes	
Profit take	Proposed in 1 LA	No	

Source Survey of Local Authorities

Components: Subscription to radio ring

A number of cities choose to include radio dispatch costs in the cost model. The element relates to the identification of costs of subscribing to or renting radios in the operation of taxi services, and are generally identifiable and readily updated from Association or Radio Ring. The element has not, traditionally, been included in the Glasgow model and has been argued for inclusion on the basis of providing as full a cross section of costs as possible. This increases the accuracy of the model, and should therefore be seen as positive. Arguments against inclusion of subscription relate to the fact that it is an optional cost, and need not be borne in the provision of a minimum service. 40% of the fleet in Glasgow do not subscribe to the TOA, and this reduces the impacts of including the cost. It is also arguable that the nature of subscriptions is small in comparison to other capital and operating costs, and in the domain of the driver.

Consideration for the 'knowledge'

The 'knowledge' test is a very specific requirement for taxi operation in London, and is identified in the costs of operation in London given the large costs of entering the market this represents. Similar tests do not apply in other cities and, given that this element applies only where a similar test is applied, it would appear not to be appropriate to Glasgow.

Social cost

A social cost element is included in a small number of cities. The cost is identified differently in differing reports, either as a payment for antisocial hours of operation, or in relation to the costs of additional individual social costs, holidays and pensions. In the first interpretation, the inclusion of a social cost element appears to conflict with the inclusion, in Glasgow, of Tariff 2 fares applied during evening and nighttime operation. It would not, therefore, appear appropriate or necessary to include this in the Glasgow model. The second interpretation, where social costs relate to pension and holiday costs, is felt to be a more appropriate to inclusion in the cost model. The definition of social costs within this interpretation, is more problematic, and usually

included within the pay 'packages' of other forms of employment and is unlikely to be directly measurable in relation to the operation of taxis. It may, however, be appropriate to include social costs (in the second definition – pension and holiday costs) as an element of earnings, more readily identifiable as a comparative cost, and set out below.

Environmental supplement

Environmental costs are included in the London model, and have become a significant issue in the operation of transport and may reflect a desire to use costs and price mechanisms in delivering an environmental benefit. The inclusion of an environmental cost supplement within the tariff model would, therefore, appear appropriate where the measurement is clear and the costs actually incurred reduce in the operation of 'greener' taxi vehicles. However, where environmental costs are incurred through the production and requirement to implement more environmentally friendly vehicles, as is the case in the increasing rigour of pollution controls applied to new vehicles, the costs are actually incurred by the taxi operator at the point of purchase and in the maintenance of the vehicle. These are already elements of the model, and the costs are, therefore, already included. Likewise, costs imposed through the taxation of fuels are already included in the model, and any additional element would tend to double count the cost and increase the cost to the passenger of using a more environmentally beneficial mode than a less environmentally friendly one.

The application of a separate environmental tax (as envisaged in carbon taxes) would appear a method of altering behaviour in driving, pattern, frequency or in vehicle choice; and could thus be identified as having a potentially positive impact. It would, however, prove somewhat counterproductive to impose an environmental tax, and then provide a method of mitigating its cost as this would effectively remove the cost and thus the incentive to move to more appropriate (compliant) vehicle types.

A6.6 Driver earnings

Identification of an explicit wage within the cost model was adopted and provides a solid base for calculating changes in that cost. Most significantly the local wage cost is independent of generalised cost assumptions, and justifiable against the earnings of similar industries. The resulting industry specific wage rate also benefits from its clarity by linking wage rates to those in similar sectors, avoiding significant disparities between earning potential in similar jobs and maintaining an incentive to remain within the taxi trade - the wage rate working through the tariff to provide a realistic income to taxi operators maintaining and reducing operating costs in other areas of operation.

The identification of an appropriate rate was taken from the Office of National Statistics Annual Survey of Hours and Earnings, and is specific to Scottish Transport and Mobile Machine operatives (ONS Sector 82). The rate is defined annually and reflects changes in transport and associated professions in Scotland. Table A6.14 illustrates the average annual rate of pay for all trades, and specific to sector 82 in Scotland. The average annual rate of pay in this sector was £19,271.00 in 2005, and this is developed as a basis for local wage levels for taxi drivers in Glasgow.

Table A6.14 Annual pay (gross) for male employee jobs, Scotland

Annual Pay	2004 cost (x)	2005 cost (y)	% change in cost
Scotland, all trades	24834	26183	5.43%
Sector 82, transport	17723	19271	8.73%

Source: ONS, annual survey of hours and earnings

Annual pay calculations are demonstrated, in Table A6.14, on the basis of increases in line with similar trades in Scotland. Current values have been taken from the National Statistics Office annual survey of hours and earnings, and demonstrate an increase in comparable wages of 8.73% over the time period from 2004-2005.

A6.7 Application of tariff review

Table A6.15 sets out the base elements within the current Glasgow tariff. Most charges are well defined, and broadly understood by taxi users. The combination of distance and time is consistent in most cities, as are charges applied as extras, including initial charges, sometimes referred to as 'Flag Fall'.

Table A6.15 Base elements and methods of applying tariff increase

Base Element	Measure	Methods of updating
Time / Distance		
Flag fall	Initial charge for first x yards	Increase cost Reduce distance
Distance	Progressive charge by yards beyond flag fall	Increase cost Reduce distance
Time	Charge incurred for waiting (and slow driving)	Increased cost Reduced time
Extras		
Additional Passengers	Additional charge for higher occupancy	Increased cost / passenger
Baggage	Charge for handling bags	Increased cost / bag
Call out charge	Charge for arriving at a journey start point	Increased cost

Source: Author

Taxi tariff tables vary in construction and layout between cities, but will typically comprise similar elements of Flag Drop, Distance and Time based charges. Many also charge additionally (extras) for more passengers, for handling baggage and make a call out charge for pre-booked journeys. Some locations (including Glasgow) may apply a supplementary charge for travel on particular days including public holidays, and for travel at specified times including on Friday and Saturday nights.

Initial charge (flag fall)

The concept of an initial charge, which usually includes a payment for initial distance, is common in the majority of cities. The cost is justified on the basis of the relatively high costs of operating short journeys compared to longer ones. Costs are higher

when considered with opportunity costs of loss of place in a ranking taxi, or directly in accessing a location where a taxi is pre-booked. Costs of each can be high, particularly in the case of a ranking vehicle having waited some time to gain a position at the head of a queue. The initial charge represents a guaranteed level of income for short journeys, and increases in line with changes in production costs appear to be appropriate. However, some negative impacts do apply, particularly in the instance where changes in the cost of the flag fall penalise those wishing to travel the shortest distances. Passengers travelling on the shortest journeys may, as a result, face the largest percentage change in fare.

Distance charges

Charges based on distance travelled are widely applied. Driven distances are charged according to predetermined cost per unit distance, measured by yards travelled. The application of tariff to distance in Glasgow is applied each time a vehicle covers a preset distance, with fares chargeable increasing by step, currently 20 pence. Any increase in the base tariff may be applied by reducing the distance purchased per unit cost, or increasing the cost of unit distance. Taxi operators in Glasgow, and in other cities, tend to support the former (reducing distance) method of applying changes in tariff, on the basis that it allows the use of a particular coin as minimum step, currently twenty pence in Glasgow.

The adoption of a reducing distance method does, however, have an impact over time, with a significant reduction in the length of journey possible per unit cost. Table A6.16 illustrates the impact of this change in the period 1998 – 2006.

Table A6.16 Additional distance travelled for a given amount

Effective date	02/06	12/04	12/03	06/02	08/00	11/98
Distance purchased for 20p (yds)	275	286	295	304	331	358

Source: Glasgow Taxis Ltd.

While the use of a specific minimum coin has clear advantages in terms of the ease of providing change for customers, and to a lesser extent in terms of clarity, the erosion in distance travelled is significant, and it may be suggested act to hide increases in tariff.

Waiting time charges

Similar arguments exist in relation to waiting time charges as in relation to distance charge. The basic premise of payment for time waiting while stationary occurs in the majority of taxi tariffs, as part of the cost of using a taxi. As with the distance charge any increase can be applied either through increasing the amount paid per unit time, or reducing the amount of time purchased for any unit of cost. Whilst there is no dispute that the reducing time method, as with the reducing cost method, are both applied accurately, both have the effect of masking any actual rate of increase, by offering less for the same amount rather than the same amount at higher cost.

Integral to the determination of time and distance charges is the discussion of their updating in the tariff table. The researcher has sought to identify options appropriate to the application of tariff changes, typically increases, resulting from the completion of a tariff review to the taxi fare sheet following the development of an enhanced

Glasgow model. A number of issues appeared to be common in the application of any increase to the tariff sheet, the accuracy of applying an increase of x% across the various elements of the tariff itself, and the impacts of an uneven increase on particular traveller groups. In effect the intent increase taxi charges by a specified percentage may be applied in a number of ways, the impact of which may be a difference in the actual (effective) percentage increased experienced by different passenger groups.

The variable nature of the actual increase in using a taxi results from the range of charges from which a total journey cost is derived, and does not in itself imply desire to apply a increase higher than that identified in the tariff review, but rather that steps within the tariff itself result in increases being felt to a differing extent by differing user groups. Most worrying among these, the fact that those travelling the shortest distances tend to experience the highest increases. A number of options appear to reduce the differential between differing traveller groups, and these include differing treatment of initial charges and consideration of a yard based charge rather than a specified (multi-yard) distance charge. Table A6.17 outlines the three main charges payable in using a taxi; Flag Fall, Distance and Time costs, and four options for applying increases to these charges, described below and tested in relation to outputs from the revised Glasgow model.

Table A6.17 Options in updating tariff tables (time and distance)

Element	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Flag Fall	Increased Cost	Cost maintained, distance reduced	Included distance removed, fare adjusted to initial hire only	Included distance removed, fare adjusted to initial hire only
Distance	Increased Cost	Cost maintained, distance reduced	Increased Cost	Cost maintained, distance reduced
Time	Increased Cost	Cost maintained, time reduced	Increased Cost	Cost maintained, time reduced

Source: Author

Table A6.17 sets out options for applying increases calculated in the cost model to the tariff table. Any change in the underlying calculations need to be carried through to passenger charges, but the method of application may in turn influence costs, actual effective increases, and these may differ as a result of rounding and method of application. Scenarios 1 and 2 represent a traditional approach in the calculation of an increase. Stepped charges are maintained in both scenarios, in scenario 1 by increasing the cost of each step by 5% results in a unit of cost of 21pence, and in the second scenario the distance and time elements are reduced. The resulting figures indicate the potential for misapplication, with the second scenario resulting in a cleaner figure but a reduced gain for shorter journeys. This results as a distances approach but do not cross the threshold for an additional unit cost. Scenarios 3 and 4 address the structure of the fare, but apply the same logical increases in the amounts or distances available to each step. Both scenarios three and four consider the impacts

of removing the inclusive distance element of the initial charge (Flag Drop), and charge for time and distance from the outset. Both scenarios 3 and 4 represent significant improvement to the passenger costs of travelling shorter distances, and achieve a closer relationship between the cost increase and the actual fare payable at these distances. A remaining issue in the calculation of costs of scenarios 3 and 4 remains the issue of stepped fares under or over stating the actual increase.

Table A6.18 identifies the impacts of the various scenarios on typical journeys, defined by distance travelled. The impacts of fare increases are most commonly identified in terms of impact on one or two mile journeys, and in these respects, both traditional methods (Scenarios 1 and 2) result in similar levels of charges.

Table A6.18 Impacts of applying a 5% tariff increase to scenarios 1 – 4

	1 mile cost	2 mile cost
Base cost (2005)	2.40	3.80
Scenario 1	2.73	4.21
Scenario 2	2.80	4.20
Scenario 3	2.64	3.90
Scenario 4	2.51	3.71

Base of calculation: 5% increase applied to 2006 tariff

The costs of travelling shorter distances is not, however, typically included in comparisons between tariffs. Short journeys typically fall within the cost of an initial charge and, depending on method of application, may result in no additional charge, a loss in terms of the taxi operator. Further inconsistencies arise in comparing like with like, particularly in the case of reducing distance/time method as actual fares relate to determined steps in distance. Effective rate comparisons are ineffective where the result of travelling an extra yard is to incur the charge of an additional tariff cost unit.

Given the potential of predetermined steps in distance and cost to result in varying levels of effective price increase, the researcher tested a further scenario (Scenario 5) in which stepped application is removed altogether. The fifth scenario applies tariffs on the basis of yards travelled from the outset, includes a flag drop charge (without inclusive distance) and applies charges arising on the basis of whole yards multiplied by yard cost. Table A6.19 illustrates the impact of applying a yard based calculation. Differences in effective change between base cost and charges raised in scenario 5 result from the removal of steps and may produce an effective increase greater than the initial 5%. However, this is offset across the tariff and represents an effective 5% increase across a full cross section of distances travelled.

Table A6.19 Impacts of applying a 5% increase on a yard-by-yard base

	¼ mile cost	½ mile cost	1 mile cost	2 mile cost
Base cost (2005)	2.00	2.00	2.40	3.80
Scenario 5	1.72	2.05	2.72	4.07

Source: Author

The fifth scenario provides a consistent method of measurement, and will not lead to differences in per distance cost that may otherwise result from the application of a stepped approach. It does, however, represent the most significant change from

current practice, and would effectively provide a significant gap between Glasgow and other cities in the UK. It may also be observed that any change from a traditional stepped approach to the actual distance measurement may result in the appearance of differing rates as the proposed actual and previous stepped calculations differ in construction. Scenario 5 also presents issues in application, given that the change in calculation method effectively discriminates against the trade, by resulting in a lower income to the taxi operator between previous 'steps' than would otherwise be achieved (using existing methodologies) its application should be considered in light of actual impacts. Few journeys effectively stop at 1 or 2 miles, and it would appear appropriate to address the application of scenario 5 in relation to actual impact. Although no direct comparison exists in the delivery of taxis, other examples exist of applying a fairer system, as with scenario 5, with initial adjustment, suggested as 1 additional 'unit' applied in a transitional period. Table A6.20 illustrates the lag between Scenario 5 and equivalent application of a traditional modelled approach, defined by intermediate distances.

Table A6.20 Comparison of income Scenarios 1, 2 and 5 by distance in year 1

Year 1 charges for yards	Scenario 1	Scenario 2	Scenario 5	Scenario 5a
500	2.10	2.00	1.76	1.96
750	2.10	2.00	1.95	2.15
1000	2.31	2.20	2.14	2.34
1250	2.51	2.40	2.33	2.55
1500	2.73	2.60	2.52	2.72
Mean values	2.35	2.24	2.14	2.34

Source: Author

Advantages of the actual distance calculations are related to the accuracy of the measurement, and the effective transparency of any future tariff updates. It is, however, a complex measurement, and is likely to represent a sea-change in charging that may not be appropriate to full application in some circumstances. Impacts on actual income, given that measured increases remain accurate and should be reflected in income, require a transitional period, of 1 year, where additional adjustment of 1 traditional unit would be required. This may represent a challenge to introducing such an approach. Any such change would, in our view, be best approached in light of detailed and full consultation with the trade and public.

The basis on which changes to the Glasgow Taxi Tariff are derived appears to be consistent with similar approaches adopted in other cities, is justifiable in its approach and in most of its findings. The Taxi Cost Model, used in tariff reviews, measures change in costs of operation and allows for a determination of appropriate increases in the tariff. It is our recommendation that this approach be continued, with a change in the frequency of tariff reviews to be completed on a twelve month cycle. The exact content of the cost model is also consistent with approaches adopted elsewhere, but should, in our view be updated to reflect changes in operating practices, vehicle technologies, and an increased use of new vehicles within the Glasgow fleet.

A6.8 Engineering solutions

A number of observations at Glasgow stances suggested that alternative approaches based on improvements to the engineering of the stance may provide a more appropriate solution to a change in license numbers alone. These included, at the Gordon Street stance, a change in the green light phasing at the adjacent traffic signals.

Effective Green Time is defined as: $EFG = GT + AT + LT$

Where:

EFG = Effective Green Time

GT = Green Time

AT = Amber Time

LT = Lost Time

Modification of the effective green time may increase the ability of taxis to serve the stance, and reduce the waiting times at the stance considerably. Table A6.21 illustrates impacts of changes in the phasing of these signals on the flow of traffic through the stance.

Table A6.21 Indicative impacts of changes in signal phasing

Increased green phase (seconds)	Flow throughput	Effective time saving at stance (seconds)
0	26	0
5	32	4.23

Source: Author

As the green phase is increased the effective supply at the stance is increased in proportion to the throughput of the junction. Timesavings are calculated on the basis of:

$$TSAS = (CAD \times EOT) / (EOT + IGP)$$

Where:

TSAS = Time savings at stance

CAD = Current arrival delay, departing from Hope Street to arrival at Gordon Street

EGT = Effective Green Time

IGP = Increase applied to green phase

Time savings achieved; Gordon Street – Aldine Street, Distance: 6.8 kms, Current Travel time: 9 minutes.

Time saving due to EGF 0.07 minutes

Time saving due to direction 0.60 minutes

Revised Travel Time 8.33 minutes

Time saving due to engineering improvements: 0.67 minutes

Achieving the same reductions on a consistent basis across the entire fleet increases the effective service at Gordon Street, and should be considered as an additional option, or an alternative to license based solutions.

Appendix 7. Sample Questionnaires

Please complete all sections of this form.

Section 1:

Please tell us a bit about yourself.

Are you in which of the following age groups

Male	<input type="checkbox"/>	Female	<input type="checkbox"/>
16 - 34	<input type="checkbox"/>	35 - 64	<input type="checkbox"/>
		65 +	<input type="checkbox"/>

The survey relates to taxis in the City of Glasgow. Are you:

A Permanent Resident	<input type="checkbox"/>
Visitor / Commuter	<input type="checkbox"/>
Tourist	<input type="checkbox"/>

Which of the following groups best describes your current work:

Full Time Employed	<input type="checkbox"/>
Part Time Employed	<input type="checkbox"/>
Unemployed	<input type="checkbox"/>
Student/Pupil	<input type="checkbox"/>
Retired	<input type="checkbox"/>
Housewife/husband	<input type="checkbox"/>
Other:	<input type="checkbox"/>

Section 2:

We would now like to ask you about your use of taxis in Glasgow. This relates to Public Hire Taxis (Black Cabs). Please do not include information about Private Hire (minicabs). If you are in any doubt please ask your survey person, or call the T2E helpline at 0845 6018643.

How often do you hire a taxi at a recognised Glasgow Taxi Stance / Taxi Rank?

Every day	<input type="checkbox"/>
At least once a week	<input type="checkbox"/>
At least once a month	<input type="checkbox"/>
At least once a year	<input type="checkbox"/>
Never	<input type="checkbox"/>

How often do you hire a Glasgow taxi using a taxi telephone booking service?

Every day	<input type="checkbox"/>
At least once a week	<input type="checkbox"/>
At least once a month	<input type="checkbox"/>
At least once a year	<input type="checkbox"/>
Never	<input type="checkbox"/>

How often do you hire a Glasgow taxi by hailing a taxi on the street?

- Every day
- At least once a week
- At least once a month
- At least once a year
- Never

We are interested in your perception of taxi fares in Glasgow. In your estimation, how much would a two mile daytime journey from a Glasgow city centre stance cost

£ _____

Do you think Glasgow taxis could be improved? Yes Not Sure No

Please tell us which of the following **best describes** the reason you do not use taxis more frequently? (*Choose 1 only*)

- No Need
- Too Expensive
- Bus Available
- Car Available
- Walk/Cycle
- Not enough taxis
- I do not live in Glasgow
- I prefer to use minicabs
- Too far to a Taxi Stance

I would now like to ask you a question about the time it takes to find a taxi. Please indicate for each situation what you consider a **reasonable** delay in the first column, and how long you **normally wait**. Please enter a value for reasonable delay, even if you do not normally use a taxi at the time shown.

	Reasonable Delay	Actual Delay
Minutes taken:		
Waiting for a taxi at stance, on a weekday - lunch time	_____ mins	_____ mins
Waiting for a taxi at stance on a FRIDAY night	_____ mins	_____ mins
Waiting for a pre-booked taxi at home on a SAT night	_____ mins	_____ mins
Hailing on Street, on a WEDNESDAY night	_____ mins	_____ mins
Waiting at a stance at 3AM on a SATURDAY morning	_____ mins	_____ mins

The next question relates to your most recent experience in using a Glasgow taxi.

Have you made a journey by black taxi in Glasgow in the last month?

If NO, please continue to Section 3.

Yes No

With reference to your **last** trip by Glasgow Black Taxi, can you please tell us:

The ORIGIN of your trip _____

The DESTINATION of your trip _____

The approximate time of the trip (*Please use 24 hour clock*) _____ : _____

Method of Hire: At Stance Hailed on street By phone

TAXI SURVEY 2005: Glasgow Taxi Supply

We have been asked to look at the time it takes to find a taxi. Please indicate for each situation what you consider a **reasonable** delay in the first column, and how long you **normally** wait.

Please enter a value for reasonable delay, even if you do not normally use a taxi at the time shown.

Minutes taken:	Reasonable Delay	Actual Delay
Waiting for a taxi at stance, on a weekday - lunch time	_____ mins	_____ mins
Waiting for a taxi at stance on a FRIDAY night	_____ mins	_____ mins
Waiting for a pre-booked taxi at home on a SAT night	_____ mins	_____ mins
Hailing on Street, on a WEDNESDAY night	_____ mins	_____ mins
Waiting at a stance at 3AM on a SATURDAY morning	_____ mins	_____ mins

NFD - n

Please tell us how often use a taxi in Glasgow.

- Every day
- At least once a week
- At least once a month
- Every 3 to 6 months
- At least once a year
- Never

FQ

By which of the follow methods do you most commonly engage a taxi:

- Hire at a Taxi Stance
- Hail on Street
- Booking by telephone

SE

The survey relates to taxis in the City of Glasgow. Are you:

- A Permanent Resident
- Visitor / Commuter
- Tourist

Please use the space below (and overleaf) to provide us with any further comments on the supply and quality of taxis in Glasgow you may wish to be included in our work.

If you are a winner in the prize draw, we will need to contact you. Please note your name and a contact telephone number below.

This survey is being completed by the TRI Taxi Studies Group. For further information, please contact: James Cooper, TRI, Napier University, Sighthill Court, Edinburgh EH11 4BN

M
F
1, 2, 3

If you are a winner in the prize draw, we will need to contact you. Please note your name and a contact telephone number below.

This survey is being completed by the TRI Taxi Studies Group. For further information, please contact: James Cooper, TRI, Napier University, Sighthill Court, Edinburgh EH11 4BN

TAXI DRIVERS SURVEY 2005: Glasgow Taxi Supply

Section 1:

We want to learn about the fleet, and the issues you experience in operating a taxi in Glasgow.

Which of the following vehicle types do you drive?

LTI TX2	<input checked="" type="checkbox"/>
LTI TX1	<input type="checkbox"/>
LTI Fairway or older model	<input type="checkbox"/>
Metrocab M3	<input type="checkbox"/>
Metrocab other model	<input type="checkbox"/>
E7/Eurotaxi	<input type="checkbox"/>
Other taxi type: <i>(Please specify)</i>	<input type="checkbox"/>

What is the approximate year of your vehicle *(Registration letter or year of first registration)*

How soon are you planning to replace your vehicle:

Next 6 months	<input type="checkbox"/>
6 - 12 months	<input checked="" type="checkbox"/>
1 - 2 years	<input type="checkbox"/>
3+ years	<input type="checkbox"/>

With which vehicle type are you most likely to replace your current vehicle?

LTI TX2	<input checked="" type="checkbox"/>
Metrocab	<input type="checkbox"/>
E7/Eurotaxi	<input type="checkbox"/>
Other taxi type: <i>(Please specify)</i>	<input type="checkbox"/>

Please use the space below to provide any comments on the **vehicle types** used in the Glasgow fleet.

Section 2

This section looks at the current supply of taxis in the city. I will use this information to determine patterns of supply, and identify issues that may arise in providing services at particular times. If you alternate patterns (week about) please let me know about both week 1 and week 2. This information will not be passed to any other organisation.

Do you work regular shifts/or at similar times in the week? Yes No

Now please turn over

Please tick each of the hours you normally work. The second set of boxes is for a different week about shift. For example, if you work between 6am and 8am, please mark the first 2 boxes.

EXAMPLE				
	6	7	8	9
sday	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

WEEK 1 pattern

	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	1	2	3	4	5	6	
Monday - Thursday	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	into Friday am
Friday	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	into Saturday am
Saturday	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	into Sunday am
Sunday	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	into Monday am

WEEK 2 pattern (Leave blank if the same as week 1)

	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	1	2	3	4	5	6	
Monday - Thursday	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	into Friday am
Friday	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	into Saturday am
Saturday	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	into Sunday am
Sunday	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	into Monday am

Are there any issues that affect your choice of shifts:
(Tick as many as appropriate)

- Personal preference
- Vehicle Availability
- Lack of customers
- Personal safety
- Other (Please specify) _____

I also want to hear your opinions about use of taxis on a Friday and Saturday night.

Does the behaviour of travellers on a Friday/Saturday night affect your desire to work at these times? Yes No

Are you willing / able to work on a Friday/Saturday night? Yes, in current conditions
Yes, with added support
No, generally not
No, Not at all

I would finally like to ask your view about the numbers of taxis in Glasgow. Please use the space below to let me know your feelings about the current fleet in Glasgow, any issues about the location and design of taxi stances in Glasgow, or any other issue you want me to include in this review.

If you are a winner in the prize draw, we will need to contact you. Please note your name and a contact telephone number below.

MARSMALL BEDFORD 0141 773 1967

This survey is being completed by the TRI Taxi Studies Group. For further information, please contact: James Cooper, TRI, Napier University, Sighthill Court, Edinburgh EH11 4BN

West Dunbartonshire Taxi Survey

1. In which of the following areas do you live or work?

	Live	Work
Dumbarton.....	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Vale of Leven.....	<input type="checkbox"/>	<input type="checkbox"/>
Clydebank.....	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Other.....	<input type="checkbox"/>	<input type="checkbox"/>

2. How often do you use the following forms of transport?

	Every Day	2/3 times a week	once a week	2/3 times a month	Less Often
Car.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bus.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Train.....	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Taxi.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

3. For each of the following journeys, how likely would you be to take a taxi?

	Very Likely	Somewhat Likely	Occasional
Home with shopping.....	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
To/from hospital or Doctor's appointment.....	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
To/from friends/relatives.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Home from a night out.....	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
To/from work or study.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other taxi journey (Please Specify).....			

4. In each of the following situations, how would you engage a taxi?

	From Rank/Stance	Hail on Street	Phone to pre-book
Home to town.....	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Town to home.....	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Pub/Club to home.....	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In town on business.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Supermarket to home.....	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Station to business.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Station to home.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

5. Please indicate if Taxi companies are good, moderate or poor in providing the following services?

	Good	Moderate	Neither	Poor	Very Poor
Arriving at booked time.....	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Available at rank/stance.....	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Driver Courtesy.....	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Vehicle appearance.....	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Vehicle Comfort.....	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Value for money.....	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Assistance with Bags.....	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

6. In your estimation, how much would a taxi cost for a short journey of two miles ?

£ 3.00

7. For each of the following situations, how long do you currently wait for a taxi?

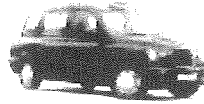
	A couple of minutes	up to 5 minutes	5 – 10 minutes	Over 10 minutes
Daytime from town centre.....	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Daytime from station.....	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Friday Night from pub/club.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

8. For each of the following situations, how long do you consider an acceptable waiting time?

	A couple of minutes	up to 5 minutes	5 – 10 minutes	Over 10 minutes
Daytime from town centre.....	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Daytime from station.....	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Friday Night from pub/club.....	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

9. This question differentiates between wheelchair accessible taxis and saloon type taxis.

Accessible taxis are generally high roofed vehicles:.....



Saloon taxis are based on saloon cars:.....



Please enter a value between 1 (Poor) and 5 (Very good) for each of the following:

	Comfort	Ease of Getting in	Ease of Getting out	Ease of carrying Shopping	Ease of carrying buggy/pram
'Accessible' Taxi.....	4	4	4	4	4
'Saloon' Taxi.....	5	5	5	2	2

Thank you for taking the time to complete this survey.

This survey is being completed on behalf of West Dunbartonshire by the Taxi Studies Group of Napier University. Please address any enquiries concerning the operation of this survey to: James Cooper, Tri Taxi Studies Group, Napier University, Edinburgh, EH11 4BN.

All completed forms will be entered into a prize draw. If you win we will need to contact you. If you wish us to do so, please provide your name and a phone number or email address.

Name

Matthew Briggs
CH

Contact Details

W. [Signature]

GLASGOW TAXI SURVEY 2005: Measurement for the presence of STD

Your Name

IC

Site Name

Gordon St

Date

28/01/05

Sheet of

Time: 1 hour from 10:00 to 11:05

Day/Night of

2005

Use this box to indicate numbers of Passengers and Taxis in queue. (Enter value at 5 minute intervals)

Time	00	05	10	15	20	25	30	35	40	45	50	55
Passengers												
Taxis												

The following table is used to measure vehicle and passenger departures. It is also used for detailing passenger delay in accessing taxis. Please enter the following detail FOR EVERY DEPARTING TAXI/PASSENGER

Examples

Pass	DEPART	DEPART
1-5	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
0	<input type="checkbox"/>	<input type="checkbox"/>
1-5	<input type="checkbox"/>	<input type="checkbox"/>
1-5	<input type="checkbox"/>	<input type="checkbox"/>
WALK	<input checked="" type="checkbox"/>	<input type="checkbox"/>
1-5	<input type="checkbox"/>	<input type="checkbox"/>

Number of departing passengers
 Empty taxi departure
 Passengers with NO delay
 Passengers with MIN SEC delay
 Passengers left on foot
 Undefined delay
 Tick box if with wheelchair / buggie

Pass	DEPART	DEPART
W	0:28	<input checked="" type="checkbox"/>
W	1:14	<input type="checkbox"/>
W	3:26	<input type="checkbox"/>
W	1:51	<input type="checkbox"/>
W	1:34	<input type="checkbox"/>
W	2:51	<input type="checkbox"/>
W	4:20	<input type="checkbox"/>
W	4:20	<input type="checkbox"/>
W	6:09	<input type="checkbox"/>
W	0:00	<input type="checkbox"/>
W	2:18	<input type="checkbox"/>
W	5:17	<input type="checkbox"/>
W	1:07	<input type="checkbox"/>

Pass	DEPART	DEPART
W	6:33	<input checked="" type="checkbox"/>
W	4:49	<input type="checkbox"/>
W	1:31	<input type="checkbox"/>

Pass	DEPART	DEPART
		<input checked="" type="checkbox"/>

Pass	DEPART	DEPART
		<input checked="" type="checkbox"/>

In addition to the case study locations, Glasgow and West Dunbartonshire, primary data was also collected from two further locations, Belfast and Edinburgh, and this has been used to provide an additional element of comparison in the course of the work.

Belfast

Taxi services in Belfast operate as a part of a larger licensing authority, the DOE, responsible for licensing taxis throughout Northern Ireland, and within a split system of Belfast only Hackney licensing alongside a Northern Ireland-wide license for all other areas. The authority does not limit license numbers but does set tariff controls as maxima. Northern Ireland also differs from most other areas of Great Britain in that larger cities operate a system of Taxibus services, known locally as 'Black Taxis'.

In the course of this study interviews were held with the Licensing Authority (the DOE), taxi operators including the Combined Group of Belfast Taxi Proprietors Associations, and the Police Service of Northern Ireland.

A key area of interest of the research undertaken in Northern Ireland, was the operation of taxi services in the Night Time Economy, full details of which are set out in Cooper, 2005. Belfast differed from Scottish cities in a number of respects, of which a fundamental difference lay in the supply of taxis, which in the Scottish focus locations was predominated by the Hackney market; while in Belfast Private Hire PHV taxis were much more common. It is significant also to note that the priorities of the licensing authorities and those of the police in their enforcement role differed between Belfast and the other locations. The PSNI expressed and demonstrated a significantly higher wish to clear streets of drunken revellers than enforce licensing distinctions between Hackney and PHV taxis; the effect of which - at the time of writing - appeared to be increasing concerns within the trade specific to illegal and semi-legal Pick-ups (PUs).

It was further noted that Belfast bus services stop in the late evening, and had not, at the time of research³, been successfully complemented by late night buses, although initiatives exist to re-launch a limited night link service. Taxi services were seen as a primary source of public transport home from entertainment.

Taxi delay was expressed as a concern among groups other than the taxi proprietors, although this was later acknowledged by the taxi companies, and specifically in terms of its contribution to illegal PUs.

The licensing authority were clear in their stated and perceived role in the oversight of taxi services in Northern Ireland, and identified strengths in the Northern Ireland operation specific to vehicle safety and control. As Northern Ireland did not control the numbers of licenses available the authority did not regularly undertake SUD type surveys, but continued to monitor use on the basis of increasing numbers of licensed vehicles available as a method of reducing illegal PUs.

Edinburgh

The City of Edinburgh operates a high quality fleet of taxis with predefined numbers of licenses and strict quality controls in terms of vehicle type. An unlimited number of PHV licenses may be issued in the city, with the result that the city operates a successful dual system - Hackney and PHV vehicles.

Discussion and interviews with licensing and taxi trade in Edinburgh took place early in the development of the thesis and informed the understanding of specific areas of taxi control, most specifically the development of the Tariff Models, and included structured interviews with the city and with the taxi trade. The development of the Edinburgh Taxi Tariff Model is reported in Cooper, 2003a, and was defined by the identification of individual sensitivities to supply and the nature of the working patterns within the trade. Drivers in the city expressed concerns over personal safety, and this often restricted their desire (propensity) to supply at particular times (and to

³ Night time buses have since been introduced on a limited number of routes.

particular locations). The concept of driver propensity to supply is developed and carried forward to the application of the new modelling framework, applied in both case study cities (see Chapter Nine).

Edinburgh also argued both for and against a broadening of the types of vehicles permissible within the fleet, this being set at the time of research to include LTI and Metrocab vehicles only⁴. The case being passionately supported in both camps by city and operator, and by one of the manufacturers of alternative vehicles.

As with Belfast and Glasgow, Edinburgh identified a number of locations and points in time where delay became an issue, and carries out regular SUD studies to determine appropriateness of fleet.

⁴ A more recent amendment in the conditions of fitness applied in the city allows for a number of additional vehicle types to be used.

Research detailed in this report was completed in the period to November 2006. In the period since the completion of the data collection the author has continued to work with Scottish and UK licensing authorities in developing appropriate solutions to the issues in supply and use of taxis, summarised here.

Glasgow City Council have set a new combined tariff model based on the linkages defined in this work, and developed in collaboration between the author, the city council and Glasgow Taxis Ltd. The new model has been agreed and is being applied in the period 2007 – 2008 and in subsequent reviews.

Similarly, Glasgow has adopted a number of Non-Licensing solutions, following principals set out in the NLSM elements of this thesis and applied in Glasgow in the period between the 2005 survey detailed in this document, and a subsequent assessment completed by the author in 2007 (see Cooper, 2007). The effects of the NLSM model solution, which included the use of marshals at Glasgow Gordon Street and Sauchehall Street stances has been a significant drop in ISUD values from ISUD = 83 in 2005, to ISUD = 32 in 2007.

Executive functions and government departmental responsibility returned to the Northern Ireland executive during 2007.

The author continues to develop other areas of taxi analysis that build on the concepts set out in this thesis and include Tariff Model (Glasgow 2007), and submission of similar analysis outlines to Leeds (2007), Liverpool (2007) and Oldham MBC (2007).