# Urban Congestion charging:

## Road pricing as a traffic reduction measure

Werner Heyns
2004

# URBAN CONGESTION CHARGING: ROAD PRICING AS A TRAFFIC REDUCTION MEASURE

W. HEYNS B. Art. et Scien. (Bepl.), Hons. B.A.

Dissertation submitted for the degree Magister Artium et Scientiae (Planning) at the North-West University (Potchefstroom Campus)

Supervisor: Prof. C.B. Schoeman

Co-supervisor: Dr. M. Landré

2005

Potchefstroom

# Abstract

Urban traffic congestion is recognised as a major problem by most people in world cities. However, the implementation of congestion reducing measures on a wide scale eludes most world cities suffering from traffic congestion, as many oppose the notion of road pricing and despite economists and transportation professionals having advocated its benefits for a number of decades. The effects of road pricing have attracted considerable attention from researchers examining its effects, as it is thought to hold the key in understanding and overcoming some inherent obstacles to implementation. Unfortunately, many of the attempts consider the effects in isolation and with hypothetical, idealised and analytical tools, sometimes loosing sight of the complexities of the problem.

This research empirically investigates the effects of road pricing in London, and identifies factors, which may prove to sustain it as a traffic reduction instrument. The results indicate that an integrated approach has to be developed and implemented, based upon the recognition of local perceptions, concerns, aspirations and locally acceptable solutions, if the acceptance of road pricing is to be improved. The key to dealing with the effects of road pricing, is to encourage a concerted effort by various stakeholders developing strategies considering a range of differing initiatives, coordinating and managing them in the realm of the political-economic context in which they exist.

# Summary and key terms

## Title

Urban congestion charging: Road pricing as a traffic reduction measure

## Summary

Traffic congestion is recognised as a major problem affecting most urban areas around the world, as road user demand outstrips the supply of road infrastructure. Because transport facilitates economic activity and social prosperity and because traffic congestion has the reverse effect it is necessary to consider instruments curbing its existence. Urban congestion charging as strategy and road pricing as instrument is one such measure to tackle the problem. Undoubtedly the introduction of road pricing will affect the socio-economic and spatial environment we live in. The effects of road pricing have been considered by a variety of researchers, as it is thought to hold the key in understanding and overcoming some inherent obstacles to implementation. Many considered the effects in isolation and with hypothetical, idealised and analytical tools, leaving gaps in empirical research.

Departing from this point, the research endeavours to empirically investigate the effects of road pricing in London identify factors, which may prove to sustain it as a traffic reduction instrument and to formulate plausible recommendations on ways of implementing a sustainable road pricing scheme. The method employed to achieve this aim gets underway by undertaking desk research, whereby a thorough literature review is achieved, reporting a well integrated review of the issues researched and the gaps identified.

The desk research is followed by an empirical investigation exploring the gaps and exposing public and stakeholder perceptions. The results will be reported and statistically analysed and interpreted, drawing conclusions, making inferences and identifying any remaining problem areas, concerns and obstacles to successfully implementing road pricing. Once a more holistic picture has been formed, the stage is set to identify various options (borne out of stakeholder perceptions) to overcome these problems and to develop and recommend feasible ways of implementing an acceptable and sustainable road pricing scheme. Multi Criteria Analysis (MCA) is used to establish preferences between alternative feasible options by reference to an explicit set of policy objectives that will be identified, and for which measurable criteria will be established, to assess the extent to which the options may contribute to achieving the objectives.

Finally, conclusions are drawn and recommendations are made based upon the MCA results taking the form of a package approach, whereby initiatives are formulated to implement road pricing in a suitable, acceptable and feasible way recognising the needs and perceptions of the stakeholders involved as far as practically possible. The results indicate that urban congestion charging does have the ability the reduce traffic congestion. Its implementation is subject to phasing and developing an integrated approach, based upon the recognition of local perceptions, concerns, aspirations and locally acceptable solutions, if the acceptance of road pricing is to be improved. The key to dealing with the effects of road pricing, is to encourage a concerted effort by various stakeholders developing strategies considering a range of differing initiatives, coordinating and managing them in the realm of the political-economic context in which they exist.

# Key terms

- **Efficiency**
- **Externality**
- **External costs**
- **Generalised cost**
- **Heterogeneous road users**
- **Internalisation**
- **Multi Criteria Analysis**
- **Pigouvian tax**
- **Revenue recycling**
- **Road pricing**
- **Transportation demand management**
- **Urban congestion charging**
- **Work schedule flexibility**

# Opsomming en sleutelterme

## Titel

Stedelike verkeerskongestie heffing: Padbeprysing as 'n verkeersverminderende instrument

## Opsomming

Stedelike verkeerskongestie word deur die meeste inwoners van wêreld stede as a groot probleem beskou omdat die voorsiening van padinfrastruktuur nie met die vraag daarna tred hou nie. Omrede vervoer ekonomiese aktwiteite en sosiale vooruitgang fassiliteer en verkeerskongestie die teenoorgestelde uitwerking het, is dit nodig om instrumente te implementeer wat hierdie probleem aanspreek. Stedelike verkeerskongestie heffing as strategie en padbeprysing as instrument is maar 'n enkele opsie in hierdie verband. Die implementering van padbeprysing het natuurlik spesifieke sosio-ekonomiese en ruimtelike ontwikkelingsuitwerkings in die omgewing waar dit geïmplimenteer word. Die uitwerking van padbeprysing het voorts aansienlike belangstelling ontlok onder die geledere van navorsers omdat geargumenteer word dat sou die uitwerking van padbeprysing verstaan word, dit moontlik die sleutel inhou tot die begryping en oorbrugging van soveel inherente beperkinge tot implementering. Ongelukkig het talle navorsingspogings die uitwerking van padbeprysing in isolasie en met hipotetiese, geïdealiseerde en analitiese instrumente ondersoek en derhalwe leemtes gelaat in empiriese navorsing.

Met hierdie probleem as agtergrond, is die doel van die studie om met Londen as teiken area, die uitwerking van padbeprysing te identifiseer en die faktore wat die onderhoubaarheid daarvan ondersteun, empriries te ondersoek. Hierdie kennis word dan aagewend om beplanningsvoorstelle te ontwikkel sodat padbeprysing as verkeersverminderende instrument op 'n onderhoubare wyse geïmplimenteer kan word. Ten einde hierdie doel te bereik word ten eerste 'n literatuurstudie onderneem sodat 'n geïntegreerde oorsig van die mees relevante teoretiese standpunte en leemtes gevorm kan word.

Na afloop van die literatuurstudie, is die volgende stap om die geïdentifiseerde leemtes en publieke en belangegroeppersepsies empiries te ondersoek. Die resultate sal daarna statisties ontleed, geïnterpreteer en gerapporteer word, waarna gevolgtrekkings en afleidings gemaak word om oorblywende probleme, bekommernisse en beperkinge tot implementering te ïdentifiseer. Hierdie nuwe kennis sal bydra tot die vorming van 'n geheelbeeld van al die komponenete wat implimentering bemoeilik en sal vooruitloop op die ontwikkeling van beleidsopsies om die probleme te oorkom en oplossings te formuleer sodat

padbeprysing as aanvaarbare en onderhoubare instrument geïmplimenteer kan word. Vir hierdie doel word multi kriteria analise aangewend om voorkeure tussen alternatiewe beleidsopsies te bepaal deur gebruik te maak van 'n spesifieke stel voorafbepaalde en meetbare beleidsdoelwitte sodat bepaal kan word tot watter mate die beleidsopsies tot die bereiking van die beleidsdoelwitte sal bydra.

Ten slotte word gevolgtrekkings en aanbevelings gemaak op grond van die multi kriteria analise. Die aanbevelings neem die vorm aan van 'n pakket benadering waardeur inisiatiewe geformuleer word sodat padbeprysing op 'n aanvaarbaare en onderhoubare wyse geïmplimenteer kan word en die behoeftes, bekommernisse en persepsies van die betrokke belangegroepe in ag neem. Die resultate toon dat stedelike verkongestie heffing wel oor die vermoë beskik om verkeerskongestie te verminder. Die implementering van padbeprysing is ook onderhewig aan die fassering en ontwikkeling van 'n geïntegreerde pakket benadering ten einde die aanvaarbaarheid van padbeprysing te bevorder met inagneming van publieke persepsies, bekommernisse, aspirasies en plaaslik geïdentifiseerde oplossings. Die sleutel tot probleem oplossing is geleë in 'n gesamentlike poging waardeur verskillende belangegroepe strategieë ontwikkel met ondergeskikte inisiatiewe, dit evalueer, implimenteer, koördineer en bestuur binne die konteks van die politiek-ekonomiese gesteldheid waarin die probleem voorkom.

## Sleutelterme

- **Algemene koste**
- **Buigsame werkskedule**
- **Doelmatigheid**
- **Eksternaliteit**
- **Eksterne koste**
- **Hetrogene padgebruikers**
- **Inkomste herbenutting**
- **Internalisering**
- **Multi Kriteria Analise**
- **Pigouviaanse belasting**
- **Stedelike verkeerskongestie heffing**
- **Padbeprysing**
- **Vervoer vraag bestuur**

# Acknowledgements

My indebtedness and gratitude to the many individuals who have encouraged and supported me throughout this study cannot adequately be conveyed in a few sentences. However, I must once again record my immense indebtedness, sincere thanks and appreciation to:

- My parents, for their encouragement, support and love throughout this study.
- Lana, for her support, love and patience during the past two years, who provided me with spiritual and intellectual inspiration to persevere under sometimes difficult circumstances, I can do no more than reaffirm my eternal devotion. She has always been there to help me maintain a proper perspective on live and living, through her own creative and artistic talents, to inspire me to think in original and sometimes unconventional ways to constructively record my problem solving thoughts.
- Prof Calie Schoeman and Dr Martin Landré for their thorough and professional guidance. I am also appreciative of the detailed and insightful comments, advice, criticisms and suggestions made.
- My friends for their interest and support.
- The personnel of Mouchel Parkman and especially my colleagues in Sidcup for their moral support.
- Gill Gupta for proof reading and editing the text.

**For Lana**

# Contents

## Chapter 1 Introduction



## Chapter 2 The case for road pricing

## Chapter 3 Effects of Road pricing

## Chapter 4 Sustainability issues

## Chapter 5 Methodology

## Chapter 6 Results

# Chapter 7 Discussion and interpretation

## Chapter 8 Multi criteria analysis

## Chapter 9 Conclusions



## Chapter 10 Recommendations

# Appendices

## Charts



## Diagrams

# Figures



# Tables

# Chapter 1 Introduction

## 1.1 Orientation

Traffic congestion is recognised as a major problem affecting most urban areas around the world, because road user demand is outstripping the supply of road infrastructure. Subsequently, road users are faced with capacity constraints manifesting themselves in journey time delays and recurrent traffic congestion. The consequential delays negatively affects economic activity as a whole and have adverse effects on the environment we live in and on peoples' welfare.

As a result a number of alternative measures have been suggested to resolve the congestion problem. Congestion charging is one of the many alternative measures and has long featured in the list of preferred measures recommended by economists and transportation professionals to solve urban traffic congestion problems. The introduction of prices in order to manage road user demand in city centres has been recognised by economists as a powerful instrument and numerous research projects and publications have been dedicated to developing models and showing the expected results of associated measures on traffic saturation levels.

Despite this prognosis, governments have fallen a long way short of committing themselves to strong traffic and demand management instruments, such as the introduction of road pricing. In the past, public and political opposition to road pricing has proved prohibitive. Officials have been hard-pressed to persuade the public that it should pay for a driving privilege, which until recently, has been virtually free and is often viewed as an inviolable right. But with mounting pressure from environmentally conscious citizens and with the growing discontent that stems from unconscionably long commute times, the tide of public opinion seems poised to be reversed.

For a few decades the congestion road pricing problem has attracted considerable attention from both economists and transportation researchers who have examined its effects in different ways, albeit in isolation. Although the theoretical foundation of congestion charging and road pricing have been well established, it has been difficult to deal satisfactorily with the effects of road pricing in hypothetical, idealized situations using analytical tools, as has been the historic trend. The general approach of this study is to empirically explore these effects against international experience and identify and investigate the means of sustaining road pricing. Fundamentally, the elements involved have to be connected in illuminating the interplay of the entire spectrum of effects and supporting measures, ultimately enabling realistic, acceptable and plausible initiatives to overcome identified obstacles.

## 1.2 Previous research

Economists have extensively explored the role that economic incentives such as congestion charging might play in bringing about a more efficient allocation of road space and natural resources. Congestion charging has been advocated as an element in urban transport policy for over 40 years following the seminal work of Vickrey in 1955 (Vickrey, 1963:452). Since then it has attracted increased attention, with proposals for other cities, and the successful implementation of the Singapore Area Licensing Scheme (Holland and Watson, 1978:14) in 1975. Singapore is a pioneer in implementing congestion charging schemes. The area licensing scheme (ALS) was the first manual road pricing system in the world. It was targeted at the CBD area. The original idea of congestion charging in urban areas originated from the Smeed Report, sponsored by the Ministry of Transport in the UK, which formed the groundwork for the increasing interest in road congestion charging which has subsequently taken place.

At a more practical level, studies were carried out in a number of British cities to assess the probable impact of road pricing on both the local transport system and urban life in the city. In the early 1970's the Greater London Council intended to introduce a daily ticket scheme. The cost would have been £1 for cars and £3 for commercial vehicles using central London roads. The proposal, however, was withdrawn the following year in the face of political opposition.

Many subsequent articles have highlighted the debate in the UK context, for example, Sharp (1966:806 and 1968:119), Smeed (1968:33), Button (1975:15 and 1982:353) and others. Interest in road pricing has also been strong in the United States (Button, 1983:15 and 1994:289). Some early attempts were made in the US advocating the implementation of congestion pricing in US cities. It was the contribution of Downs in 1962 and Boardman et al. in 1977, which put road pricing on the public agenda. Subsequently, attempts to utilize pricing policies to alleviate the urban traffic congestion problem were made both from federal and some state agencies.

During the period of the 1960's and 1970's there have been many desktop studies in the US context, for example, Walters (1961:676) on US expressways and Higgins (1979:99) on more general issues. In the mid-80's Hong Kong have made a serious attempt to implement a truly electronic road pricing (ERP) system. After a two-year trial the system demonstrated significant benefits to the urban transport system but the project was eventually terminated due to social and political pressures. In particular, the privacy issue was highlighted as a main concern as the system must capture the license plate. Dawson (1986:79) has given detailed coverage on these developments.

This was followed by the implementation of the first Norwegian Toll Rings (Larsen, 1995:187, 2001:1) in the late 1980's, further studies in London (Richards et al., 1996:66) and other UK cities and an extensive US review in the mid 1990's. Despite this considerable activity, however, only a handful of operational schemes exists, notably that in Singapore (recently converted to electronic road pricing), the three toll rings in the Norwegian cities of Bergen, Oslo and Trondheim, the operation of toll lanes in the US and most recently, the cordon toll operational in London. While economists saw road pricing as an attractive policy tool, most attempts to introduce economic incentives of this type in the transportation sector have failed (Jones, 1998). These failures it is fair to say, are not primarily due to the technical difficulties of introducing the appropriate price incentives. Rather, road pricing is rarely adopted because the public does not support these policy measures.

In the late 1990's, Small and Gomez-Ibanez (1998:213) drew attention to the growing urgency for managing congestion problems in almost all countries with a substantial vehicle population. It had become evident that there was no room for wishful thinking - traffic congestion was just going to get worse and worse. In recognising the need to manage road capacity and to introduce acceptable measures to address traffic congestion, the concept of transportation demand management (TDM) was developed (Burris and Pendyala, 2002:241). The concept refers to a structured hierarchy of measures moving from the more general to the more specific application of traffic restraint instruments. By way of example, congestion charging is seen as the overarching strategy describing a combination of programs or instruments and road pricing - one of many underlying instruments to restrain traffic congestion.

Throughout the historic empirical development of road pricing, authors such as Holland and Watson (1978:14), Watson and Holland (1976:20), Toh (1977:52), McCarthy and Tay (1993:296) and Koh and Lee (1998:31), thought that, by modeling, researching and predicting the impacts of road pricing, some light might be shed on understanding and overcoming the specific difficulties in implementing road pricing. This list is by no means exhaustive - many others attempted to identify methods and conditions for successful implementation. There is an extensive literature in the theory of road pricing. For more discussion on this subject interested readers can refer to Walters (1961:676), Vickery (1969:251), Henderson (1974:346), Layard (1977:297), Button and Pearman (1983:15), Morrison (1986:87), Starkie (1986:169), Small (1983:90), Newbery (1990:22), Hensher and Sullivan (2003:139), Evans (1992a,b), Hau (1992b) and Thomson (1998:93).

Sadly the current literature in road pricing has revealed a number of existing shortcomings in accurately and realistically mapping out the effects of road pricing, thereby providing the substantiation for undertaking this study. The following section briefly outlines existing gaps and shortcomings, which once filled, will move road pricing a great deal closer to successful implementation.

# 1.3 Shortcomings in previous research

As the theme of the investigation suggests, the general approach of this study is to explore the effects of road pricing as a traffic reduction instrument, by placing the research in the context of previous work. A review of the current literature has revealed a number of issues pertaining to the effects of road pricing and the factors which may support road pricing especially need to be clarified. Once these issues have been addressed, and admittedly once a greater appreciation of public perception is achieved, plausible recommendations can be formulated to put road pricing forward as a viable and sustainable instrument in reducing traffic congestion. The shortcomings reported in the following sub-sections are divided into two categories. The first relates to the effects of road pricing and the second to supporting factors.

## 1.3.1 The effects of road pricing

Authors such as Ferrari (2002), Leontaridi (1997), Newbery and Santos (2002), Santos (2000a,b), Van Dender and Proost (2001) and Verhoef et al. (1998, 2002) to name but a few, point to the economic justification of road pricing, based on the argument of road users imposing external cost on other travellers when using the road network without realising this when making a decision to travel. A great deal of research relies on modelling the economic effects of road pricing without identifying the exact nature of the local economic effects caused by road pricing.

Attempts have been made by Ferrari (2002), Lindsey and Verhoef (2000), Marcucci (1998), Proost and Van Dender (2001) and Santos (2002a) to identify an optimal charge to increase social welfare. Their research, however fails to quantify the impact road pricing has on the social welfare of local road users and local and peripheral residents - their results rely on modelling and assumptions and they do not consider the effect of road pricing on heterogeneous users and their respective behavioural adjustments.

The current effects road pricing has on land use patterns in urban areas are not fully explained in the current literature. Chatterjee et al (2001) confirms this view by stating the way in which land use patterns have adapted to road pricing and alternative modes of transport has not yet been considered thoroughly and needs to be examined more closely in future transport strategies. More attention must also be given to exploring the complementary role which may exist between land use planning and road pricing as Stead and Banister (2001) suggest.

The positive side effects of road pricing in relation to environmental benefits have been researched significantly. However little has been done in terms of advancing this positive side effect in order to increase the acceptance of road pricing. Chin (1996), Hillman (1992), Santos and Newbery (2002) and

Santos et al. (2000) have shown that road pricing is beneficial to the urban environment in economic terms. The idea of introducing green taxes instead of, or in conjunction with, road pricing may well be an alternative worth exploring as Rufolo and Bertini (2003) suggest.

### 1.3.2 Measures supporting the acceptance and success of road pricing

The literature has identified a number of potential measures or factors which may prove to sustain the viability and feasibility of road pricing. They are:

- Revenue recycling
- Driver information provision
- The provision of greater work schedule flexibility
- Political and public acceptability.

Revenue recycling has been and is acknowledged as an important source of investment in public transport and infrastructure maintenance according Parry and Bento (1999). However, little research has been done to identify other methods of redistributing the income to increase efficiency and equity (Litman, 1999) and (Newbery and Santos, 1999).

According to Daganzo (1995, 1998), Emmerink et al (1998), Emmerink and Van Beek (1997) and Jakobson et al. (2000), social welfare may increase, and road space be used more efficiently, if road users are provided with appropriate driver information and sensible work schedule flexibility. Generally their research has not determined the factors influencing work schedule flexibility, the level of satisfaction derived from the actual work start time, the amount of flexibility (allowed for by both the employer and the employees themselves) in the work start time and how it can be employed as a factor supporting the success of road pricing.

Public and political acceptance have been identified as important conditions for implementation. Despite a thorough theoretical background to road pricing very few have been implemented world wide (Goodwin, 1990; Lindsey and Verhoef, 2000; Marcucci, 1998:1). The obvious question is why? A greater understanding of public and other stakeholder reasoning and perception is required if public acceptability is to be achieved.

## 1.4 Problem statement

Once the main shortcomings and important gaps have been identified, the problem to be solved is formulated as follows:

- It is recognised that urban traffic congestion is an unsatisfactory situation in major cities, as road capacity does not increase in the same proportion as the volume of traffic, resulting in a wide variety of adverse consequences and impacts.

- Implementing road pricing as a fiscal instrument managing the excess demand for road space has definitive effects on the socio-economic, environmental and land use patterns of the urban landscape.

- There appears to be a gap in empirical research and current knowledge of the local level effects of road pricing on the local economy, the social welfare of people, land use patterns and the environment, in terms of different stakeholder perception.

- A better understanding of the link between road pricing and the factors supporting its sustainability and viability is required for it to be incorporated in a viable instrument reducing traffic congestion.

## 1.5 Research question

The following central research question has been formulated to address the problem statement:

**What effects does urban road pricing have and which factors underpin its sustainability and viability as an acceptable urban traffic congestion reduction measure?**

The research question is more general and not in itself answerable because of its generality. For this reason, the study and especially the data-gathering process will be guided by 11 more **specific research questions** presented below. The purpose of these questions is to simplify the research question by narrowing the focus of the research. They are more specific, detailed and are directly answerable because they point to where the data needed to answer them, can be found.

1. What are the local economic effects of urban congestion charging on local and peripheral residents?

2. What impact does road pricing have on the social welfare of local and peripheral residents?

3. Do businesses, local and peripheral residents and local authorities envisage changes to land use patterns as a result of road pricing?

4. What effect do residents, businesses and environmental agencies think road pricing would have on the environment?

5. Do residents, businesses and public transport providers think that revenue recycling would increase the efficiency and reliability of public transport?

6. Would providing greater work-scheme flexibility to local residents be advantageous to an urban congestion charging scheme?

7. Is the public's unwillingness to accept urban congestion charging a reason for non-implementation?

8. Would public acceptance backed by political will make urban congestion charging a viable and acceptable option to reduce traffic congestion?

9. Do stakeholders such as local residents, businesses, local Authorities, public transport providers and environmentalists perceive road pricing as a cause of traffic displacement?

10. Do the stakeholders perceive the provision of driver information as a persuasive tool increasing the acceptance of urban congestion charging?

11. Do the stakeholders think there will be any benefits or non-benefits from road pricing?

# 1.6 Research aims and objectives

The research aims to:

i) explore the effects of road pricing
ii) explore the factors sustaining its viability and acceptance
iii) formulate plausible recommendations on ways of implementing a sustainable road pricing scheme.

The study therefore aims to achieve the following research **objectives:**

i. determine whether road pricing is perceived to and actually reduces urban traffic congestion levels
ii. determine the scope of the effects road pricing has as a fiscal instrument in reducing urban traffic congestion in the local setting
iii. identify and explore factors such as revenue recycling, work schedule flexibility, public and political acceptance and driver information provision in support of road pricing sustainability
iv. comprehensively review the current literature on urban congestion charging and more specifically road pricing, in sharpening the focus of the study to give structure and to connect the empirical results with the literature
v. answer the general and more specific research questions
vi. identify locally perceived problem areas or obstacles
vii. identify, evaluate and rank options to overcome locally perceived problem areas or obstacles
viii. formulate plausible recommendations on how to present road pricing as a viable and sustainable policy instrument.

# 1.7 Key concepts

The following key concepts, features as an important part of the terminology of this study and are defined as follows:

- **Direct democratic approval** represents a political process in which voters (also road users) are provided with strategic information about congestion charging and are forced to vote directly for or against it.

- **Efficiency** is a benchmark criterion for resource use that is satisfied when resources are used over any given period of time in such a way as to make it impossible to increase the well-being of any one person without reducing the well-being of any other person, also known as a Pareto optimal outcome.

- An **externality** refers to any costs or benefits unknowingly generated by road users as a result of their use of a road, affecting the costs and benefits of third party road users.

- **External costs** such as accidents, noise, and road damage refers to the real costs of road usage imposed by an individual driver, not faced by him but by road users collectively.

- **Generalised cost** refers to the operating costs of a vehicle, tolls or congestion charges paid, the cost of in-vehicle travel time involved in making the journey and varies by mode.

- **Green taxes** refer to taxes being levied on road users causing externalities.

- **Heterogeneous road users** are road users exhibiting different behavioural patterns, driver styles and decision making processes.

- **Internalisation** of external cost occurs when a corrective tax such as a congestion charge is levied on road users to adjust their marginal private benefits or costs incurred, forcing them to consider the actual or true marginal social benefit or cost of their decisions.

- **Local residents** are those residents residing within a cordon area being charged.

- **Multi Criteria Analysis** (MCA) is a tool used in establishing preferences between options by reference to an explicit set of policy objectives identified, and for which measurable criteria established to assess the extent to which the options may contribute towards achieving the objectives.

- **Peripheral residents** are those residents residing on the periphery or adjacent to the cordon area.

- A **Pigouvian tax** is a government imposed tax on third parties for causing an externality, levied by an amount equal to the externality, hence internalising the externality and associated external costs.

- A tax is **progressive** if the ratio of tax paid to earned income rises when moving up an income scale.

- **Public transport providers** refer to the stakeholders responsible for the direct provision of passenger transport by different mode, such as bus services, overland train services, underground services and taxi services.

- A tax is **regressive** if the ratio of tax paid to earned income declines when moving up an income scale.

- **Revenue recycling** refers to the process of using funds obtained from road pricing to financing road maintenance, public transport improvements, cash rebates and the provision of subsidies.

- **Road pricing** is a demand management instrument by which motorists pay directly for using a particular road or driving in a particular area.

- **Transportation demand management** (TDM) is a term used to describe transport strategies that result in more efficient use of existing transportation infrastructure.

- **Urban congestion charging** refers to the implementation of strategies and/or instruments specifically designed to reduce driving and encouraging alternative modes of transport by charging motorists.

- **Work schedule flexibility** is defined as the number of minutes between the latest and earliest work start time as permitted by the employer.

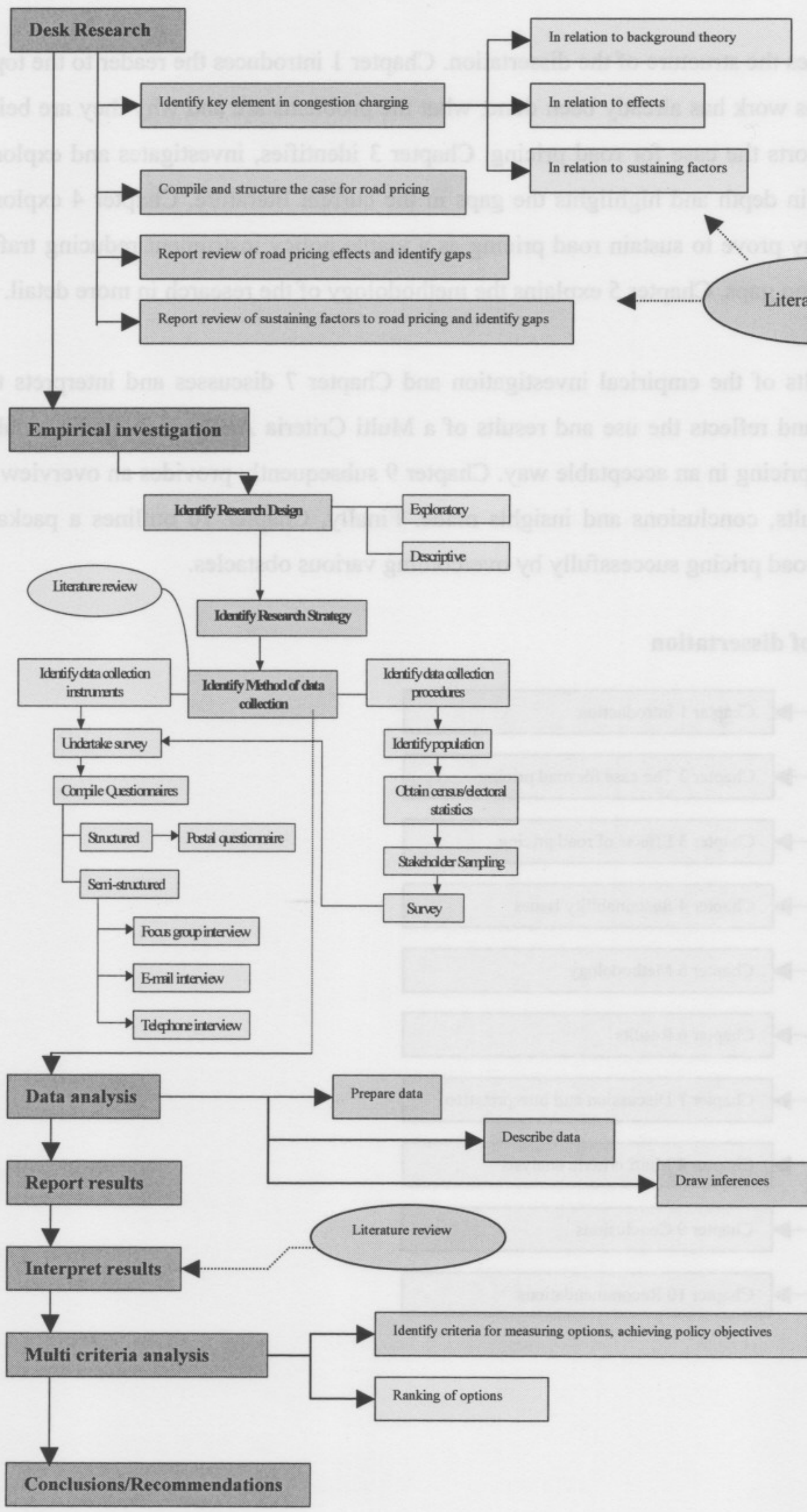
# 1.8 Method of investigation

Diagram 1.1, the conceptual model of the research process on page 11, briefly summarises the method of the investigation followed. The study gets underway by undertaking desk research, whereby a thorough literature review is undertaken, reporting a well integrated review of the issues discussed and the gaps identified. The information, viewpoints and insights obtained from primary sources are used to contribute towards clarifying arguments which are discussed and developed and to confirm or disprove the views and findings of the research and form part of critical discussion with such authors.

The desk research is followed by an empirical investigation exploring the gaps and exposing public and stakeholder perceptions. The results will be reported and statistically analysed and interpreted, drawing conclusions, making inferences and identifying any remaining problem areas, concerns and obstacles to successfully implementing road pricing. Once a more holistic picture has been formed, the stage is set to identify various options (borne out of stakeholder perceptions) to overcome these problems and to develop and recommend feasible ways of implementing an acceptable and sustainable road pricing scheme.

Multi Criteria Analysis (MCA) is used to establish preferences between alternative feasible options by reference to an explicit set of policy objectives that will be identified, and for which measurable criteria will be established, to assess the extent to which the options may contribute to achieving the objectives. Finally, recommendations are made based upon the MCA results with regard to making decisions about proposals for future action and the actual choice of options. The recommendations will take the form of a package approach, whereby initiatives are formulated to implement road pricing in a suitable, acceptable and feasible way recognising the needs and perceptions of the stakeholders involved as far as practically possible. The method of investigation is explained in more detail in Chapter 5.

**Diagram 1.1 Conceptual model of the research process**

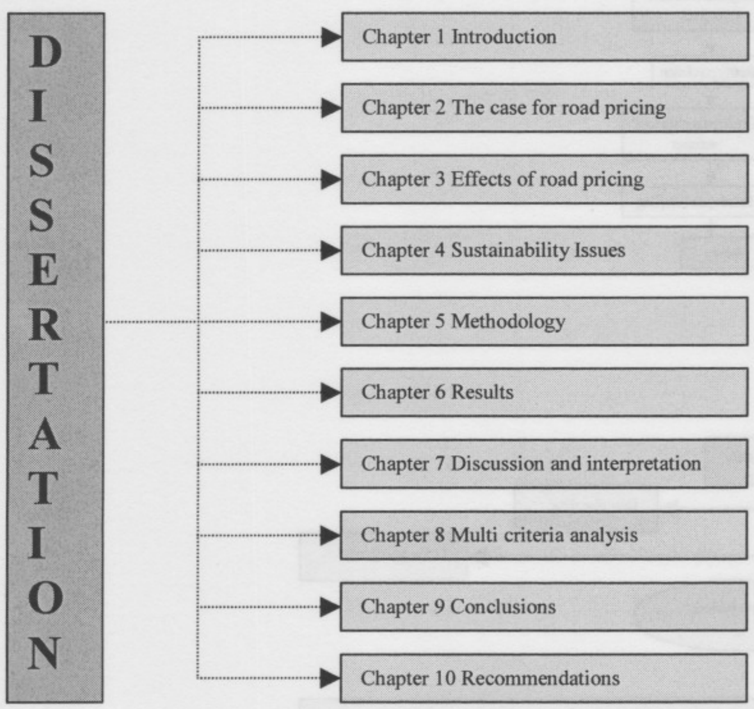


## 1.9 Structure of the dissertation

Diagram 1.2 below illustrates the structure of the dissertation. Chapter 1 introduces the reader to the topic of discussion, what previous work has already been done, what the problems are and why they are being investigated. Chapter 2 reports the case for road pricing. Chapter 3 identifies, investigates and explores the effects of road pricing in depth and highlights the gaps in the current literature. Chapter 4 explores identified factors which may prove to sustain road pricing as a viable policy instrument reducing traffic congestion, and some existing gaps. Chapter 5 explains the methodology of the research in more detail.

Chapter 6 reports the results of the empirical investigation and Chapter 7 discusses and interprets the results. Chapter 8 reports and reflects the use and results of a Multi Criteria Analysis in finding viable options to implement road pricing in an acceptable way. Chapter 9 subsequently provides an overview of the main findings and results, conclusions and insights made. Finally, Chapter 10 outlines a package approach to implementing road pricing successfully by overcoming various obstacles.

**Diagram 1.2 Structure of dissertation**



# Chapter 2 The case for road pricing

## 2.1 Introduction

The aim of this chapter is to introduce some important concepts in road pricing discussion to form a foundation for arguing the case for road pricing. In achieving this objective a number of intrinsically linked concepts will be explained and described, setting the stage for the chapters which follow.

The discussion will begin by identifying the link between and the importance of transport and the economy, and current trends in both. It is important to appreciate the link, since road pricing as an *economic* fiscal instrument is employed to combat traffic congestion as a *transport* phenomenon. This is followed by examining and identifying the role of the speed-flow relationship and how traffic congestion are caused. Once these concepts have been explored, it will be shown graphically how the speed-flow curve can be converted to a travel-time flow curve to reflect the financial cost of a journey. Showing how a financial value can be attributed to journey time, paves the way for explaining the rationale behind charging motorists in reducing traffic congestion.

Having clarified the logic of charging motorists, the concept of transportation demand management (TDM) will be investigated as will the relationship between TDM, congestion charging and road pricing hence moving from a more general approach to a more specific application of the chosen charging instrument. The identification of the relevant principles of taxation is equally important. When a tax is levied, its successfulness is measured against efficiency and equity principles. Whether road pricing is an efficient and equitable instrument can be judged using these criteria as a yardstick. The chapter will conclude by identifying those factors influencing the sustainability of road pricing and a brief reference to examples of current practice in road pricing.

## 2.2 The link between transport and the economy

There are good reasons why any government or highway authority should seek to have a thorough understanding of the nature and importance of the relationship between transport provision and the economy. Because transport can facilitate economic activity, it is necessary to consider the impact on economic growth and on proposals to invest in infrastructure or to adopt traffic reduction measures. Governments are usually committed to promoting sustainable development whilst embracing environmental, economic and social objectives. As key players in the planning process they need to be mindful of the link between transport, the economy and other political considerations when deciding on efficient transport and planning strategies.

Developing a clear understanding regarding the link between transport and the economy is difficult. Asking questions about that relationship, challenges a fundamental and obvious assumption: that economic growth, the need for movement and the need to invest to facilitate that movement go hand in hand. In order to ensure efficient decision-making the economic justification for traffic schemes must be as robust as possible while taking into consideration their impact on other areas.

The provision of road infrastructure is mainly a public function, hence government financing and investment is justified on the basis of promoting economic growth. Given the scarcity of public funds highway authorities are finding it increasingly difficult to finance new road construction and maintenance, as the rate of growth of travel demand outstrips the growth of road capacity (Hau, 1992a:3). What has become ever more apparent is that as new road capacity is created the latent demand expands and neutralises the impact of the road capacity expansion. This is an illustration of Parkinson's Law or Downs' law of peak-hour expressway congestion, in which commuter traffic ascends rapidly to the level of new capacity in urban areas (Downs, 1962:393), (Hau, 1992a:3). Clearly increasing road capacity per se is not enough to cope with increasing demand and calls for transportation demand management to intervene.

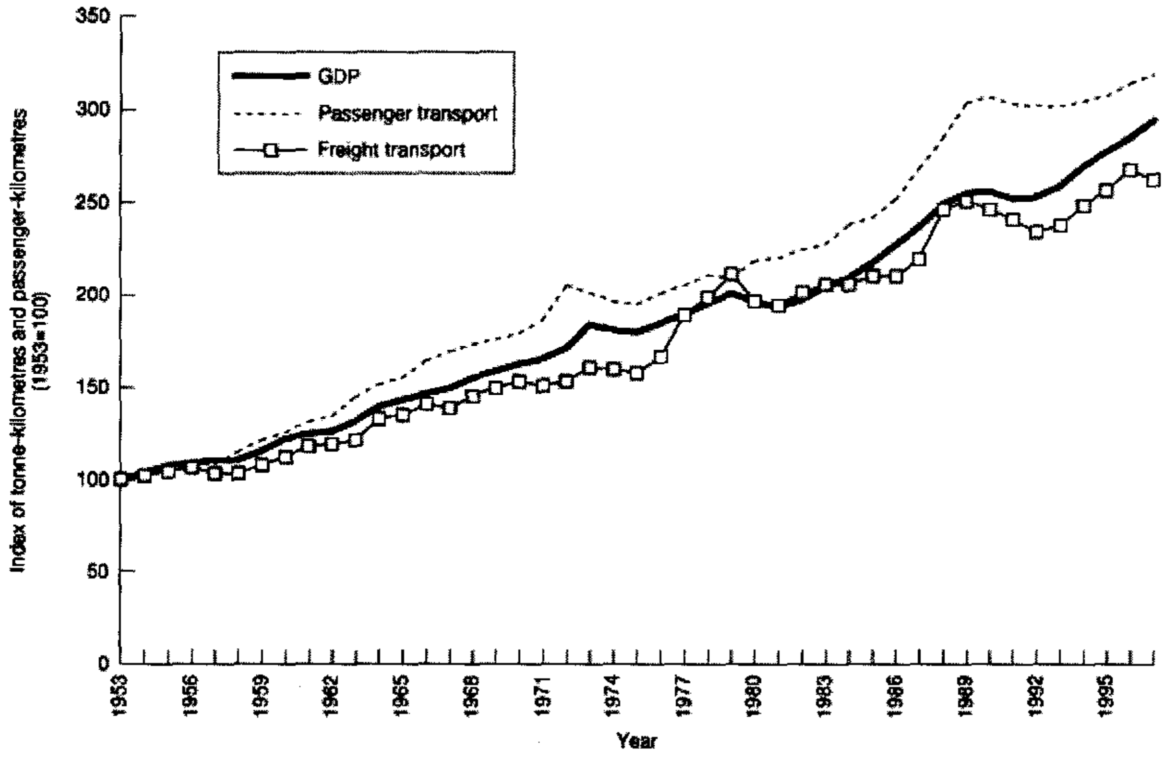
Public finance teaches that roads infrequently used possess the characteristic of non-rival consumption among users and are traditional examples of public goods. Collective consumption means that roads yield services that are simultaneously enjoyed by more than one user, without substantial detriment to the satisfaction of others. If roads are totally non-rivalrous, then neoclassical economic principles dictate that roads ought to be provided for by the public sector and financed from general revenue taxation, fully taking into account the social opportunity cost to public funds. On the other hand, roads which are heavily used have the nature of rival consumption among users and are called congestible public goods.

With free access to roads and property rights not clearly delineated, people are not barred from the use of scarce resources, resulting in overuse and eventually to the "free-rider" problem. Hence, the congestible characteristic of road space due to non-excludability, calls for governmental intervention in the form of better designed road user charges and motivating charges which would correct externalities and encourage Pareto optimal usage (Hyman, 1999:155), (Leontaridi, 1997:1-2).

## 2.2.1 Transport and economic trends

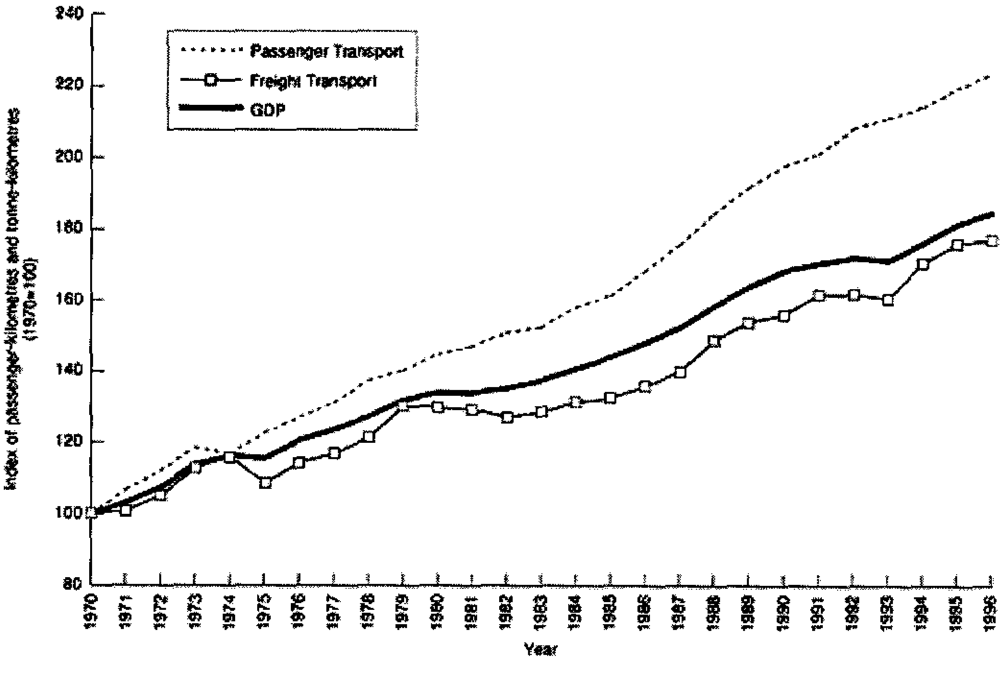
The debate about the link between transport and the economy takes place against the background of significant trends in both. Figures 2.1 to 2.7 and Tables 2.1 to 2.3 on pages 15 – 20, seek to give some indication of how the economy and the demand for transport have changed over time in the United Kingdom (Department for Transport, 2003b).

**Figure 2.1: Transport trends against GDP: UK 1953 – 1997**



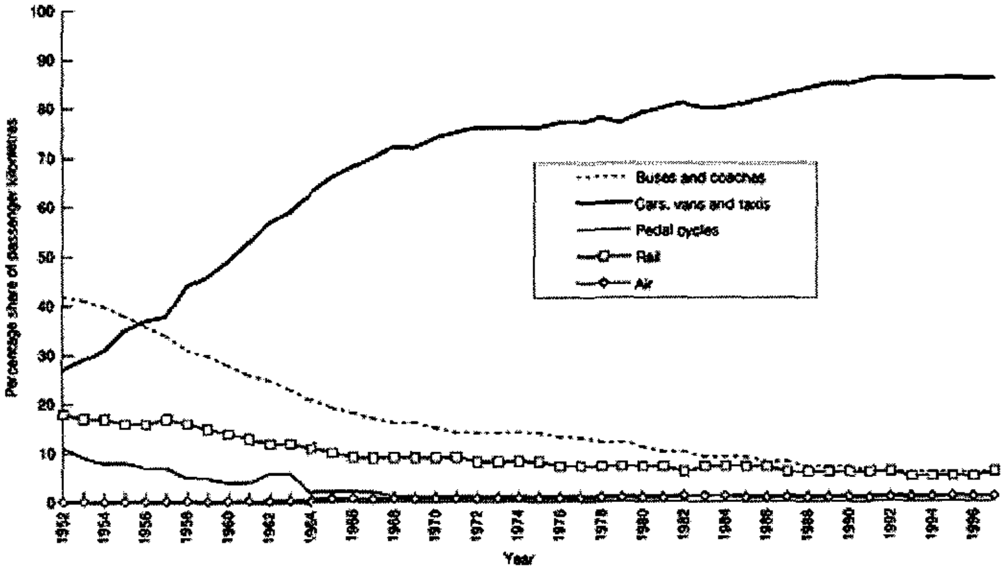

**Source: Department for Transport (2003b)**

**Figure 2.2: Transport Trends Against GDP: EU 1970-1996**



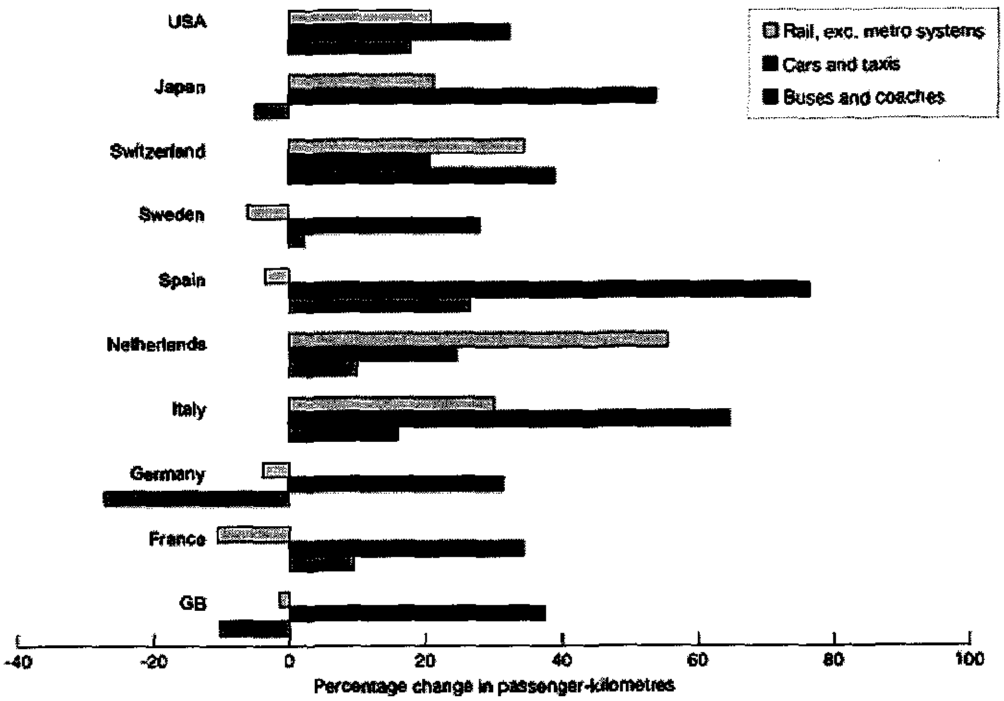

**Source: Department for Transport (2003b)**

**Figure 2.3: Passenger transport by mode: UK 1952-1997**



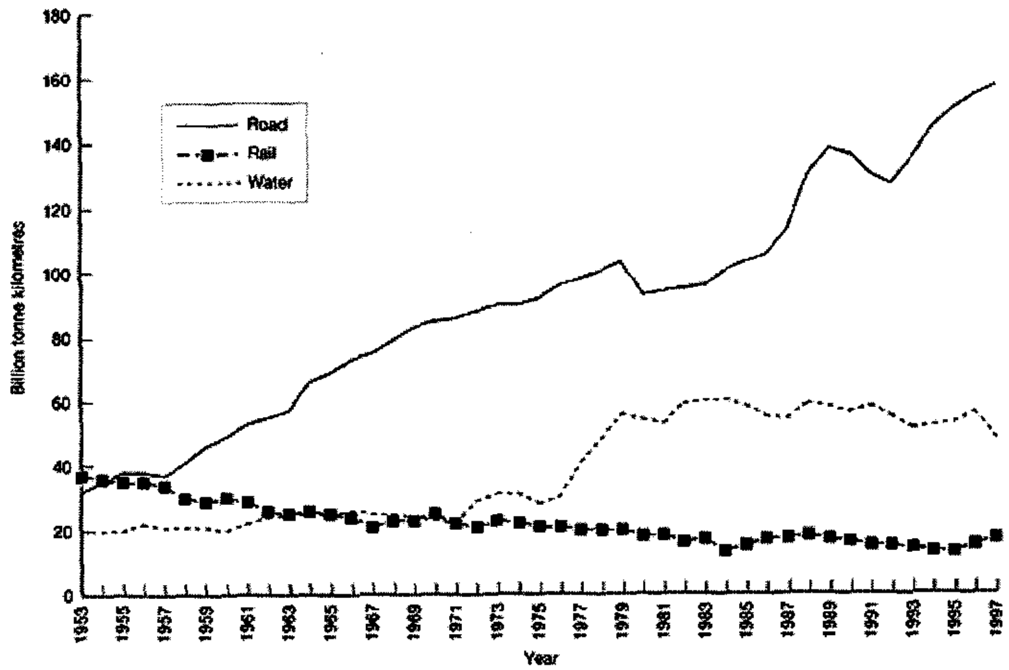

**Source: Department for Transport (2003b)**

**Figure 2.4: International comparison of model trends in passenger transport: 1985 – 1995**



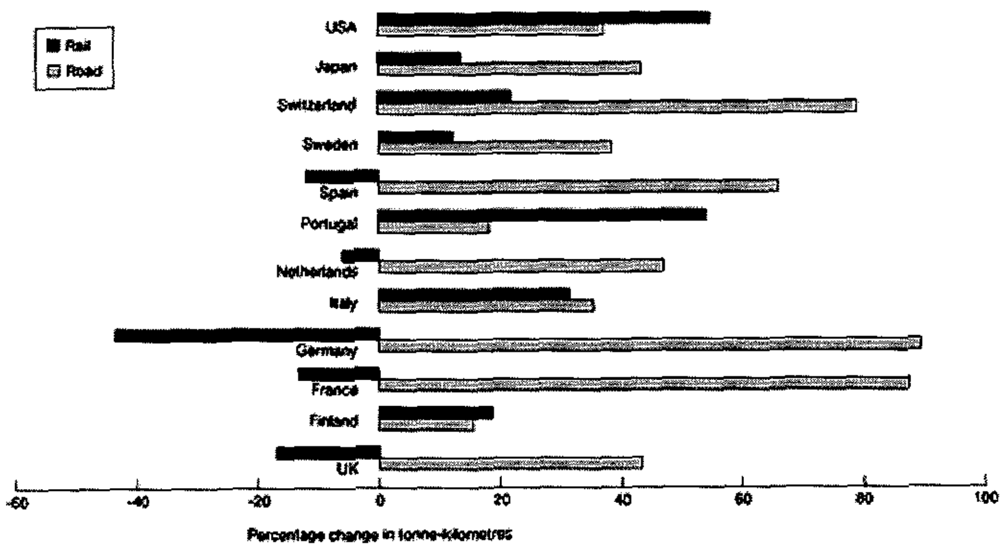

**Source: Department for Transport (2003b)**

**Figure 2.5: Domestic freight transport by mode: UK 1953-1997**



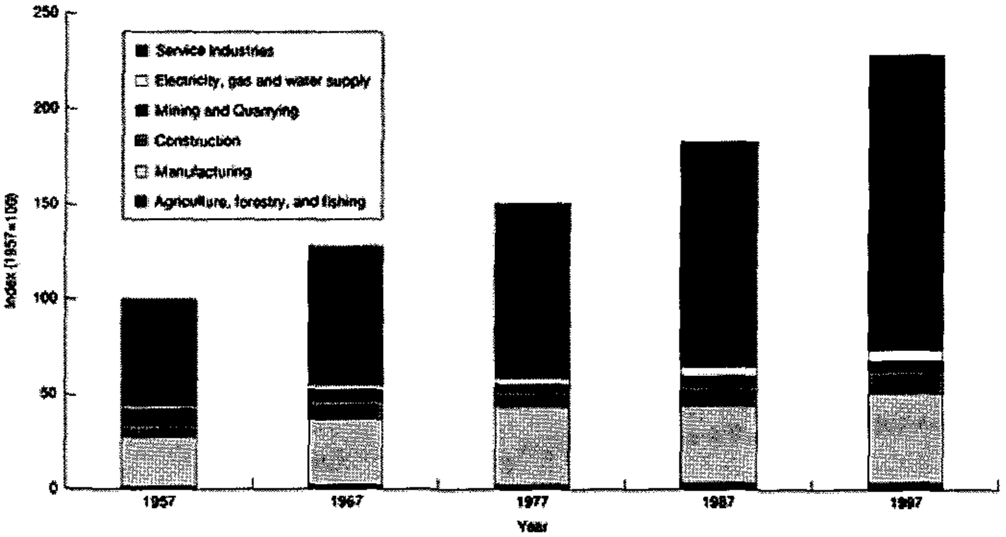

**Source: Department for Transport (2003b)**

**Figure 2.6: An international comparison of modal trends in freight transport: 1985-1995**




**Source: Department for Transport (2003b)**

**Figure 2.7: Growth in Economic sectors: UK 1957-1997 (By Gross Value Added constant 1995 basic prices)**




**Sources: Department for Transport (2003b)**

**Table 2.1: Average distance travelled by mode of travel: UK 1975-1997**

| Mode | Kilometres per person per year | Kilometres per person per year | Kilometres per person per year | Change (%) to 1995/7: | Change (%) to 1995/7: |
|---|---|---|---|---|---|
| | 1975/6 | 1985/6 | 1995/7 | From 1975/6 | From 1985/6 |
| **Walking** | 399 | 393 | 314 | -21 | -20 |
| **Bicycle** | 82 | 71 | 63 | -24 | -11 |
| **Private hire bus** | 240 | 211 | 169 | -30 | -20 |
| **Car** | 5139 | 6108 | 8346 | 62 | 37 |
| **Motorcycle/moped** | 76 | 82 | 48 | -36 | -41 |
| **Van/lorry** | 293 | 367 | 422 | 44 | 15 |
| **Other private** | 24 | 53 | 64 | 167 | 17 |
| **Buses in London** | 92 | 63 | 80 | -12 | 5 |
| **Other local bus** | 594 | 415 | 325 | -45 | -22 |
| **Non-local bus** | 80 | 175 | 150 | 86 | -15 |
| **LT Underground** | 55 | 71 | 82 | 50 | 22 |
| **Surface rail** | 457 | 470 | 473 | 4 | 1 |
| **Taxi/minicab** | 21 | 43 | 69 | 231 | 45 |
| **"Other public, inc. air"** | 27 | 35 | 121 | 341 | 180 |
| **All modes** | 7578 | 8555 | 10726 | 42 | 25 |

**Sources: Department for Transport (2003b)**

**Table 2.2 Journeys per person per year by main mode and journey purpose : UK 1995/7**

| Kilometres | Walk | Bicycle | Driver[1] | Passenger[1] | Motorcycle | Buses | Tube[2] | Rail[3] | Taxi | All modes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Purpose** | | | | | | | | | | |
| Commuting | 19 | 6 | 92 | 20 | 2 | 12 | 3 | 5 | 1 | 162 |
| Business | 4 | 1 | 27 | 3 | 0 | 0 | 0 | 1 | 0 | 37 |
| Education | 31 | 1 | 3 | 18 | 0 | 10 | 0 | 1 | 1 | 68 |
| Escort education | 24 | 0 | 19 | 6 | 0 | 1 | 0 | 0 | 0 | 51 |
| Shopping | 71 | 2 | 76 | 48 | 0 | 20 | 1 | 1 | 2 | 222 |
| Other escort | 11 | 0 | 46 | 23 | 0 | 1 | 0 | 0 | 0 | 83 |
| Other personal business | 31 | 1 | 40 | 24 | 0 | 6 | 1 | 1 | 1 | 106 |
| Visiting friends at home | 31 | 2 | 52 | 45 | 1 | 6 | 1 | 1 | 2 | 141 |
| Visiting friends elsewhere | 15 | 0 | 11 | 13 | 0 | 1 | 0 | 0 | 2 | 44 |
| Social/entertainment | 11 | 1 | 22 | 21 | 0 | 3 | 0 | 0 | 1 | 62 |
| Holidays/day trips | 2 | 2 | 10 | 13 | 0 | 2 | 0 | 0 | 0 | 31 |
| Other, inc. just walking | 43 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 45 |
| All purposes[4] | 293 | 17 | 401 | 236 | 4 | 64 | 6 | 11 | 10 | 1052 |

1 Note: Drivers and Passengers of cars and vans
2 Note: London Transport Underground
3 Note: Surface rail
4 Note: Figures rounded to nearest whole number

**Sources: Department for Transport (2003b)**

The last 40 years have seen growth in both the national economy, as measured by GDP and domestic traffic. Figure 2.1 shows that passenger traffic across all modes has grown at a faster rate than the economy as a whole, while freight traffic has grown at a slightly slower rate. Figure 2.2 indicates that this trend is broadly one that the UK has shared with other European countries.

Cars (together with vans and taxis) have accounted for an increasing share of UK passenger kilometres over the last 40 years, plateauing at about 86% of passenger travel during the 1990s as shown by Figure 2.3. Figure 2.4 shows that while there has been strong growth in passenger kilometres travelled by car in recent years in many developed economies, some countries have also experienced significant growth in passenger kilometres travelled on some forms of public transport (e.g. Netherlands, Switzerland, Italy and USA). However, not all have experienced the latter trend and there has been a significant contraction in public transport passenger kilometres travelled in some countries, particularly in Germany.

Tables 2.1 to 2.3 provide a more detailed snapshot of the components of passenger travel in the United Kingdom. Table 2.1 shows that the distance travelled per year by the average person has increased by more than 40% over the last twenty years to 10,726 kilometres. Looking at personal travel across all modes the three most significant reasons for travelling are shopping, commuting and visiting friends at home, accounting for 21%, 15% and 13% respectively of journeys per person per year (Table 2.2). In terms of the distance covered by the average person, however, these journey purposes account for 17%, 20% and 13% respectively of the total (Table 2.2).

**Table 2.3 Journey distance per person per year by main mode and purpose : UK 1995/7**

| Kilometres | Walk | Bicycle | Driver[1] | Pass-enger[1] | Motor-cycle | Buses | Tube[2] | Rail[3] | Taxi | All modes |
|---|---|---|---|---|---|---|---|---|---|---|
| Commuting | 23 | 23 | 1429 | 230 | 23 | 95 | 37 | 201 | 6 | 2108 |
| Business | 3 | 2 | 882 | 103 | 0 | 5 | 6 | 50 | 5 | 1146 |
| Education | 27 | 2 | 42 | 80 | 2 | 80 | 3 | 18 | 5 | 302 |
| Escort Education | 16 | 0 | 97 | 32 | 0 | 3 | 0 | 0 | 0 | 150 |
| Shopping | 63 | 5 | 616 | 483 | 3 | 122 | 6 | 32 | 6 | 1345 |
| Other escort | 8 | 0 | 380 | 214 | 0 | 10 | 2 | 5 | 2 | 624 |
| Other personal business | 24 | 3 | 375 | 2216 | 3 | 34 | 6 | 32 | 6 | 722 |
| Visiting friends at home | 27 | 6 | 825 | 785 | 5 | 61 | 6 | 68 | 10 | 1823 |
| Visiting friends elsewhere | 13 | 2 | 132 | 156 | 2 | 16 | 3 | 13 | 11 | 359 |
| Social/entertainment | 11 | 5 | 304 | 298 | 3 | 27 | 5 | 23 | 6 | 721 |
| Holidays/day trips | 3 | 14 | 391 | 647 | 10 | 116 | 2 | 77 | 6 | 1350 |
| Other, inc. just walking | 51 | 0 | 14 | 5 | 0 | 0 | 0 | 5 | 0 | 79 |
| All purposes[4] | 272 | 61 | 5488 | 3253 | 50 | 566 | 77 | 523 | 64 | 10726 |

1 Note: Drivers and passengers of cars and vans
2 Note: London Underground
3 Note: Surface Rail
4 Note: Figures rounded to nearest whole number

**Sources: Department for Transport (2003b)**

In the case of freight, Figure 2.5 shows that road transport has become the predominant mode of moving goods in the UK over the last 40 years. As with passenger transport, Figure 2.6 shows that many other countries have recently experienced strong growth in road freight traffic, although again some countries (eg USA, Portugal, Italy and Finland) have seen significant increases in freight traffic moved by rail.

Finally, there have also been significant structural changes in the nature of economic activity in the UK. Figure 2.7 shows how the contribution of the service sector to national GDP has grown in importance compared with, for example, manufacturing (although this remains an important sector). All of these statistics read together give a clear indication that economic growth leads to an increase in mobility, which translates into more traffic on the roads and rail network.

### 2.2.2 Micro-level relationship between transport and the economy

Transport, as one factor in the production of goods and services, represents a cost to individual businesses. A traditional theoretical view suggests that transport improvement which reduces transport costs (through shorter journey times and lower vehicle operating costs) enables firms to sell their products more cheaply. This stimulates greater demand, so that as firms enjoy enhanced scale economies, a virtuous circle of further cost reductions and sales growth is set in motion (Hyman, 1999:230-231).

Economic policies generally aim to promote an efficient use of *resources* - defined as land, labour and capital; in general it might be expected that improvements in transport contribute to a more efficient use of resources but the provision of such improvements can be costly. Changes in transport costs have economic, social and land use effects. They influence regional patterns of commerce, incentives to invest and to innovate, the decisions of firms regarding location and those of households concerning commuting and migration. These effects are also felt through other costs to the economy such as pollution and congestion. For the economy to operate at a more efficient level, transport has to be efficient. As traffic congestion does not promote efficiency, the demand for road space has to be managed more carefully.

UK businesses appear to perceive clearly that improvements in transport efficiency will enhance their competitiveness and that transport plays an important part in promoting competitiveness in contestable markets (Department for Transport, 2003b). One example is the increased efficiency of goods distribution resulting from schemes which improve the reliability of journey times. The improved efficiency in this example manifests itself through reduced fuel consumption and consequently reduced levels of emissions which has a positive impact on the environment.

The importance attached by business to the need for transport improvements has been questioned. Some critiques claim that the small transport cost reductions usually associated with schemes mean that they will only ever be of limited benefit to businesses. Others have called into question whether the small time savings for individual journeys can in practice be translated by businesses into enhanced productive capacity.

### 2.2.3 Macro-level relationship between transport and the economy

The debate about the relationship between transport and the economy focuses not only on the impact on individual businesses and on local or regional areas, but also on the economy as a whole. The close correlation between economic growth and increased movement - and, since 1945, the correlation in particular between road traffic growth and economic growth - is seen as evidence of a close link between transport and the economy. But this does not help clarify the direction of cause and effect - whether increased movement is a sign of economic growth stimulated by other factors; whether traffic growth, facilitated by transport improvements stimulates economic activity; or whether there is some amalgamation of the two (Department for Transport, 2003b).

Nevertheless commentators point to the historical contribution of transport improvements to economic development. This is particularly true in the case of developing countries, where the transition from a fragmented communications system to even a poorly developed network is of great importance. Perhaps the single most important factor is the transition to all-weather, all-year-round road surfaces. In this sense the complete absence of a well developed transport system acts as a serious constraint on growth. However, it would be wrong to assign undue prominence to any one particular mode, even railways, which are often seen as the most spectacular invention of the Industrial Revolution.

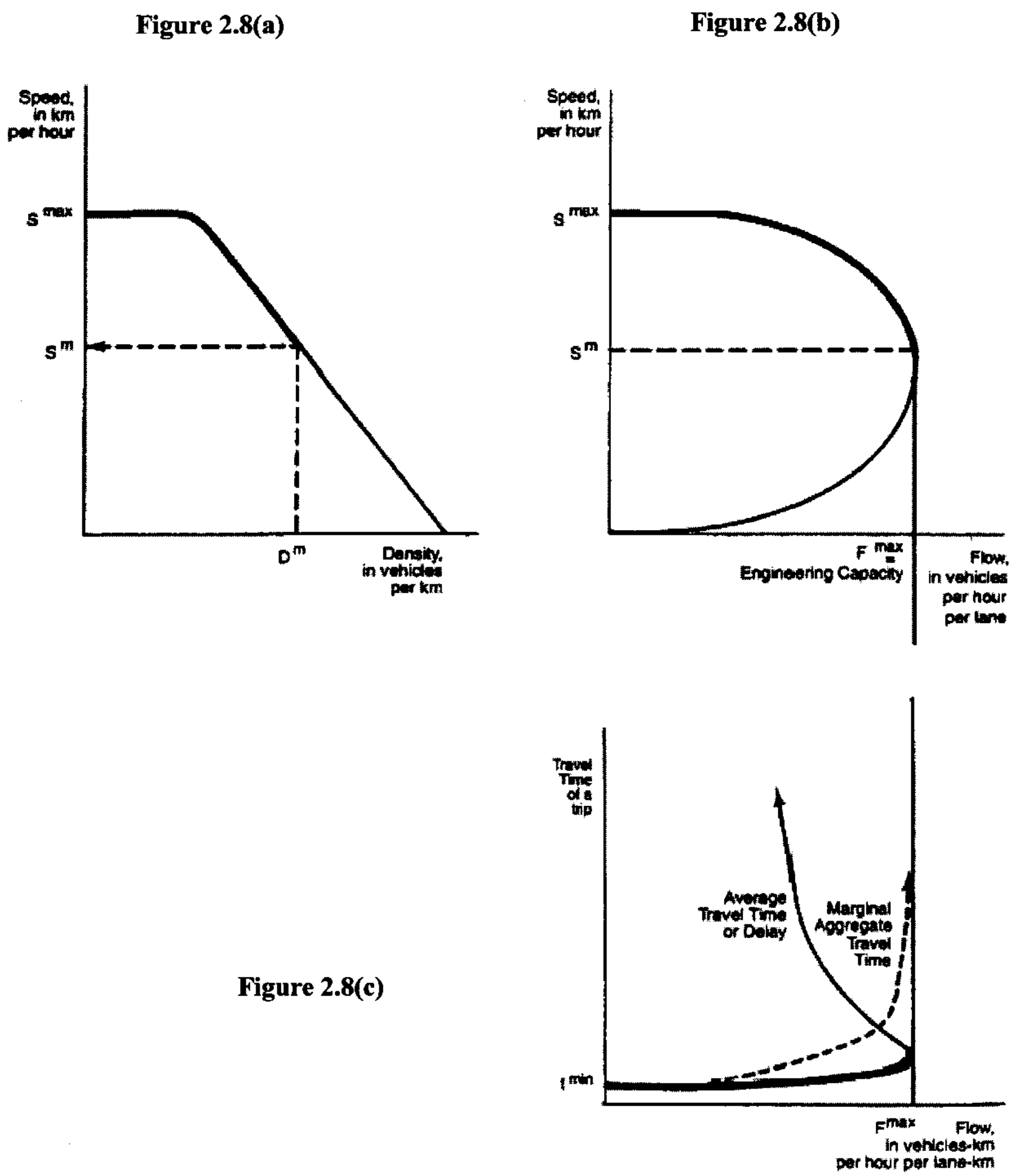
It also holds true that the inequalities in and varying production potential of European regional economies explain the differences in per capita GDP as a function of the regional endowments of labour, capital and various forms of infrastructure. While the lack of an effective transport system does appear to prevent some regional economies from achieving their full production potential, this was not the case in many poorer world regions, thus simply improving transport without other parallel interventions does not lead to growth.

Another line of argument suggests that public investment in transport does have more than a marginal positive impact on GDP. Aschauer (1989:193-194) argues that public investment in infrastructure leads to improvements which increase profitability - or the rate of return to private capital (such as the capital invested in a company's distribution fleet). Firms then respond to increased profit by expanding the pace of capital investment, in turn leading to higher labour productivity and output, so perpetuating a further virtuous spiral of investment. The result, contends Aschauer, is a return on publicly-invested infrastructure projects, which are significantly higher than investment in private firms. The empirical evidence used by Aschauer (1989, 194-195) could suggest a different relationship of cause and effect - higher transport investment not causing economic growth but being made affordable by that growth in income.

## 2.3 Speed-flow relationship

Having explained the link and relationship between the economy and transport, the concept of speed-flow is drawn into the argument in favour of road pricing. The relationship between speed or travel time and flow is fundamental to the understanding of congestion and plays an important role in the standard economic model of road pricing (Verhoef et al., 1999:533-539). Failure to understand this relationship correctly may result in inaccurate conclusions and misconceptions. Indeed, there is considerable confusion and dispute in the literature concerning the appropriate use of the speed-flow relationship to evaluate road pricing. The disputes are best represented by debates between Evans (1992a:212-216) and Hills (1993:91-95).

**Figure 2.8: Derivation of a travel time-flow curve of an urban highway**




**Source: Hau (1992a)**

The basic theoretical argument used to explain the speed-flow relationship is shown in Figure 2.8 above. It illustrates a relationship which is well founded in economics and transport literature (Hau, 1992a:8), (Li, 2002:734), (Yang and Huang, 1998:45-46), (Verhoef, 1995:459-460) and (Leach, 2001:5-7).

It begins by considering a homogenous traffic stream moving along a given stretch of urban road with fixed beginning and end points. The traffic stream would be able to achieve a speed that balances the benefits of a faster trip against the costs of a trip with higher energy requirements and a greater risk of an accident. *Ceteris paribus*, as other vehicles enter the road thereafter, density increases, speed drops and travel time (or delay) lengthens (and accident probability rises). The causality is as follows: traffic density determines speed and not vice versa. Paralleling the theory of fluid dynamics, traffic flow is the product of density, in vehicles per kilometre and speed in kilometres per hour, with traffic flow attaining a maximum at $F^{max}$ with speed at $S^{m}$ in Fig. 2.8(b) (Hau, 1992a:8-9).

As additional vehicles join the traffic stream, the volume of traffic grows and hence the demand for road space. This phenomenon increases the demand beyond $F^{max}$ onto the backward bending part of the speed-flow curve towards the origin on the horizontal axis. Intuitively, traffic congestion develops and rapidly worsens and may cause "traffic-jams" at times. As travel demand diminishes toward the end of rush hour, the demand for road space decreases and traffic flow returns to the upward sloping part of Figure 2.8(b). It is this phenomenon where demand exceeds supply during the daily rush hour periods that calls for the introduction of TDM.

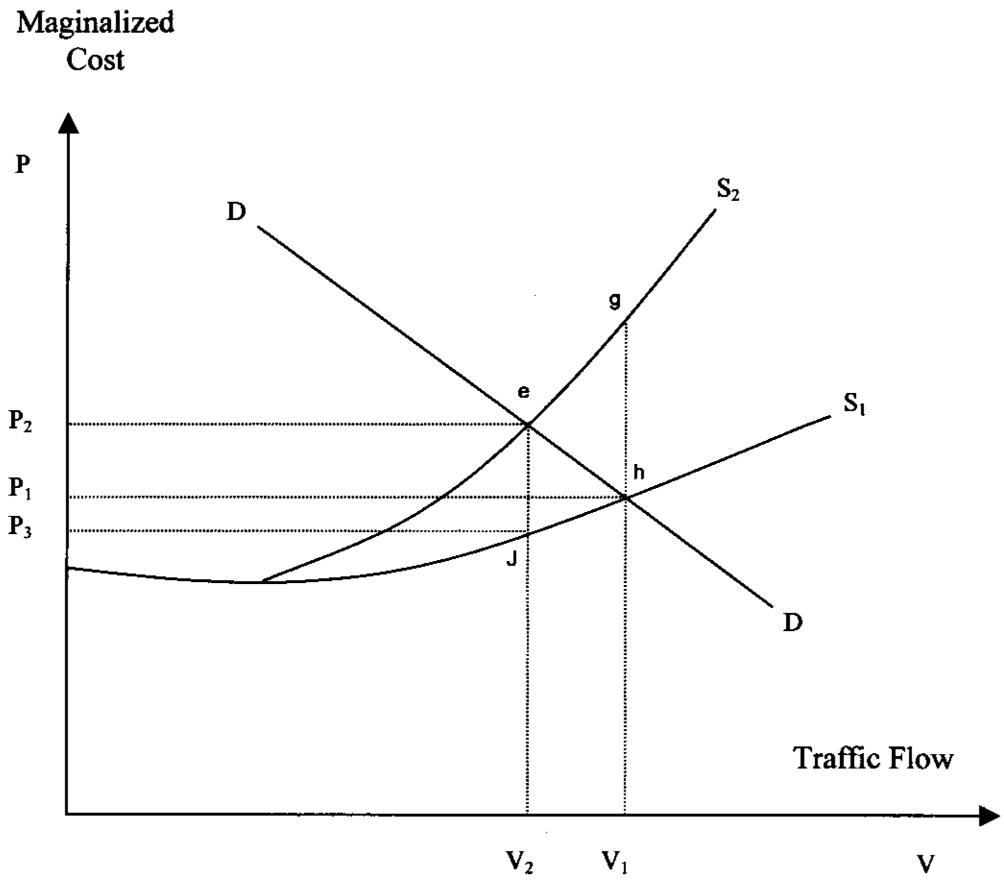
## 2.4 The economic logic of congestion charging

Having identified and explained the relationship between speed and flow and by adding capacity constraint to the argument, it was shown graphically how and why congestion occurs. This paves the way for explaining how road pricing as an economic instrument could aid a reduction in traffic congestion, hence connecting the economy to transport. The economic logic or rationale in favour of road pricing is not controversial and has been documented by a number of authors. The modest aim here is to introduce the reader to the economic justification for charging motorists in order to reduce traffic levels to a socially optimal level.

The individual motorist incurs journey time and money costs when he undertakes a journey. The money costs are the fuel and other vehicle operating costs associated with the journey. In congested conditions the time and money costs may be very substantial. However, the motorist will nevertheless undertake the journey if the value he derives from it outweighs the costs (Li, 2002:734-735), (Mogridge, 1997:11-12), (Bayliss, 1998:26) and (Leach, 2001:5,7).

In congested condition, an additional vehicle on the road imposes costs on other road users. This is largely because each vehicle on the road reduces the speed of other road users. If the value to the motorist undertaking the journey is less than the sum of his own journey cost and the journey costs imposed on others, then road users as a whole are worse off. If a price were charged to use the congested road network equal to the cost imposed on other traffic, the motorist would only use the road if the value of the journey exceeded the sum of the charge and his other journey costs. This would deter additional trip-making when the costs to society as a whole exceeded the benefits. The excess travel that produces congestion costs may also give rise to other external costs such as air pollution, noise and accident costs. Hence, it can be argued that the price to be charged should reflect the overall social cost of congestion, environmental damage and accidents. Figure 2.9 demonstrates these points.

**Figure 2.9: Principle of congestion pricing**




**Source: Li (2002)**

To arrive at Figure 2.9 the speed-flow curve is converted into a travel time-flow curve. The speed-flow curve (see Fig. 2.8(b) page 23) can be straightforwardly converted to a travel time-flow curve as travel time is the reciprocal of speed, with vehicles-kilometre per lane-kilometre-hour on the horizontal axis (see Fig. 2.8(c)). Using a constant value of time as a shadow price for the representative traffic stream, travel time is then converted to a money basis which yields time cost, presented on the vertical axis of Fig 2.9.

Fig. 2.9 then goes on to illustrate the economic logic of road pricing. Traffic volumes are depicted on the horizontal axis and the cost of travel, the time and money costs for making the journey (generalized cost), are plotted on the vertical axis. The demand for travel is represented by curve DD. This indicates that as journey costs rise, demand for travel falls. The marginal social cost curve $S_2$ (MSC) shows the additional costs imposed on *all* road users, as traffic volumes rise. The average variable cost, also known as marginal private cost depicted by $S_1$ (AVC/MPC), on the other hand, shows the costs incurred by each individual trip-maker.

Low traffic volume corresponds with relatively high speed so fuel costs would be high. With high traffic flow and low speed, however, the fuel costs would be high because of fuel inefficiencies caused by the alternate acceleration and deceleration associated with dense traffic. These two factors roughly cancel one another out leading to the plausible assumption that the costs of operating a vehicle (which includes fuel, oil, maintenance and depreciation costs) are approximately independent of the level of traffic flow (Hau, 1992a:9). A fixed money cost for the vehicle operating cost can therefore be added to the time cost portion to form the generalized cost - an accepted construct of transport economists (Button, 1982:357). Similarly, the road's variable maintenance cost which is assumed to be proportional to the traffic level can also be calculated. Hence the time cost element is mainly responsible for the upward-sloping portion of the AVC curve ($S_1$).

When traffic volumes reach a certain level both marginal cost curves rise because network speeds reduce. This is as a result of vehicles slowing one another down which increases the generalized cost of trip-making because at slower speeds journeys take longer and the vehicle cost rises as drivers engage lower gears and begin to stop/start frequently to allow for movement through the congested road.

The individual trip-maker bases the decision to travel on his marginal private cost and the value of the trip to him (Hau, 1992a:10-11). Hence, the trip-maker will undertake the journey if the benefit he would receive from making the journey outweighs the cost of the trip borne by him. In figure 2.9, an equilibrium is reached at price $P_1$ and traffic volume $V_1$ at h. Point h, however does not reflect the optimal traffic flow, as curve $S_1$, the MPC curve does not take into account the congestion costs imposed on other road users by the marginal motorist (Li, 2002:734-735).

Each motorist only considers the actual level of congestion on the road when deciding whether to make a trip. He does not realise that by making a trip he adds to the congestion and further slows down the existing traffic. The difference between the MSC and the MPC is the congestion cost caused by the additional vehicle. At traffic volume $V_1$ the MSC of the traffic exceeds the marginal benefits. In other words, there is excessive congestion imposing marginal costs on other motorists in excess of the benefits gained by a marginal driver. Put differently, the road is being consumed beyond the point of maximum efficiency or optimality (Leach, 2001:5-7).

However, the optimum or efficient traffic volume is at $V_2$ where the marginal social cost and demand curves meet at e. The additional traffic volume ($V_1$-$V_2$) imposes costs of $V_2egV_1$ but yields benefits of $V_2ehV_1$ only. The net loss arising from the additional traffic is therefore defined by the area egh. Hence, only at traffic flow $V_2$ is the demand for road space equated to the full marginal costs of using it. Any volume of traffic above $V_2$ implies the social cost of trip-making exceeds the benefits gained and is associated with a negative externality. This is the cost imposed on motorists not directly responsible for the congestion but who have an external social private expense as a result of the additional cost imposed on them (Levine and Garb, 2000:12-14).

The real problem lies in making the motorists aware of the congestion costs they impose upon others and to reduce the traffic volume to the level $V_2$. In order to restrain traffic to the socially optimal level $V_2$ a road pricing charge equal to ($P_2$-$P_3$) is needed. The charge then 'internalises' the externality by adjusting the marginal private cost so that the user considers the actual benefits of the cost of his decision to travel and ultimately reduces the congestion level to the optimal level $V_2$. The charge or Pigovian tax of ($P_2$-$P_3$) would dissuade motorists from undertaking certain road journeys and as a result the demand for scarce road space is matched by the available supply (Leontaridi, 1997:1-2), (Schotter, 2001:631).

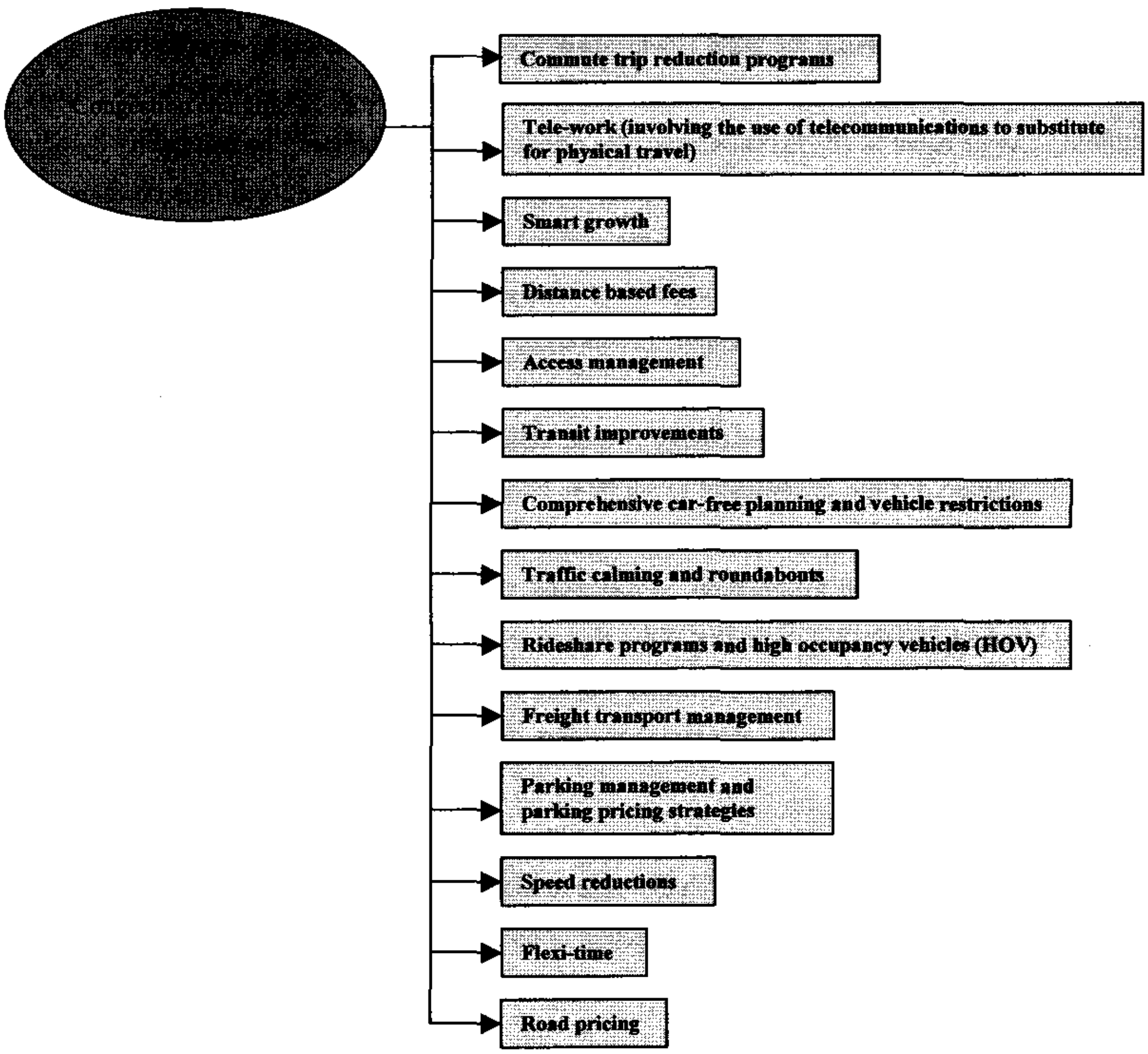
The only down side to the congestion charge is that, although it seems ideal in theory, it is difficult to administer it because, for the government to set its congestion charge at an optimal level, it must know the exact amount of the externality in order to reduce the traffic levels to the efficient level. As governments do not have full information on this issue, their accurate judgements will have to suffice. Hyman and Mayhew (2002:189) states that if the charge is sub-optimal only a few users will be priced off the roads and there will be no congestion relief. Should the charge be excessive, too many users may be priced off and there would not be enough remaining users to benefit from the reduced congestion.

This obviously means the Pigovian tax solution is unlikely to lead to an efficient traffic level on its own. This is one of the reasons why this research attempts to highlight the importance of some factors required to aid the congestion charge in achieving an efficient or optimal traffic level.

# 2.5 Transportation demand management

Having explained and identified the economic rationale in favour of road pricing and the need to manage the demand for road space, the concept and role of TDM comes to the forefront. Burris and Pendyala (2002:241) broadly defines transportation demand management (TDM) as a general term used for strategies that result in more efficient use of existing transportation infrastructure, including shifting journeys to less congested times of day. TDM treats mobility as a means to an end rather than an end in itself, and so helps individuals and communities meet their transport needs in the most efficient way, which often reduces total vehicle traffic. TDM prioritises travel based on the value and costs of each trip, giving higher value trips and lower cost modes priority over lower value, higher cost travel and when doing so increases overall system efficiency. It emphasizes the movement of people and goods, rather than motor vehicles under congested urban conditions.

**Diagram 2.1 Congestion charging instruments**



There are many different TDM strategies with a variety of transportation impacts. Some improve the transportation options available to consumers. Some cause changes in trip scheduling, route, destination or mode. Others reduce the need for physical travel through more efficient land use, or transportation substitutes. To put congestion charging, TDM and road pricing in perspective they can be arranged in a structured hierarchy moving from the more general to the more specific application of traffic restraint measures. TDM is at the top of the hierarchy followed by congestion charging as a TDM strategy and road pricing being an instrument. Congestion charging is the overarching strategy used to describe a combination of programs or schemes as depicted in Diagram 2.1 page 28, to reduce traffic congestion. Road pricing being at the bottom of the hierarchy represents the more specific application of congestion charging.

Road pricing involves charging motorists directly for driving on a particular road or driving in a particular area (cordon area). Road pricing should not be confused with congestion pricing which is road pricing with higher rates during congested periods (TDM Encyclopedia, 2003). The following section will briefly outline the possible types of road pricing that can be employed as part of a congestion charging strategy.

## 2.5.1 Types of road pricing

### 2.5.1.1 Toll Roads

Tolls are a common way to fund highway and bridge improvements. Such tolls are a fee-for-service, with revenues dedicated to maintenance and improvement costs. This is considered more equitable and economically efficient than other improvement funding options which cause non-users to help pay for improvements. Tolling is often proposed in conjunction with road privatisation (i.e. highways built by private companies and funded by tolls).

### 2.5.1.2 Congestion Pricing

Congestion Pricing (also called Value Pricing) refers to road pricing as a scheme to reduce peak-period vehicle trips. It is a type of responsive pricing meaning that it is intended to change consumption patterns (TDM Encyclopedia, 2003). Congestion pricing requires time-variable tolls with higher charges during peak periods and lower or non-existent charges when roads are uncongested. Time-variable tolls can be based on a fixed daily and/or weekly schedule, or they can be dynamic, so that rates change depending on the level of congestion existing at a particular time.

#### 2.5.1.3 HOT Lanes

High Occupancy Toll (HOT) lanes are high occupancy vehicle (HOV) lanes that also allow access to low occupancy vehicles if drivers pay a toll. This allows more vehicles to use HOV lanes while maintaining an incentive for mode shifting and raising revenue.

#### 2.5.1.4 Cordon (Area) Tolls

Cordon tolls are fees paid by motorists who want to drive in a particular area, usually a city centre. Some cordon tolls only apply during peak periods such as weekdays. This can be achieved by simply requiring vehicles driven within the area to display a pass or by electronic tolling at each entrance to the area.

#### 2.5.1.5 Road Space Rationing

Road space rationing seeks to ration peak period vehicle-trips or vehicle-miles based on the optimal road system capacity. For example, each resident in a region could receive a ticket for 20 peak-period vehicle-miles each week. They could use the tickets themselves or trade or sell them to somebody else. The ration unit can be variable with higher rates under more congested conditions and lower rates under less congested conditions. The result is a form of congestion pricing in which revenues are captured by residents rather than road owners or governments.

#### 2.5.1.6 Vehicle Use Fees

Vehicle use fees or distance based charges such as mileage fees can be used to fund roads or reduce congestion. This is a possible way to reduce traffic congestion and reflect more equitably the road costs imposed by each vehicle.

### 2.5.2 Road pricing implementation methods

Road pricing can be implemented in a number of ways. Each method however has certain advantages, disadvantages and applications as summarised in Table 2.4 on the next page.

**Table 2.4 Summary of Road Pricing Methods**

| Type | Description | Equipment Costs | Operating Costs | User Inconvenience | Price Adjustability | Advantages | Disadvantages | Applications |
|---|---|---|---|---|---|---|---|---|
| **Pass** | Motorists must purchase a pass to enter a cordoned area. | Low | Low | Medium | Poor to medium | Cheap and quick to implement. Convenient to use. | Limited price adjustability. Not marginal. | Cordon pricing. Unlimited use road or bridge fees. |
| **Toll Booths** | Motorists stop and pay at a booth. | High | High | High | Medium to high | Many are in place. Moderate price adjustability. | High cost. Requires vehicles to stop. | Major bridges, highways and cordons. |
| **Electronic Tolling** | An electronic system bills users as they pass a point in the road system. | High | Medium | Low | High | High price adjustability. User convenience. | High implementation costs. Some privacy concerns. | Any road system. |
| **Optical Vehicle Recognition** | An optical system bills users as they pass a point in the road system. | High | Medium | Low | High | High price adjustability. User convenience. | High implementation costs. Some privacy concerns. | Major bridges, highways and cordons. |
| **GPS** | GPS is used to track vehicle location. Data are automatically transmitted to a central computer that bills users. | High | Medium | Low | High | Highest price adjustability. User convenience. | High implementation costs. Privacy concerns. | Any road system with comprehensive pricing. |

**Source: TDM Encyclopedia (2003)**

The method employed should suit the specific policy objectives in the transport strategy as far as possible. The following sections outline some of the most common methods of implementing road pricing.

## 2.5.2.1 Passes

Motorist must purchase a pass to enter a particular area (a cordon) such as a city or a central business district. Passes may be specific to a particular type of vehicle or a particular time. Some systems only require passes during congested periods such as weekday mornings. Free or discounted passes may be provided to area residents. Passes may be sold directly by government agencies or by retail stores. They tend to be inexpensive to implement and easy to use.

## 2.5.2.2 Toll Booths

Conventional tollbooths located on a road require motorists to stop and pay with money or tokens. Most have attendants, although some have automatic coin collection systems. These tend to have high operating costs, are inconvenient to motorists and increase traffic congestion and local air pollution. Prices can vary by time and vehicle type and they are generally only applicable on bridges, grade separated highways or cordon entrances.

#### 2.5.2.3 Electronic Tolling

Electronic toll collection refers to automated systems that measure and bill motorists. A small transponder is placed inside the vehicle, which is counted each time it passes a roadside sensor. The tolling agency maintains an account for each vehicle, debiting the owner with each use of the road. Another system uses a "smart card" which is charged with a certain money value and is placed inside the transponder. Each time the vehicle passes a beacon the appropriate fee is subtracted. This system protects motorists' privacy since there is no record of when or where the vehicle is driven. Unfortunately the system tends to have high implementation costs and moderate to high operating costs.

#### 2.5.2.4 Optical Vehicle Recognition

This system tracks vehicles as they pass a certain point in the road by automatically scanning the license plate. This information is used to generate a bill that is either subtracted from the vehicle's account or mailed as an invoice. Again, these systems tend to have high implementation costs and moderate to high operating costs.

#### 2.5.2.5 GPS-Based Pricing

The GPS (Global Positioning System) based pricing uses a small electronic transponder to track an object's geographic location. Transponders must be securely installed and wired into vehicles. GPS-Based pricing can incorporate virtually any pricing factor, including factors related to driver, vehicle, time and location of vehicle travel. As a result it can be a very accurate pricing system. The downside is that GPS-Based Pricing raises privacy concerns since it records a vehicle's travel time and location.

## 2.6 Economic principles relevant to road pricing

Newbery (1990a:22) states that road space is a valuable and scare resource and that economists argue for rationing or reallocating it by applying a price. This price is none other than a tax levied on road users to deter them from using congested road networks. However care must be taken in applying the tax. The relevant economic principles of taxation must be considered for they are used as a yardstick to measure the success or failure of road pricing as a method of reducing traffic congestion.

Efficiency and equity are the two main principles used to evaluate the success and impact of taxes when applied as a measure to reallocate resource. For a tax to be efficient one has to consider (i) whether it is

Pareto optimal (ii) the excess burden of the tax (iii) its price distortionary effects and (iv) if it changes road user behaviour. For a tax to be equitable, consideration has to be given to the ability to pay principle and the benefit principle. In general it is felt that a tax should be fair. The problem involved in applying this criteria is that people differ in their ideas regarding what is fair. The pursuance of efficient and equitable resource allocation has unfortunate distributional implications which can only be minimised by a trade-off between the various criteria. These will briefly be explained in turn.

## 2.6.1 Efficiency

### 2.6.1.1 Pareto optimality

One of the most important principles in designing an efficient traffic demand management strategy is the Pareto optimality principle. The problems that the economy must solve here are: (i) how to allocate the existing supply of road space optimally and (ii) how to distribute it optimally among the population. Musgrave and Musgrave (1989:60) define optimality in this context in terms of Pareto efficiency. A given economic arrangement is efficient if there can be no rearrangement which will leave someone better off without worsening the position of others. In the context of transport road space is utilised optimally when motorists using a road do not exert additional cost on their fellow road users thus making them worse off.

In addition, optimal road use is subject to the marginality principal. That is that the marginal cost to the marginal road user should equate to the marginal benefit and equate the price throughout the economy (Daganzo, 1995:139). Obviously this situation is difficult to attain in practice and when these conditions for optimal or efficient use are not met, there is market failure. This is a *prima facie* case for government to intervene to correct the market failure by applying a corrective tax.

### 2.6.1.2 Price distortions

A congestion charge can be described as a price distorting tax (Newbery and Santos, 2002:4-5). A price distorting tax is one that causes the net value received from the use of roads to diverge from the gross price paid by the road user and the subsequent value attained. The tax induced increase in the price of road usage will therefore affect the road user's choices when undertaking trips and reduce his usage of the charged road network. Hence, for road pricing to encourage efficiency, it has to be a less distortive tax.

#### 2.6.1.3 Change in road user behaviour

Hyman (1999:4-5) also points to the change in the road user's behaviour as a result of price distortive taxes. Some of the typical behavioural changes are reflected in the income and substitution-effects, changes in consumption, changes in savings and investment etc. Again it is observed that for efficiency to be attained, road pricing has to have less of an effect on user behaviour. Against this background Emmerink et al. (1997:231) is of the opinion that the effect of road pricing on the work-leisure choice of the traveller still needs further empirical investigation.

#### 2.6.1.4 Excess burden of a tax

Musgrave and Musgrave (1999:280-284) points to the excess burden of a tax or deadweight loss to the road user when subjected to a congestion charge. In simple terms, when a price distorting tax such as a congestion charge is levied on a road user it reduces his income and leaves him bearing an additional tax burden, which in turn gives rise to a loss in the well-being of the road user. The loss of well-being is *viz a viz* equal to the excess burden of the tax. The total excess burden of the tax is therefore an additional cost to the road user over and above the amount already paid in the form of road taxes and vehicle running costs. Only when road users are compensated for the excess burden will the charge be efficient.

### 2.6.2 Equity

#### 2.6.2.1 Ability-to-pay principle

The ability-to-pay principle suggests that taxes should be collected according to the capacity of the tax payer to pay them. Therefore, people with greater ability to earn income, for example, should be taxed more heavily than those with less capacity to earn according to Musgrave and Musgrave (1999:223). This view however does not account for the amount of marginal benefit received by the tax payer, as the benefit would be disproportionate to the amount of tax paid in this case.

Related to the ability-to-pay principle are the notions of horizontal and vertical equity. Horizontal equity is achieved when individuals of the same economic capacity (i.e. income) pay the same charge or tax, whereas vertical equity is accomplished when individuals of differing economic ability pay a differing charge proportionate to their economic capacity.

### 2.6.2.2 Benefit principle

It is common knowledge that the tax system should be equitable and road pricing be no exception to the rule i.e. that each road user should contribute his or her fair share. But there is no such agreement about how the term "fair share" should be defined. The benefit principle argues that the means of financing a public good should be linked to the benefit that its users or consumers receive. Congestion charges are ideal for distributing the cost of usage and the burden of the tax amongst consumers (Musgrave and Musgrave, 1999:219-222). Hence, the road user pays directly for the benefit obtained from using the road.

A related issue to the benefit principle is the issue of tax-incidence - the ultimate distribution of the tax burden. Newbery (1990b:22-23) suggests that because the road user is charged to use the road and the demand for road space is fairly inelastic, the burden of the tax will fall mainly on the user. This is partly true. The demand for road space is fairly inelastic but the burden of the tax does not necessarily fall on the road user only as Seagal and Steinmeier (1980:52-55) and Small (1983:90-93) points out. The extent of the effects, distributional implications and incidence of the charge needs further investigation.

## 2.7 Criteria for an effective road pricing scheme

Hau (1992b:5) suggests that many studies have examined the critical factors or criteria that go together to produce a feasible, acceptable and effective urban pricing scheme in order to implement the economic principles of road pricing. These criteria are summarised in Diagram 2.2 on the next page. The role players who decide whether or not a scheme is effective are mainly represented by the users, the highway authority and society at large.

These requirements are the textbook criteria for an effective road pricing scheme. However, a number of authors propagate the importance of additional sustainability requirements. Hau (1998:51), Litman (1999a:8), Newbery and Santos (1999:104) and Parry and Bento (2001:1-3) all argue for the recycling or re-investment of revenue into the transport system to facilitate improvements. This is crucial from society's point of view as acceptance is largely based on how government will put the income raised by the charge to work.

It is argued by Arnott et al (1991a:317), El Sanhouri and Bernstein (1994:49), De Palma and Lindsey (1998:668-688) and Emmerink et al (1995a:293-308) that information provision relating to traffic levels in real time would enable the informed motorist to avoid congestion hot-spots. Another valid point is made by Arnott et al (1988:56-57,1992:94-96), Boden (1999:81-82), Daganzo and Garcia (2000:303-304)

**Diagram 2.2: Criteria for an effective road pricing scheme**

- Scheme must be free from fraud and evasion from the highway authority's point of view, by having a credible enforcement regime
- Highway authority should accommodate occasional users
- Highway Authority must utilise mature and reliable technology
- Scheme must be flexible and fit into the urban environment without detrimental aesthetic or disruption impacts
- Scheme must have minimum road work intrusions in facilitating infrastructure
- Scheme must have minimum environmental intrusion and tolerance to varied geography
- Users and society should feel the benefits received outweighs the cost of paying to use the road, i.e. the benefit-cost test should be passed
- Scheme must be supported by suitable administrative systems to deal with payments/licence issuance and enforcement

- Scheme should be relatively simple and easy for users and society to understand and use
- Scheme must be transparent so that users know what they have to pay and what the revenues are to be used for
- Scheme must provide facilities for both pre-and post-payment from the users' and society's perspective
- Scheme must be fair and equitable to users and society to ensure that the numbers of 'losers' are minimised
- Scheme must be supported by complementary and compatible measures that offer viable travel alternatives to users
- Scheme must offer tangible improvements in accessibility so that users can appreciate the benefits of the system
- Scheme must afford anonymity to users and society
- Scheme must provide for mixed traffic and dispensation of public transport, emergency vehicles etc;
- Scheme must pass the revenue-cost test for the highway authority
- Scheme must be supported by appropriate information and marketing measures that raise awareness of the need for the system and the way it operates

- Scheme should target the major congestion and environmental impacts
- Scheme should be designed to integrate with other modes and transport strategy improvements
- Scheme should impose charges that are sufficiently high to prompt users to reconsider travel choices
- Scheme should impose charges that are not so high as to be punitive and suppress economic activity, hence an optimal charge should be imposed

and Lam (2003:16) pertaining to work schedule flexibility. The argument here is that alternative working hours could ease traffic congestion by spreading the flow of traffic over a longer period.

Probably one of the hardest criteria to meet according to De Corla-Souza (2000:17), Eichenberger (2002:5), Giuliano (1992:335-336), Oberholzer-Gee and Weck-Hannemann (2002:357-358) and Schade (2002:2) is the public acceptance and political backing of road pricing. Although this is a very simple criterion, the highway authority will have an uphill struggle unless it gives some thought to the problem overcoming unnecessary criticism and negativity towards road pricing. I will argue in the following chapters that these additional criteria are equally important role players in the effectiveness and acceptability of road pricing.

## 2.8 Examples of current practice

Road pricing as a policy instrument to alleviate congestion, environmental and other problems related to urban transportation has received much attention during the last decade. However, despite the benefits of road pricing being demonstrated by economists and other analysts, it has not been implemented on a broad scale. It is still widely considered to be a radical and controversial policy (Emmerink et al., 1995b:581).

Table 2.5 below presents a snapshot of some road pricing schemes introduced worldwide with varying degrees of success and focus.

**Table 2.5 Road pricing worldwide**

| City/County | Type of Road pricing | Method of implementation | Cost of charge at peak periods | Cost of charge at off-peak periods | User satisfaction | Change in congestion level | Revenue recycling |
|---|---|---|---|---|---|---|---|
| **Route 91 (US)** | Toll lane | Electronic road pricing | \$3.50 | \$0.75 | Favorable | - 10% | Yes |
| **Highway 407 (Canada)** | Toll lane | Electronic road pricing | \$0.10/mile | \$0.08/mile | High | - 8% | Yes |
| **Auto route A1 (France)** | Toll lane | Electronic road pricing | \$3.00 | \$0.90 | Favorable | - 8% | Yes |
| **New York** | Congestion pricing | Electronic road pricing | \$5.00 | \$3.00 | Favorable | - 10% | Yes |
| **Interstate 15 (San Diego)** | HOT lane | Electronic road pricing | \$8.00 | \$4.00 | Favorable | - 7% | Yes |
| **Singapore** | Cordon (Area) Toll | Electronic road pricing | \$1.50 | - | Favorable | - 15% | Yes |
| **Hong Kong** | Cordon (Area) Toll | Toll booth | \$2.00 | - | Favorable | - 10% | Yes |
| **Norway** | Cordon (Area) Toll | Toll booth | \$1.56 | \$0.62 | High | - 10% | Yes |
| **London** | Cordon (Area) Toll | Electronic road pricing | \$5.85 | - | Favorable | - 20% | Yes |
| **Rome** | Roadspace rationing | Toll booth | \$2.00 | - | Favorable | - 10% | Yes |

**Source: TDM Encyclopedia (2003)**

It can be seen from Table 2.5 that predominantly first world countries have introduced road pricing and road users are in general prepared to pay a price in return for less congestion. This may be coupled with all the schemes recycling the revenue in one way or the other. Table 2.5 also reflects an average 10% drop in congestion which indicates that the schemes actually redistributes road space more efficiently.

## 2.9 Conclusion

Because transport facilitate economic activity via vehicular movement traffic congestion resulting from such movement negatively affects the micro and macro economy and merits the imposition of instruments curbing its occurrence. TDM present various strategies and instruments aimed at promoting more efficient use of existing transportation infrastructure without compromising road user equity. The economic argument in favour of road pricing as one such instrument is based upon the principles relevant to taxation whereby road users are charged as to internalise the externalities they cause, subsequently discouraging road use and reducing traffic levels to the efficient level. Given the associated problems of traffic congestion and the environmental constraints acting against any substantial increase in road capacity, the ultimate necessity to restrain road users is obvious. Worldwide experience have demonstrated reduced congestion levels where implemented successfully and also that any transport initiative has certain effects. These will be examined in greater detail in the next chapter.

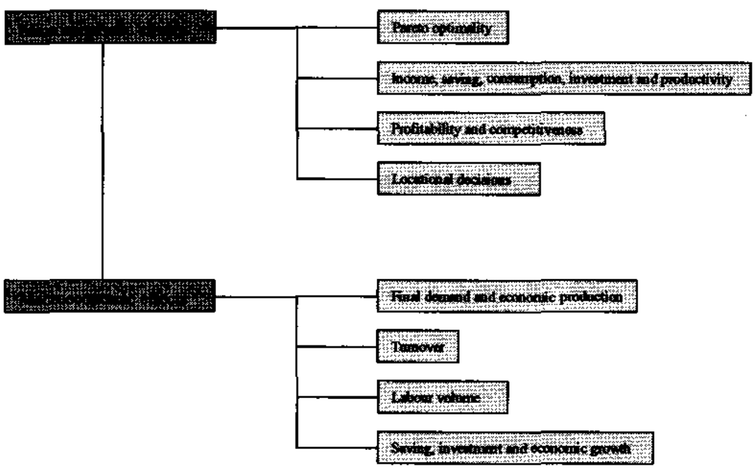
# Chapter 3 Effects of road pricing

## 3.1 Introduction

The focus of discussion now turns to a critical evaluation of the current available literature which provides an insight into the effects road pricing has on the local economy, the social welfare of road users, land use and the environment. The review seeks to establish "where" the present understanding of these issues is and will identify gaps in the current knowledge which will be addressed by this study. These issues will be discussed in turn starting with the effects on the local economy.

## 3.2 Effect on local economy

**Diagram 3.1 Economic effects**




Road pricing affects the economy on a micro and macroeconomic level. The focus of this research is on the local setting so the microeconomic effects will be explored in more detail, without discounting the effects on the macroeconomy. Such an approach is congruent to the model employed by Madsen and Jensen-Butler (2001:7-8) which implies that microeconomics is a tool for understanding people's economic behaviour and relating that back to social welfare. Diagram 3.1 depicts the main points to be discussed in this section.

### 3.2.1 Microeconomic effects

#### 3.2.1.1 Achieving Pareto optimality

Road pricing can reduce congestion and in theory, increase society's welfare (Daganzo, 1995:139). More specifically, if a toll is charged which is equal to the additional cost imposed on other travellers by an extra traveller, the sum of the consumer surplus, utility and total revenue is maximised. This is, as explained in the previous chapter, a condition for achieving Pareto optimal use of a charged area or lane.

This theory generally assumes that all road users value time and money similarly and that society's welfare is the sum of an individual's surpluses. A person's surplus is typically defined as the monetary equivalent of his or her time savings, plus any refund, minus the charge paid. These assumptions are somewhat questionable, because vehicular travel is not equally important to everyone and not everyone has the same willingness or ability to pay. In addition, the definition of aggregate welfare as a sum of surpluses minus the sum of individual cost, ignores all equity issues, which is unfortunate because tolls penalise some people for the benefit of others.

Research by Daganzo (1995:139-140) suggests that road pricing has the ability to lead to a strict Pareto improvement, although it will initially leave most road users worse off, if revenues are not recycled. This translates into the charged area or lane being used efficiently, only when all road users' utility increase. Because utility functions are impossible to observe in practice, it will be difficult to estimate gains or losses in personal utility as a result of road pricing. However, **the aim here is to establish if road users perceive their utility to increase or decrease as a result of the congestion charge.** Should more users agree to road pricing increasing their utility, the nearer it draws to Pareto optimality. The opposite also holds true.

### 3.2.1.2 Income, saving, consumption, investment and productivity

General economic theory predicts taxes (inclusive of road pricing) will reduce income, saving, consumption and investment (Dornbusch and Fischer, 1994:123-125; Musgrave and Musgrave, 1989:325; Hyman, 1999:482-493 and Madsen and Jensen-Butler, 2001:1). While much has been written regarding the efficiency aspects of congestion, Segal and Steinmeier (1980:45-47) reports **that little has been written about how and to what extent private and business income or surplus, saving, consumption and investment are affected by road pricing.** A quantification of these effects will point to the magnitude of the loss of revenue. **Similarly the effects on labour productivity in the local setting requires clarification.**

The change in business productivity as a result of road pricing has also not been comprehensively documented according to Madsen and Jensen-Butler (2001:50) and Verhoef et al. (1995:1-3). Business productivity is a function of the labour, capital and infrastructure cost to businesses. The increase in transport cost may influence the productivity of businesses and the output of the economic sectors as a whole.

### 3.2.1.3 Profitability and competitiveness

Taxes in any form reduce the profitability and competitiveness of businesses (Hyman, 1999:555-556 and TDM, 2003). Road user charging is no exception to the rule. As businesses rely heavily on road freight transport for deliveries, the possibility exists for businesses to shift the increase in their generalised cost to the consumer. The competitive firm will attempt to maximise profits by setting the prices of their commodities equal to the marginal cost of obtaining or producing the commodities or services. When businesses pay a congestion charge their marginal cost increases and in order to stay profitable and competitive, they increase the price of their commodities or services. Generally an increase in commodity price leads to a decrease in demand and an increase in supply to maintain profitability and competitiveness.

Because there are very few charging schemes anywhere in the world which have been operational for a long period of time, documented evidence of local economic change and their effect on business profitability and competitiveness is not readily available according to Segal and Steinmeier (1980:13) and Whitehead (2002:221), although some attempts have been made to quantify the effects. It may prove to be valuable to **explore the extent to which freight induced increases in transport cost are shifted to the consumer to maintain profitability and competitiveness.**

#### 3.2.1.4 Locational decisions

The location of the business function in a city is of fundamental importance to its competitiveness, growth and sustainability in relation to similar functions on the periphery. Seagal and Steinmeier (1980:41-52) reports there is little empirical evidence available on the extent to which road pricing influences residential and business locational decision making. They also argue that residents may relocate to the charged area if the savings in transport cost are exactly offset by the increase in their generalized cost. The same principle can not be straightforwardly extrapolated to businesses as they are dependant on various types of transport modes for delivering commodities and will almost always have transport cost variables included in their profitability calculation. **As the perceived effect of road pricing on locational decisions in this regard appears unclear, it is worth exploring the factors influencing their decision to centralise or decentralise.**

### 3.2.2. Macroeconomic effect

#### 3.2.2.1 Final demand and economic production

The products sold to final users are those sold to consumers, the government and foreign countries. These transactions are called final demand. They are mainly used for consumption and investment. The total output of an economic sector is equal to the sum of all final goods sold to other sectors and all final demand goods sold to final demand users (Schotter, 1994).

Transportation is a major factor in the production of most goods and services. Transportation delivers raw materials to factories and finished goods to markets. It delivers employees to worksites and meetings, and allows customers to reach markets. Even information-based businesses that are distributing final products by the internet, require physical mobility to obtain or distribute the necessary resources including employees, equipment and material (TDM, 2003).

By reducing excessive road use other transportation costs including congestion, facility costs, accident costs and environmental degradation are also reduced. Such reforms benefit consumers directly, and increase productivity by improving the mobility of higher value travel while reducing external costs (Holland and Watson, 1978:16).

The potential economic benefits from road pricing do not imply an automatic increase in productivity, development and final demand in every situation. For, if implemented inappropriately, inefficient road pricing may result where: (i) the program has high overhead costs and minimal travel impacts and (ii) price changes are sudden and unpredictable which can be economically harmful.

The final demand for goods and services provided in the economy in the presence of road pricing can only be estimated after the secondary effect (i.e. the effect on social welfare) of road pricing has been analysed (Verhoef et al., 1995:2-3). Although it is beyond the scope of this research to quantify the **changes to final demand as a result of road pricing, it will be valuable to explore the perception of the stakeholders involved.**

#### 3.2.2.2 Turnover

Verhoef et al. (1998:11-13) points to the increase in business turnover under the conditions of road pricing. This occurrence is however subject to revenue recycling. Where revenue is not recycled, a reduced average turnover for different economic sectors is possible. **Without having to model these effects the purpose here is to evaluate the business perception of their return and to verify Verhoef's findings.**

#### 3.2.2.3 Labour volume

Labour is an important factor in production (Hyman, 1999:77-80). Little research has been done to establish the possible effect road pricing has on labour market productivity. Research by Madsen and Jensen-Butler (2001:14) suggests road pricing reduced the rates of employment in Denmark. It is not clear from their findings whether and why employment rates will change in the presence of road pricing and if it can be coupled to a change in labour productivity.

Parry and Bento (2001:1) modelled the effects of road pricing on labour supply. Their work suggested a slight initial decrease in the supply of labour followed later on by an increase in the supply when revenue is recycled and subsidies are granted. **The questions that needs to be addressed here are: (i) does the supply of labour increase or decrease as a result of road pricing and (ii) does revenue recycling play a role in that change?**

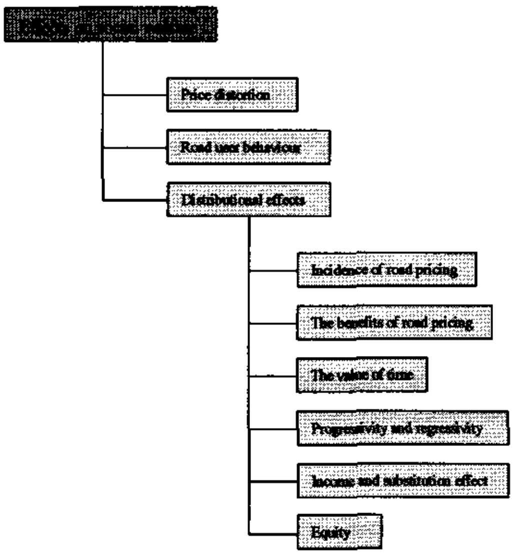
### 3.2.2.4 Saving, investment and economic growth

Savings and investment play an important part in macroeconomic growth and the effect of road pricing on this issue should be considered with care. Holland and Watson (1978:16) report that in Singapore road pricing did not have an adverse impact on economic savings and investment.

## 3.3 Effect on social welfare

The social welfare effects of road pricing have been extensively modelled through the contributions to the current literature by Arnott et al. (1994), Verhoef et al. (1995), Button and Pearman (1983) and Cohen (1987) to name but a few. The underlying theory is typically based on the analysis of homogeneous road users and the cost only imposed by and on the road users themselves. Clearly, theory per se builds on various assumptions, as it would be almost impossible to anticipate each road user and non-road users' behavioural patterns, to calculate the individual cost incurred and benefits received.

**Diagram 3.2 Effects on social welfare**




The effects road pricing has on the social welfare of road users and residents are measured in terms of (1) the effect of price distortions, (2) the effect on road user behaviour and (3) the distributional effect of the charge. The distributional effect is measured in terms of (i) the incidence of road pricing, (ii) the benefit of road pricing, (iii) the value of time, (iv) its progressivity and regressivity, (v) income and substitution effects and (vi) equity considerations. Diagram 3.2 depicts the main points to be discussed in this section.

## 3.3.1 Price distortion

The increase in transport cost as a result of road pricing distorts commodity prices and are transferred to production and consumption. Madsen and Jensen-Butler (2001:11,43) argue that road pricing affects commodity prices at the place of residence, reflected by an increase in the cost of shopping and shopping trips in the charged area. Road pricing also reduces disposable income and subsequently private consumption. It is then a natural conclusion that road pricing will have the same effect on demand and supply of goods and services in the local economic setting. **It is not clear however if this may lead to a decrease in production or increase to drive the prices of consumables down to counter a reduction in consumption.**

## 3.3.2 Road user behaviour

As travel demands on congested roads are not pre-ordained, neither are individual choices of how, when and which mode of transport to use pre-ordained. Quite reasonably road users make decisions in their own interest, rather than that of the community as a whole and on the basis of the best information available at the time, which is often rather poor. If road users are forced to pay a charge reflecting the marginal cost they impose on other users, they may opt to modify their travel behaviour. Therefore, only by acquiring a deeper knowledge of the travel decision process, will one be able to field policies capable of producing the desired results. **The purpose of having knowledge about road pricing induced behavioural changes or the alternate choices which have been made, is to allow some prediction of the distributional effects of road pricing.**

In order to consider road pricing induced changes to travel behavior trip makers have to be delineated in terms of how they value time and how they are affected financially by the charge (Levine and Garb, 2000:20,23-24; and Holland and Watson, 1978:16). In broad terms, six different categories of trip makers can be considered as illustrated in Table 3.1 below.

**Table 3.1 Categories of trip makers**

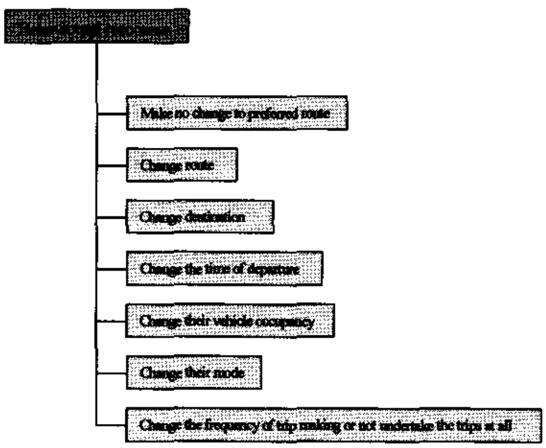
| Category | Trip Maker | Response |
|---|---|---|
| 1 | High value of time motorist | Continue to travel |
| 2 | Medium value of time motorist | Continue to travel |
| 3 | Medium to low value of time motorist | Avoid travelling along charged route for some trips |
| 4 | Medium to low value of time motorist | Avoid travelling along charged route for most trips |
| 5 | Public transport user motorist | Unaffected |
| 6 | Combination of category 1-5 | Affected by displaced traffic |

Category 1 are represented by individuals with high valuations of time savings who had travelled before the imposition of the toll and continue to travel under tolled conditions such as business journeys. They benefit because the value of the time they save exceeds the value of the toll they need to pay. Category 2 is represented by people who continue to travel under toll conditions but are worse off after the imposition of a congestion toll. They continue to travel because the benefits of the trip outweigh its costs; yet their valuation of time is such that they would have preferred to suffer the cost of time spent in congestion rather than paying the congestion toll that relieved it. Category 3 is represented by individuals who had travelled the route prior to tolling, but avoid it under conditions of toll for some of their trips.

Category 4 is represented by people who had travelled the route prior to tolling, but avoid it under conditions of toll for most of their trips. Category 5 is represented by travellers along the route who had used public transport prior to the imposition of the toll and are unaffected by the toll. Category 6 includes travellers whose travel behaviour is not directly affected by the charge but by the travel behaviour of the five other categories of trip makers e.g. traffic diverted away from the central area may cause congestion on peripheral streets.

Specific categories of road users are also characterised by specific responses as Table 3.1 suggests. Hills (1993:92, 1996:6-10) identifies seven additional possible responses as illustrated in Diagram 3.3 below. In real life, journey decisions are often more complex and this list should not be regarded as exhaustive.

**Diagram 3.3 Possible behavioural responses to road pricing**




It is quite clear from the preceding paragraphs that the first category benefits the majority, in terms of the value of time savings relative to tolls paid and improved accessibility due to greater flexibility in the timing of car trips. Thus for example, members of the first category who had previously travelled at inconvenient times in order to avoid congestion are freer to travel in a fashion that more closely matches their preferences. To a lesser extent this benefit accrues to category 2 and 3, however, it is in most circumstances more than balanced by the value of the tolls paid. The road users in category 3 and 4 could shift from the tolled road to slower non-toll roads, to public transport, to new travel destinations or they could cancel their trip.

Holland and Watson (1978:16) also report that road pricing possibly has the most adverse effects on the behavioural patterns of trip makers in category 3 and 4 - people who travel to work in the charged area. For these people the monthly cost of commuting by car will rise and in response, the proportion of trips decrease, while an increase in the use of public transport may occur. The changes in travel time for travellers who do not change mode and who travelled to work through the charged area to destinations on the other side of the city are very small.

Road pricing also causes traffic displacement, which describes congestion induced travel behaviour where road users divert to peripheral routes. Litman (2001:8) and Hills (1996:5-8) recognizes that traffic congestion per se diverts traffic to peripheral routes, increases time of travel and increases the journey length and alter the frequency. Although road pricing provides road users with an incentive to reduce the number of journeys, Litman (2001:1) and Hills (1996:5-8) argue traffic displacement may reduce the benefit it brings.

Transport for London (2003a:1-5) reports that recent traffic counts taken on the inner ring road and across a system of radial screen-lines in Inner London has not shown significant increases in traffic congestion coinciding with the introduction of charging. On the inner ring road overall traffic levels at a sample of sites have been relatively static across the period of the introduction of charging as a result of reduced radial movements that partly use the inner ring road and increased orbital movement. A similar pattern has been reported in traffic crossing a system of four radial screen-lines extending outwards from the charging zone. These results suggest the net volume of diverted traffic is relatively small and has not created any significant additional stress on the inner ring road or the network of radial routes around the charging zone in Inner London. It would be valuable to verify these findings with public perception.

**It is unclear whether the public perceives road pricing as a source or cause of traffic displacement.** *Some critical questions need to be answered in establishing the public mood. These include, (i) why do road users divert to other routes?, (ii) do road users change route?, (iii) does the length of the trip increase or decrease?, (iv) do road users change mode?, (v) does road pricing encourage a change in travel departure time?, (vi) does it increase vehicle occupancy?, and (vii) does road pricing influence peripheral residents' travel choices to the extent of changing mode and planned and unplanned journeys?* In answering these questions the relationship between public perception and current research findings will be established and it will also verify or disprove some commonly held beliefs about the nature of traffic displacement.

### 3.3.3 Distributional effects

The standard argument in favour of road pricing tends to ignore distributional effects. The key issue revolves around which groups in society would benefit and which would lose as a result of its introduction. The central relationship seems to be that between travel time savings and changes to income levels for various (income) groups of road users. The distributional effects arise since there are some high income road users for whom the value of a given reduction in journey time is greater than the increase in the toll rate. Such users could gain as a result of paying the toll. Low income users might be made worse off and suffer a reduction in welfare by paying tolls if they value a similar reduction in journey time less than the increase in the toll rate (Button and Pearman, 1983:24).

The distributional effects of congestion tolls can be off-set by a lump sum system of income redistribution as Cohen (1987:242) suggests by using the toll revenues to compensate those who would otherwise be made worse off and ignores the fact that compensation schemes might cause distortions in resource allocation. While it is possible that an optimal road price will result in a Hicks-Kaldor improvement in economic efficiency, Button and Pearman (1983:24) argue the distributional implications are much less clear cut since no strict Pareto improvement is likely to result in reality as Foster (1975:186) argues. Concern over the possible distributional consequences is certainly one of the most often cited official reasons for the rejection of road pricing.

### 3.3.3.1 Incidence of road pricing

Knowing that road users are financially affected by road pricing in different ways and their responses vary, the question arises as to how one can place a reliable monetary value on the corresponding gains or losses in order to establish how the burden of the tax is proportioned between different income groups. Road pricing leaves commuters with an excess tax burden according to Arnott et al. (1994), Langmyhr (1997:27) and Parry and Bento (2001:1). Verhoef (1995) reports however that little empirical information is available regarding which income groups carry most of the burden. It may be assumed in theory that road users carry the brunt of the tax rather than businesses, but it is not known whether the rich or the poor pay proportionally more. Even if the rich paid proportionally more, it does not mean they are adversely effected by the increased tax burden.

Furthermore, Layard (1977:302) and Jones and Hervik (1992:140) argue that the incidence of road pricing depends not only on the income elasticity of journeys but also on the different effects of the charge on the cost per journey experienced by different income groups. The burden can be reduced if revenue is recycled back to the commuter or if employees succeed in shifting the burden to their employers through wage negotiations. **It is however not known whether employees will indeed succeed in shifting this burden.**

### 3.3.3.2 The benefits of road pricing

Several authors maintain that as marginal cost pricing creates a social surplus there must be some methods of redistributing the benefits to all groups (Goodwin, 1989:495-496; Small, 1983:90). Feasibility studies of a proposed scheme for London underline the possibility of gaining public support through "a package approach" to benefit all the major groups involved (Jones, 1991a:255). This type of approach has been systematically applied in political negotiations concerning the road pricing scheme in Oslo (Johansson and Mattsson, 1995:8).

However, in distributional issues there are always winners and losers and policy makers have to convince road users that benefits will accrue to them all. A catalogue of benefits may include increased welfare, a cleaner environment to live, work and shop in, subsidies, increased mobility for the poor resulting from improved public transport, increased time saving, increased consumption, savings and investment (Johansson and Mattsson, 1995:9-10; Levine and Garb, 2000:4-5; Morrison, 1986:87-91; Jones and Hervik, 1992:138 and Dawson, 1986:79). Realisation of these benefits is however subject to revenue recycling.

### 3.3.3.3 The value of time

One of the principle components of the benefit element in road pricing is the time saved due to faster journeys. Button and Pearman (1983:20), Cohen (1987:242) and Oort (1969:282) argue that the value of time differs for different individuals. They report that in a recent study on the value of time the question of the evaluation of small time savings has been considered in some detail and it appears to suggest that (i) small time savings may not even be perceived by the beneficiaries and (ii) even if perceived, they may not be of as much use as larger time savings.

Layard (1977:297) attempts to model the distributional effect of road pricing in terms of the value of time and concludes that journeys with high time values, such as those for business trips, will probably be encouraged and journeys with low time values will probably be discouraged. In terms of welfare the charge decreases road user surplus; journey makers with a high time value will gain and the journey makers with low time value will generally lose. Those who have never made journeys during peak congestion times, may now consider doing so as the cost might be less than not making the journey at all. **The extent to which the value of time differs between income groups and the role it plays in deciding whether to make a journey or not is an empirical question which does not appear to have been tackled yet.**

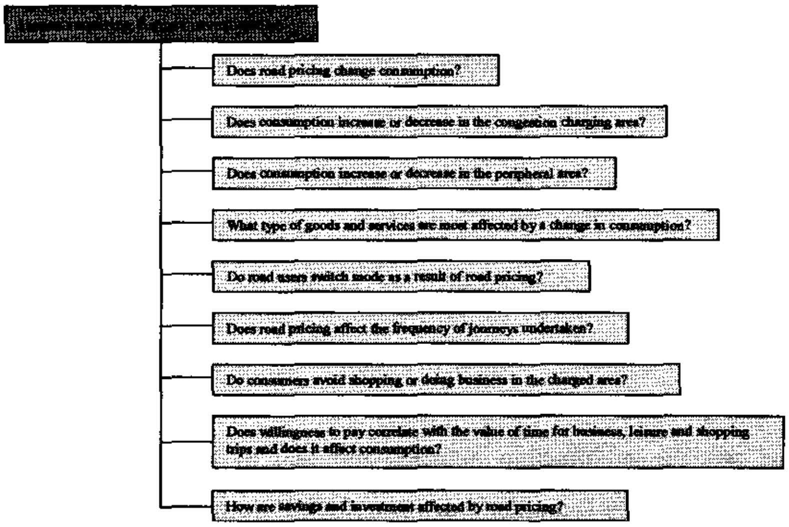
### 3.3.3.4 Progressivity and regressivity

Foster (1975:187) points out that a progressive tax indicates that its yield is a rising proportion of the net income of a household. Regressive taxes would indicate the yield as a decreasing proportion of the net income. The road pricing tax does not increase proportionally with income as income tax does, suggesting it is a regressive tax. Road tolls represent a greater financial burden on lower-income motorists than on higher-income motorists but they are not necessarily more regressive than other latent road funding options, such as fuel taxes or general sales taxes.

Whether a toll is regressive overall depends on how much lower-income consumers use roads, the quality of travel alternatives and how revenues are used (Giuliano, 1994:250). If the possibility exists for the higher income group to experience a greater net income loss than the lower income group, it would point to road pricing being progressive.

### 3.3.3.5 Income and substitution effect

**Diagram 3.4 Consumption issues**




Madsen and Jensen-Butler (2001:11) report that road pricing reduces the disposable income of road users and hence private consumption as a result of the increase in commodity prices. However, the analysis does not indicate how the high, medium and low-income groups are affected or how the disposable income will change for each group as a result of the revenue being recycled. More importantly, **little empirical theory is available to verify the** effects of an income-induced change in the demand for road space (**income-effect**). The change in demand is reflected in a reduction of road use as a result of having less income to spend on the consumption of road space. **Little empirical theory is also available on the substitution effect** which occurs when the road user switches his demand to another source or mode of transport when the price of which has at least remained constant in the face of a congestion charge. (Schotter, 2001:77). Diagram 3.4 illustrates the **more specific issues which require clarification in understanding how road pricing affects consumption.**

#### 3.3.3.6 Equity

Equity is a term loosely used by the public to describe fairness. This translates to questions of whether road pricing of any nature is regarded as having a disproportionate effect on some groups relative to others (Jones, 2001:1). The main concern in equity terms is that of the group. Those who contribute the most do not necessarily stand to gain the most from transport improvements. Those individuals who use public transport or no transport at all still benefit from the road improvements, yet they contribute very little towards it.

The social equity concern is especially acute where high disparities between low and high income groups exists, thereby accentuating the differences between willingness to pay and ability to pay issues. The general consensus is that everyone should pay their fair share. Unfortunately, the term is interpreted by road users in many different ways. **It may be of political value if policy makers knew what is publicly perceived by fairness and paying a fair share. It should also be verified if road users perceive exemptions or discounts as increasing equity** (Jones, 2001:4), (Hau, 1998:68) and (Mayeres and Proost, 2002:2).

Any major road pricing scheme will be accepted only if it shows clear welfare gains for a sufficiently large majority of the voters, which can only be achieved through revenue recycling. This is the essence of the economic approach to acceptability.

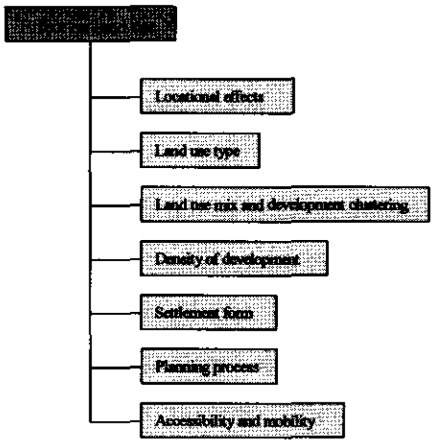
## 3.4 Effect on land use

Land use planning and transportation are very much inter-related and the aim generally is to devise new ways of planning development which would make it possible to develop transport systems in the future to serve our needs and overcome the transport problems we face today. The aim here is to establish the effects of road pricing on land use and the relationship between the two in identifying possible uncertainties. Komannoff (1997:1-2) contends that the effects of road pricing on urban form and land use depend on the pricing instrument, where and how widely it is applied, the current metropolitan configuration and especially, the uses to which the proceeds are put. No single generalized conclusion can be drawn.

Chaterjee et al. (2001:11) cites the UK Government's planning policy guidance on transport (PPG13) states that *"by shaping the pattern of development and influencing the location, scale, density, design and mix of land uses, planning can help to reduce the need to travel, reduce the length of journeys and make it safer and easier for people to access jobs, shopping, leisure facilities and services by public transport, walking and cycling"*. If this can be perceived as a policy goal it will be meaningful to establish whether and to what extent road pricing causes land use patterns to detract from these objectives.

Unsurprisingly theory about the link between road pricing and land use is hard to obtain as this is an area where little empirical research has been done, possibly because road pricing has not been introduced on a wide enough scale to evaluate the effect (Stead and Banister, 2001:317-321). The main points to be discussed in this section are illustrated in Diagram 3.5.

**Diagram 3.5 Effect on land use**




## 3.4.1 Locational effects

Martinez (1995:317-321,457) mentions an axiom of modern transportation planning; the notion that transportation is a "derived demand", that is, people rarely consume transportation for the pleasure of movement *per se*, but rather travel in order to reach opportunities available at destinations. This fundamental understanding is primarily an underpinning of travel demand analysis that facilitates the modelling of transportation flows based on the arrangement of connecting land use patterns across a region and the facilitation of economic activity. Hence, journeys are undertaken to specific locations because of the benefits received at the destination. For this reason journeys and the cost they involve should be as short as possible.

The location of different land uses critically affect travel patterns and therefore when building new stock road pricing will have to be included as an influencing factor in the cost benefit analysis when establishing the feasibility of the location (Stead and Banister, 2001:317-221). Planning and regulating new development is an important function of local authorities as is stimulating the livelihood and attractiveness of existing land use patterns within an area. The emphasis clearly needs to move towards a plan-led system with peripheral development only being allowed if there are no suitable development sites in town centres (Chatterjee et al., 2001:29).

Eliasson and Mattson (2000:417) has attempted to model the locational effect of road pricing on land use. Their results indicate the effects on location are small compared to the effects on traffic volumes, modal split and travel patterns. The locational effects are fairly small and depend strongly on the size of the charged area. They also maintain that if the charged area is sufficiently large, locations outside a charged are will become less attractive than before and will have a centralising effect. **These conclusions must however be verified empirically in the local setting.**

### 3.4.2 Land use type

Stead and Banister (2001:317-221) argues that where empirical evidence is available the effects of road pricing are often suggested to be small. The reasons for this are that many changes take time to have an effect and, more importantly, the adjustments are not just in one direction but in many directions.

Whitehead (2002:227) mentions that road pricing may influence land use types in the different ways. The retail function is potentially the most sensitive sector, as out-of-centre competition causes fear of the CBD (Central Business District) losing its importance as the hub of retail activity, lucrativity and consumers. High order office functions are not sensitive to road pricing as this function draws clients and customers who do not necessarily require motorised access. Road traffic does not appear to be a concern to this sector. However the low order office function, such as lawyers, accountants and other professional firms, branch banks and building societies may be affected more directly as they heavily rely on day-to-day customer contact, which necessitates access by car. The cost of the charge may discourage prospective clients and hence persuade this sector to relocate outside the charged area.

The leisure industry caters primarily for local people who reside in the catchment area and who frequently use the restaurants, cafes, bars, pubs, cinemas and theatres on offer in the city centre. The daytime leisure economy is driven by shoppers and office and retail workers who use the restaurants and cafes. With a day time charge imposed, the day time economy might be slightly sensitive to charging even with revenue recycled. The night-time leisure economy operates after the charges ends and is mainly unaffected (Whitehead, 2002:232).

In relation to residential functions, the popularity of urban living has increased in recent years because of the range of attractions on offer, proximity to work and the perception that your lifestyle can be more attractive and sustainable. The manufacturing function appears to be on its way out of city centres and hence, is only slightly affected by road pricing since the remaining manufacturers are not customer dependant but rather production focussed.

### 3.4.3 Land use mix and development clustering

Mixed-use developments may also help reduce travel demand and it is perfectly possible to have houses with shops, light industrial uses and recreational facilities in close proximity. Rigid zoning is not as necessary as in the past since society is now much more based on a service economy than a manufacturing economy. There is considerable potential for high-quality mixed-use centres that encourage the use of local facilities, public transport and walking. In addition, there is a considerable interest in transport development areas and pushing development into high-density transit-oriented corridors as a means of providing a greater intensity of land use. **There is however little empirical evidence to suggest that road pricing has caused land uses to mix and alternative modes of transport to interact and integrate. The perspective of the Local Authorities in this regard may shed some light on this possibility.**

### 3.4.4 Density of development

According to Arnott (1998:1) and Bell (1997:669) the standard model of urban traffic congestion and urban spatial structure, road pricing results in a more concentrated city and the concentration of economic activity. The intuition is that travel would be more costly with the congestion toll in place, which would discourage travel and encourage building at higher density. Accordingly, the best guess is that road pricing does cause urban spatial structures to become more concentrated though not by as much as conventional wisdom suggests. **The effect on development density needs further research** because congestion charging could alter urban spatial structure qualitatively by reducing the CBD orientation of cities and inducing more sub-centering.

Levine and Garb (2000:5-6) argue that by making access to the charged area more expensive, it might encourage the migration of homes and jobs to locations outside the charged area and reduce the relative attractiveness and density of development in central locations. Thus their argument contradicts Arnott and Bell's argument.

As a rough guide, pricing vehicle miles travelled will tend to centralise development although this result could be undermined if the proceeds are used for highway construction. Similarly, pricing limited to the central city can strengthen the urban core if the proceeds are used to offset the increased cost of driving - by reducing sales taxes, and/or fuel duty for example. Revenue-neutral congestion-pricing is the pricing form least likely to favour the central city, although it will not necessarily harm it.

The increase in development density may promote more sustainable patterns of development. If less land is required for development, the potential exists to use energy more efficiently and to reduce the need to travel. Higher density development may also assist the introduction of the other measures such as strategy concentrating development in transport arteries and nodes (increasing the accessibility to public transport, providing more local employment, services and facilities and reducing the availability of parking). Research and evidence from a number of sources suggests that higher density development is associated with less personal travel, reduced reliance on motorized modes and increased levels of walking and cycling (Stead and Banister, 2001:317-321).

## 3.4.5 Settlement form

Settlement size and form is also a key determinant of travel patterns. Urban and street design and the layout of development, are all factors that may be influenced by road pricing either restricting vehicle access or at worst encouraging it. Banister (1999:314-316) reports that the effect of road pricing on these factors are generally not known and would vary from city to city.

## 3.4.6 Planning process

As the integration of land use and transport are central to achieving sustainable development, planning authorities play a complementary role in achieving the goal of traffic restraint. Banister (1999:323) and Stead and Banister (2001:317-321) argue in favour of the planning process being a great tool in aiding the general goals of road pricing and that it should be employed as complementary to road pricing in reducing traffic congestion. This can be done by considering land use patterns that reduce the amount of traffic and dependency on the car. In terms of causation **Banister (1999:324) reports that little evidence exists about the way in which road pricing influences the planning process.**

## 3.4.7 Accessibility and mobility

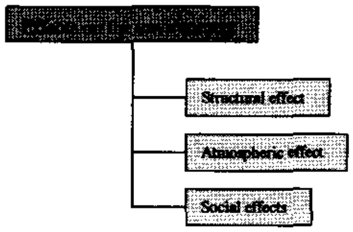
Levine and Garb (2000:24-25) report that where road pricing is focused on increasing mobility (ease of movement) it may cause metropolitan decentralisation and where it focuses on accessibility (ease of reaching destinations) it leads to urban concentration. Obviously the policy maker has a trade-off between accessibility and mobility focused pricing instruments.

A "mobility-based" implementation of road pricing is one that is orientated towards ensuring free-flow traffic per se; an "accessibility based" instrument seeks to maintain and enhance CBD accessibility. The distinction, lies primarily in the use of the collected tolls (Levine and Garb, 2000:24-25).

If road pricing is not explicitly designed for accessibility enhancement, it can ultimately be one of a family of congestion-fighting and mobility-enhancing policies that end up diminishing metropolitan accessibility. This can occur when a pricing policy which works by pricing some journeys off the road, fails to replace the now-missing drivers to a previously congested area with residents and travellers who arrive there by other means. The economic vitality of congested areas depends on their ability to attract flows of customers and employees; restriction of that flow with no attention to replacement threatens these areas and risks accelerating outward development of the region. In contrast, a pricing policy rooted in accessibility would build in inherent linkages assuring that as journeys to a congested area are made more costly in time and money terms, access by other means is rendered more affordable.

# 3.5 Effects on the environment

**Diagram 3.6 Effects on the environment**




Although there has been a considerable amount of research on road pricing, little significant progress has been made in quantifying the public perceived environmental effects it causes (Chin, 1996:188). The interest in road pricing's environmental effect includes areas such as (i) its structural effect, (ii) effect on atmospheric emissions and (iii) the effect on welfare (Beamon, 1996:65; Johansson-Stenman and Sterner, 1998:150-151; Mayeres, 1998:3-4 and Newbery, 1990:3). These areas of interest, illustrated by Diagram 3.6, will be evaluated next.

## 3.5.1 Structural effect

Ferrari (1995:357) draws attention to the environmental capacity of a road which is described as the maximum traffic volume that can travel along a road without exceeding a certain threshold of environmental damage. By implication it follows that in order to combat congestion, one way of dealing with the congestion problem would be to create additional capacity. The creation of additional capacity can be referred to as the structural effect of road pricing and translates into a negative environmental effect.

Where road pricing is applied, less vehicle journeys are made. The decrease in vehicle journeys is paralleled with a decrease in the demand for road space and the level of vehicle emissions, hence a cleaner environment. Where road expansion is demand driven, road pricing serves as a mechanism to dampen substantial expansion projects. **In this context it will be valuable to establish whether the public will be willing to pay a charge if it is perceived that it will reduce environmental decay and benefit the environment we live in.**

Although congestion pricing discourages peak travel journeys as Komanoff (1997:4) suggests, it displaces some journeys to alternative routes, hence increasing environmental damage elsewhere. Chin (1996:787-788), Hillman (1992:228-230), Santos and Newbery (2002:3-5) and Santos et al. (2000a:9) suggests the success in containing congestion and related pollution problems does not lie with road pricing alone. Legislative and fiscal measures, careful land use planning, reorganization of and investment in an efficient public transport system, investments in road infrastructure, traffic management measures and enforcement make up the rest of the equation. To this end, traffic regulations and schemes can control traffic problems efficiently and improve the environment. Whether road users perceive these benefits as actual cost and time savings is a different matter altogether.

### 3.5.2 Atmospheric effect

Economists see the problem of vehicle induced air pollution as a special example of market failure in the absence of clearly defined private property rights in the environmental media. Because allocative efficiency can not be reached by assigning individual property rights to environmental media, calls are made for a system of taxation and some other instruments to equate the marginal social damage caused by the wastes concerned to the policy objective called for. By introducing road pricing the general belief is that it will reduce the environmental impact of vehicular traffic. Emissions from vehicles constitute the greater part of atmospheric pollution according to Otterström (1995:334) and McCubbin & Delucchi (1999:253). The most representative pollutants are (i) Sulphur dioxide - $SO_2$, (ii) Nitrogen dioxide - $NO_2$, (iii) Lead - Pb, (iv) Carbon dioxide - $CO_2$, (v) Carbon monoxide - CO, (vi) Methane - $CH_4$, (vii) Ammonia - $CH_3$, (viii) Ozone ($O_3$) and (ix) dust particles.

Accurate calculations of emission are notoriously difficult as data about vehicle type, age, speed of travel, individual vehicle's performance and engine capacity travelling along a priced road is difficult to obtain. In order to discuss the likely allocative gains from environmental road pricing in relation to their cost, it is necessary to have some idea of the magnitude of the environmental external costs at stake. Common (1990:1297) reports that in the absence of the required information it is not possible either to identify the target levels of pollution (that is, those corresponding to allocative efficiency) or to compute the tax rates required to realize the attainment of that target. This represents the practical difficulty in measuring the effect of air pollution.

The most obvious decision criterion would then be to weigh the costs and benefits of a standard improvement and choose the alternative where the social net benefit, that is, social benefits minus social costs, is maximized. Alternatively, the road user's willingness to pay in return for a healthier environment can be used as a measure of improvement. Without having to resort to complicated calculations these arguments can be compared to theory by putting these options to the public. **If the**

**public perceives road pricing to result in a reduction in the level of traffic emissions** as Otterström (1995:315), Santos et al. (2000a:1-9) and Santos and Newbery (2002:14) suggests, **then a change in emission levels can be measured successfully using this method.**

Given the objective of reducing environmental decay as a result of motorised vehicles, a number of instruments are distinguished in the literature by Common (1990:1298), Proost and Calthrop (2002:2,4), Johansson-Stenman and Sterner (1998:163-164), Santos and Newbery (2002:14) and Proost and Van Dender, (2001:384) to realize this objective. They are (i) cleaner vehicle technology, (ii) regulation of activity, (iii) pricing (green or pollution taxes and road pricing) and (iv) incentive-based instruments such as subsidies.

These instruments operate by altering motorist behaviour, which in turn alters the level of air pollution. Proost and Calthrop (2002:4-5) have modelled and simulated the effects of a pollution tax as an incentive to reduce traffic and also pollution levels and concludes that if a pollution emission tax is set at an optimal level, drivers will make decisions corresponding to the efficient outcome.

Although regulation is one of the most widespread instruments used to deal with local and regional traffic induced air-pollution problems, Johansson-Stenman and Sterner (1998:153-156,163-164) argues in favour of road pricing as it attempts to equate the marginal cost of abatement to allocative efficiency. They add that it is the allocative efficiency advantage over regulation that is one of the fundamental reasons why road pricing is particularly relevant to local environmental problems. Recently policy makers have called for a shift in regulation from dedicated fuel efficiency and atmospheric pollution regulation to pure transport policies such as road pricing, targeting congestion indirectly (Proost and Van Dender, 2001:402-403). This does not mean that road pricing should necessarily replace regulation and fuel taxes currently used (Johansson-Stenman and Sterner, 1998:163-164).

Santos and Newbery (2002) confirm these arguments by modelling and simulation and show in their case study that cordon tolling will have positive environmental benefits through health improvement and a reduction in global warming. Proost and Van Dender (2001:383-385) refines this argument even further by estimating that of all the road pricing measures available, congestion pricing probably yields the most substantial emission reductions, however modest in comparison to welfare and possible economic efficiency gains.

Cleaner vehicle technology is cited by Proost and Calthrop (2002:149) as an effective alternative to reducing emissions. However, it is important to realize that as vehicle technology becomes more sophisticated, the levels of emission will fall irrespective of the effect of road pricing on traffic volume. The disadvantage of advocating cleaner vehicle technology, coupled with emission reduction subsidies is that it will actually induce drivers to undertake journeys rather than curbing them as the vehicles are environmentally cleaner.

Frey et al. (1985:62) reports that with few exceptions economic literature is strongly in favour of using incentive-based instruments in advocating a cleaner environment, thus rejecting regulatory control. However, there are but few cases in which incentive-based instruments have been applied in practical environmental policy; regulation is the dominating approach.

It appears from the preceding paragraphs that useful progress towards the public acceptance of road pricing can be made if the stakeholders perceive the side effects on the environment as positive. **The objective here is to find which of the instruments the public perceives more favourable and acceptable.**

### 3.5.3 Social welfare effects

Road pricing's positive effect on the environment is also manifested in the social benefits to society. A decrease in the number of journeys implies less pollution induced diseases, less noise pollution and increased convenience and comfort for pedestrians and residents living or having access to a charged area. It also reduces losses to private and business revenue.

It is very difficult to attach a realistic monetary value to the cost of the disbenefits caused by vehicle induced environmental effects. Because road pricing induced environmental disbenefits and benefits have a subjective nature, Otterström (1995:315) suggests assessing and measuring these benefits not in financial terms but rather by the road user's willingness to pay in return for a healthier environment. It can then be concluded that **if a large percentage of road users are willing to pay for a healthier environment, it signals greater acceptance.**

In relation to the equity effect of different instruments to reduce the environmental effects, the question is (i) how are different groups in society financially affected by the introduction of not only road pricing, but also green (pollution) taxes and regulation and (ii) who benefits most from the recycling of the revenue?

Rufolo and Bertini (2003:40) attempt to answer some of these questions in their argument of geographic equity, i.e. improving the welfare of residents in a specific geographic area through the application of a road price. As Proost and Calthrop (2002:13), they too contend that local authorities may act to maximize the welfare of local residents rather than the community as a whole. Countering this argument is the use of green (pollution) taxes such as duty on petroleum or the use of regulatory control to reduce vehicle induced environmental decay. These taxes and or regulations are usually set and applied not only to local consumers but have a regional and country wide application and might tend to shift the tax burden wider than the local setting. These instruments draw revenue from a much wider revenue pool than road pricing, hence it has the added benefit of being an attractive revenue source, which is not necessarily drawn from the local community, but largely benefits the local community through funding.

**What appears to be unclear though is (i) whether the public and businesses are aware of the alternative instruments to reduce the environmentally induced impacts from vehicles on society and (ii) whether the public perceives the use of green taxes and regulation or indeed cleaner vehicle technology more equitable and/or favourable than road pricing** which many motorists see as an added toll and form of double taxation, in achieving the same policy objective.

# 3.6 Conclusion

In investigating and evaluating the primary effects of road pricing, it has identified the effects on the economy in general terms. In terms of peoples' welfare, road pricing affects road users most severely in forcing behavioural adjustments and induces income and substitution effects. Some unanswered questions were identified in terms of the incidence of road pricing not being fully explained in the current research literature. It was also found that little empirical research has been carried out on the link between road pricing and land use with a number of gaps identified in terms of peoples' and businesses' locational decisions, land use type, density of development and the effects on the planning process. In terms of the effect on the environment, many authors recognized the benefits attained. However, it is unclear whether road users' willingness to pay in return for a healthier environment will contribute towards road pricing's long term acceptability.

Having explored the effects of road pricing, some important ideas, concepts and themes, which have not yet been explored fully in current research attempts, have been highlighted. These are the gaps this study aims to address and are indicated in Diagram 3.7a-c, pages 60 - 62. In exploring these gaps and finding relationships between road pricing and its effects, it is of great importance to progress these issues against the background of public perception. The stakeholders identified in Chapter 1 will therefore form the basis for extracting information by answering the research questions and addressing the research problem.

**Diagram 3.7a Issues to be investigated**

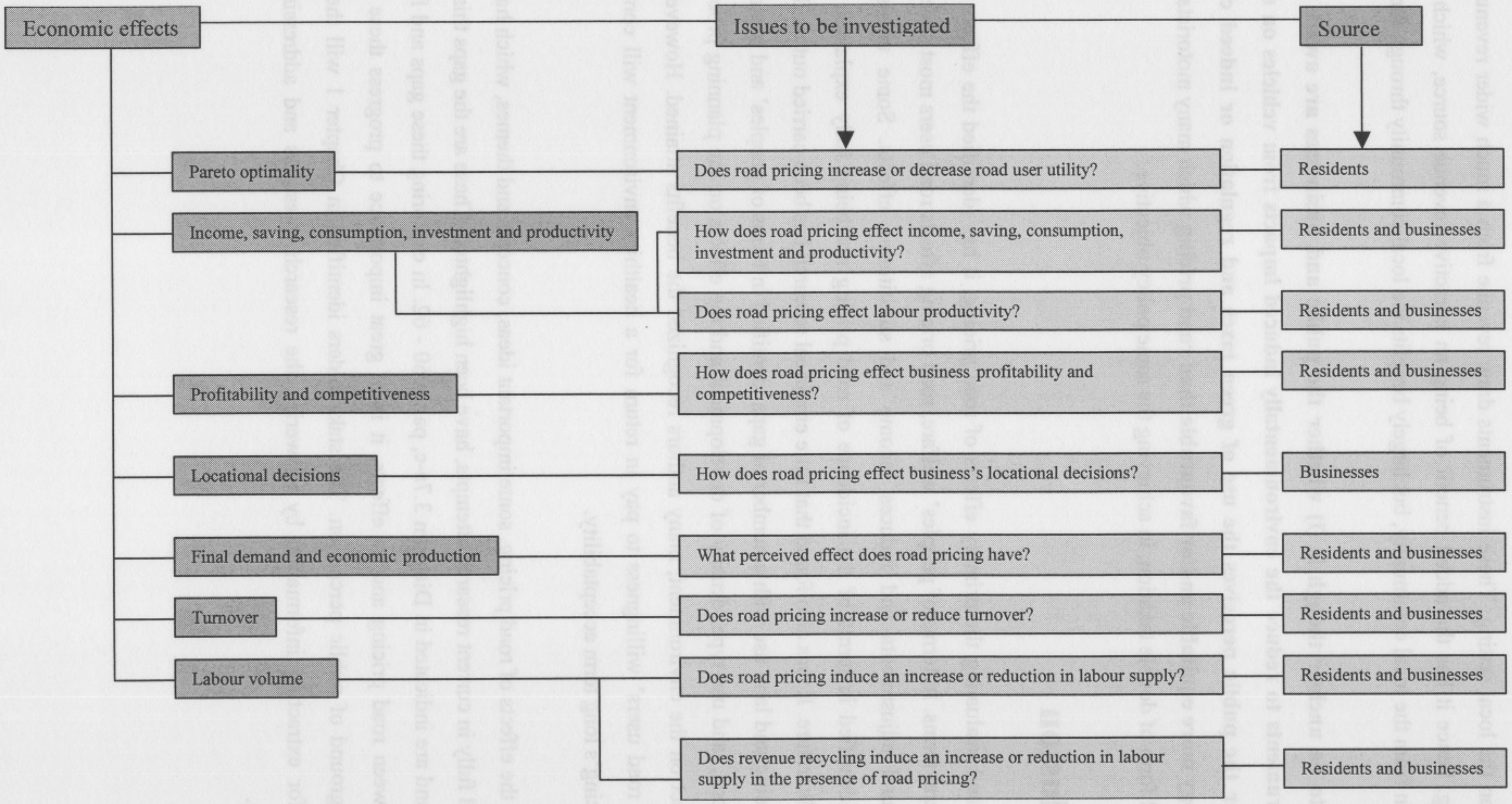


**Diagram 3.7b Issues to be investigated**

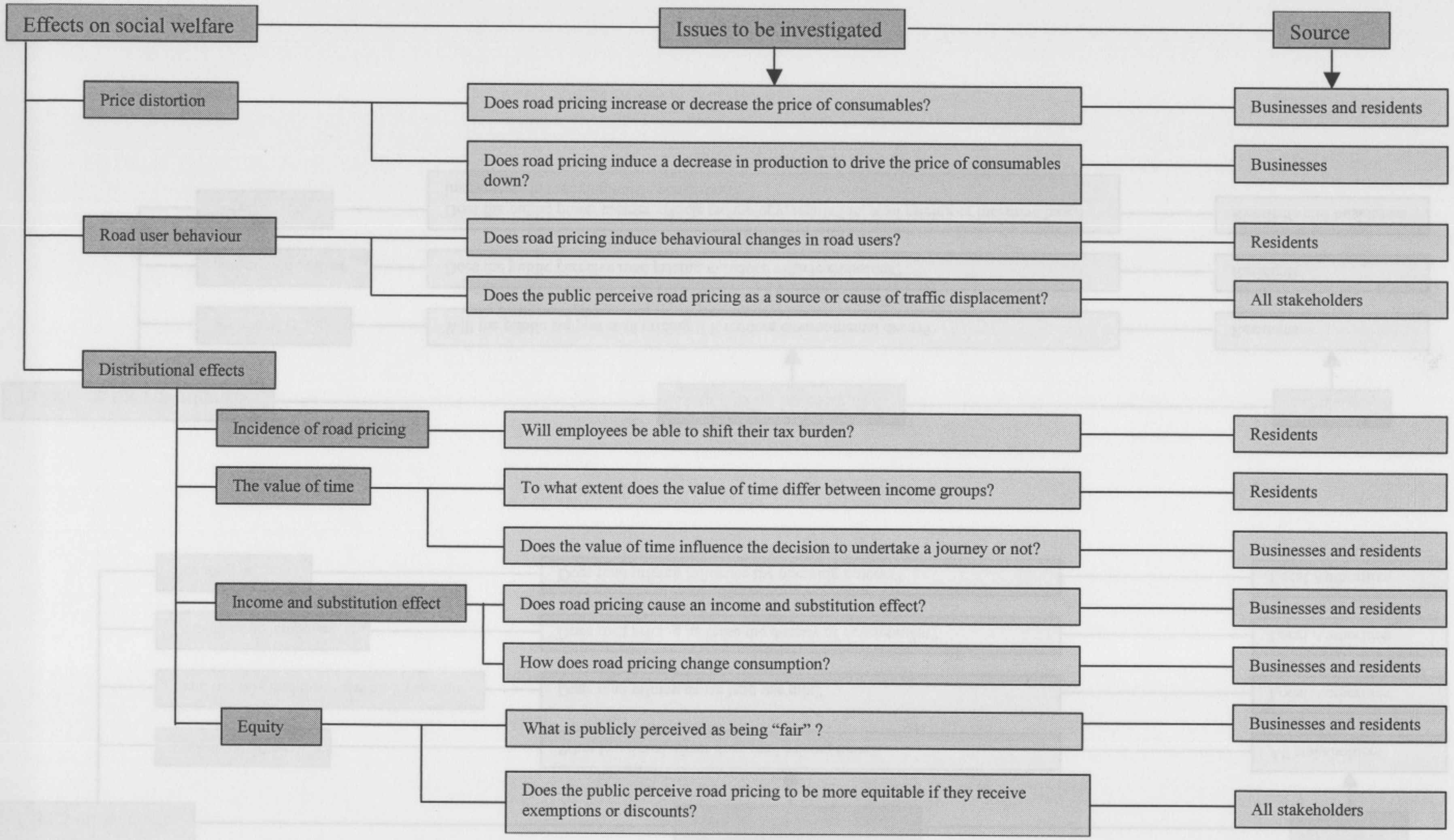
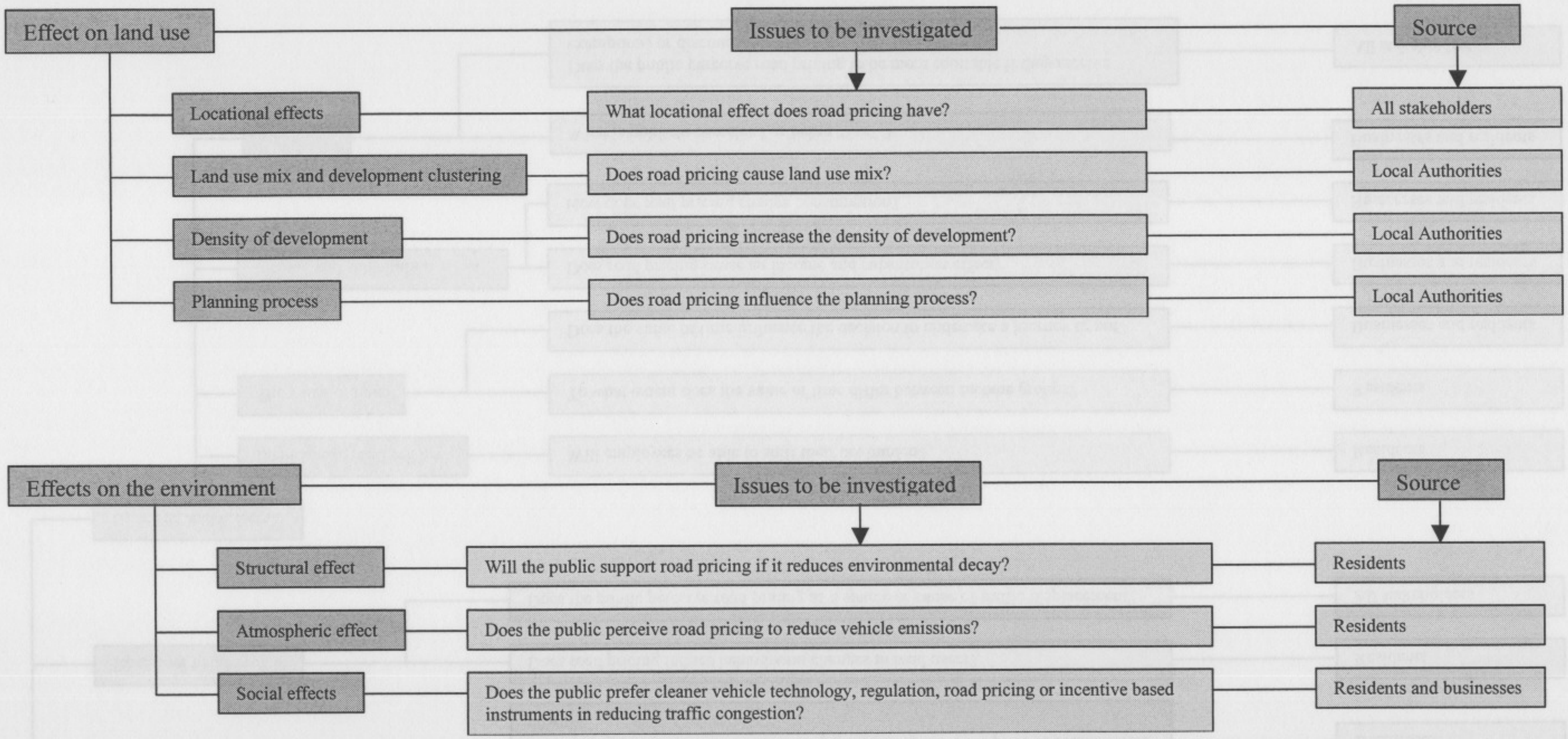


**Diagram 3.7c Issues to be investigated**



# Chapter 4 Sustainability issues

## 4.1 Introduction

Having identified the effects of road pricing and subsequent issues requiring further investigation, the focus of discussion now moves to the examination of the factors which sustain a road pricing scheme. In the context of road pricing sustainability refers to maintaining the viability and acceptability of road pricing by promoting the factors supporting it as a traffic reduction instrument. The factors which may prove to sustain road pricing have been identified by Adler and Cetin (2001:448), Arnott et al. (1991:309-310), Chang and Cheng (2002:2), El Sanhouri and Bernstein (1994:44), Emmerink and Van Beek (1997:222), Henderson (1974:346), Parry and Bento (2001:1) and Sim et al. (2001:399) to name but a few. These include revenue recycling, work-scheme flexibility, driver information provision and public and political acceptability. In exploring these issues, starting with revenue recycling, the gaps in the current literature will again be highlighted.

## 4.2 Revenue recycling

Road pricing is advocated both by economists and members of the transportation community as an effective instrument for not only alleviating traffic congestion but also financing road maintenance while bringing about a degree of fairness to the tax system. In achieving this policy objective revenue recycling has been identified as a factor which may contribute to sustaining a road pricing scheme. This presumption is explored by (i) examining the prerequisites for revenue recycling as a factor advancing the sustainability of road pricing, (ii) potential distribution methods and (iii) the benefits which may arise.

### 4.2.1 Prerequisites for the recycling of revenue

Litman (1999:1) cites 3 prerequisites for revenue recycling as a factor advancing the sustainability of road pricing: (i) economic efficiency, (ii) equity and (iii) political feasibility.

Of these three, economic efficiency is the easiest to achieve (Litman, 1999a:8). The conditions required for the efficient use of the revenue raised are based on the cost and benefits derived from its allocation or redistribution. The benefits represent the amount of satisfaction a user derives when receiving a financial benefit. The marginal social benefit (MSB) is the additional benefit obtained by a road user when one extra unit of benefit (in monetary terms) is afforded to a road user. The marginal social cost (MSC) is the minimum sum of money required to compensate road users to make an additional journey or to persuade them to divert to another route. It also presents the cost of facilitating and maintaining the pricing scheme.

Hyman (1999:54-56) cites the marginal condition for efficient resource (revenue) redistribution is met where the revenue is allocated so that the MSB = MSC, hence the cost of providing a road pricing scheme should equate the benefits it generates. It is also important that the revenues be used to benefit society as a whole, not only those paying a charge and that road users are not refunded in proportion to how much they pay individually. If drivers pay to use a road on Monday knowing that the money will be returned on Friday they have little incentive to change their travel behaviour. Because economic efficiency does not require revenue to be dedicated to road or transportation improvements, the revenue could be returned to groups, such as vehicle owners or residents as a class, provided that individuals receive the benefit whether or not they pay the fee. It would be inefficient, however, if targeting revenue at these classes induced individuals to drive more, which may occur if revenues were returned in proportion to car ownership or use.

The redistribution of the revenue must also promote horizontal and vertical equity. Horizontal equity implies that revenues should be returned to vehicle users as a class but only after external costs are compensated. Whether compensation should cover only the incremental impacts from traffic on a particular road or the total external impacts caused by car use depends on how broadly the scope of responsibility is defined. Any residual revenues could be used for road improvements or tax reductions that benefit drivers. Since most estimates of external vehicle costs are larger than the expected revenue of road pricing proposals, the horizontal equity justification for returning revenues to drivers is reduced or eliminated.

Vertical equity requires that recycled revenue benefits low-income drivers as a class at least as much as the costs they bear and that disadvantaged residents (including non-drivers) benefit overall. This can be accomplished by funding transportation improvements, targeting lower income drivers and non-drivers by replacing more regressive taxes with special funding services, or by cash payments.

The final criterion to be met is for the revenue recycling process to be politically acceptable and feasible. Whereas economic efficiency and equity can be evaluated with a certain degree of objectivity, political acceptability must reflect popular perceptions and the distribution of political power. To be politically feasible road pricing revenues must be perceived as significantly beneficial to people who wield the most political power. Hence, for revenue recycling to be a force sustaining the viability of road pricing, it has to be perceived attractive and acceptable by road users.

### 4.2.2 Methods of redistributing the revenue

Congestion charging increases production costs, product prices and the overall costs of commuting to work. This ultimately reduces the real household wage and according to Parry and Bento (2001:1), slightly reduces the overall quantity of labour supply. If the revenue is used to reduce labour taxes or to improve public transport, the efficiency gain in the labour market can raise the overall welfare gains of the congestion tax.

Adler and Cetin (2001:448) and Roth (2000:36) state that while conventional thinking suggests that revenues must be dedicated to transport improvements to be politically feasible, there are indications that alternative distribution methods benefit the largest number of residents and therefore may be more politically popular. It is then important to use the revenue in a manner that is economically efficient, promotes equity and is politically acceptable. However, the current literature does not single out a specific "best" method for redistributing the revenue. Although there are various methods which will be evaluated next, it is not clear which method the public would prefer.

The most popular method of revenue recycling is by a general approach of road and public transport improvements, resulting in a reduction in traffic congestion. Revenue neutral cash rebates, the provision of subsidies to road users or transport providers or tax reductions to vehicle users are further options that have been considered. A direct redistribution method may prove to enhance the quality and reliability of public transport through improved bus, underground and overland services. Additionally, the charge could be returned to road users by reducing other road use taxes, such as fuel taxes and vehicle-licensing fees as suggested by Roth (1990:36). A combination of these revenue redistribution methods will help to satisfy the criteria for an efficient road pricing scheme.

Newbery and Santos (1999:129-130) advance the case for earmarking road pricing revenue. Tax earmarking is the allocation of certain tax revenues to a designated end use and an application of the benefit principle of taxation, such as duty paid on fuel, which is subsequently allocated to road improvements. McCleary (1999:81) however expresses concern from the World Bank's point of view, by stating that international experience of earmarking government revenue in general has not worked very well. He adds however, that under defined and restrictive conditions it might be applied with some success.

In countries such as the United Kingdom, where the government does not hypothecate revenues for particular types of expenditure, the average road user perceives road pricing as just another general form of taxation, not recognising the efficiency argument. Jones and Hervik (1992:139) report that in Norway, where revenues are earmarked, the problem does not arise to the same degree because the revenue is linked to expenditure on roads and public transport improvements and/or perceived more acceptable.

Therefore, if earmarking is applied properly it should lead to an economically efficient structure of road charging and a sustainable system of road pricing. Earmarking may also be justified when there is a strong relationship between the beneficiaries of public expenditure and the payers of the tax. In this case, earmarking would be more successful in the (decentralised) local government context. Hence, road pricing will be more acceptable to the public if revenues raised locally are spent locally without diverting funds to other government programs.

### 4.2.3 Benefits obtained

Hau (1998:51) states that not only does the implementation of a congestion charge internalise the external congestion cost caused by road users but it can also cover the short-run and long-run average maintenance cost of the road. The benefits from recycling revenue as cited by Adler and Cetin (2001:459) includes a reduction in travel cost for everyone not only road users and fewer equity concerns. Using revenues to fund transportation improvements and to realise broad economic benefits to residents and businesses, rebates or community programs may provide the greatest overall benefit and earn the widest political support.

In the absence of lump sum transfers earmarking could serve as a useful device in principle to approximating benefit taxation as a way of satisfying a commonly accepted notion of "fairness". When the proceeds are channelled back to the users in this way, road pricing and road taxes become a road user "fee" and are no longer regarded as a "tax" per se.

Additionally, if the revenues are used to reduce labour taxes they reduce the deadweight costs of the tax system by encouraging labour force participation in addition to offsetting the externality distortion caused by congestion (Parry and Bento, 2001:3). The increase in labour participation arises because the combination of reduced congestion and reduced labour taxes more than compensates commuters for the congestion fee, leading to an increase in returns to work.

Recycling the revenues in public transport, maintenance and improvements rather than reducing labour taxes is less efficient according to Parry and Bento (2001:22-23) and the relative welfare discrepancy between these two alternatives is larger the greater the amount of traffic reduction. International experience dictates that revenue is used mainly to improve public transport rather than decreasing labour taxes. **As a possible policy benefit these two alternatives must be put to the public in forming an idea of public perception.** If it turns out the public perceives reducing labour taxes more beneficial than improving public transport and the increase in the Pigouvian efficiency gains from internalising the congestion externality is larger than the resulting efficiency losses in the labour market, it may well be a policy worth pursuing. This view is supported by Litman (1999b:8) and Newbery and Santos (1999:104).

# 4.3 Work schedule flexibility

Work schedule flexibility is referred to by Emmerink and Van Beek (1997:222) as the number of minutes between the latest and earliest work start time as allowed for by the employer. In early studies of peak-period traffic congestion, no consideration was generally given to the departure time decisions of road users. This oversight was remedied by Vickrey (1969:257-260) who derived the departure rate along a single route, subject to queuing congestion as the outcome of individual cost minimization. The departure time problem was rediscovered by Hendrickson and Kocur (1981:62-63), Henderson (1974:346-347, 1977:163-165, 1981:349-351) and others. Most of this literature treats only one origin, one route and one destination (Alfa, 1986:492).

A major shortcoming of the literature is that of the reliance on generalised and erroneous assumptions. This obviously impacts on the validity of extension and application to real word situations. Emmerink and Van Beek (1997:221-230) cites, theory generally assumes (i) travel demand being deterministic and inelastic, (ii) road users have identical cost functions, (iii) mode choice and mixed flow of vehicles do not exist, (iv) all road users are homogeneous and (v) no relocation of residents, commuters and businesses takes place as a result of road pricing.

Flexible working hours have been promoted as a low cost approach to reduce traffic congestion (Chang and Cheng, 2002:3). However, there are only a few empirical studies evaluating the relationship between work scheme flexibility and road pricing. Arnott et al. (1992:72) and Hendrickson and Plank (1984) also stress that little has been done at a conceptual and empirical level to bring road user heterogeneity into the works schedule flexibility debate. One way of achieving this goal is by investigating the factors influencing and determining the work schedule flexibility, the level of satisfaction derived from the actual work start time, the amount of flexibility (allowed for by both the employer and the employees themselves) in the work start time and how it can be employed as a factor supporting the success of road pricing. These factors will be explored in the following sub-sections.

## 4.3.1 Factors influencing and determining work schedule flexibility

Emmerink and Van Beek (1997) identify three factors influencing and determining work schedule flexibility, (i) net household income, (ii) the individual level of education and (iii) the number of hours worked per week. With respect to net household income, lower income groups are more likely to have a fixed (determined by the employer) work start time, whereas high-income groups have jobs that provide a greater flexibility towards the work start time. Employees with a relatively high level of education have on average a more flexible work start time than those with a relatively low level of education. Additionally, Emmerink and Van Beek (1997:222-223) found that part-time workers have a much less flexible work start time than full-time workers. This indicates that part-time workers are much more likely to work according to employer-determined, fixed schedules.

It is generally assumed that lower income groups add a low value to their time and are not as readily willing to pay a charge if the benefits from it are smaller than the cost of the trip to them. They would rather change their work schedule, departing early and avoiding paying the charge. For the higher income group the opposite holds true. They have a high value of time and the disbenefit of paying the charge is exceeded by the benefit of less time spend in transit. This means the high income group will rather pay the congestion charge to avoid congested road conditions and will adjust their work schedule more easily than the lower income group. It indicates that road pricing is likely to be a regressive policy instrument as the relatively high-income earners are more easily able to avoid paying the road price.

As the high income group tends to have a more flexible work schedule in any event, the presence of road pricing might favour the high income group more than the lower income group. This indicates that having work schedule flexibility is not as important a factor to the high income group as it is to the lower income group.

Arnott et al. (1988:56,67; 1992:85) and Chang and Cheng (2002:6-7,14) go further than Emmerink and Van Beek (1997:222) by identifying additional factors through modelling. These include, (i) the cost of time spent in transit, (ii) schedule delay cost (the cost of arriving early or late), (iii) road users with different starting times at work, (iv) different commuting behaviour and (v) the generalised cost of commuting. Since commuters in a given group prefer their existing departure times to departure at any other times, the charge induces commuters to self-select into more socially efficient departure time intervals.

The type of road pricing also alters the departure time and road user behaviour, hence directly influencing the work schedule flexibility. Arnott et al. (1988:56-58) reports that congestion pricing or variable pricing may yield significantly higher levels of efficient use of existing road capacity than a uniform charge such as a cordon pricing scheme because the road users are able to adapt to a more flexible work schedule which translates into a more even distribution of traffic flow through rush hour periods. Most of the benefits from charging are due to reduced congestion brought about by changing departure time decisions.

Additionally, Hendrickson and Plank (1984:25) outlines four further major influences which may cause a road user to plan to arrive earlier or later than his start time. These are (i) congestion avoidance, (ii) service reliability, (iii) peak and off-peak tolls and parking availability and (iv) the choice of alternative routes.

## 4.3.2 Level of satisfaction

In arguing the case for work scheme flexibility as a necessary element to sustain road pricing it is necessary to evaluate the level of satisfaction road users derive from their individual work scheme flexibility. Emmerink and Van Beek (1997:222-226) found in their research that peak-hour workers were relatively dissatisfied with their present work start time. This dissatisfaction is ascribed to not having enough flexibility in work start and finish times and subsequently having to incur the cost of the charge.

They also report that road users with a vocational education and a high income are more likely to have a satisfactory work start time unlike less educated and lower income road users. It was also found in their research that employees who are allowed more flexible work conditions by their employers are more likely to be satisfied with their actual work schedule. These findings correspond with intuition and suggest that employees to some extent, actually make use of the employer-provided flexibility. It also strengthens the case for implementing work-schedule flexibility in conjunction with road pricing.

## 4.3.3 Degree of flexibility

The amount of flexibility allowed by the employer and used by the employee in the work start time is another meaningful aspect in the determination of a road user's work schedule flexibility. If employees have a flexible work start time, road users may adapt their work start times to avoid the possibility of being charged or paying more under conditions of congestion charging.

The opposite also holds true. Employees do not always make full use of the flexibility their employers allow them. Restrictions relating to family-life and work conditions among other things constrain the employees' work start time. In particular, the work constraints imposed by employees on themselves are difficult to relax by means of government regulation as these are not imposed by the employer. If a major part of the population is not constrained by a single departure-time option then both road pricing and more flexible working hours may prove more effective and efficient in dealing with congestion.

The empirical evidence gathered by Emmerink and Van Beek (1997:223) supports the notion of the regressiveness of road pricing. As the high-income group in particular have a greater flexibility with respect to work start time, it is in a better position to avoid paying the toll. On the other hand, the low-income groups generally do not have the option to change their work start time and therefore either turn to another transport mode or pay the toll. In both cases these income groups will be worse off as congestion theory requires that peak period commuters on average be made worse off as a result of the tolls. If this were not the case insufficient numbers of commuters would be tolled off the road (Giuliano, 1992:346).

Congestion tolls and other transport or workplace policies affect the distribution of welfare. Because the cost of travel time varies with income and because income groups differ in the flexibility of their work hours, the benefits of congestion relief tend to fall unequally. Arnott et al. (1988:67) found that congestion tolls and road investments both tend to favour commuters with high values of travel time relative to schedule delay. Since such commuters are likely to be white-collar workers with above-average incomes, this finding is consistent with the findings of Emmerink and Van Beek (1997:222).

Although employees may be afforded flexible work conditions as Emmerink and Van Beek (1997:217) suggest, Hendrickson and Plank's (1984:35) modulation reveals that road users do not always fully use the flexibility afforded by the employer because of built-in behavioural patterns. However it at least recognises people's differences by allowing them to choose between alternative departure times, modes, delay and the penalty they must pay for using a congestion charged area (Daganzo, 1995:152-153; Burris and Pendyala, 2002:241).

Lam (2003:1-3) simulates the impact of tolled lanes and congestion pricing on scheduling and route choice. His results suggest these types of road pricing do not only produce time savings but also produce considerable scheduling benefits. This is because tolled lane users have high values of time and high travel costs. Their subsequent time savings and increased scheduling convenience thus yield larger welfare improvements in comparison to the provision of newly-built free or uncharged lanes.

### 4.3.4 Performance of work scheme flexibility

Chang and Cheng (2002:2) equate work scheme flexibility to a TDM strategy. Hence work schedule flexibility can be employed on its own to help reduce traffic congestion. Their research suggests that when both road pricing and work scheme flexibility are combined this combination becomes a powerful and inexpensive tool in reducing traffic congestion. Road users will shift their departure time to avoid traffic congestion by applying a more flexible work schedule policy.

Sim et al. (2001:399) report that Singapore has been successful in alleviating severe traffic congestion due to its comprehensive and highly co-ordinated land transport policy which combines integrated land use and transport planning and demand management measures. Many studies suggest that implementing these policies together should results in a reduction of traffic congestion.

The majority of authors have only modelled the factors influencing work scheme flexibility which subsequently result in generalised assumptions. **Little empirical theory is available however as to how and to what extent work scheme flexibility is perceived by the public as a sustaining element in congestion charging. It is also unclear to what extent the factors influencing work schedule**

**flexibility are responsible for the level of road user satisfaction and to what extent it is responsible for influencing the degree of flexibility in the work start time.**

## 4.4 Driver Information provision

Emmerink et al. (1994:365) argue that current literature in road pricing suggests that road networks are not used as efficiently as they should be. Up to 12% of all travel time is wasted and up to 6% additional travel distance is added to journeys as a result of traffic congestion. Hence it seems plausible to argue that there is some room for travel time and distance savings to be made through driver information provision.

Although a great deal is known about both road pricing and driver information systems in isolation, very little is known about the joint implementation of such systems (El Sanhouri and Bernstein, 1994:44). The purpose of information provision is to influence route and departure time decisions to avoid areas of congestion. All driver information systems on their own have at least one of the following objectives, (i) for the road network to be used more effectively, (ii) to reduce traffic congestion, (iii) to provide road users with the most up to date travel information and (iv) to achieve shorter journey times and reduce schedule delay (Topp, 1995:34). These objectives stress the importance of driver information provision and its relevance in being a viable support to road pricing. In advancing this argument, the following sub-sections will examine the importance of driver information provision, the different types available to the policy maker, its effects and the possibility of an integrated use of road pricing and driver information systems.

### 4.4.1 The importance of driver information provision

Information provision is expected to be one of the more promising instruments to improve road network efficiency and to diminish levels of congestion (Emmerink et al., 1997:217-218). Simulation and experiments have indicated that depending on various factors such as information quality, market penetration, driver compliance, occurrence of non-recurrent incidents' driver information provision may lead to a reduction in average travel time and therefore an increase in road network efficiency.

In addition to simulation models a number of theoretical models have recently been developed to analyse and explain the factors that influence the usefulness of information provision to drivers. Researchers have published various articles in which they extended Vickrey's bottleneck model (Vickrey, 1969:253) in several directions (Arnott et al., 1990:209, 1991:309-310, 1992:71-73; Ben-Akiva et al., 1991:251-252 and Noland and Small, 1995:1). These authors focused on route-split and/or departure time effects within simple one or two-link networks in models typically based on assumptions not congruent with reality.

Arnott et al. (1991:309-310) proposed an alternative theoretical approach for studying the impacts of driver information. His approach explicitly treats travel costs as random variables. Information then provides travellers with realisations of these random variables. Uninformed travellers, in contrast, base their behaviour on expected rather than actual costs. Emmerink et al. (1997:217) go further and reports that experiments have demonstrated information provision to be beneficial both to informed and uninformed travellers, that is, it leads to a strict Pareto improvement by increasing network efficiency and system welfare irrespective of a traveller receiving information or not. Although the theoretical models yield much insight into the factors that influence the usefulness of information provision, a major criticism is their lack of realism.

Although very little is known about the joint implementation of road pricing and driver information provision, the case for implementation in tandem should be perused on at least three grounds. First, while a traffic command-and-control approach in regulating usage might be feasible, it would often be unwieldy. Second, information and pricing systems enjoy technological complementarities. For example, both ATIS (Advance Travel Information System) and electronic road pricing use central computing facilities, communications between vehicles and roadside beacons or stations, some form of vehicle identification and a means of displaying information in an intelligible way to drivers. Third, pricing usage would give individuals an incentive to comply with advice or instructions that enhance system-wide efficiency but conflict with their self-interest.

One of the greatest uncertainties facing road users are road capacity, coming across congestion and being delayed (Arnott et al. 1991:311). Because commuting and traffic patterns in general are unpredictable, the uncertainty can be alleviated by providing up-to-date information to prospective users.

## 4.4.2 Types of driver information provision systems

Just as there are several ways to implement road pricing, many different driver information systems also have also been developed. To some extent the differences among them are determined by the technologies they employ. El Sanhouri and Bernstein (1994:44-47) differentiate between the different driver information systems on the grounds of their functional differences.

First, driver information systems may vary in the information they provide. That is, they can provide either status or guidance information. In addition, the information they provide can be historical, current or predictive. The exact nature of the information influences how road users respond to them in real time and during the long run. A typical example is the Advanced Traveller Information System (ATIS). This system which has been under development since the 1970s, informs motorists about travel delays due to accidents, bad weather and other unforeseen occurrences and also recommends alternative travel times, routes and destinations (De Palma and Lindsey, 1998:667).

Second, the spatial structure of driver information systems can vary in important ways. In particular, they can vary by geographic extent or coverage (including whether both pre trip and en route information is available) and in their specificity (i.e. whether information is provided to individual vehicles or whether the same information is provided to all of the vehicles in a given area). In this instance Arnott et al. (1991:317) report that on board satellite navigation systems appear to have promising results.

Finally, different driver information systems may have different temporal structures. Most important, the frequency with which the information is updated can vary which can also affect resolution of the driver information system. A typical example is radio and TV traffic updates. The more effective and up to date the information provided, the better the position of the road user to avoid congestion. The effectiveness of these systems however, depends largely on drivers' response to the information received.

What is unclear is the local effects these technologies have on (i) driver behaviour, (ii) perceived time and cost saving (benefits) (Al-Deek and Kanafani (1993:303-304); Emmerink et al. (1995a:293-294). The latter issue in particular is of great importance for the evaluation of the benefits and costs involved in designing and implementing road pricing systems with driver information provision in tandem.

### 4.4.3 Effects of information provision

By examining the effects of driver information provision it will be possible to establish whether it will be a useful tool in supporting road pricing as a traffic reduction mechanism.

In moderate congestion conditions, providing driver information will lead to initial cost saving by road users as Eliasson (2001:595-598) and Emmerink et al. (1998:71-73) report. Arnott et al. (1991:309), however argue that the cost savings as a result of driver information will decline once drivers disseminate the information and alter their departure time and route choice. Their assumptions relies on modelling and although plausible have not yet been empirically verified.

Emmerink et al. (1994:363-365, 1996:137) and Eliasson (2001:595-598) report that driver information provision will reduce travel time not only to users using the information but also to users not using the information. An important finding of Emmerink et al. (1994:363-365) is that due to time saving (and cost savings), the road network will become more efficiently used which will eventually encourage more traffic and hence nullify the benefits raised through time savings.

Arnott et al. (1991:309-310,317) model various aspects of driver information provision and report a very sceptical finding in that traffic flow conditions will almost certainly not be affected and that it will not reduce congestion. **The question then arises, if road users receive traffic information do they react to**

**it positively by changing their travel behaviour or not? If they do it would point to an induced change in traffic flow.**

In simulation studies drivers' behaviour has generally been modelled using simple behavioural rules. When road users receive traffic information it is reported by Arnott et al. (1991:309), De Palma and Lindsey (1998:667-670), Eliasson (2001:595-598) and Khattak (1993:101) that it changes their travel behaviour. The change in pre-trip behaviour or reaction to the information is usually manifested in an adjustment in departure time, mode, decision to travel, choice of destination and route choice in an attempt to avoid traffic congestion. Arnott et al. (1991:309) is sceptical about this argument pointing to the fact that if a large number of road users receive the same information they may divert to other routes and increase congestion elsewhere. This assumption is made without considering how many drivers actually respond and divert and that individual drivers will react differently to information provision due to their rational behaviour characteristic.

An additional shortcoming that crops up very often in simulation studies is the discounting of rational expectations in behaviour predictions. This may lead to simulated overreaction to driver information which negatively affects the research findings of the relevant researcher.

Although it is difficult to predict how road users will respond to driver information it is a valid point that needs empirical clarification. **It will be meaningful to establish the percentage of road users actually responding, how many do not respond at all and how many do not receive driver information.** These are all issues that have not yet been empirically addressed in the literature. If uninformed drivers know that some other drivers are informed on network conditions they may adjust their behaviour. Knowing that uninformed drivers are adapting their behaviour because some drivers are informed, the informed drivers may alter their behaviour as well. Clearly this process can be repeated until none of the informed and uninformed drivers are willing to change behaviour.

Khattak et al. (1993:109-110) report that driver information provision may also influence en route decision making via road travel updates and hence travel behaviour. **The literature is not clear on whether pre-trip driver information provision affects road user behaviour in the same way as en route travel behaviour. These points need further investigation. Similarly, as road pricing influences road user decision making to travel and their choice of destination, mode, route or departure time so does driver information provision.** However no comparison of the effects have been carried out to date to establish the compatibility between the two policy instruments.

Transport researchers do not agree on the scale of the benefits obtainable from motorist information systems; estimates show large variations. One explanation for this divergence in results might be found in the different methods, models and situations employed for assessing the benefits. Another explanation may be that the benefits depend on the shape of the network, the scale of the network and the current level of congestion. This has recently been suggested by Emmerink et al. (1995a). Seen from this perspective the results obtained by different researchers are not contradictory, but rather complementary in nature.

De Palma and Lindsey (1998:667-670) and Emmerink et al. (1998:71-73) report that better driver information provision together with road pricing is welfare improving by increasing the efficient use of a road network, although the welfare gain from road pricing per se is much larger than that of "perfect" information provision. However it is always better to provide any information rather than providing no information as long as the information is consistently unbiased and as perfect as possible (Emmerink et al.,1998:92).

Although a driver information system is only one of the available tools to tackle the congestion problem, combined with a road pricing strategy, transport planners have a strong tool to influence traffic flows in road networks and ultimately reduce congestion.

### 4.4.4 Integrating road pricing and driver information systems

In promoting the interaction of driver information systems and pricing schemes it is important that road pricing schemes be perceived only as traffic redirecting and reducing instruments and never as traffic "punishing". The distinction may seem subtle but it is extremely relevant if one considers the different reactions drivers might have. If the driver is well informed and willingly decides to take, for example, a shorter but probably congested route he will perceive paying the tariff as a traffic reducing inducement to him as to everybody else, whereas if he unexpectedly ends up into a traffic jam he will feel that he is not only paying in terms of time lost but also being unjustly punished by having to pay a tariff if he wants to avoid it. In this latter scenario he is likely to react more strongly than in the former and be more inclined to lobby against the implementation of the pricing scheme.

The relevance of these interactions between information diffusion and road pricing is confirmed by the conclusions of a more recent work by Emmerink et al. (1988) where the welfare effects of various kinds of information (perfect, imperfect and no-information) dissemination on two groups of drivers (informed and uninformed) are examined. Given the assumption of linear link travel cost and demand together with that of the homogeneity of travellers except for their willingness to pay to make a trip, these scholars conclude the provision of either perfect or imperfect information guarantee strict Pareto improvements.

Hence driver information provision appears to be a viable policy option in complementing road pricing and rendering it sustainable. Although simulations have been used to a large extent by many authors, they have helped identify the issues that are still unclear and which will be addressed in this research.

# 4.5 Public and political acceptability of road pricing

Marcucci (1998:1) raised a valid question when asking why, in spite of a thorough theoretical background to road pricing, there has been such an unsatisfactory policy impact and implementation of congestion charging. Research by Goodwin (1990:6-7), Lindsey and Verhoef (2000:22) and Santos (2000b:7) and others conclude that a major obstacle to introducing road pricing is political and public acceptability. The obvious question is: why is there so much public opposition to road pricing? This question is particularly perplexing to proponents who cite the extensive research that has been devoted to demonstrating its economic and welfare benefits. This section seeks a greater understanding of the reasons why road pricing has been publicly and politically opposed in providing a basis for identifying some determinants advancing the degree of its acceptability. These issues will be discussed in turn.

## 4.5.1 Obstacles to public and political acceptance of road pricing

The problems associated with introducing road pricing and overcoming the political implementation problems are extremely hard to solve. Emmerink et al. (1995b:590) label congestion-pricing as "an intrinsically unpopular policy, which will always meet opposition from different angles". The following sub-sections will identify the most relevant obstacles to its acceptance.

### 4.5.1.1 Problem perception

Strategies that involve road pricing are extremely difficult for the public to accept although they recognise traffic congestion as a serious problem. When introduced to the concept of congestion charging many drivers react strongly against the idea that they should be charged on the basis of the amount of congestion they encounter. It seems irrational and inappropriate for them to be charged for something they wish to avoid, against something they wish to acquire. Road users see themselves as victims of congestion not contributors to it (Jones, 1998:265), (De Corla-Souza (2000:17) and (Gomez-Ibanez, 1992:347). For a problem to be solved it needs to be perceived as one first of all (Schade, 2003:3). However, as Rienstra et al. (1999:181,197-198) argue, even if traffic congestion is perceived to be a problem, road pricing may still be rejected as a measure to solve the problem.

### 4.5.1.2 Mobility related social norms

Road pricing conflicts with a fundamental and highly valued belief held by many people, namely that mobility is a right. Mobility provides opportunities to engage in spatially dispersed activities and many consider these opportunities important. Road pricing is then viewed as an infringement of their freedom of movement and an invasion of their privacy. Thus the perception of restricting the right to travel to the extent that some road users are priced off the road and into less preferred modes may consequently be seen as an insurmountable obstacle despite the fact that it would generate benefits to society as a whole.

Many people have built their life-style around the car and anticipate considerable difficulties in and a lack of enthusiasm for adapting to a less car-oriented society although there is a high level of awareness and a great deal of concern about the problems which cars can cause. Drivers often express the opinion that pricing will be a very ineffective means of discouraging car use, or in economic terms that drivers will be inelastic to road user charges. This view is strengthened by the feeling that, however high the charges, most drivers will be "forced" to carry on driving as the alternative transport modes are not always tailor made to specific transport needs (Jones, 1998:266). **It will be valuable in this regard to verify these findings in establishing the public's susceptibility to change.**

### 4.5.1.3 Fairness of pricing

Equity or fairness is widely considered to be another major barrier to public acceptance. Several studies have been devoted to analysing its distributional effects, from the seminal work by Vickrey (1963), Richardson (1974) and Foster (1975:186-187) to the work by Small (1983), Cohen (1987:239), Jones, (1998) and Oberholzer-Gee and Weck-Hannemann (2002). People feel road pricing is unfair because they believe they have already paid for the use of the road by paying road taxes. The general consensus is road pricing will benefit higher income groups while penalising the lower income group. The possible solution according to Jones (1998:280-283) will be to design a road pricing strategy with a built in mechanism to recognise the needs and benefits of different income groups, thus increasing its fairness.

### 4.5.1.4 Scepticism and uncertainty

Despite apparent policy imperatives, public scepticism, misunderstanding and uncertainty regarding the effects of road pricing are important barriers to effective congestion pricing programs (Giuliano, 1992:335-336). The findings by Jakobsson et al. (2000:157) suggest that providing information about the policy objectives of road pricing may lead to a more positive attitude towards it without necessarily increasing its acceptability. Jones (1998:280-283) speculates that many people simply don't believe that road pricing will cause road users to shift to other modes or change their work schedule. Residents also fear that in response to road pricing many drivers will park just outside the area and complete their journey on foot or by public transport and that large volumes of through traffic will divert around the area bringing congestion to previously uncongested areas.

#### 4.5.1.5 Impacts on business

The fear of negative impacts on businesses within areas subject to congestion tolls is another illustration of how the concept is misunderstood reports Giuliano (1992:341-342). Congestion pricing theory suggests positive effects. Congestion tolls reduce the full cost of travel, thus the targeted area would have a competitive advantage relative to areas that remain subject to congestion as long as the toll revenues remain within the targeted area. Yet businesses are sceptical of this benefit especially if they report a reduction in profits. **If it is considered that businesses rely on shoppers and clients for business, then should it not be the shoppers and clients who should be informed of the benefits of shopping in a less congested area?** In this regard it will be valuable to determine the path of causation.

#### 4.5.1.6 Political will

Without support of politicians as key decision-makers, the introduction of any road pricing scheme is impossible (Giuliano, 1992:355). The politicians' opinion and acceptance are of great importance for successful implementation (Schade, 2002:2). If politicians are sceptical of road pricing they will not risk pursuing the implementation for the fear of losing votes. Research by Schade and Schlag (2000) showed politicians to have a misperception of public opinion and attitudes towards road pricing which inherently present an obstacle to any demand management strategy. **The unresolved questions here are: (i)** does the public perceive the judgement of politicians as credible and convincing? and **(ii)** would the public accept road pricing if it were backed by political will in making urban congestion charging a viable and acceptable option to reduce traffic congestion?

### 4.5.2 Determinants advancing the degree of acceptability and support for road pricing

Having identified some obstacles to the public and political acceptance of road pricing, this section will identify some determinants advancing the degree of acceptability of road pricing. If the policy maker heeds these determinants, public and political will may swing in favour of greater acceptance increasing the viability and sustainability of road pricing.

#### 4.5.2.1 Direct democratic approval

Road users are only willing to accept road pricing if they know the government, as imposing authority, cannot use road pricing to their detriment. Because road pricing is endogenous to the political process, Eichenberger (2002:5) cites the reform of the political process as an important condition for voters' and road users' acceptance. An important step in this direction is advancing direct democracy through the provision of strategic information, referendums and by handing some autonomy to local governments whereby voters (and hence, road users) can express their preference. By pursuing this objective the acceptance of road pricing may be increased because the road user would have a direct democratic instrument to control governance. Additionally this will allow governments to obtain feedback on voter preferences which allows it to improve pricing strategies in order to finally gain the support of a majority of the population. Eichenberger (2002:5) cites this concept as one which has not yet been given enough empirical consideration.

#### 4.5.2.2 Overcome public scepticism

As public scepticism is a major obstacle in accepting road pricing, Schlag and Schade (2000) argues in favour of advancing a psychological approach to increasing acceptance. This concept is based on hypothecating the positive effects of road pricing. These include (i) discussing the externalities arising from road usage to create awareness of the problem, (ii) citing some positive aims and solutions, (iii) providing a trial period for people to change their mode of transport, (iv) pointing out what the revenue would be used for, (v) allowing the freedom of choice, (vi) creating new mobility related social norms on a collective and a personal level. Hence, by altering the cognition about the situation and by observing the benefits first-hand, the road user may adapt his behaviour and overcome some scepticism.

Parallel to their argument are those of Jakobsson et al. (2000:156-157), Goodwin (1989:495-496,1990:6-7) and (Truelove, 2000:15-17). They argue in favour of increasing the fairness of road pricing and for the introduction of less intrusive schemes as a condition for greater acceptance. Compensating road users through tax reductions is another method winning public support. However, Oberholzer-Gee and Weck-Hannemann (2002:367-368) warn against the emphasis of tax reductions as it stands to neutralise the congestion reduction induced by road pricing. Certainly if road users are compensated for the expense incurred they would have no incentive to change their driving behaviour.

Goodwin (1989:495-496,1990:6-7) advances the argument of Schlag and Schade (2000:314-317) by citing the application of the "Rule of Three" in advancing public acceptability. These rules pertain to allocating the released road space and revenue raised from road pricing. Accordingly he suggests the released road space should be used for (i) environmental improvements, (ii) accommodating extra traffic and (iii) increased speed. Additionally, the revenue raised should be used for (i) reducing existing taxes, (ii) new road infrastructure and associated maintenance and (iii) improvement to public transport. This view is supported by a recent survey carried out by Ison (2000:276) in Great Britain. Giuliano (1992:335) on the other hand criticises this argument, by stating that it is simply not good enough to attempt to gain public support based on the promise of recycling revenue per se. The policy maker has to inform the voter of exactly how the revenue will be put to use. Given these mixed arguments and concepts, Goodwin (1989:495-496, 1990:6-7) argues that it would prove informative to investigate the credibility of these concepts in reducing public scepticism.

#### 4.5.2.3 Political will and interest groups

The motivational drive from politicians and interest groups is an important condition in winning public support as Small and Gomez-Ibanez (1998:213-214), Flowerdew (1993), Oberholzer-Gee and Weck Hannemann (2002:364), and Jones (1998:263-264) report. In order to implement road pricing successfully, politicians and interest groups need to overcome the inherent obstacles to implementation. Santos (2002a:7-9), Giuliano (1992:353-355) and Goodwin (1989:495-496, 1990:6-7) suggest that the only way forward is for politicians and interest groups to pursue a scheme where road tax funds are reduced, compensation is awarded and revenue is recycled and kept in the transportation sector. Additionally, Harrington et al. (2001:88) argues that politicians must persuade and fully inform the public that road pricing is not just another tax increase by another name penalizing the user.

#### 4.5.2.4 Environmentalists support

Without a doubt congested roads are seen as a major issue (Jones, 1991:194). But when the UK Lex Survey asked respondents which problems concerned them most, more than twice as many indicated that it was air pollution rather than traffic congestion (Jones, 1998:270). Air quality and congestion management objectives imply somewhat different tolling strategies and the political support for air quality may not be strong enough alone to support tolling measures. To make road-pricing schemes politically more acceptable the air quality argument for tolling should be advanced in conjunction with road pricing strategies where it is plausible and appropriate. There is thus an urgent need to develop pricing systems that treat congestion and environmental externalities in an integrated manner (Oberholzer-Gee and Weck-Hannemann, 2002:366-367), (Jakobsson et al., 2000:157) and (Gomez-Ibanez, 1992:359-360).

### 4.5.3 Encouraging the balance between the determinants and obstacles to increase acceptability

It is important to recognise the legitimacy of the differing arguments discussed above and to build them into a scheme design from the outset. From the current literature it appears as though the ultimate implementation of road pricing will depend on striking a balance between these determinants and obstacles in advancing acceptability backed by political will. In achieving this goal however, the following **empirical questions** have to be pursued to obtain a clearer view of the public perception.

(i) How many people will oppose the action?

(ii) Will compensation of those who lose from road pricing be an acceptable and implementable option?

(iii) Would the public support politicians and interest groups pursuing road pricing in reducing traffic congestion?

(iv) Would direct democratic approval aid in increasing public acceptability?

(v) How low/high is current level of acceptability?

(vi) To what extent do the obstacles impact on the level of acceptability?

(vii) Does the public have knowledge of alternative transport demand management strategies?

(viii) Which strategy do they perceive to be most acceptable?

## 4.6 Conclusion

This chapter identified the four most cited and important factors relevant to maintaining the viability and sustainability of road pricing. Revenue recycling especially was identified as an effective instrument for financing road maintenance, investment in public transport and in bringing about a degree of fairness to the charging scheme - subject to meeting three prerequisites. In addition work schedule flexibility and driver information provision were identified as further factors sustaining the viability of road pricing. These were explained in the current context and subsequently identified a few gaps to be explored, which once filled will expand the current knowledge about how these factors can successfully be employed to help reduce traffic congestion efficiently and equitably.

The public and political acceptability of road pricing were identified as not only one of the major obstacles to implementation but also as one of the most difficult criteria to meet in implementing a sustainable charging scheme. Fundamentally, a balance must be struck between its determinants and obstacles as to increase acceptability. Throughout examining the factors that contribute to sustaining road pricing, some important ideas and concepts which have not yet been explored fully in current research attempts, have been identified. These are more gaps this study aims to address and are illustrated in Diagram 4.1 below.

## Diagram 4.1 Issues to be investigated

- [illegible]
  - Does the public favour a reduction in labour tax instead of paying a congestion charge?
- [illegible]
  - Does the public perceive greater works schedule flexibility as an instrument enhancing the sustainability of road pricing?
  - To what extent does road pricing influence the degree of flexibility in the work start time?
- [illegible]
  - Do road users change the preferred route when driver information is provided?
  - Does the same percentage of road users respond to pre-trip driver information than those receiving en route information?
- [illegible]
  - Check public perceived mobility related norms.
  - Do businesses perceive road pricing will reduce their customer base or clientele?
  - Does the public perceive the judgement of politicians as credible and convincing?
  - Would the public accept road pricing if it were backed by politicians?
  - Answering and exploring empirical questions.

# Chapter 5 Methodology

## 5.1 Methods in brief

The literature review identified the effects of road pricing and those factors that may prove to sustain it as a viable instrument in reducing traffic congestion. It highlighted concepts, issues and themes which have not been explored fully in previous research. This chapter will describe and explain how these gaps will be investigated, enabling the results to form a holistic picture of the effects of road pricing and the sustaining factors. It will also explain how the different elements in the research design will be integrated with an overall strategy.

This includes describing how the geographic area for data collection has been identified, the methods of data collection together with the sampling technique employed, data analysis and the techniques used to interpret the collected data. How the research results will be reported and interpreted through to identifying remaining stakeholder concerns and problem areas will also be explained. Once the concerns and problem areas have been identified and alternative options have been developed to address the remaining concerns, they will be evaluated in terms of a multi criteria analysis. This enables conclusions to be drawn and plausible recommendations to be made. This chapter concludes by examining how data validity will be promoted, how confidentiality and anonymity of participants will be safeguarded and the use of the literature review.

## 5.2 Overall methodological approach

### 5.2.1 Research design

The method of study involves an **exploratory** and **descriptive** investigation into the effects of road pricing and the factors underpinning its sustainability. These design types are ideally suited to describe market and social characteristics, to pick up on perceptions and to determine relationships and possible causes and effects.

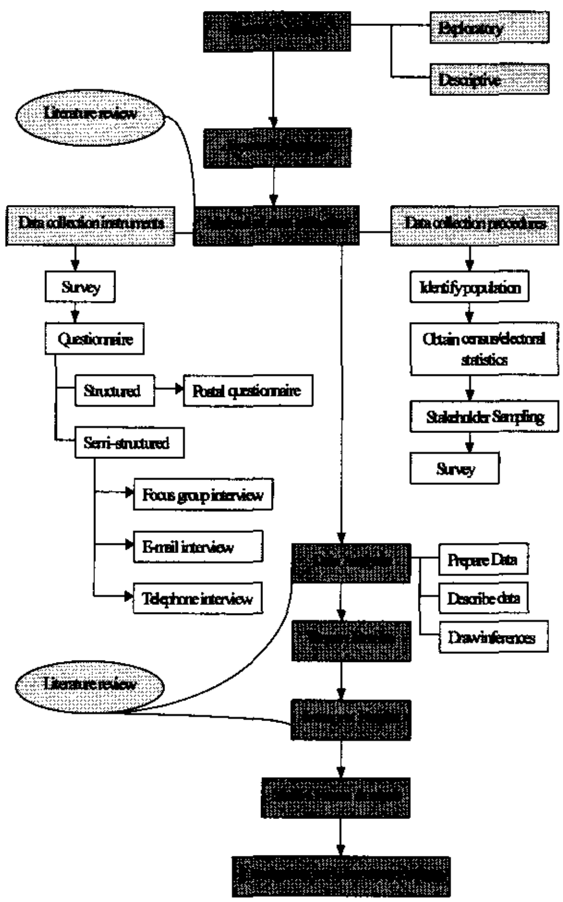
### 5.2.2 Strategy

The research strategy represents the reasoning, or the set of ideas, by which the study intends to proceed in order to answer the research questions, to solve the research problem, to attain the research aims and to realise the purpose of the research. In achieving this goal the gaps identified need to be explored first of all, necessitating an empirical investigation. For this purpose data will be collected by means of a survey. The data collection procedure will be initiated by identifying the population from which data is to be extracted and about whom generalisations are then made. The selected population is dependant on the stakeholder involved.

Once the population has been identified a sample will be drawn and the survey will be carried out in both a structured and semi-structured form, enabling the collection of both quantitative and qualitative data. Once the questionnaires have been returned and the focus group meetings held, the data will be prepared for analysis to establish whether the effects seen on the dependent variables are in fact attributable to road pricing and, if so, what the nature of these effects is.

Quantitative data will be reported with the aid of descriptive and inferential statistical instruments as it is designed for making comparisons. Qualitative data will be reported with the aid of descriptive statistical instruments as it will help form themes, ideas and concepts and identify similarities. Once the analysis has been carried out the results will be reported and interpreted, forming a holistic view of the effects of road pricing and the factors sustaining it. More importantly it will identify any remaining problem areas or concerns highlighted by the stakeholders.

**Diagram 5.1 Empirical investigation**




In addressing these concerns and problems alternative policy alternatives or options will be developed and appraised as to address the concerns. For this purpose a Multi Criteria Analysis (MCA) is used in establishing preferences between alternative policy options by reference to an explicit set of policy objectives that have been identified and for which measurable criteria have been established in order to assess the extent to which the options may contribute in achieving the policy objectives. Once this has been carried out, the MCA results positions the research to draw conclusions and formulate plausible recommendations on how to present road pricing as a viable and sustainable policy instrument in urban areas experiencing traffic congestion. The strategy followed for the empirical investigation is illustrated in Diagram 5.1.

### 5.2.3 Method of data collection

The method of data collection refers to the instruments and procedures used to obtain raw data in providing a comprehensive approach to detect and document stakeholder perceptions. These mechanisms will be explained in turn.

#### 5.2.3.1 Data collection instruments

The survey forms the basic design for collecting data. The survey will have structured and semi-structured components and will be administered by 5 unique questionnaires and cover letters tailored for each stakeholder. Appendix A – E illustrates the questionnaires used and Appendix F – J the cover letters. The questionnaires together with a cover letter will be sent by post in a structured form to local and peripheral residents and businesses following sampling. The questionnaires for the remaining stakeholders will be used in a semi-structured form (i) at focus group interviews, where the relevant stakeholder will give his/her input into the research, (ii) telephone interviews and discussions and (iii) by e-mail interviews and discussions. In these cases, data will be recorded by taking notes and reconstruction after the interview, e-mail and/or telephone interview or discussion.

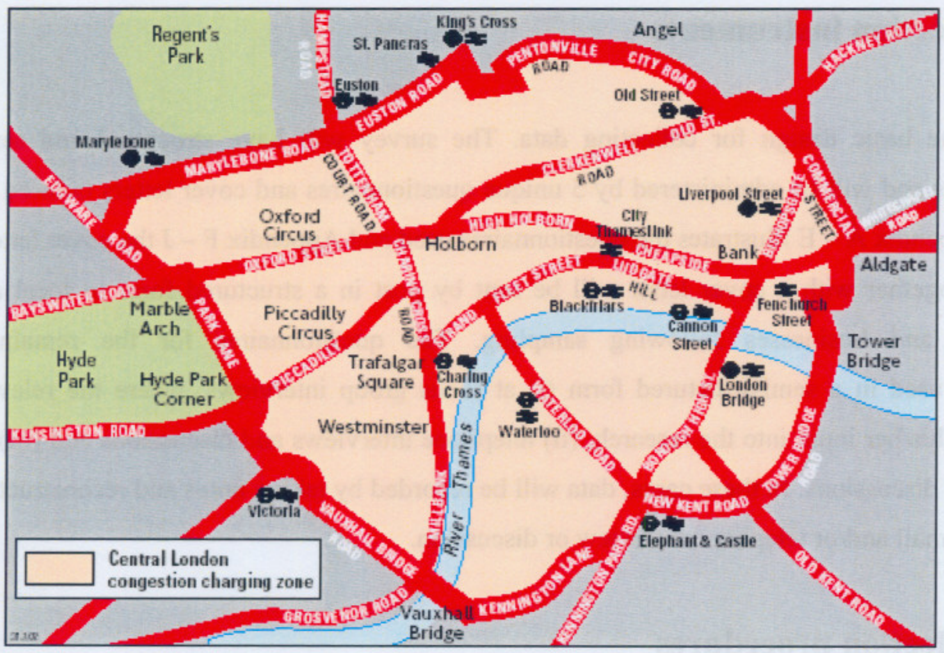
#### 5.2.3.2 Data collection procedures

The data collection procedures refer to the actual process of data collection and how the instruments are used or administered. The research has identified five stakeholder groups from which information is required in addressing the research questions and the more specific gaps identified. They are (i) local and peripheral residents, (ii) Local Authorities within the London congestion charging area, (iii) public transport providers, (iv) environmental interest groups and (v) businesses situated within the congestion zone and peripheral area. Having a large enough sample will enable generalisation back to the general population, validating the research methodology. For this reason each stakeholder has a unique sampling procedure which will now be explained in turn starting with that of the local and peripheral residents.

##### 5.2.3.2.1 Local and peripheral resident sampling procedure

Because the intention is to generalise the research findings to the general London population, a representative sample has to be drawn from the same population. The chosen population consists of the residents of the congestion zone in central London (covering 8 Local Authorities) and the peripheral residents (covering 14 Local Authorities). The population is drawn from a geographically demarcated area within the boundary of the Inner (London) ring road, formed by the A406 (North circular) and the A205 (South circular). Hence the peripheral area is situated between the boundary of the congestion zone and the Inner ring road. Diagrams 5.2 and 5.3 below, illustrate the congestion charging zone and peripheral area respectively.

**Diagram 5.2 London congestion charging zone**




**Source: Transport for London, 2003b**

**Diagram 5.3 Route A406 and A205 - Inner (London) ring road**


**Source: Transport for London, 2003b**

As it is almost impossible to find an accurate listing of the London population due to Data Protection legislation, the 2003 electoral role and/or census data for each Local Authority (whichever is available) will be used as an **accessible population** (against the theoretical population, which represents each individual in society as a whole). The electoral roll and/or census data will be more representative than using a telephone directory, as many people are not listed (ex-directory) or do not have a telephone.

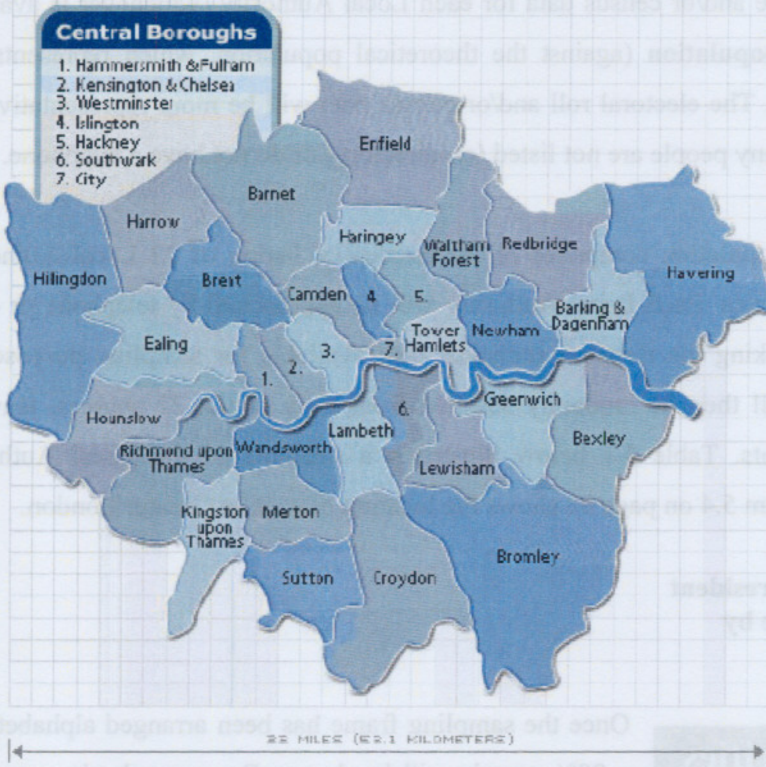
Hence the accessible or study population comprises of the residential listing of 22 Local Authority's electoral role and or census statistics. Each Local Authority will be approached by telephone or e-mail seeking their co-operation in making the required statistical data available for sampling purposes. An equal proportion of residents will then be randomly selected from each of the 22 sources, leaving a sampling frame of 5000 residents. Table 5.1 below illustrates a schedule of the Local Authorities involved in the survey and Diagram 5.4 on page 88 shows the location of each in Greater London.

**Table 5.1 Local and peripheral resident and business stakeholder sphere by Local Authority**

| | Local Authorities |
|---|---|
| Central London | Southwark Council<br>London Borough of Lambeth<br>Tower Hamlets Borough Council<br>Westminster City Council<br>Camden Council<br>Islington Council<br>London Borough of Hackney<br>City of London |
| Peripheral | The Royal Borough of Kingston and Chelsea<br>Hammersmith and Fulham Council<br>Wandsworth Borough Council<br>London Borough of Lewisham<br>Greenwhich Council<br>London Borough of Barnet<br>Newham Council<br>Hounslow Council<br>London Borough of Waltham Forest<br>London Borough of Redbridge<br>Haringey Council<br>Brent Council<br>Ealing Council<br>Enfield Council |

Once the sampling frame has been arranged alphabetically, a 20% sample will be drawn. For example, in a sampling frame of 5000 residents with a required 20% sample, every fifth sample unit on the list will be selected once the starting point has been randomly selected. This will leave a sample size of 1000 participants. Each participant will receive his/her questionnaire by mail. The questionnaire will include a cover letter explaining the purpose of the research, how and why participants have been selected, seek informed consent and provide some background information as to what congestion charging involves. The cover letter will also include information about how the participant's confidentiality and anonymity will be preserved, how the information will be safeguarded and how their identity will be protected. Participants will also be told who owns the data and the conclusions drawn from the survey, how it will be reported and disseminated and assured that the data will not be abused or used for any other purpose than the research.

**Diagram 5.4 Local Authorities in Greater London**




**Source: Transport for London, 2003b**

## 5.2.3.2.2 Business sampling procedure

Yellow Pages provide an online service at their website http://www.yell.com when searching for a specific listed business and provide the option of searching by postal code within 17 business categories. These are illustrated in Table 5.2 below.

**Table 5.2 Business categories**

| Categories | |
|---|---|
| * Building and construction | * Business services |
| * Computer and the Internet | * Education and employment |
| * Entertainment | * Financial and legal |
| * Food and drink | * Health and beauty |
| * Home and garden | * Manufacturers and engineers |
| * Media and communication | * Motoring |
| * Public and social services | * Shops |
| * Sports and Leisure | * Tourism and Transport |
| * E-commerce | |

The 8 London postal districts are organized by 119 sectors according to Anon (2004), illustrated in Table 5.3 on page 89 and then numbered within their sectors. The postal districts are, WC (West Central), EC (East Central), N (North), NW (North West), SW (South West), SE (South East), W (West) and E (East).

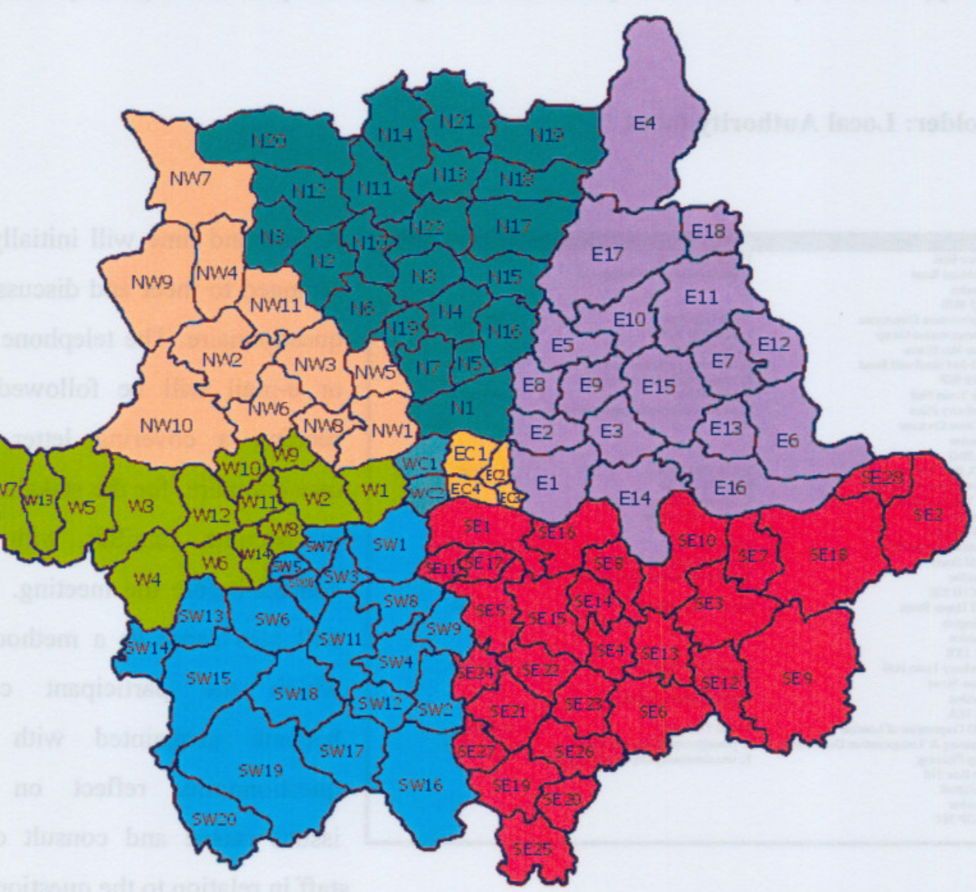
**Table 5.3 London postal districts**

| Postal districts | Postal codes |
|---|---|
| WC | WC1, WC2 |
| EC | EC1, EC2, EC3, EC4 |
| N | N1, N2, N3, N4, N5, N6, N7, N8, N9, N10, N11, N12, N13, N14, N15, N16, N17, N18, N19, N20, N21, N22 |
| NW | NW1, NW2, NW3, NW4, NW5, NW6, NW7, NW8, NW9, NW10, NW11 |
| SW | SW1, SW2, SW3, SW4, SW5, SW6, SW7, SW8, SW9, SW10, SW11, SW12, SW13, SW14, SW15, SW16, SW17, SW18, SW19, SW20 |
| SE | SE1, SE2, SE3, SE4, SE5, SE6, SE7, SE8, SE9, SE10, SE11, SE12, SE13, SE14, SE15, SE16, SE17, SE18, SE19, SE20, SE21, SE22, SE23, SE24, SE25, SE26, SE27, SE28 |
| W | W1, W2, W3, W4, W5, W6, W7, W8, W9, W10, W11, W12, W13, W14 |
| E | E1, E2, E3, E4, E5, E6, E7, E8, E9, E10, E11, E12, E13, E14, E15, E16, E17, E18 |

It is important to note that London postal districts rarely coincide with the boundaries of the Local Authorities. The numbering system also appears arbitrary as, for example, NW1 is close to central London, but NW2 is a long way out in the peripheral area. This is because within each sector, they are numbered by first assigning the number 1 to the closest district to the centre and then the rest of the numbers are assigned alphabetically by the name of the district they represented.

As with the Local and peripheral residents the population of businesses will be drawn from the same geographic area. The population of businesses will be selected by identifying one sample unit for each business category from each of the 119 postal districts as illustrated in Diagram 5.5 below.

**Diagram 5.5 Graphic illustration of London postal districts**




**Source: Anon, 2004**

Hence, 17 businesses will be selected from each postal district covering the congestion zone and the peripheral area. This will leave a population of 2023 businesses. Once selected they will be arranged alphabetically and a 20% sample drawn. For example, in a population of 2023 businesses with a required 20% sample, every fifth sample unit on the list will be selected once the starting point has been randomly selected. This will leave a sample size of 405 businesses. Each selected business will receive a questionnaire and a cover letter by mail. The cover letter will communicate the same information as that sent to the local and peripheral residents.

## 5.2.3.2.3 Local Authority, environmental and public transport provider sampling procedure

Table 5.4 below depicts the schedule of Local Authorities to be approached, inclusive of address details, contact details and interview date.

The sampling size here is a function of the purpose of the study, the need for qualitative data and practical constraints to the research. The **Local Authority** stakeholder population consists of 8 Local Authorities included in the London congestion zone. A sample will not be drawn from this population. The complete population will be approached by e-mail or telephone in seeking their co-operation to participate in the survey.

**Table 5.4 Stakeholder: Local Authority focus group schedule**

| Stakeholder | Address | Contact Details | Interview Date |
|---|---|---|---|
| Southwark Council | Town Hall<br>Peckham Road<br>London<br>SE5 8UB | T: 020 7525 5000<br>E: paul.evans@southwark.gov.uk | 13-04-2004 |
| London Borough of Lambeth | Environment Directorate<br>Transportation Group<br>Blue Star House<br>234-244 Stockwell Road<br>SW9 9SP | T:020 7926 9000<br>T: 020 7926 1000<br>F:020 7926 3127<br>E: infoservice@lambeth.gov.uk<br>E: mbridgeland@lambeth.gov.uk | 13-04-2004 |
| Tower Hamlets Borough Council | The Town Hall<br>Mulberry Place<br>5 Clove Crescent<br>London<br>14 2BG | 020 7364 5000<br>E: elise.boon@towerhamlets.gov.uk | 21-04-2004 |
| Westminster City Council | P.O. Box 240<br>Westminster City Hall<br>64 Victoria Street<br>London<br>SW1E 6QP | T: 020 7641 3326<br>F: 020 7641 3102<br>E: sdwyer@westminster.gov.uk<br>Contact: Sean Dwyer | 13-04-2004 |
| Camden Council | Camden Town Hall<br>Judd Street<br>London<br>WC1H 9JE | 020 7278 4444<br>020 7974 5962/5070/5198<br>E: laurie.baker@camden.gov.uk | 13-04-2004 |
| Islington Council | 222 Upper Street<br>Islington<br>London<br>N1 1XR | Tel: 020 7527 2000 | 21-04-2004 |
| London Borough of Hackney | Hackney Town Hall<br>Mare Street<br>London<br>E8 1EA | T: 020 8356 5000<br>F: 020 8356 2185<br>E: info@hackney.gov.uk | 21-04-2004 |
| City of London | C/O Corporation of London<br>Planning & Transportation Department<br>City Planning<br>PO Box 270<br>Guildhall<br>London<br>EC2P 2EJ | T: 020 7332 1151<br>E: plans@corpoflondon.gov.uk<br>E: iain.simmons@corpoflondon.gov.uk | 21-04-2004 |

A date and time will initially be arranged to meet and discuss the questionnaire. The telephone call or e-mail will be followed by sending a covering letter and questionnaire, for the stakeholder to become familiar with the content before the meeting. This will also serve as a method by which the participant could become acquainted with the questionnaire, reflect on the issues raised and consult other staff in relation to the questions.

A focus group meeting will then be held at the stakeholder's office. At the interview the questionnaire will be administered by myself in the presence of the participant(s) by taking notes. Once the notes have been completed the participant(s) will be given the opportunity to discuss the issues raised in the questionnaire in more detail and to raise any concerns. They will then be asked to check the notes and whether they believe they are a true reflection of their statements, ideas and perception. The data will then be reconstructed following the interview.

Transport issues in the London metropolitan area are managed by Transport for London (TfL). It primarily provides and co-ordinates alternative modes of transport in the city. There are 6 principle modes of **transport**, each provided by a different service provider - forming the population. They are represented by (i) London Buses, (ii) Serco Docklands Limited, (iii) London Underground, (iv) London River Services, (v) Public Carriage Office (taxis) and (vi) London Rail and are illustrated in Table 5.5 below.

As with the Local Authority stakeholder group, no sample will be drawn from the population. The complete population will be approached by e-mail or telephone seeking their co-operation in participating in the survey. The same procedure in relation to approaching the stakeholder, arranging an interview and the reconstruction of the data will be followed as for the Local Authorities.

**Table 5.5 Stakeholder: Public Transport focus group schedule**

| Transport provider | Address | Contact Details | Interview Date |
|---|---|---|---|
| **Busses** | Customer Services Department<br>172 Buckingham Palace Road<br>London<br>SW1W 9TN | T: 020 7918 4300<br>F: 020 7918 3999<br>E: customerservices@tfl-buses.co.uk | 14-04-2004 |
| **London Underground** | Customer Services<br>Castor Lane<br>London<br>E14 ODS | T: 020 7363 9700<br>F: 020 7363 9532<br>E: CSERVICE@dlr.co.uk | 14-04-2004 |
| | 55 Broadway<br>London<br>SW1H OBD | T: 020 7222 5600<br>T: 0845 330 9880<br>F: 020 7918 4093<br>E: customerservices@tube.tfl.gov.uk | 14-04-2004 |
| **River Services** | Windsor House<br>42-50 Victoria Street<br>London<br>SW1H 0TL | T: 020 7941 4500<br>E: james.gilbert@tfl-river.co.uk | 14-04-2004 |
| **Public Carriage Office** | 15 Penton Street<br>London<br>N1 9PU | T: 020 7941 7941 | 14-04-2004 |
| **National Rail** | TfL London Rail<br>2nd Floor<br>1 Butler Place<br>London<br>SW1H 0PT | T: 0845 7 48 49 50<br>E: enquire@tfl.gov.uk | 14-04-2004 |

Four **environmental groups** have been identified to serve as population in the survey. These are reflected in Table 5.6 below.

**Table 5.6 Stakeholder: Environmental interest focus group schedule**

| Stakeholder | Address | Contact Details | Interview Date |
|---|---|---|---|
| Friends of the Earth | 26-28 Underwood Street<br>London<br>N1 7JQ | T: 0808 800 1111<br>T: 020 7490 1555<br>F: 020 7490 0881<br>E: info@foe.co.uk | 22-04-2004 |
| Greenpeace | Canonbury Villas<br>London,<br>N1 2PN | T: 020 7865 8100<br>F: 020 7865 8200<br>E: info@uk.greenpeace.org | 22-04-2004 |
| Environment Agency | Swift House<br>Camberley<br>Surrey<br>GU16 5SQ | Tel: 08459 333 111<br>E: terry.bedger@environment-agency.gov.uk | 22-04-2004 |
| English Nature | Northminster House<br>Peterborough<br>PE1 1UA | T: 01733 455101<br>F: 01733 455103<br>E: enquiries@english-nature.org.uk | 22-04-2004 |

As with the Local Authority stakeholder group, no sample will be drawn from the population. The complete population will be approached by e-mail or telephone in seeking their co-operation in participating in the survey. The same procedure in relation to approaching the stakeholder, arranging an interview and the reconstruction of the data will be followed as for the Local Authorities.

### 5.2.3.3 Nonresponse

No matter how well the sampling design is planned, a poor response rate to the survey can have a detrimental impact on the study. Burkell (2003:241) defines survey nonresponse "as the discrepancy between the group approached to complete a survey and those who eventually provide data". Hence, those participants not returning questionnaires directly affect the generalizability of the findings and conclusions. If one considers that a 75% response rate is highly desirable if generalizability of the findings are to be maintained, it makes all the more sense to reduce nonresponse as far as practicable. Nonresponse normally occurs as a result of one or more of the following reasons:

(i) Participants residing at the location are away (e.g. for holiday) at the time of the survey

(ii) Participants refuse to answer and or return the questionnaire

(iii) Some participants may have moved and left no forwarding address or are not contacted due to an unforeseen error in the survey procedures.

Nonresponse presents two problems for the interpretation of research results. First it reduces the sample size and thus decreases the precision with which results can be stated. Secondly as nonresponse increases the potential for a biased sample increases. Hence the obtained responses may no longer be representative of the larger population and render the conclusions much weaker. Burkell (2003:244-250) recommends several strategies to deal with nonresponse. Below are some methods followed in this study to address the problem.

Firstly a cover letter will be included with the questionnaire briefly introducing urban congestion charging to the uninformed participant. It also presents the opportunity to build a certain degree of rapport with the participant by personalizing the questionnaire and removing an unwanted businesslike appearance. Secondly a self-addressed, stamped envelope will be included with the questionnaire to increase the response rate. Thirdly a reminder letter will be sent to the residential and business stakeholder participants two weeks after sending their questionnaires.

Finally, in the event of having a very poor return i.e. 30%, an additional 300 residential participants and 100 business participants will be selected as a **reserve sample** to boost the response rate and increase the desired level of confidence and precision. This sample will be drawn in the same way and from the same population as the original 1000 residents and 405 businesses.

### 5.2.4 Data analysis

Following the survey, the collected data will be analysed in three phases, as described below, whereby raw data will be cleaned and organised, described and inferences drawn from and reported in the results chapter of the research. These phases form the platform for unlocking the required information to fill the gaps in previous research.

(1) **Preparing the data for analysis.** This will involve checking and logging the data, checking the data for accuracy and entering the data into a computer. Qualitative data will undergo a content reduction to reduce the amount of data, reduce the volume of information, identify significant patterns and construct a framework for communicating the essence of what the data reveals. The identification of significant patterns in the data will be facilitated by a procedure whereby a relatively small number of coding schemes or categories are developed and assigned to similar concepts and/or ideas.

Because quantitative data is analysed using quantitative data analysis which requires the data to be in the form of numbers, the data will be transformed by coding or enumeration. For example, a closed question from the questionnaire may read as follows:

Do you think road pricing enhances your business profitability and competitiveness?

Please tick appropriate box.

| | |
|---|---|
| Yes | 0 |
| No | 1 |

The response "Yes" is given the numerical value of 0 and "No" is given the numerical value of 1. Once all the replies have been coded, the number of "0's" and "1's" can be counted. This information can then be used, for example, to calculate the percentage frequencies and other types of data. Hence by working through the interview transcripts and questionnaires, each separate concept or idea is allocated with a numerical code. The answers to open questions will be coded by coding similar patterns, concepts and ideas in the same way. To enable statistical analysis, road pricing as program or cause will be regarded and coded as an independent variable and the effects and sustaining factors will be regarded and coded as dependent variables.

(2) **Describing the collected data**. Descriptive statistics will be used to provide simple summaries about both quantitative and qualitative data in describing the basic features of the data. This will be carried out by presenting the data with the aid of tables, figures, graphs, pie charts, bar-charts and histograms.

(3) **Drawing inferences**. Inferential statistics will serve as an additional technique investigating the research question and more specific research questions. To this end the software program Analyse-it will be used for statistical analysis. The use of inferential statistics makes it possible to measure the relationship between the independent and dependent variables and to establish whether the relationships truly exist, if they are significant or whether they occurred by change. Measuring the probability of the effects arising by chance or because they were caused by the introduction of road pricing is of particular importance as is calculating the probability to show (i) whether the relationship between two variables has occurred by chance, (ii) whether there is a real relationship and (iii) establishing if one variable changes whether the others change too. These measurements will be carried out with the aid of correlation tests and significance tests. The inferences drawn will be linked to each of the research questions.

### 5.2.5 Report results

Following the analysis the results will be reported with descriptive statistical instruments and report writing. The results will help form a holistic picture of the effects of road pricing and the factors sustaining its viability in terms of stakeholder perceptions.

### 5.2.6 Discussion and interpretation of results

Once the results have been reported it is equally important to interpret and explain what has been found, how it fits in with what is already known about the subject and to identify remaining problem areas. This positions the research for a multi criteria analysis, evaluating the results and developing and ranking various options to overcome the problems.

### 5.2.7 Multi criteria analysis

Following the discussion and interpretation, a multi criteria analysis will be performed. The purpose of the Multi Criteria Analysis (MCA) is to evaluate various formulated policy options to overcome the identified problems against an explicit set of policy objectives which have been identified, and for which measurable criteria have been developed to assess the extent to which the options may contribute to achieving the policy objectives.

### 5.2.8 Conclusions

Following the MCA, conclusions will be drawn from the study, including:

1. a summary of its principle components
2. an outline of the main findings
3. the implications of the research
4. the achievement of objectives
5. the main results of the research
6. directions for future research

### 5.2.9 Recommendations

This is the final stage in the research and will be used to formulate recommendations and practical suggestions within a specific context and be based upon a combination of options open to use by policy and decisions makers.

## 5.3 Data validity

Throughout the investigation the research design will promote internal validity; this is the approximate truth about inferences regarding cause and effect or relationships. The careful and precise application of the research methodology will ensure reliable and consistent data, results and conclusions which will meet the criteria of good science, reproducibility, precision and verification. The validity of the research will also be emphasised by the research design fully addressing the research questions and objectives.

External validity can be achieved by drawing a representative and random sample from the population. Because the sample should represent the population the results obtained can be generalised back to the population, strengthening the external validity of the results. Hence external validity refers to the approximate truth of the conclusions reached that involves generalisation. By analysing the results statistically, the validity of the relationship between the dependent and independent variables will also be strengthened and enhance the validity of conclusions and interpretations made in the research.

# 5.4 Confidentiality and anonymity

As ethical issues are involved in research participants will be informed about the purpose of the research so they can make an informed decision as to whether to take part or not. The data collected will remain the property of the researcher and will not be used for any other purpose except for this study. Data gathered will be treated in a way that protects the confidentiality and anonymity of participants by quantifying and coding the data. The questionnaires will also briefly explain how and why participants have been chosen and how their information will be treated.

# 5.5 Literature review

The purpose of the literature review was to initially identify the main concepts in road pricing, areas where gaps in the current knowledge exists and to identify concepts that have been contested. The literature review will also be used to place the research questions in the context of previous work as to explain and justify the decisions made with respect to (i) how and why the research questions were formulated in the presented form and (ii) why the proposed research strategy was selected. The literature will be connected to the research results as to confirm, challenge or extend previous findings. This process will also contribute to the internal validation of the findings.

# 5.6 Conclusion

This chapter has set out the methodology for investigating the gaps identified in the literature, enabling the results to form a holistic picture of the effects of road pricing and the sustaining factors. The method involves an exploratory and descriptive investigation whereby data is collected using a survey and stakeholder focus group meetings. It explained how the collected data will be analysed, evaluated and conclusions be drawn from as to recommend initiatives enhancing the sustainability and viability of road pricing. Additionally it has shown how the study will deal with data validity, confidentiality and anonymity and the use of the current literature. First however, the results obtained from the survey will be reported in the next chapter.

# Chapter 6 Results

## 6.1 Introduction

The survey was used as a tool to ascertain various stakeholder views and gather information about the issues being investigated. The results reported here are as far as possible descriptive in nature and will be evaluated, interpreted and explained in the next chapter.

## 6.2 Survey characteristics

**Table 6.1 Residents survey characteristics (n = 638)**

| Indicator | Percentage | |
|---|---|---|
| | Survey % | UK % |
| **Gender** | | |
| Male | 59 | 48.8 |
| Female | 41 | 51.2 |
| **Age** | | |
| 18 or under | 4 | 19 |
| 19 - 35 | 37 | 21 |
| 36 - 50 | 36 | 35 |
| over 51 | 23 | 25 |
| **Population Group** | | |
| Asian | 5 | 4 |
| Black | 13 | 2 |
| Chinese | 3 | 0.4 |
| Mixed | 7 | 1.2 |
| Other | 2.5 | 0.3 |
| White | 69.5 | 92.1 |
| **Net Income** | | |
| < £10 000 per annum | 13 | 8 |
| £10 000 - £20 000 | 17 | 30 |
| £21 000 - £30 000 | 45 | 30 |
| £31 000 - £40 000 | 17 | 20 |
| > £41 000 | 8 | 12 |
| **Educational Level** | | |
| No formal education | 11 | 15 |
| School level | 56 | 45.8 |
| National diploma | 13 | 10.5 |
| First Degree | 18 | 22.5 |
| Post Graduate | 2 | 6.2 |
| **Employment status** | | |
| Self Employed | 22 | 5.1 |
| Employed | 61 | 74.9 |
| Student/Graduate | 9 | 2.9 |
| Pensioner | 6 | 12.3 |
| Unemployed | 2 | 4.8 |
| **Vehicle ownership** | | |
| None | 36 | 28 |
| One | 51 | 44 |
| Two | 12 | 23 |
| > Two | 1 | 5 |
| **Opposing congestion charging** | 19.9 | - |
| **Residency** | | |
| Lives within the zone | 72 | - |
| Lives in the peripheral area | 28 | - |
| **Reduction in traffic congestion** | 68.5 | - |

**Source:** **Office of National Statistics (2004)**
**Own calculations from survey**

At the time when the survey was held (April 2004) congestion charging had just been brought into the public domain with Transport for London's campaign to extend the existing zone in a westerly direction. For this reason a large proportion of road users in London can therefore be expected to be familiar to some extent, with the concept of congestion charging and with the possibility of its proposed extension. This may partly explain the relatively high response rate to the residential and business questionnaires. It would take too long to discuss the questionnaires themselves in great detail here Appendix A - E gives an impression of the questions asked.

The residential sample of 1000 randomly selected participants yielded a response of 63.8% with 638 questionnaires returned by post. The sample characteristics of interest are given by Table 6.1. In summary the sample consisted of 59% men, with a mean age of 38 and a mean annual income of £25 500. 41% were female with a mean age of 39 and a mean annual income of £21 150. 21% responding had a university education and 56% a school education. Respondents with no education formed 11% of the respondents. 61% were employed, 15% unemployed and 6% retired. The majority of respondents were from the white population group (69.5%). The number of vehicles owned by the respondents was as follows: 36% owned none; 51% owned one; 12% owned two vehicles; 1% owned three or more. 19.9% of the respondents claimed they oppose congestion charging with 79.1% stating they do not. Finally, 72% responding live within the congestion zone and 28% in the peripheral area and 68.5% perceives traffic congestion to have reduced. Compared to national statistics the sample does not differ significantly from the national averages.

**Table 6.2 Business survey characteristics (n =247)**

| Indicator | (%) |
|---|---|
| **Annual turnover** | |
| < £50 000 per annum | 16 |
| £50 000 - £100 000 | 9 |
| £101 000 - £200 000 | 6 |
| £201 000 - £300 000 | 5 |
| £301 000 - £500 000 | 18 |
| > £501 000 | 47 |
| **Workforce** | |
| < 20 | 43 |
| 20 – 40 | 22 |
| 41 – 60 | 9 |
| 61 – 80 | 18 |
| > 81 | 8 |
| **Ownership of company vehicles** | |
| < 3 | 92 |
| 3 –10 | 5 |
| 11 – 20 | 2 |
| 21 – 30 | 0 |
| 31 – 40 | 0.5 |
| > 41 | 0.5 |
| **Location** | |
| Businesses in congestion zone | 64 |
| Businesses in peripheral area | 36 |
| Businesses considering to move from: | |
| Congestion zone to Peripheral area | 2 |
| Peripheral area to Congestion zone | 2 |
| **Provide flexible working hours** | |
| Yes | 73 |
| No | 27 |
| **Allowance for employees being late:** | |
| 1 – 5 min | 5 |
| 6 –10 min | 35 |
| 11 –15 min | 19 |
| 16 – 20 min | 31 |
| > 20 min | 10 |
| **Time lost due to traffic congestion** | |
| 10 – 20 min | 16 |
| 21 – 30 min | 71 |
| 31 – 40 min | 9 |
| 41 – 50 min | 3 |
| > 50 min | 1 |
| **Acceptance of congestion charging** | 71 |

The business sample of 405 randomly selected businesses yielded a response rate of 61% with 247 questionnaires returned. Table 6.2 illustrates the characteristics of interest. In terms of annual turnover 47% indicated a turnover in excess of £501 000 whereas businesses with a turnover of less than £50 000 and up to £100 000 per annum represented 25% of the response. 8% of businesses indicated a work force greater than 81 employees. Those with less than twenty employees represented the greatest percentage (43%) of the total number of businesses replying. The greatest percentage of businesses (97%) had 10 or less company vehicles.

64% of businesses responding are located within the congestion charging zone. The remainder are located in the peripheral area. In terms of relocating, very few businesses indicated they intend to move from either the congestion zone to the peripheral area (2%) or from the peripheral area to the congestion zone. 73% provide flexible working hours and 35% allow for employees being no moere than 6 –10 minutes late for work. 1% reported a greater than 50 minute loss in time per journey when using congested roads. The greatest proportion of respondents (71%) experienced a 10 –20 minute delay per journey. Finally, 71% of businesses accept congestion charging as an instrument to reduce traffic congestion with the remainder opposing it.

Four focus group meetings were held with the three remaining stakeholders. These focus groups were used to highlight their concerns, to communicate ideas, views and perceptions and to explore a variety of issues raised in the questionnaires. Although interviewees were mainly the heads of their departments it was necessary to convey a great deal of background information about congestion charging and the purpose of some of the questions throughout the meetings. The focus groups proved quite useful in terms of identifying issues for clarity and content. All criticisms and suggestions were also dealt with as deemed appropriate. A considerable interest and concern regarding traffic issues was perhaps one of the main reasons that kept the respondents engaged in the interview process.

# 6.3 Empirical results

This section reports the attitudes, opinions, perception and views of the participating stakeholders. By carefully sifting through the collected data, the following sub sections describe the findings in terms of the identified effects and factors sustaining road pricing.

## 6.3.1 Economics

Central London is the "powerhouse" of the British economy and a key location for attracting global investment and tourism. London's economy is extraordinarily complex and is subject to a wide variety of short and long-run influences. It is also unique, particularly in central London, and has no equivalent that could be used as a "control" to account for these influences in the absence of congestion charging. Disentangling any significant effects of the scheme on London's economy will therefore be a challenging task but it is essential if the full implications of congestion charging for London are to be understood.

The remainder of this section reports the findings of the survey mainly from the point of view of residential and business respondents in and directly around the congestion zone. It is further divided into sub-sections reporting the key findings in relation to the identified gaps. Where applicable specific viewpoints will be included as to give the findings more substance.

### 6.3.1.1 Pareto optimality

As it is quite difficult to establish how road pricing affects or influences Pareto optimality, a couple of questions in the questionnaire were designed to gauge Pareto optimality in terms of "derived satisfaction" and "willingness to work". Of the 459 (72%) residential respondents who stated that they lived within the zone 68.7% indicated congestion charging is perceived to increase their derived user satisfaction when journeys are undertaken to and from and within central London. When the respondents were asked whether they would work more or less hours following the imposition of congestion charging, only 8.5% indicated they would, leaving 91.5% indicating that they will make no changes to their working hours.

### 6.3.1.2 Income, saving, consumption, investment and productivity

In establishing the extent to which congestion charging will affect the public's and businesses' finances, the respondents were asked about how it impacts on their income, savings, consumption, investment and productivity. These variables had to be assigned a number ranging from 1 (no change) to 4 (not sure).

Table 6.3 below shows the resulting comparative statistics for both residents and businesses taking part in the survey.

**Table 6.3 Comparitive statistics for residents and business finance (R = Residents [n = 638]; B = Businesses [n =247])**

| Variable | No change % | | Reduce % | | Increase % | | Not sure % | |
|---|---|---|---|---|---|---|---|---|
| | R | B | R | B | R | B | R | B |
| Income | 68.3 | 83 | 23.5 | 0 | 2.1 | 0 | 5.6 | 17 |
| Savings | 79.5 | 98 | 5.5 | 1 | 3.6 | 1 | 11.8 | 0 |
| Consumption | 68.3 | - | 17.6 | - | 4.6 | - | 9.5 | - |
| Investment | 82.3 | 95 | 1.7 | 1 | 2.5 | 4 | 13.5 | 0 |
| Labour Productivity | - | 79.5 | - | 0 | - | 0 | - | 20.5 |

| Residents | Mean | SD | SE | 95% CI of Mean | Median |
|---|---|---|---|---|---|
| **No change** | 59.68 | 33.966 | 15.190 | 17.51 to 101.85 | 68.30 |
| **Reduce** | 9.66 | 10.351 | 4.629 | -3.19 to 22.51 | 5.50 |
| **Increase** | 2.56 | 1.733 | 0.775 | 0.41 to 4.71 | 2.50 |
| **Not sure** | 8.08 | 5.401 | 2.415 | 1.37 to 14.79 | 9.50 |

| Businesses | Mean | SD | SE | 95% CI of Mean | Median |
|---|---|---|---|---|---|
| **No change** | 71.10 | 40.504 | 18.114 | 20.81 to 121.39 | 83.00 |
| **Reduce** | 0.40 | 0.548 | 0.245 | -0.28 to 1.08 | 0.00 |
| **Increase** | 1.00 | 1.732 | 0.775 | -1.15 to 3.15 | 0.00 |
| **Not sure** | 7.50 | 10.344 | 4.626 | -5.34 to 20.34 | 0.00 |

The results shown in Table 6.3 shows that the majority of respondents feel congestion charging has not changed their income. 79.5% indicated that it does not affect their savings and 68.3% and 82.3% respectively have declared it does not change their consumption of goods, services and investment. In relation to labour productivity both residents and businesses reported the influence of road pricing being very insignificant, with 83.5% and 79.5% respectively reporting no change to perceived productivity.

The statistical data also suggests the probability is 0.95 that the actual mean change in income is statistically significant for both residents and businesses. This is because the actual mean income for both stakeholders lies between the upper and lower identified confidence limits. It also suggests the mean change in income for both lies within the 1.96% (for a 95% confidence interval) standard errors of the sample.

### 6.3.1.3 Profitability and competitiveness

The purpose of this section is to highlight how the business stakeholders especially perceive their profitability and competitiveness when congestion charging is in operation. Apart from reporting on the gap identified, respondents showed. a great interest in reporting how their profitability and competitiveness have been influenced, in some cases identifying some factors they feel have influenced them.

Starting with the identified gap, businesses were asked about their logistical or freight arrangements in establishing whether freight induced increases in transport cost are being shifted to their consumers in order to maintain profitability and competitiveness. It was found that of the 247 businesses responding only 7.5% indicated that they own goods delivery vehicles. When asked if they met the increased cost of deliveries as a result of the charge 3.2% indicated they do. Respondents were also asked whether they shifted the increased cost of deliveries to consumers through higher product, service or consumable prices. 6.9% indicated they do. Furthermore, only 3.1% indicating they own goods delivery vehicles declared congestion charging has a detrimental impact on their businesses as a direct result of increased transportation cost.

Residential respondents were also asked: "*Do you think the consumption of goods, services and consumables will increase in the peripheral areas adjacent to the congestion zone?*". 59.3% indicated they do. When asked "*Do you think the price of consumables have been reduced in the congestion zone so businesses could stay profitable and competitive?*" 11.2% indicated they thought this would be likely to occur.

A number of businesses were keen to provide additional information regarding factors which influenced their profitability and competitiveness. In brief, they explained that London's economy has been subject to a variety of specific and longer-term local, national and international factors during 2003. Collectively these have had a much greater impact on their economic performance than congestion charging. They have also made the task of identifying and quantifying congestion charging related impacts more difficult.

#### 6.3.1.4 Locational decisions

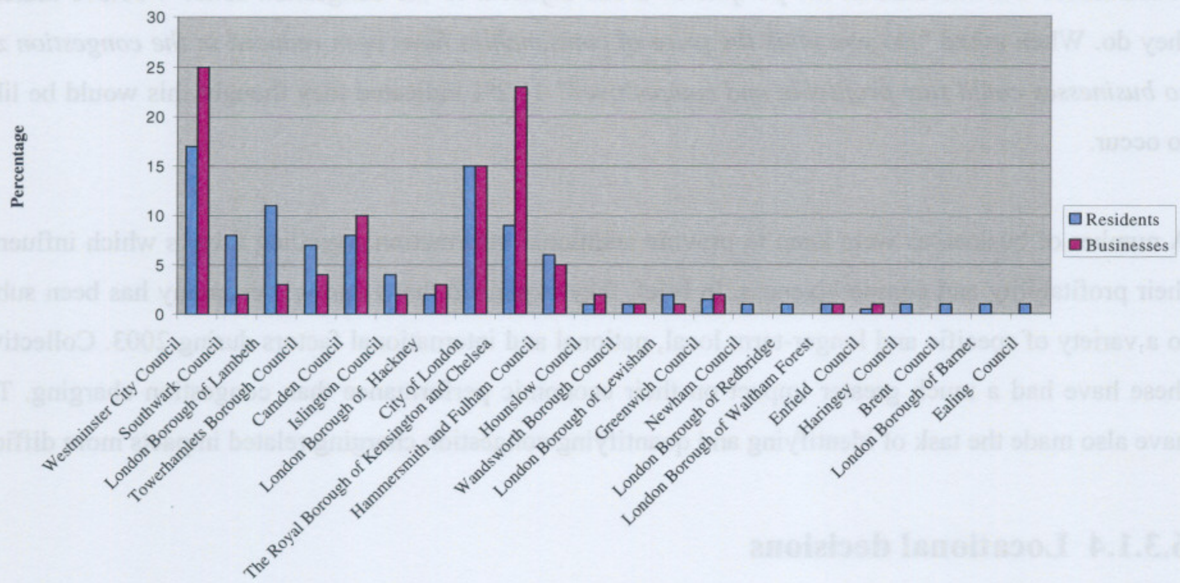
This section reports the percentage of businesses responding in terms of geographical locality and also their locational decisions. It also reports the extent to which residents would want to centralize or decentralize from or away from the congestion charging area. These findings are important in order to draw conclusions about whether the public perceives the congestion zone attractive in terms of (i) off setting a potential reduction in transport cost with the increased generalized cost and (ii) the economic viability of living in or doing business there.

When business respondents were asked in which London Borough they are located 64% indicated they have premises within the congestion zone with 36% stating they are located in the peripheral area. These findings are shown in more detail in Table 6.4 and Chart 6.1 on page 102. Of the 64% responding only 2% stated they intend moving to a location outside the congestion zone within the next 5 years. Respondents were also asked: "*Have you or will you consider moving to an area within the congestion charging zone where clustering of similar businesses takes place if you are not already located in the congestion zone?*". Only 4.5% indicated they would.

**Table 6.4 Where residential respondents live and businesses are located**

| Central London Borough | Residents % | Business % | Peripheral London Borough | Residents % | Business % |
|---|---|---|---|---|---|
| Westminster City Council | 17 | 25 | The Royal Borough of Kensington and Chelsea | 9 | 23 |
| Southwark Council | 8 | 2 | Hammersmith and Fulham Council | 6 | 5 |
| London Borough of Lambeth | 11 | 3 | Hounslow Council | 1 | 2 |
| Towerhamlets Borough Council | 7 | 4 | Wandsworth Borough Council | 1 | 1 |
| Camden Council | 8 | 10 | London Borough of Lewisham | 2 | 1 |
| Islington Council | 4 | 2 | Greenwich Council | 1.5 | 2 |
| London Borough of Hackney | 2 | 3 | Newham Council | 1 | 0 |
| City of London | 15 | 15 | London Borough of Redbridge | 1 | 0 |
| | | | London Borough of Waltham Forest | 1 | 1 |
| | | | Enfield Council | 0.5 | 1 |
| | | | Haringey Council | 1 | 0 |
| | | | Brent Council | 1 | 0 |
| | | | London Borough of Barnet | 1 | 0 |
| | | | Ealing Council | 1 | 0 |

**Chart 6.1 Residents and business locations**




Business respondents also highlighted some influencing factors in their decision to centralise or decentralise. Overall the results show that businesses perceive the hypothecation of revenues into public transport and the environment as a potential factor for the enhancement of their business performance and location, if the are located within the congestion zone. However there is a great deal of uncertainty and trepidation about the ability of government bodies to bring about the required changes and the length of time involved.

This compared with a great deal of scepticism among business and property development surveyors and consultants who suggested that it would take upwards of 20 years for the full positive amenity impacts of hypothecation to be realized in central London. There appeared to be little faith among businesses in the government's ability to either spend the revenues wisely or for the purposes intended.

There was also concern particularly among business respondents that improvements should be made up-front in advance of charging to avoid fluctuations in trade and relocations in the years before improvements take full effect. However although business would prefer an initial step-change in the level of public transport provision prior to introducing charging, there was general recognition that this was unlikely to occur. Businesses declared they will be more willing to centralize when public transport is reliable and efficient and when it does not erode their customer base.

Table 6.4 also shows the percentage of residents living in each local Authority covered by the survey. The results reveal that 72% live in the congestion zone and the remaining 28% in the peripheral area. When the residents were asked to comment on the benefits or disbenefits of living in the congestion zone, many different opinions and viewpoints were expressed. The following paragraphs summarises the main concepts and themes addressed.

Although residents who live within the zone are 90% exempt from the charge, the survey revealed a line of thought that, where revenue is not directly recycled into public transport it would dampen the trend towards urban living or centralization. However if revenue were to be recycled into public transport, respondents suggested congestion charging might be conducive to urban living. The feeling that congestion charging would stifle centralization was best summarized by one of the respondents who suggested that "charging would only be seen as an inconvenience (to both private investors and residential developers) because the environment of city centres is deteriorating and road user charging alone would not result in any environmental improvement".

Another respondent declared that residents would still be bothered by road user charging even though they were exempt from the tariff because "one's social life may be affected as friends, family and associates (who live outside the congestion zone) would have to pay the tariff if they come to visit". Such troubles may culminate in a tendency for residential development to move immediately outside the cordon boundary, drawing on the presumption of decentralization.

Another argument by the respondents was that "although there would be no hypothecation, the programme still had the ability to reduce the number of commuters significantly", resulting in less congestion and pollution. The improved environment "would further stimulate residential investment", and "send the right signal to property developers" and residential investors. Other respondents also noted that "the trend (toward increasing residential investment in city centres) was a function of much stronger forces than a road user charge", and that "urban living was an overwhelming growth industry that would override any inconveniences" brought on by a charge.

The overall feeling of these respondents was that people would not make decisions on where to live based upon tolls and there will always be more people who place a premium on urban living than available stock because of the relatively constrained nature of most city centre precincts. Another respondent noted that "residents already pay for residential parking permits and this has not deterred investment". Some respondents also expressed their concern about "social polarisation" occurring, as "poorer people are squeezed out of the zone". In sum, the most frequently cited factors in deciding where to live are in summary mainly transport cost to and from work and home, the additional living expense caused by the charge, its influence on travel behaviour, location near shopping and leisure facilities, its effect on social life and its effect on property prices.

## 6.3.1.5 Macroeconomic indicators

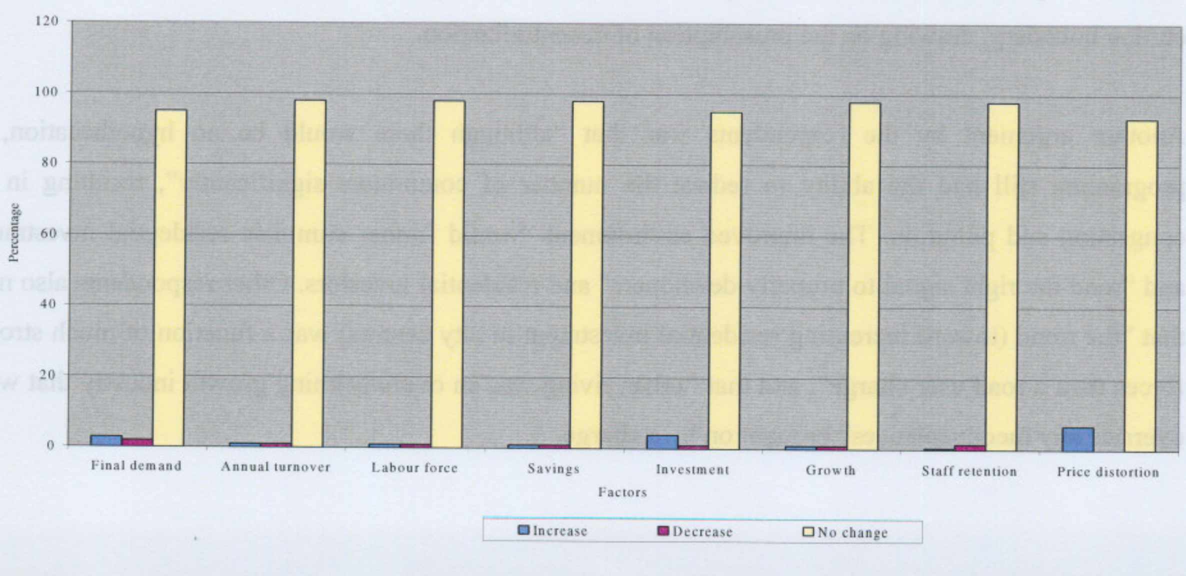
Businesses were asked how congestion charging affects them in terms of their (i) final demand, (ii) turn over, (iii) labour force, (iv) savings, (v) investment in their own companies, (vi) their growth, (vii) staff retention and (viii) price distortion. Table 6.5 and Chart 6.2 below illustrate these findings.

**Table 6.5 Macroeconomic impact**

| | Indicators | | |
|---|---|---|---|
| Factors | Increase % | Decrease % | No change % |
| Final demand | 3 | 2 | 95 |
| Annual turnover | 1 | 1 | 98 |
| Labour force | 1 | 1 | 98 |
| Savings | 1 | 1 | 98 |
| Investment | 4 | 1 | 95 |
| Growth | 1 | 1 | 98 |
| Staff retention | 0.5 | 1.5 | 98 |
| Price distortion | 6.9 | 0 | 93.1 |

| Indicator | Mean | SD | SE | 95% CI of Mean | Median |
|---|---|---|---|---|---|
| Increase | 2.30 | 2.221 | 0.785 | 0.44 to 4.16 | 1.00 |
| Decrease | 1.06 | 0.563 | 0.199 | 0.59 to 1.53 | 1.00 |
| No change | 96.64 | 1.970 | 0.696 | 94.99 to 98.28 | 98.00 |

**Chart 6.2 Congestion charging's macroeconomic affect**



Of the 247 responding businesses only 4% are involved in the manufacturing industry. Of the 4%, only 5.6% indicated they will decrease their production in an attempt to drive the prices of their products down. However they also mentioned this is not the only reason for reducing production. Amongst others they cited a decrease in demand for their products and gaining competitiveness and profitability as other reasons for lower product or service prices.

It appears that the responding businesses do not perceive congestion charging to have a great upward impact on any of the factors shown in the Table. The only factors of significance are that of an increase in price distortion, i.e. the prices of products being increased, as well as observing small investment increases. The statistical data also suggests the probability is 0.95 that the actual mean of an increase in price distortion is statistically significant. This is because the actual mean lies between the upper and lower identified confidence limits. It also suggests the increase in price distortion lies within the 1.96% (for a 95% confidence interval) standard errors of the sample.

## 6.3.2 Social welfare

This section reports how respondents' social welfare is being affected by the congestion charge. The emphasis is on identifying, understanding and exploring social impacts amongst those respondents most likely to be affected, combining a general picture of their scope and intensity with the ability to answer specific questions. This is performed by reporting the perceived change in road user behaviour and distributional effects in turn.

### 6.3.2.1 Road user behaviour

**Table 6.6 Congestion charging's effect on travel behaviour**

| Response | (%) |
|---|---|
| Continue to travel with your normal mode of transport | 23.7 |
| Avoid travelling along charged route for some trips | 3.5 |
| Avoid travelling along charged route for most trips | 9.6 |
| Unaffected | 27.5 |
| Affected by displaced traffic | 3.6 |
| Make no change to preferred route | 21.4 |
| Change route | 41.6 |
| Change destination | 3.4 |
| Change the time of departure | 37.0 |
| Change vehicle occupancy | 5.1 |
| Change the frequency of the trip | 11.6 |
| Change mode | 57.6 |
| Do not undertake the trip any longer | 27.5 |

In identifying the extent to which congestion charging has influenced road user behaviour several questions were put to respondents in forming a general picture of the likely effects. Respondents were asked: "*How will congestion charging affect your travel behaviour if you have to enter the congestion charging zone?*". They were then asked to rank as many options as applicable to their individual situations. The findings are illustrated in Table 6.6. The findings reveal that 41.6% of the residential respondents indicated they will or have changed route to any destination within or outside the to the congestion zone. 37% declared their departure times to work has changed. However 27.5% said they were unaffected while 21.4% indicated they will or have made no changes to their preferred route and 23.7% declared they will continue to travel with their normal mode of transport. Of the 638 respondents, 57.6% indicated they will change their preferred mode of transport and planned or unplanned journeys to the congestion zone. Congestion charging had a lesser significant influence on road user behaviour judged against responses about "changing destination", "changing vehicle occupancy" and/or "trip frequency".

In relation to individual behavioural change, Table 6.7 illustrates the changes in travel behaviour for those charging zone residents and peripheral residents who continue to drive in the area during charging hours compared with the total number of residents responding. Of those charging zone residents who continue to drive in the zone, 18% are doing so less often and 14% are doing so more often. Among the total number of respondents 51% are using their cars less and only 5% have declared they are using their cars. Among all the respondents taking part in the survey, on balance more are using buses (39% against 7% who claim to use them less) and are also walking and cycling more often.

**Table 6.7 Changed travel behaviour by driving charging zone and peripheral residents and all respondents (driving and non driving).**

| Mode | Charging zone residents (%) | | | All residents (%) | | | Peripheral residents (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Less often | Same as before | More often | Less often | Same as before | More often | Less often | Same as before | More often |
| Car driver | 18 | 68 | 14 | 50 | 42 | 8 | 43 | 55 | 11 |
| Car pool | 11 | 78 | 11 | 31 | 67 | 2 | 21 | 72.5 | 6.5 |
| Bus | 16 | 63 | 21 | 7 | 54 | 39 | 15 | 58.5 | 30 |
| Tube | 11 | 78 | 11 | 11 | 57 | 32 | 11 | 67.5 | 21.5 |
| Train | 16 | 77 | 7 | 13 | 65 | 21 | 14.5 | 71 | 14 |
| Taxi | 9 | 84 | 7 | 5 | 76 | 19 | 7 | 80 | 13 |
| Motorbike | 2 | 98 | 0 | 2 | 58 | 40 | 2 | 78 | 20 |
| Cycle | 0 | 64 | 36 | 5 | 67 | 29 | 2.5 | 65.5 | 32.5 |
| Walk | 12 | 64 | 24 | 13 | 68 | 19 | 12.5 | 66 | 12.5 |

| Change in mode | Mean | SD | SE | 95% CI of Mean | Median |
|---|---|---|---|---|---|
| **Less often** | 13.35 | 11.732 | 2.258 | 8.71 to 17.99 | 11.00 |
| **Same as before** | 68.22 | 11.100 | 2.136 | 63.83 to 72.61 | 67.00 |
| **More often** | 18.56 | 11.219 | 2.159 | 14.12 to 22.99 | 19.00 |

The pattern of change in travel modes is noticeably different for peripheral residents who continue to drive in the zone during charging hours, against the charging zone residents. Among those who are still driving in the zone half say they now drive less often into or within this area. In contrast, a significant proportion of these drivers are using buses and the Underground more often (39% and 32% respectively). Among inner London residents as a whole (i.e. including those who continue to drive in the zone), a smaller proportion are claiming to use public transport more often. This implies that drivers are making more changes to their public transport usage than current public transport users.

The statistical data also suggests the probability is 0.95 that the actual mean shift in mode is statistically significant across all the modes. This is because the actual mean shift in mode lies between the upper and lower identified confidence limits. It also suggests the mean shift in mode lies within the 1.96% (for a 95% confidence interval) standard errors of the sample.

### 6.3.2.2 Distributional effects

Respondents were asked: "*Will you be able to negotiate your wage with your employer to compensate you for the loss of earnings due to the charge?*". Only 2.5% indicated they would. This result is relevant in establishing the incidence of road pricing. Respondents were also asked: "*If you consider the value of your time and consider the value to differ between income groups, number the following occupational classes according to the value of their time as you perceive it to be. Rank the class with the highest value of time as 1 and that of the lowest value with 29.*" The findings reported in Table 6.8 allows the drawing of conclusions on the role played by differing time values in deciding to travel to or in the congestion charging zone.

**Table 6.8 Perceived value of time**

| Occupational class | Rank | Occupational class | Rank |
|---|---|---|---|
| Executive | 1 | Logistics | 3 |
| Accountancy/Finance | 2 | Taxation | 3 |
| Architecture | 2 | Transportation | 3 |
| Banking | 2 | Media & Marketing | 4 |
| Education | 2 | Public sector | 4 |
| Engineering | 2 | Telecoms | 4 |
| IT | 2 | Treasury | 4 |
| Legal | 2 | Admin and office support | 5 |
| Planning | 2 | PA/Secretarial | 5 |
| Property & surveying | 2 | Purchasing & supply | 6 |
| Construction | 3 | Sales | 6 |
| E-commerce/New media | 3 | Tradesmen | 27 |
| Facilities management & maintenance | 3 | Graduate/student | 28 |
| Human resources | 3 | Other | 29 |
| Insurance & financial services | 3 | | |

The findings suggest respondents either interpreted the question incorrectly or they perceived the 29 different occupational classes to have in general a high or relatively equal value of time. The option "executive" was ranked first, then 9 occupational classes were assigned the same value of time being ranked second. Eight occupational classes were jointly ranked third, 4 classes ranked fourth and the remaining occupational classes between 5 and 29. Respondents perceived "graduates or students" time as carrying the least value in terms of travel cost.

Respondents were also questioned about the income and substitution effect road pricing may have. One way of finding whether the survey will reflect an income affect is by asking respondents whether they will be visiting the congestion zone less because of its additional costs impact and because it reduces net income. When respondents were asked: "*Would you enter a congestion charging zone less because you have to pay for it and because it would reduce your income?*", 22.6% indicated they would visit the congestion zone less, reflecting the existence of an income effect. In establishing the extent of the substitution effect respondents had to declare their use of different modes of transport as to establish the modal shift caused by road pricing.

In terms of equity, respondents were asked to define their understanding of the term "fair road use". Many respondents stated they perceive "fair road use" as a situation where all road users of differing income groups contribute an equal financial share towards the use of roads. Others stated that fair road usage can only be accomplished if congestion charging were more equitable, i.e. it should financially affect all road users in the same way. These findings were endorsed when respondents were asked:

"*Would you perceive congestion charging to be more equitable if you were to receive exemptions or discounts when entering the zone?*" with 73.8% stating they would.

## 6.3.3 Land use

The purpose of this section is to shed some light on the likely effects road pricing may have on the locational decisions of residents and businesses in relation to centralizing or decentralizing. It also reports how road pricing affects or the role it plays, in development clustering, development density and the planning process.

### 6.3.3.1 The locational effects of road pricing

Residential respondents were asked: "*In which London Borough do you live?*" and businesses were asked "*In which London Borough are you located?*". These results are given in Table 6.4. It reveals that the highest percentage of residential respondents live in Westminster City Council (17%) and the City of London (15%). When separating the respondents by geographical origin, 72% live within the congestion zone and 28% live in the peripheral area. A similar pattern emerges in relation to the business respondents. 64% are located in the congestion zone and 36% in the peripheral area. The highest percentage of businesses responding is located in Westminster City Council (25%).

When residential respondents (residing in the peripheral area) were asked if they would consider relocating to the congestion zone within the next year, 99% indicated they would not. 3% of the residential respondents residing in the congestion zone have indicated they will attempt to move to the peripheral area. Businesses located in the congestion zone have strongly indicated (95%) that they will stay in the congestion zone for the next year, leaving only 5% considering relocating from the congestion zone to the peripheral area.

When businesses (located in the peripheral area) were asked if they would relocate to the congestion zone within the next year, 98% indicated they will not consider this option, leaving 2% considering relocation to the congestion zone. None of the transport groups and environmental interest groups expressed any intention of relocating their offices from the congestion zone to the peripheral area or *vice versa.*

When the representatives from the Local Authorities were asked to indicate whether they 'agree' or 'disagree' with the following statement: "*Some land use classes are centralising to the congestion zone due to the charge*", they indicated that they agreed. Table 6.9 on page 109 illustrates their answers in more detail.

**Table 6.9 Land use classes decentralising from and centralising to the congestion zone**

| Land use | Centralise | | Decentralise | |
|---|---|---|---|---|
| | Yes | No | Yes | No |
| Retail | | X | X | |
| Higher order office function | X | | | X |
| Lower order office function | | X | X | |
| Leisure | X | | | X |
| Food and drink | X | | | X |
| Residential | X | | | X |
| Manufacturing | | X | | X |

From Table 6.9 it can be seen that the higher order office function, leisure, food and drink and the residential function are said to be most likely to centralize to the congestion zone or to stay in the congestion zone. It also shows the retail and lower order office function to be most likely to decentralise from the congestion zone. The manufacturing land use class appears unaffected by congestion charging in relation to locational decisions. In this regard, the Local Authorities stated that the manufacturing industry is fairly insensitive to changes in road user numbers as they are production orientated and not consumption orientated. Their only concern was about how these industries will cope with an increase in travel cost. They concluded however that congestion charging will have a relatively insignificant influence on this land uses' locational decisions.

From the Local Authority point of view those businesses which are heavily reliant on one-to-one meetings with clients, such as solicitors, dentists and general practitioners, are more likely to decentralize from the congestion zone or be discouraged from locating their firms there, for the fear the zone will discourage their clientele. The general picture emerging from Table 6.9 is that it is anticipated that congestion charging will lead to centralization of some of the key land use classes in London.

One of the main concerns raised by the Local Authorities was congestion charging's potential to undermine the economic vitality of businesses located within the congestion zone. Many representatives from the Local Authorities said the retail function was potentially the most sensitive to the congestion charge. It was also said that it would be difficult to judge whether these businesses would necessarily decentralize as a result of the charge or due to national economic conditions.

Although the representatives of the Local Authorities admitted to an increase in popularity of urban living in recent years and the trend causing dramatic increases in land use values in and around central London, they were hesitant to predict a definitive decentralisation or centralization of the residential function in the first few years of the congestion charging program. The Local Authorities does however encourage an increase of residential use in the congestion zone through their respective Unitary Development Plans.

### 6.3.3.2 Land use mix and development clustering

Following some debate about whether road pricing causes land use classes to mix and the clustering of similar land uses, the Local Authorities were of the opinion that in the short term they see no relationship.

However, given that the London congestion charging scheme has only been operational for about 14 months when the survey was held, it was indicated that land use mix may occur over the long term and clustering over the medium term. It was envisaged that similar land uses would cluster so as to benefit from mutual inclusive characteristics, services and economies of scale. Local Authority representatives also forecast that congestion charging would only account for about 20% of potential land use mix and clustering within the congestion charging zone.

When the Local Authority representatives were asked: "*Will/Have you considered allowing congestion charging to cause land use classes to mix?*" the response was they have not. The Local Authorities made it clear that development control was guided by the council's Unitary Development Plan (UDP), which is reviewed every 5 – 10 years. They have no special mechanism in the UDP at present to encourage either land use class mix or clustering of land uses but will attempt to control isolated cases observed.

#### 6.3.3.3 Density of development

When representatives from the local authorities were asked to indicate their level of agreement to the following statement "*Congestion charging causes an increase in development density in the congestion zone*" on a scale of 'strongly agree' to 'strongly disagree', they all indicated that they disagree with the statement in general terms. When asked why they feel this way, they answered that they have not experienced an increase in development density reflected in terms of the number of planning applications for higher density residential developments or high density mixed use centres which may have been caused by the congestion charge. The congestion zone was however identified as a zone suitable for higher residential densities in the local authority's UDP.

#### 6.3.3.4 Planning process

Local Authority representatives indicated the planning process will be influenced by congestion charging over the next few years. This is reflected for example by the congestion charging zone being identified as a zone suitable for higher residential densities in the local authority's UDP. It was stressed however that the planning process will not be dictated by congestion charging or its effects but rather the planning process will be used as an instrument to restrain traffic congestion, pointing to its complementary role in reducing traffic congestion. Table 6.10, on page 111 illustrates how Local Authority representatives may apply the planning process when considering several alternative policy options for reducing traffic congestion.

**Table 6.10 Policy option ranking**

| Policy option | Rank |
|---|---|
| The development of an integrated land use and transport planning strategy | 1 |
| The implementation of urban congestion charging | 2 |
| The creation of a comprehensive network of safe cycle and walking routes which do not involve the use of heavy trafficked roads | 3 |
| The encouragement of home working | 4 |
| Cheaper public transport fares | 5 |
| An improvement in the frequency and reliability of public transport | 6 |
| The encouragement of car sharing | 7 |
| A doubling of parking charges in urban areas | 8 |
| Banning/restricting vehicles in central areas | 9 |
| Introduction or expansion of park and ride sites | 10 |
| An increase in the price of petrol to £5 per gallon | 11 |
| Selective expansion of road construction in urban areas | 12 |

From Table 6.10 it is evident that "the development of an integrated land use and transport planning strategy" is favoured as the most preferred option to reduce traffic congestion and "selective expansion of road construction in urban areas" as the least preferred option. Note that the implementation of urban congestion charging ranks as the 2nd most preferred policy option and "the creation of a comprehensive network of safe cycle and walking routes which do not involve the use of heavy trafficked roads" was ranked as the 3rd most preferred policy option, reflecting its priority to local authorities when considering alternative options for addressing traffic congestion.

## 6.3.4 Environment

### 6.3.4.1 Structural effect

One way of dealing with traffic congestion is to create additional road capacity through the construction of new roads or adding lanes to existing ones. In this process the natural habitat is destroyed. Ferrari (1995:357) refers to it as the structural effect of traffic related congestion. When road pricing is applied to urban roads experiencing traffic congestion, it reduces the potential structural effect of capacity expansion. When the residential and business respondents where asked: "*Will you support congestion charging if it reduces environmental decay?*", 83.2% indicated they would.

When this question was asked at the environmental focus group meeting, the group members confirmed these findings and collectively added that when congestion charging serves as a mechanism to dampen capacity expansion it will have definitive benefits to the environment we live in. The environmental group went further adding that where the environmental capacity is exceeded, fluctuations and instability in traffic flow is caused. This stops the flow in urban roads and causes unacceptable environmental damage over a prolonged period of time, necessitating some form of congestion charging or other traffic control methods to hold traffic flow levels below its capacity limits.

Concern was also expressed about traffic displacement to the peripheral area increasing traffic related environmental damage elsewhere. In this instance, the local authorities argued the case for applying an integrated land use and transport strategy with the increased use and reliability of public transport coupled with stringent parking and traffic enforcement to overcome the rat-run caused by the charge.

#### 6.3.4.2 Atmospheric effect

When the focus groups where asked to indicate their level of acceptability for the following statements "*Road user charging will lead to a cleaner environment*" and "*Road user charging reduces vehicle emissions*" they all agreed with the statements to varying degrees. When these question were asked of the public and businesses, respondents indicated an overwhelming (95%) belief that road pricing has the capability of reducing the level of traffic related emissions. 79% of the residential respondents and 71% of the business respondents accepting congestion charging are willing to enter the zone in return for a healthier environment.

The Environment Agency indicated their surveys of Londoners 'on-street' in and around the charging zone suggest that the beneficial effects of congestion charging and other initiatives on environmental quality are being recognised. However, they added, relationships between these 'perceptual' indicators and the more 'scientific' evidence is not clear-cut. Any instrument designed to reduce traffic congestion, particularly at peak times, would yield environmental benefits. Although congestion charging may encourage more and longer journeys elsewhere, environmental benefits would accrue at least in terms of health and global warming.

The environmental focus groups added that by reducing the overall volumes of traffic within the charging zone and increasing the efficiency with which it circulates, congestion charging has been directly responsible for reductions of approximately 12% in emissions of $NO_x$ and $PM_{10}$ from road traffic within the zone (for a 24-hour annual average day). Traffic changes on the Inner Ring Road are estimated to have resulted in very small changes to emissions of $NO_x$ and $PM_{10}$ from road traffic - of less than plus/minus 2% respectively.

In relation to the measurements of actual air quality across London, it strongly reflects the statistically unusual weather patterns that prevailed for much of 2003, overwhelming any smaller-scale effects that might have been caused by congestion charging. The environmental group stated that it is therefore not possible to identify congestion charging effects in the available dataset they had for 2003, either for the charging zone or the Inner Ring Road.

In terms of traffic changes resulting from the charge, the focus group estimated that it has led to savings of 19% in traffic-related emissions of $CO_2$ and 20% in fuel consumed by road transport within the charging zone (for a 24-hour annual average day). They stated that between 2002 (pre-charging) and 2003 (post-charging), the total primary emissions of nitrogen oxides on major roads in the charging zone from road traffic fell from 6250 to 5260 tonnes, a total reduction of 16% (for a 24-hour annual average day). The equivalent figures for $PM_{10}$ were 370 and 310, also a reduction of 16%. On the Inner Ring Road between 2002 and 2003, the total primary emissions of nitrogen oxides from road traffic fell by 4% (from 3190 to 3050 tonnes). For $PM_{10}$ the equivalent figure was a 7% decrease (from 180 to 170 tonnes).

All of the stakeholders were also asked to rank alternative policy instruments for reducing the atmospheric effect of traffic related emissions. The alternative instruments were given as regulation, cleaner vehicle technology, incentive based instruments and congestion charging. The results are shown in Table 6.11 below. Cleaner vehicle technology was consistently ranked as the first choice for reducing related emissions, congestion charging was ranked second, incentive based instruments third and regulation fourth.

**Table 6.11 Alternative policy instruments**

| Alternative | Rank | | | | |
|---|---|---|---|---|---|
| | Residents | Local Authority | Environmental group | Businesses | Public transport |
| Regulation | 4 | 3 | 4 | 4 | 3 |
| Incentive based instruments | 3 | 3 | 3 | 3 | 2 |
| Cleaner vehicle technology | 1 | 1 | 1 | 1 | 1 |
| Congestion charging | 2 | 4 | 2 | 2 | 4 |
| Mean | 2.5 | 2.7 | 2.5 | 2.5 | 2.5 |
| SD | 1.3 | 1.2 | 1.3 | 1.3 | 1.3 |
| SE | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| 95% CI of mean | 0.45 | 0.75 | 0.45 | 0.45 | 0.45 |
| Median | 2.5 | 3.0 | 2.5 | 2.5 | 2.5 |

The environmental focus group estimated the change in traffic emissions brought about by charging are responsible for about 75% of the reductions in the charging zone for both $NO_x$ and $PM_{10}$. The remaining 25% arises from changes to vehicle technology (i.e. cleaner vehicle technology) between 2002 and 2003; the extent to which these are 'relevant' to the charging zone of course being affected by the differential effects of charging on the various vehicle types. On the Inner Ring Road the effect of vehicle technology changes is more pervasive. This ranking reflects the opinion that traffic related atmospheric emissions should be curbed as source instead of resorting to alternative methods for reducing emission levels.

### 6.3.4.3 Social welfare effects

A relatively large percentage of residential and business respondents (79.9% and 71% respectively) indicated their willingness to pay for a healthier environment, signalling acceptance as long as visible signs or indicators are observed. These may include additional benefits linked to fewer accidents, the reduction of emissions, less pollution, noise and other forms of degradation. Traffic accidents, however, are related to both speed and traffic volume. If congestion charging increased speed accidents would increase but since road pricing reduces traffic volumes, accidents should decrease.

The Environment Agency stated the recent trend in overall year-on-year decreases in road traffic accidents seen across London is continuing. However there is no evidence of disproportionate changes to the numbers of accidents involving two-wheeled vehicles and there is some evidence of an accelerated decline in accidents inside the charging zone. Hence no clear-cut evidence exists suggesting road pricing has reduced accidents in the congestion charging zone.

It appears to be important to respondents to have in place mechanisms for increasing social welfare – congestion charging being one of them. When respondents and focus groups were asked whether they were aware of alternative instruments to reduce environmentally induced impacts form vehicles, an average of 27% of residential respondents and businesses indicated they were. When residential respondents were asked whether they perceive the use of green taxes and regulation or cleaner vehicle technology more equitable or favourable than congestion charging, they ranked cleaner vehicle technology as most equitable and green taxes as the next most equitable. Accordingly the public perceives cleaner vehicle technology as a more equitable mechanism to reduce the effects of traffic on the environment and to increase the social welfare of people.

The focus groups gave an informed account of alternative methods or policy instruments to congestion charging. The environmental group and Local Authority focus groups explained that at the most basic level environmental degradation can be seen to occur because of the basic problems in the economic incentive structure that results in transport users and suppliers not taking full account of all the costs in their decision making. This in turn leads to the excessive use of transport, the use of inappropriate transport technology, the choice of less suitable travel patterns and other decisions which, from the environmental perspective, are sub-optimal. These physical causes are then transmitted to the environment in the form of pollution, noise, and other forms of degradation. The final effects of this are the impacts on human welfare, of illness, premature death, discomfort and damage to the surrounding physical environment.

This also strengthens the case for introducing a measure that is able to reduce noise levels in urban areas. English Nature and Friends of the Earth indicated that there is no evidence from the sample noise measurements they carried out in and around the zone to suggest any significant changes in the ambient noise climate. Their projections of likely traffic changes arising from congestion charging suggested that changes, either positive or negative, in ambient noise in and around the charging zone were unlikely to be significant.

Their one-day measurements at a small sample of sites would not be expected to provide a robust statistical indication of noise levels across the charging zone. Changes at any one site may, of course, be affected by changes in sources of noise other than traffic and changes between a survey in any one year and in the next may be affected by factors such as atmospheric conditions for which it is not possible to fully adjust. Hence they concluded the changes observed in relation to noise reduction are inconclusive in the London congestion charging zone.

In relation to policies and instruments to reduce excessive environmental degradation – these should ideally be introduced at the economic and physical causes stage. When applying different policies and in meeting different objectives, policies usually tend to embrace a range of measures designed to intercept the effects at various points. All environmental policies, therefore, involve the deployment of a portfolio of fiscal and command-and-control instruments.

National variations in approach manifest themselves in terms of the mix of fiscal and command tools used in their individual characteristics and in the rigour with which they are pursued and enforced. The variation of policies applied are also sometimes left to different responsibilities, in some cases, to international bodies but within countries there are also wide variations in the powers of different levels of government (e.g., national/provisional or local/urban) and the extent to which specific, dedicated agencies are given responsibility of particular aspects of policy.

When the environmental group were asked about the idea of introducing a green tax instead of congestion charging, they said that if green taxes (environmental taxes) were to be introduced they must be clearly distinguished from other taxes and charges. The green taxes must be set at levels determined by acceptable methods of computing the cost of damage done and applied to all sources of the same damage. They stated this objective is a toll-order and one that still needs some extensive development if it were to be introduced instead of congestion charging.

## 6.3.5 Revenue recycling

### 6.3.5.1 Perception

The research has identified the prerequisites for revenue recycling, the methods of redistributing the revenue and some general benefits. Two alternatives were put to the public in establishing an idea of their perception about whether recycling revenue in public transport, maintenance and improvements are perceived more beneficial and acceptable than using those revenues for reducing labour tax.

When residential respondents were asked: "*Would you support congestion charging if the revenue raised by the congestion charging scheme was earmarked to improve road conditions and public transport reliability?*" 81% indicated they would. When they were asked "*Would you support congestion charging if the revenue raised was used to reduce your income tax contributions?*" 78% stated they would. When they were asked: "*Would you support congestion charging if you received tax rebates?*" 71% indicated they would. These results reflects the notion that both alternatives are accepted to more or less the same degree. When respondents were asked "*Do you think reducing labour taxes are more beneficial than improving public transport?*" 19% indicated they agreed with the statement.

### 6.3.5.2 Hypothetical use of revenue

When it comes to using the revenue raised, the stakeholders were also asked to indicate how they would spend 100 units of money, representing the total amount of money raised by congestion charging on 12 alternative policy options. Table 6.12 illustrates how many units on average they allocated to each option.

**Table 6.12 Units spent on alternative policy options to reduce traffic congestion (Total units = 100)**

| Policy option | Unit allocation per stakeholder | | | | | |
|---|---|---|---|---|---|---|
| | Residents | Business | Local Authorities | Environment | Public Transport | Ave. |
| Selective expansion of road construction in urban areas | 3 | 6 | 0 | 10 | 2 | 4.2 |
| The encouragement of home working | 6 | 10 | 5 | 10 | 4 | 7 |
| The encouragement of car sharing | 5 | 5 | 5 | 5 | 3 | 4.6 |
| The creation of a comprehensive network of safe cycle and walking routes which do not involve the use of heavy trafficked roads | 9 | 10 | 10 | 5 | 5 | 7.8 |
| An increase in the price of petrol to £5 per gallon | 1 | 0 | 0 | 5 | 0 | 1.2 |
| Introduction or expansion of park and ride sites | 5 | 17 | 0 | 10 | 5 | 7.4 |
| Cheaper public transport fares | 30 | 10 | 20 | 15 | 25 | 20 |
| A doubling of parking charges in urban areas | 1 | 0 | 0 | 5 | 0 | 1.2 |
| An improvement in the frequency and reliability of public transport | 13 | 20 | 40 | 10 | 25 | 21.6 |
| The development of an integrated land use and transport planning strategy | 20 | 20 | 20 | 5 | 16 | 16.2 |
| The implementation of urban congestion charging | 3 | 3 | 0 | 10 | 10 | 5.2 |
| Banning/restricting vehicles in central areas | 4 | 4 | 0 | 10 | 5 | 4.6 |

The results reflect the competing interests over how the revenue should be spent as perceived by the various stakeholders. It was found that every stakeholder allocated the largest proportion of the revenue to the improvement of public transport (average of 21.6 units). Providing cheaper public transport was the second ranking area of expenditure with an average of 20 units allocated to this option. The residents however allocated a slightly higher average amount of units (30) to this policy option, reflecting their preference.

As with the Local Authorities, the preference was for the revenue to be spent on improvement of local public transport (average of 40 units). Public transport providers, however, preferred to allocate 25 units to the improvement of the service they provide and also on cheaper public transport fares (25 units). The third ranking area of expenditure allocated the revenue (average of 16.2 units) to developing an integrated land use and transport strategy. The stakeholders indicated relatively comparative figures for expenditure on this policy with the exception of the environmental group.

Spending money on increasing the price of a gallon of petrol and doubling parking charges within the congestion zone are the most unfavoured policy options with only 1.2 units being allocated to these options respectively. Other options such as spending on non-transport policies were given a much lower priority with little overall support. It is interesting to note that an allocation of revenue to non-transport areas was only in the region of 12.8 units of the overall spending available.

Among the Local Authorities, Environmental group and public transport providers a preference was expressed for local as opposed to national expenditure of the revenue raised. The suggestion was that 73 units of spending should be utilised in the area in which congestion charging was introduced.

The information presented in Table 6.12 reveals consistently strong support for using the revenue raised from congestion charging to improve public transport, a notion even supported by the public transport providers. When the data in Table 6.12 were analysed statistically the following descriptive statistics were generated, shown in Table 6.13 below. The table shows without much exception the significance of allocating revenue raised at an individual stakeholder level and at the aggregate level as extracted from Table 6.12. Where the stakeholders' allocation preferences are compared it appears significant at the 95% confidence level.

**Table 6.13 Comparative descriptive statistics between stakeholders (n12 = policy options)**

**A**

| Stakeholders | n | Mean | SD | SE | 95% CI for Mean |
|---|---|---|---|---|---|
| **Residents** | 12 | 8.333 | 8.7317 | 2.5206 | 2.785 to 13.881 |
| **Business** | 12 | 8.750 | 7.1111 | 2.0528 | 4.232 to 13.268 |
| **L. Auth.** | 12 | 8.333 | 12.4924 | 3.6063 | 0.396 to 16.270 |
| **Environment** | 12 | 8.333 | 3.2567 | 0.9401 | 6.264 to 10.402 |
| **P. Transport** | 12 | 8.333 | 8.9273 | 2.5771 | 2.661 to 14.005 |
| **Average** | 12 | 8.417 | 6.9635 | 2.0102 | 3.992 to 12.841 |

**B**

| Source of variation | SSq | DF | MSq | F | p |
|---|---|---|---|---|---|
| **Stakeholders** | 1.667 | 5 | 0.333 | 0.00 | 1.0000 |
| **Within cells** | 4638.313 | 66 | 70.277 | | |
| **Total** | 4639.980 | 71 | | | |

**C**

| Contrast | Difference | Tukey's 95% CI |
|---|---|---|
| **Residents v Business** | -0.417 | -10.462 to 9.628 |
| **Residents v L. Auth.** | 0.000 | -10.045 to 10.045 |
| **Residents v Environment** | 0.000 | -10.045 to 10.045 |
| **Residents v P. Transport** | 0.000 | -10.045 to 10.045 |
| **Residents v Average** | -0.083 | -10.128 to 9.961 |
| **Business v L. Auth.** | 0.417 | -9.628 to 10.461 |
| **Business v Environment** | 0.417 | -9.628 to 10.461 |
| **Business v P. Transport** | 0.417 | -9.628 to 10.461 |
| **Business v Average** | 0.333 | -9.712 to 10.378 |
| **L. Auth. v Environment** | 0.000 | -10.045 to 10.045 |
| **L. Auth. v P. Transport** | 0.000 | -10.045 to 10.045 |
| **L. Auth. v Average** | -0.083 | -10.128 to 9.961 |
| **Environment v P. Transport** | 0.000 | -10.045 to 10.045 |
| **Environment v Average** | -0.083 | -10.128 to 9.961 |
| **P. Transport v Average** | -0.083 | -10.128 to 9.961 |

## 6.3.5.3 Reported public transport changes following revenue recycling

This section summarises key changes to the public transport network in central London since the introduction of congestion charging and the recycling of revenue based upon focus group discussions. Congestion charging was expected to result in a net increase in the use of public transport to and from the charging zone as ex-car users shifted to public transport. There was also expected to be some transfer from short distance Underground and rail trips to bus services as they became more attractive as a result of increased services and reduced congestion. These anticipated effects necessitate revenue recycling as part of the government's promise to the public in delivering a world-class public transport service. The following sub-sections briefly report the extent to which this promise has been kept, how the money is being spent and the change of use for each stakeholders service as a result of some form of revenue recycling.

#### 6.3.5.3.1 Bus service

London Buses reported a total of nearly 3,000 buses entering the zone in the morning peak period during Autumn 2003, currently being 560 (23%) more than 2002 prior to the introduction of the charge. This was possibly due to better focused investment in maintaining and buying new rolling stock. There has also been some increase in the average number of passengers observed on each bus, although these have generally been accommodated acceptably. The annual count of bus passengers entering the cordon shows an increase from 88,000 in Autumn 2002 to 104,000 in Autumn 2003 during the morning peak period, an increase of 18%. Within the charging zone London Buses reported improvements in both the main indicators of bus service reliability, being (1) additional waiting time due to service irregularity - falling by 30% and (2) disruption due to traffic delays - falling by 60%. Overall bus speeds within the charging zone improved by 6% consistent with the improved traffic speeds. This was another reason for increased service reliability and usage.

#### 6.3.5.3.2 Underground service

The London Underground reported a reduction in the number of passengers exiting their stations in and around the charging zone although investment was put into the system. Since charging was introduced, there has been a reduction in the number of people exiting stations by an average 8%, from 513,000 to 473,000 in the morning peak period.

A number of reasons were given. Firstly, they report the decline was mainly due to the Central line closure in 2003 which took some time to recover, with an estimated 2% revenue loss for some months after the Central line came back into service. This is in addition to the estimated 2% loss due to better and faster bus services. Secondly, they reported that there is some indication that the hot summer of 2003 resulted in a loss of patronage and also tourist numbers on the Underground were down by about 5% on the previous year. All these factors would tend to bear most on passengers travelling to or in the congestion charging zone.

In explaining their current situation London Underground conceded that none of these factors are related to congestion charging with the partial exception of reduced patronage due to improved bus services. Money being put into the system via revenue recycling has been eroded by unforeseen circumstances. Although timetable changes have been made to improve operations, no increases to the number of peak hour trains in operation were made. For the majority of the year the London Underground network has not been performing as reliably as it had the previous year which may have contributed to the reduction in passengers and encouraged shorter distance trips to transfer to the bus network.

### 6.3.5.3.3 National Rail service

National Rail reported no significant change to the number of passengers entering central London on their network following the imposition of the charge and increased investment in the network. National Rail commissioned comprehensive passenger count surveys at all 22 central London stations in Spring 2002 and 2003. They were intended to establish whether congestion charging was associated with any noticeable increases in rail travel. In the 3 hour morning peak, 07:00 to 10:00, the number of passengers arriving by National Rail at central London stations in 2003 decreased by 1 percent compared with 2002, from 451,000 to 447,000. During charging hours there was an increase of 1%, from 564,000 to 573,000 passengers, departing from stations in the charging zone.

These changes were not deemed statistically significant. Overall they stated there is no evidence of systematic net changes in National Rail patronage coinciding with the introduction of congestion charging even though they recycle revenue into the reliability and efficiency of their network.

### 6.3.5.3.4 Docklands Light Railway (DLR) service

The Docklands Light Railway (DLR) reported an average decline in passenger numbers from 9,900 to 9,700 (2%) exiting DLR stations in the charging zone compared to the same periods the previous year during the morning peak period, amidst revenue being spent in the network. During the charging day there was an increase from 23,400 to 23,700 (1%) in passengers, a patronage change not being considered significant. DLR also reported at Tower Gateway in the morning peak, there was an 11% reduction, but during charging hours a 3 percent increase. They explained that this could be due to passengers transferring to buses in the morning peak or part of a general shift in travel patterns. This is reflected in the changes at Bank station where there was no change in the morning peak but there was an 8% reduction across the day.

The DLR declared that, revenue is being invested in improving service reliability and punctuality throughout their network. They are also investing a great proportion of money in extending the DLR service by building new stations elsewhere, connecting the London City airport to the existing DLR line. They concluded that congestion charging was not expected to affect their patronage significantly, or as much as the London Underground or Buses as they only have two stations within the congestion zone. Money is however being invested in the entire network and is paying off on other parts of their network.

#### 6.3.5.3.5 Taxi and river boat service

Representatives of both the Public Carriage office and the London Boat services said they have received no money from central government to invest in their services. They added that their services had seen very insignificant changes to patronage and do not foresee the effect of congestion having an adverse impact on their service.

### 6.3.6 Work schedule flexibility

Two issues have been identified which require exploration. They are whether (i) the public perceives greater works schedule flexibility as an instrument enhancing the sustainability of road pricing and (ii) the extent to which road pricing influences the degree of flexibility in the work start time. These issues were put to the public and businesses in search of answers. For these issues to be addressed it is necessary to report on the following points as to draw conclusions in the next chapter. They are:

1. The level of employee satisfaction in relation to work start time with regard to the relationship between work schedule flexibility, income and the level of the respondents' education
2. The amount of flexibility allowed to employees in the work start time with regard to the relationship between work schedule flexibility, income and the level of the respondents' education
3. The use of alternative modes of public transport
4. The public perception of applying work schedule flexibility in conjunction with road pricing to reduce traffic congestion

Table 6.14 illustrates the tolerance of employees being late as perceived by themselves and their employers for each time interval. The Table also illustrates that 43% of employees perceive their being no more than 10 minutes late for work, as tolerable, but more importantly 39% of employers find it tolerable or acceptable and this results in an impression of flexibility in the work start time. When respondents were asked: "*Are you satisfied with your current work start time?*" 58% indicated they were.

**Table 6.14 Results of work start time interval tolerance (n= 638 and n = 247)**

| Interval (min) | Employees | | Employers | |
|---|---|---|---|---|
| | Percentage | Cumulative % | Percentage | Cumulative % |
| 1 – 5 | 12 | 12 | 16 | 16 |
| 6 – 10 | 43 | 55 | 39 | 55 |
| 11 – 15 | 21 | 76 | 25 | 80 |
| 16 – 20 | 16 | 92 | 12 | 92 |
| > 20 | 8 | 100 | 8 | 100 |

Of the 638 residential respondents 83% indicated their employers allowed them a reasonable degree of **flexibility in their work start time** whilst 53% stated they have a formal flexi-time policy at work. Of the 247 business 64% indicated they do not mind their employees arriving between 1 – 15 **minutes later** than the official work start time.

Among the variables available in the questionnaire, all potentially explanatory variables, which were exogenous, were included in the analysis. Statistically significant factors are (i) net household income and (ii) education level and (iii) age. The main findings in relation to employer and employee work start time tolerance and satisfaction are shown in Table 6.15 below.

**Table 6.15 Estimation of results for work schedule flexibility**

| Variables | Employers tolerance | Employees tolerance | Satisfaction |
|---|---|---|---|
| **Age** | | | |
| 18 or under | 1.55 | 0.21 | 0.59 |
| 19 - 35 | 2.27 | 0.22 | -0.35 |
| 36 - 50 | 1.40* | 0.28 | 0.59 |
| over 51 | 2.70* | 0.11 | -1.05 |
| **Gender** | | | |
| Male | 0.99 | 0.05** | 0.43 |
| Female | 0.91 | 0.03 | 0.31 |
| **Net Income** | | | |
| < £10 000 per annum | -2.11 | 0.37 | 0.16 |
| £10 000 - £20 000 | -1.71* | 0.16* | 0.31 |
| £21 000 - £30 000 | -1.09 | 0.21 | 0.22 |
| £31 000 - £40 000 | -0.40 | 0.28 | 0.31 |
| > £41 000 | -0.13 | 0.31 | 0.42 |
| **Educational Level** | | | |
| No formal education | -0.97 | -0.13 | 1.27 |
| School level | 0.43 | 0.05 | 0.75** |
| National diploma | 0.75 | 0.09 | 0.25 |
| First Degree | 1.50* | 0.16 | -0.39 |
| Post Graduate | 1.64*** | 0.55 | -1.08 |
| **Workforce** | | | |
| < 20 | -0.16 | -0.51 | 1.23 |
| 20 – 40 | -1.31 | -0.24 | 1.13 |
| 41 – 60 | -1.58 | 0.29 | 0.60 |
| 61 – 80 | 0.87 | 0.50** | 0.91* |
| > 81 | 1.06 | 0.71 | 0.95 |
| **Employees work start time** | | | |
| < 07:15 | -2.54 | 0.37 | 0.07 |
| 07:15 – 07:45 | 1.19 | -0.33 | 0.14 |
| 07:45 – 08:15 | 0.80** | -0.24 | 0.62 |
| 08:15 – 08:45 | 0.01 | -0.22 | 0.22 |
| > 08:45 | 0.09 | -0.17* | 0.33 |

Note: * significant at 90% level
** significant at 95% level
*** significant at 99% level

With respect to income, it was found that lower income groups are more likely to have a fixed (determined by the employer) **work start time.** This exogenous variable is probably a surrogate for the type of job. Apparently, high-income groups have jobs that provide a greater freedom of choice related to the work start time. The coefficient of the variable educational level indicates that the type of education strongly influences the **flexibility of the work start time.** A relatively low income seems to decrease the indifference flexibility – lower income groups are more sensitive to the work start time. Males are relatively less flexible than females. Employees with a relatively high level of education have on average a more flexible work start time than those with a relatively low level of education. With respect to age, older people are more likely to have a small indifference interval – they are less affected by the work start time, although flexibility decreases as age increases. Finally, if the employer allows for more flexibility, the estimates show the employee is also more likely to have a larger indifference interval. Hence the exogenous variables included (as a group) significantly explain the variance in the work start time.

These empirical results will no doubt have some interesting implications for the debate on the regressiveness and or progressiveness of road pricing: an issue that has been subject of controversy from the time road pricing was proposed as a congestion-relieving policy. If, for example, high-income groups have a relatively larger commuting distance then a road pricing scheme is relatively more disadvantageous for these workers, thereby rendering the scheme regressive. This is because the regressiveness and progressiveness of a road pricing scheme is, amongst other factors, dependent upon the commuting distance.

The survey data, however, did not provide any evidence of the existence of such relationships. A regression of the commuting distance as the dependent variable and all potentially explanatory variables as exogenous variables did not give significant results with respect to income or level of education. The only significant parameter reflects gender and indicates that males are more likely to have a larger commuting distance than females. Finally, when respondents where asked: "*Do you think your journey time could be reduced if congestion charging is applied in conjunction with affording greater work schedule flexibility?*" 39% indicated that it might.

## 6.3.7 Driver information provision

As little is known about the possible integration of road pricing and driver information provision as a traffic demand management instrument, the aim here is to report on whether the public perceives its joint application as being advantageous. This is performed against the background of the objectives of driver information provision as identified by Topp (1995:34). The results reported in this section are based upon the response of 166 (26%) respondents indicating that they drive to and from work, forming part of 408 (64%) respondents stating that they own a vehicle.

When drivers were asked: "*Do you think that by providing driver information, it will reduce traffic congestion?*" 68% indicated they thought this to be so. In establishing whether they were achieving shorter journey times and reducing schedule delay, they were asked: "*Have you saved any time by visiting the congestion charging zone?*" 63% indicated they have. When asked to consider the joint application of congestion charging as a tool to reduce schedule delay, 37% indicated that it had some chance of success.

The question: "*Will you change your preferred route when driver information warns you about possible delays ahead on your normal journey?*" elicited the following response. 89.4% said they would. Table 6.16, page 123, illustrates this point and some other comparative statistics about drivers' perceptions of information provision. The first couple of columns marked "changed preferred route" refers to drivers diverting after they have been warned about traffic congestion on their normal journey. From those replying in the affirmative, 61% were male and 28.4% female.

Drivers were also asked whether they would respond to pre-trip driver information. 98.9% indicated they would. Again the majority of the affirmative replies were from male drivers totalling 64.5%. A similar pattern emerges when drivers were asked whether they would respond to en-route driver information, 66.3% male and 24.3% female respondents indicated they would.

**Table 6.16 Comparative statistics for driver information provision (n=166)**

| Variable | Changed Preferred route (%) | | Pre-trip Info (%) | | En-route info (%) | |
|---|---|---|---|---|---|---|
| | Yes | No | Yes | No | Yes | No |
| **Gender** | | | | | | |
| Male | 61.0 | 6.3 | 64.8 | 0.7 | 66.3 | 4.9 |
| Female | 28.4 | 4.3 | 34.1 | 0.4 | 24.2 | 4.6 |
| Total | 89.4 | 10.6 | 98.9 | 1.1 | 90.5 | 9.5 |
| **Net Income** | | | | | | |
| < £10 000 per annum | 86.0 | 14.0 | 98.2 | 1.8 | 91.2 | 8.8 |
| £10 000 - £20 000 | 87.3 | 12.7 | 99.1 | 0.9 | 89.6 | 10.4 |
| £21 000 - £30 000 | 91.2 | 8.8 | 99.0 | 1.0 | 90.3 | 9.7 |
| £31 000 - £40 000 | 93.4 | 6.6 | 99.5 | 0.5 | 89.1 | 10.9 |
| > £41 000 | 89.1 | 10.9 | 98.7 | 1.3 | 92.3 | 7.7 |
| **Educational Level** | | | | | | |
| No formal education | 47.0 | 53.0 | 49.5 | 50.5 | 51.2 | 48.8 |
| School level | 65.5 | 34.5 | 66.3 | 33.7 | 67.1 | 32.9 |
| National diploma | 64.8 | 35.2 | 68.5 | 31.5 | 67.3 | 32.7 |
| First Degree | 96.7 | 3.3 | 85.0 | 15.0 | 92.5 | 7.5 |
| Post Graduate | 91.5 | 8.5 | 83.0 | 17.0 | 91.7 | 8.3 |

| Statistics relevant to variables | Mean | SD | SE | 95% CI of Mean | Median |
|---|---|---|---|---|---|
| **Gender** | | | | | |
| Male | 34.00 | 32.997 | 13.471 | -0.63 to 68.63 | 33.65 |
| Female | 16.00 | 14.552 | 5.941 | 0.73 to 31.27 | 14.40 |
| Total | 50.00 | 47.260 | 19.294 | 0.40 to 99.60 | 50.00 |
| **Net Income** | | | | | |
| < £10 000 per annum | 50.00 | 46.116 | 18.827 | 1.60 to 98.40 | 50.00 |
| £10 000 - £20 000 | 50.00 | 46.348 | 18.921 | 1.36 to 98.64 | 50.00 |
| £21 000 - £30 000 | 50.00 | 47.844 | 19.532 | -0.21 to 100.21 | 50.00 |
| £31 000 - £40 000 | 50.00 | 48.426 | 19.770 | -0.82 to 100.82 | 50.00 |
| > £41 000 | 50.00 | 47.707 | 19.476 | -0.06 to 100.06 | 50.00 |
| **Educational Level** | | | | | |
| No formal education | 50.00 | 2.068 | 0.844 | 47.83 to 52.17 | 50.00 |
| School level | 50.00 | 17.870 | 7.295 | 31.25 to 68.75 | 50.00 |
| National diploma | 50.00 | 18.553 | 7.574 | 30.53 to 69.47 | 50.00 |
| First Degree | 50.00 | 45.660 | 18.641 | 2.08 to 97.92 | 50.00 |
| Post Graduate | 50.00 | 42.662 | 17.417 | 5.23 to 94.77 | 50.00 |

The survey also revealed 43.2% of drivers receive driver information by radio traffic reports, 34.7% by variable message signs, 17.6% by their own observations and the remaining 4.5% said they receive traffic information via other sources. In establishing the percentage of drivers actually responding to the information, drivers were asked: "*Do you take an alternative route after receiving information about delays to your usual journey?*". 94.7% indicated they do or would consider doing so.

The statistical data also suggests a 0.95 probability that the actual mean change in response is statistically significant. This is because the actual mean change in response lies between the upper and lower identified confidence limits. It also suggests the mean change lies within the 1.96% (for a 95% confidence interval) standard errors of the sample. Table 6.16 also illustrates, in terms of net income, higher income drivers are more inclined to change their preferred route, apart from the highest income group. A similar pattern is observed in relation to pre-trip information provision as well as en-route driver information provision. In relation to educational levels, the higher the level of academic qualification the more inclined drivers will be to divert. Only 47% of drivers with no formal education will divert following a traffic congestion warning. 96.7% with post graduate degrees will divert.

In achieving a further objective of driver information provision, namely an efficient use of the road network, drivers were asked whether they think the congestion charging zone is being used more efficiently. Only 23.7% indicated they agree with this notion. By definition, efficiency in road use can only be attained when every driver is equally well off in terms of road use. Hence no driver should be experiencing more or less delays then his fellow drivers. These results also indicate that prescriptive information such as instructions to use a certain route displayed on variable message signs has been found to encourage diversion. When drivers divert it implies driver information provision does have an effect on travel behaviour.

### 6.3.8 Public and political acceptance

The survey asked residential and business respondents: "*If an urban congestion charging scheme was introduced, how concerned would you be about each of the following issues?*" The results for all respondents are shown in Table 6.17.

**Table 6.17 Issues of concern with respect to urban road pricing (residential [R] and business [R] respondents)**

| Issue | Very/fairly unconcerned (%) | | Very/fairly concerned (%) | |
|---|---|---|---|---|
| | R | B | R | B |
| 1. The fact that the introduction of road pricing would mean that in congested periods the road user would have to pay for the use of the road | 76.5 | 78.7 | 23.5 | 21.3 |
| 2. Invasion of road user privacy | 54.6 | 61.3 | 45.4 | 38.7 |
| 3. The impact on delivery vehicles and commercial traffic | 14.3 | 12.2 | 85.7 | 87.8 |
| 4. Exemption for certain groups | 15.4 | 26.8 | 84.6 | 73.2 |
| 5. How urban road pricing would be integrated with other congestion management measures | 15.2 | 28.8 | 84.8 | 71.2 |
| 6. The cost of implementing an urban congestion charging scheme | 11.7 | 8.7 | 88.3 | 81.3 |
| 7. Equity/fairness of an urban road pricing scheme | 13.6 | 6.3 | 86.4 | 83.7 |
| 8. The reliability and accuracy of urban road pricing equipment | 12.8 | 10.5 | 87.2 | 89.5 |
| 9. The economic impact on the urban area in which urban road pricing is introduced | 7.8 | 5.3 | 92.2 | 94.7 |
| 10. Enforcement of an urban road pricing scheme | 9.5 | 8.7 | 90.5 | 91.3 |
| 11. The need for clearly stated objectives, such as, the regulation of traffic demand, the achievement of environmental benefits and the raising of revenue for investment in transport systems | 4.5 | 9.2 | 95.5 | 90.8 |
| 12. The reliability of public transport once urban road pricing has been introduced | 6.2 | 6.3 | 93.8 | 93.7 |

| Issue | Mean | SD | SE | 95% CI of Mean | Median |
|---|---|---|---|---|---|
| 1 | 50.000 | 31.8950 | 15.9475 | -0.752 to 100.75 | 50.000 |
| 2 | 50.000 | 9.9616 | 4.9808 | 34.149 to 65.85 | 50.000 |
| 3 | 50.000 | 42.4526 | 21.2263 | -17.551 to 117.55 | 50.000 |
| 4 | 50.000 | 34.0137 | 17.0069 | -4.123 to 104.22 | 50.000 |
| 5 | 50.000 | 33.2714 | 16.6357 | -2.942 to 102.94 | 50.000 |
| 6 | 47.500 | 43.1824 | 21.5912 | -21.213 to 116.21 | 46.500 |
| 7 | 47.500 | 43.4753 | 21.7376 | -21.679 to 116.67 | 48.650 |
| 8 | 50.000 | 44.3027 | 22.1513 | -20.495 to 120.49 | 50.000 |
| 9 | 50.000 | 50.1925 | 25.0962 | -29.867 to 129.86 | 50.000 |
| 10 | 50.000 | 47.2295 | 23.6148 | -25.153 to 125.15 | 50.000 |
| 11 | 50.000 | 49.8992 | 24.9496 | -29.401 to 129.40 | 50.000 |
| 12 | 50.000 | 50.5182 | 25.2591 | -30.386 to 130.38 | 50.000 |

The Table illustrates a number of important issues relating to urban road pricing and it is possible to separate them into issues of principle and practice. Issues of principle relate to aspects such as whether road users should be charged for the use of road space and the invasion of road users' privacy resulting from urban road pricing. Practical issues relate to the "practicalities" of introducing an urban road pricing scheme - the uncertainty and lack of detailed knowledge of issues such as who should be exempt, how a road pricing scheme would integrate with other congestion management measures, how the scheme would be enforced, the adequacy of public transport provision and how the revenue raised from an urban road pricing scheme would be utilised.

What is apparent from Table 6.17 is that two main issues of principle, "the fact that the introduction of urban road pricing would mean that in congested periods the road user would have to pay for the use of the road" and "the invasion of road users' privacy are of least concern to respondents. When the invasion of road users privacy is used as a gauge to measure mobility related norms, it looks as though the public is rather divided on this issue with 54.6% being very/fairly unconcerned and 45.4% being very/fairly concerned. It would appear that road pricing is then viewed as less of an infringement on their freedom of movement.

In relation to practical issues particularly in terms of "the need for clearly stated objectives with respect to urban road pricing" and the "provision of reliable public transport", the latter is deemed of greatest concern. It is perhaps somewhat surprising that the principle of charging for the use of road space was of least concern - with 76.5% of respondents being either very or fairly unconcerned. On the other hand the lack of real concern in terms of "the invasion of road users" privacy may be a result of the development of pricing enforcement technology.

94.7% of business respondents indicated they are very/fairly concerned about the economic impact on the urban area. Clearly they perceive an impact on customer base or clientele. The survey also revealed that only 13.5% of the public will accept congestion charging if it is backed by politicians and only 16.8% indicated that they perceive the judgement of politicians to be credible and convincing in terms of traffic congestion reduction measures.

The statistical data also suggest a probability of 0.95 that the values of the issues of concern is statistically significant. This is because the actual means (calculated in terms of percentage values) lies between the upper and lower identified confidence limits. It also suggests the mean change lies within the 1.96% (for a 95% confidence interval) standard errors of the sample.

Residential respondents were also asked: "*What do you think is the main reason for opposing congestion charging?*" The results summarised in Table 6.18 can also be used as a control to those results in Table 6.17.

**Table 6.18 Reasons for opposing congestion charging (n = 638 (R); n = 247 (B)**

| Reason | Residents (%) | Businesses (%) | Mean | SD | SE | 95% CI of mean | Median |
|---|---|---|---|---|---|---|---|
| Pricing what was free | 23.5 | 26.3 | 14.29 | 9.08 | 3.43 | 5.85 to 19.31 | 24.1 |
| Tax resistance | 8.9 | 4.2 | 6.5 | 3.05 | 2.08 | 0.02 to 3.04 | 6.55 |
| Harmful to businesses | 25.7 | 22.4 | 15.87 | 4.12 | 1.89 | 0.34 to 17.58 | 24.05 |
| Invading privacy | 15.1 | 6.1 | 9.23 | 2.93 | 2.75 | 1.32 to 11.98 | 21.2 |
| Scepticism | 11.1 | 19.6 | 7.89 | 5.62 | 3.78 | -0.23 to 12.14 | 15.35 |
| Equity/fairness | 8.5 | 5.1 | 5.79 | 4.98 | 3.47 | 1.45 to 6.80 | 6.8 |
| Right to travel | 7.2 | 16.3 | 8.69 | 3.56 | 4.20 | 1.06 to 6.49 | 11.75 |

Table 6.18 illustrates that the foremost reasons for opposing congestion charging is pricing what was free (23.5%;26.3%) and the perception of road pricing being harmful to businesses (25.7%;22.4%). Tax resistance, equity/fairness and the right to travel appear to be of lesser importance in opposing congestion charging, reflected by 8.9%, 8.5% and 7.2% of the respondents respectively.

This statistical data, also suggests the a 0.95 probability that the actual mean of pricing what was free and it being perceived as being harmful to businesses is statistically significant for both residents and businesses. This is because the actual mean (calculated in terms of percentage values) for both stakeholders lies between the upper and lower identified confidence limits. It also suggests the mean for both lies within the 1.96% (for a 95% confidence interval) standard errors of the sample. The remaining reasons given by respondents is still significant at least at the 95% confidence interval although they were less likely to be the cause of opposing congestion charging.

# 6.4 Conclusion

The results reported in this chapter is based upon a good response rate for both the residential and business surveys, 63.8% and 61% respectively. The remaining stakeholder interviews served an equally useful purpose in terms of identifying perceptions, concerns and views. The results have shown road pricing to have a rather small impact on the micro and macroeconomy with respondents attributing current economic conditions to other non-transport related factors. On the other hand, road pricing was reported to significantly affect road user welfare measured in terms of behavioural adjustment and reported distributional effects.

Although it was reported that road pricing had a very small effect on land use patterns it was found that the majority of respondents felt road pricing has a positive effect on the environment and should be encouraged based upon the positive side effects it has. The sustaining factors have also yielded a positive response in terms of using the revenue from the charge to increase transport efficiency and in bringing about a degree of fairness to the charging scheme. Employees are reported to favour mechanisms which allow them greater flexibility in their work start time as to avoid being charged. Driver information provision was reported as an important condition to avoiding traffic congestion. It was also confirmed that a large percentage of road users support congestion charging in London, however they have cited a large number of reason why congestion charging will be opposed however.

Based on these findings, the next chapter attempts to explain the results and relate it to published work in identifying its meaning, whether they agree with the aims and objectives of the research and to what extent they address the research problem.

# Chapter 7 Discussion and interpretation

## 7.1 Introduction

This chapter considers the results obtained in the survey using emerging data to fill identified gaps as far as possible and to identify what the results mean and whether they agree with the aims and objectives of the research. Information is assessed, interpreted and discussed not only in the context of the results but also in the context of the literature review in establishing how it fits in with published work in the subject field, allowing the identification of locally perceived problem areas, concerns, obstacles and/or restrictions.

The discussion first considers the perceived effects of road pricing on the economy of London, the social welfare of Londoners, land use and the environment. It then focuses on the role of the factors sustaining congestion charging. During this process the remaining perceived problem areas and concerns will be identified and collectively reported. The chapter concludes by considering the appropriateness of the methodology and data collection methods.

Throughout the process recognises and reflects the following:

(i) the interdependency between road pricing, its effects and the sustaining factors

(ii) the relationship of the results to the purpose and objectives of the research

(iii) the relationship to current literature.

To enable the recognition and reflection of the relationship between the results obtained and the purpose and objectives of the research, Diagram 7.1 below briefly summarises the purpose and objectives of the research, serving as a quick reference when interpreting the results.

**Diagram 7.1 Purpose and objectives of research**

| Purpose and objectives |
|---|
| The **purpose** of this study is to investigate the localised effects of road pricing as perceived by the identified stakeholders and to identify and evaluate factors supporting the viability and sustainability of road pricing as a measure to reduce urban traffic congestion.<br><br>The **objectives** of the research is to:<br>i) determine whether road pricing is perceived to, and actually reduces urban traffic congestion levels<br>ii) determine the scope of the effects road pricing has as a fiscal instrument in reducing urban traffic congestion in the local setting<br>iii) to identify and explore factors such as revenue recycling, work schedule flexibility, public and political acceptance and information provision in support of road pricing sustainability<br>iv) to answer the general and more specific research questions identified in Chapter 1<br>v) to identify locally perceived concerns, problem areas and obstacles<br>vi) to formulate plausible recommendations for the presenting of road pricing as a viable and sustainable policy instrument. |

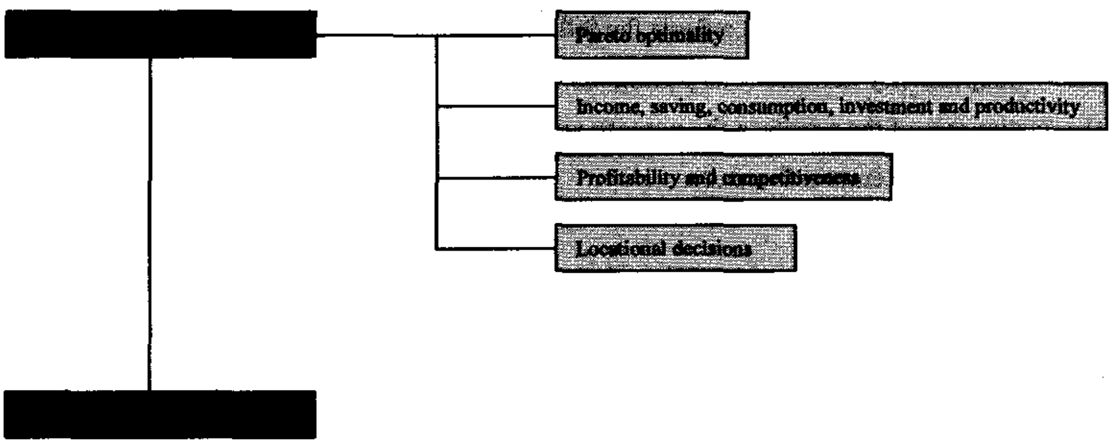
# 7.2 Interpreting the results

When interpreting the data it is necessary to bear in mind the rate with which different impacts will occur and reach a stable post-charging situation. Estimates made by Transport for London (2003c) suggest public transport patronage, public and political acceptance and revenue expenditure would stabilise within the first two years of the congestion zone's operation. The effects on the local economy, peoples' welfare, land use and the environment will follow a process of progressive adaptation lasting for several years. The discussion will begin by interpreting the economic effects and then the remaining effects and factors in turn.

## 7.2.1 Economics

This section addresses the effect of road pricing on the economic factors identified. Diagram 7.2 illustrates the main issues to be discussed in the following sub sections.

**Diagram 7.2 Economic effects**




### 7.2.1.1 Micro economic effects

#### 7.2.1.1.1 Pareto optimality

Efficiency is a normative criterion for evaluating the effects of resource use on the welfare of individuals. Here, efficiency means achieving Pareto efficiency or optimality when resources (the road network in the congestion zone) are used in such a way as to make it impossible to increase the well-being of any one road user without reducing the well-being of any other road user (Hyman, 1999:53 and Schotter, 2001:574).

For the purpose of the survey Pareto optimality was measured in terms of derived satisfaction and also willingness to work to serve as indicators reflecting change in utility. The aim was to establish whether road users perceive their utility to increase or decrease as a result of the congestion charge. More than two thirds (68.7%) of respondents residing in the congestion zone perceived congestion charging to have increased their derived user satisfaction when undertaking journeys to and from the congestion zone. This leaves the impression of road pricing increasing user utility, suggesting the road network within the congestion zone is being used 68.7% Pareto optimal in terms of the response. These findings are supported by the arguments of Daganzo (1995:139-140).

The opposite also holds true, in that 31.3% of respondents felt they have not gained any satisfaction or benefit from the implementation of the charge. This is possibly due to vehicle travel not being equally important to everyone and because not everyone has the same willingness to pay or ability to pay. In this regard Hyman (1999:53-54) suggests the criterion of efficiency is based on an underlying value judgement that individuals should be allowed to pursue their self-interest as they see fit, provided that no one is harmed in the process. The individualistic ethic underlying the efficiency criterion, therefore, is not acceptable to all persons.

#### 7.2.1.1.2 Income, savings, consumption, investment and productivity

General economic theory predicts taxes to reduce income, saving, consumption and investment (Dornbusch and Fischer, 1994:123-125; Musgrave and Musgrave, 1989:325; Hyman, 1999:482-493 and Madsen and Jensen-Butler, 2001:1). Additionally, some effect on business and labour productivity has also been predicted. The results illustrated in Table 6.3 demonstrate that, the majority of respondents (residents as well as businesses) feel congestion charging has not changed their income, savings, consumption and investment to the extent initially anticipated by some of the authors. The same applies to business and labour productivity where results suggest that the effect on productivity is not statistically significant.

This may come as a surprise as many authors have predicted the charge in central London to have a detrimental impact on business and private income, savings, consumption, investment and productivity. It may suggest that some people and businesses have managed to adjust to the additional tax burden, thereby neutralising its impact but it does not hold true for all who took part in the survey. Also, the findings are based upon short term data. When long term data are used (when available in the future) the picture may adjust and be more in line with the above author's modulation and predictions.

#### 7.2.1.1.3 Profitability and competitiveness

Taxes in any form reduce the profitability and competitiveness of businesses (Hyman, 1999:555-556 and TDM, 2003). The competitive firm will attempt to maximise profits by setting the prices of its commodities equal to the marginal cost of obtaining or producing the commodities or services. When businesses pay a congestion charge their marginal costs increase and in order to stay profitable and competitive they increase the price of their commodities or services. One way of accomplishing this is by shifting the additional transport cost incurred to their consumers to remain profitable and competitive. Logically, the area having seen the highest degree of adjustment in reaction to increased freight cost is the timing of freight deliveries either to avoid the congestion charge or to take advantage of the reduced congestion within the zone. This is particularly prevalent in the retail and distribution sectors as would be expected.

In this regard, the results in paragraph 6.3.1.3, page 100, have shown that only 3.2% of businesses have increased the cost of their products or services so as to maintain profitability and competitiveness, opposed to 11.2% of residential respondents perceiving it to be the case. About 3.1% of business respondents, perceived the congestion charge as having a detrimental impact on their profitability and competitive advantage. However when residents were asked whether they perceive public consumption to have decreased in the peripheral area, 59.3% indicated they had, suggesting businesses in the congestion zone will either have to enhance their marketing skills to stay profitable or to find ways of shifting the burden for fear of losing customers especially in the retail industry.

The results in paragraph 6.3.3.1, page 108, have demonstrated that the retail sector in central London is the most sensitive economic sector and the most likely land use to decentralise from the congestion zone. Evidence from TfL (2003c) and the Local Authority stakeholders confirm these findings and further suggests that the trends in the retail sector in central London were different to those of the UK as a whole, which show a stable, if relatively sluggish growth trend. The retail sector's performance initially declined in central London but in 2003 it showed an increase in growth. Furthermore the performance of the retail sector has now re-converged with that of the UK as a whole despite the continued operation of congestion charging.

From these points it can be deduced that a relative under-performance in retail sales in central London is consistent with the overall economic growth performance of London during the period under consideration and can not necessarily be ascribed to the imposition of the charge. When the TfL findings are compared to the findings of this research it can be concluded that congestion charging has had a fairly minimal effect on retail performance. This argument is supported by not observing any significant adjustment to traffic patterns at weekends that might be attributable to congestion charging, suggesting that retail performance and road traffic levels in central London are not strongly interrelated (TfL, 2003c).

Only a small percentage of businesses perceive their profitability and competitiveness to be affected by congestion charging. Other economic forces and non economic influences have also been at work during 2003 as many respondents suggested. These are notably the Central line closure, the Iraq war and the associated increase in the threat of terrorism, the reduction in overseas tourists, the unusually warm summer and internet shopping which all formed part of the equation in destabilising a profitable and competitive environment. This may reflect their belief and observation that London's economy has been subject to a number of long term local, national and international factors which may have overshadowed the impact of congestion charging in terms of economic performance.

**7.2.1.1.4 Locational decisions**

In exploring the factors influencing the decision of businesses to centralise or decentralise to or away from the congestion zone, it is important to remember the differentiation between a prime central London economical location and a peripheral location. In terms of businesses in the congestion zone, their decision to be established in the zone is based upon trading from the English capital. London is the hub of economic activity and vitality and a magnet to prospective clients, investors and tourists. Only 2% of business respondents have indicated a desire to relocate to the peripheral area, suggesting that their economic viability and vitality has not been affected detrimentally as predicted by authors such as Seagal and Steinmeier (1980:41-52), Whitehead (2002:221) and Verhoef et al. (1995:11-13) and despite the concerns expressed elsewhere that the charge would drive businesses out of the charging zone.

These findings which are reported in paragraph 6.3.1.4, page 101, are also in line with the TfL (2003c) survey about the "churn" rate of businesses. Their surveys established how long responding businesses had been established in their current sites. Their results indicated a "churn" rate of around 10%, that is up to 10% of businesses will leave the area currently located each year to be replaced in most cases by a new business. This occurrence is ascribed amongst others to the expiry of leases and businesses responding to their needs in relation to expansion or a decrease in the demand for floor space, customer and business needs. This implies the 2% of businesses responding in this research fall within the naturally occurring levels of business "churn". It does not however suggest businesses will relocate only because of the imposition of congestion charging.

It was predicted by Seagal and Steinmeier (1980:41-52) that businesses from the peripheral area will relocate to the congestion zone if the savings in transport cost are directly off set by the cost of the charge. The results in paragraph 6.3.1.4 suggested only 4.5% have considered relocating, indicating the off setting of increased transport cost is a difficult objective for a large percentage of respondents to achieve. They may also want to avoid fluctuations in trade.

Both residents and businesses suggested revenue recycling into public transport would be conducive to urban living and would add to the attractiveness of the central London business district. Many respondents suggested they would prefer an initial step-change in the level of public transport provision prior to introducing the charge, as it will eliminate fluctuations in trade and potential relocations. Unfortunately there appears to be very little faith among businesses in the government's ability to spend the revenues wisely or for the purpose intended. There is also a great deal of concern and uncertainty amongst the respondents about the long term effects of congestion charging on people's and businesses' locational decisions.

### 7.2.1.2 Macro economic indicators

The macro economic impact of congestion charging can only be estimated over at least the medium to long term. Over the short term, however, this research attempts to identify possible trends in the macro economic indicators which may prove useful to predict long term trends at this stage. The results illustrated in Chart 6.2, page 104, have shown the majority of businesses participating in the survey have noted no significant change to their (1) final demand, (2) annual turnover, (3) labour force, (4) savings, (5) investments, (6) growth and (7) staff retention ability. About 6.9% have indicated some form of price distortion had taken place following the imposition of congestion charging.

This would suggest congestion charging has had a very small impact on the macro economic indicators contrary to Verhoef et al. (1995:11-13) who suggested that business turnover would increase under conditions of road pricing. At this stage of the London congestion charging's operation their prediction can not be wholly substantiated. Similarly, labour volume and staff retention have not been reported to be much affected by the charge as Madsen and Jensen–Butler (2001:4) and Parry and Bento (2001:1) predicted. Nor have the results illustrated in Table 6.5 suggested that revenue recycling would increase labour productivity significantly.

Parry and Bento (2001:1) also suggested a slight initial decrease in the supply of labour followed later by an increase in the supply when revenue is recycled and subsidies are granted. Taken from Table 6.5 page 104, the results have only suggested a 1% and 0.5% reduction in these indicators and a 1% to 1.5% increase in supporting their findings even at this early stage, although the percentages are rather insignificant as would be expected at this stage.

It is also quite early to interpret precisely the impact of congestion charging on macro savings, investment and economic growth. In drawing a parallel between London and Singapore, Holland and Watson (1978:16) reported road pricing did not have an adverse impact on the indicators above, similar to London over at least the short term. At present it would be difficult to compare and to suggest congestion charging has had significant effects on macro savings, investment and economic growth in London as any small changes may have occurred as a results of other national and international economic activities and trends. The observed findings therefore suggest road pricing has had a very limited impact on the macro savings, investment and economic growth trends in London.

**Summary of discussion**

Micro economic effect

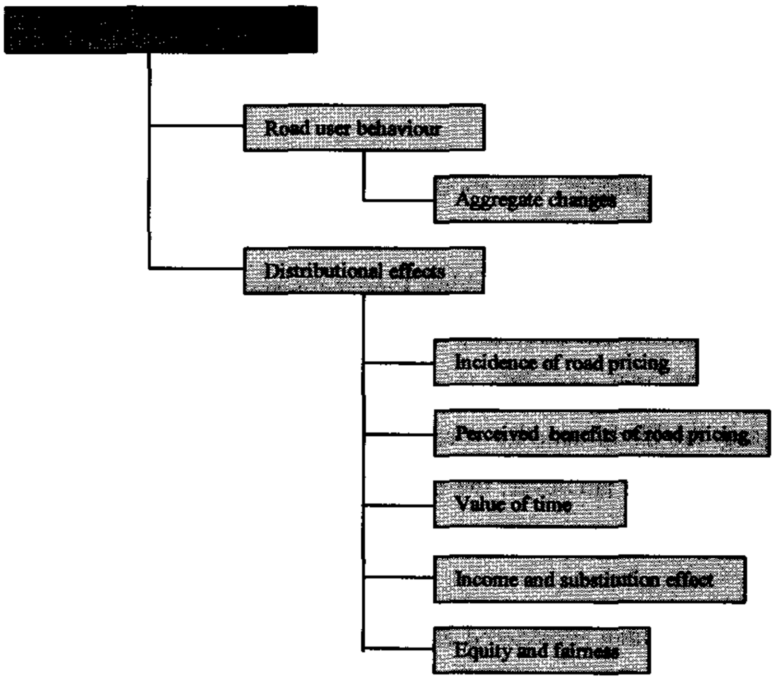
- The congestion charging road network is perceived to be used 68.7% Pareto optimal.
- Respondents' income, savings consumption and labour productivity has largely been unaffected by congestion charging because adjustments have been made to overcome the additional tax burden.
- Competitiveness and profitability of retail and distribution sectors are most likely to decentralise.
- Small percentage of businesses perceive road pricing to have a detrimental impact on their long term competitiveness and profitability. Non economic influences also had a negative impact on business performance during 2003.
- Small percentage of business respondents have indicated their intention to relocate from the congestion zone to the peripheral area – the percentage is however within the natural "churn rate" of businesses leaving the area due to leases etc. expiring.

Macro economic effects

- No significant change to final demand, annual turn over, labour force, savings, investment, growth and staff retention.
- Congestion charging had a very limited impact on macro economic trends in London.

## 7.2.2 Social welfare

**Diagram 7.3 Social welfare effects**




People making changes, whether to their daily travel behaviour or to other aspects of their lives lies at the heart of all the other effects observed in relation to congestion charging. This section, summarised in Diagram 7.3, describes the effects of congestion charging on respondents' travel behaviour and some distributional effects arising from it. These effects reflect numerous individual decisions about how to optimise travel to enable the conduct of daily life. The next section will begin by assessing how congestion charging affects road user behaviour in relation to the identified gaps.

### 7.2.2.1 Road user behaviour

The scale of changes in travelling into the charging zone by car and its close correspondence with the introduction of congestion charging suggests that this effect is very closely associated with charging. However, these people did not simply disappear. The majority of car users (51%) have made adaptations such as using public transport which will have provided an alternative to enable most elements of daily life to continue largely unchanged.

The results observed in Table 6.7, page 106, have shown that about 39% of respondents changing their preferred mode of transport had transferred to busses. Those transferring to buses will be counted alongside the many others who are using buses more because of 'background' improvements to bus services London-wide. Separating those new bus users who have transferred from cars because of congestion charging from those more generally attracted to the buses (particularly from the Tube) because buses are now perceived more attractive is not straightforward.

Car occupants transferring to the Tube (amounting to 32%) have been off-set by a reduced overall passenger number resulting from a variety of "background" local, national and international events during the preceding year. In addition when generalizing to the greater London population, it is also anticipated that over the course of any one year a relatively high proportion of Londoners will have moved house or job or undergone other life changes that will have altered their travel needs. Such "churn" is a further complicating factor in any assessment.

#### 7.2.2.1.1 Aggregate changes to road user behaviour

The results illustrated in Table 6.6, page 105, suggest that about 41.6% of respondents will be **diverting** around the congestion zone if they previously used the congestion zone as a through way to their final destination. This implies that these respondents are now making longer-distance movements around the congestion zone. This form of traffic displacement induces a significant reduction in through traffic as TfL suggested - prior to charging about 20-25% of traffic in central London were through movements (TfL, 2003). This phenomenon increases the likely benefits of reduced vehicular traffic within the zone as Litman (2001:1) and Hills (1996:5-8) suggests. However, the downside to traffic being displaced is the possible increase of congestion along the fringes of the congestion zone.

Of those respondents indicating they will or have considered **changing the mode of transport** they use to access central London (57.6%), an upward shift has taken place in relation to using cycles, taxis and motor cycles more often when compared to TfL statistics (TfL, 2003c). The results contained in Table 6.7, page 106 also suggest that even walking as mode of transport has increased in the congestion zone.

**Car pooling** has seen an insignificant increase. Only 2% of respondents have indicated they will access the zone by this means. There are two effects here: it is likely that cars with lower occupancies have changed their behaviour to a greater extent than those with higher occupancies and that some increase in car sharing has taken place in response to the charge. These findings would suggest car-pooling or car sharing is a predominantly unpopular incentive to reduce traffic congestion, which is reflected by the percentage of respondents adjusting their travel behaviour.

A significant change in road user behaviour has been reported in relation to respondents' **departure times**. About 37% responding have indicated that they have reacted to charging by adjusting the timing of their journeys in order to make them outside charging hours. This response is more likely to apply to less-frequent trips, suggesting the actual effect on car movements would be smaller. This finding is indirectly confirmed by TfL (2003b) in that a surge of traffic is observed entering the zone up to an hour before it becomes operational and an hour after charging had stopped.

**Change of destination** to locations outside the charging zone is the stated response of around 3.4% of car drivers who have changed their travel arrangements in response to the charge. This change is however more likely to apply when less frequent trips are undertaken. In summary these changes in road user behaviour translate directly into less vehicle journeys undertaken to the congestion zone through modal shift. Hence, these findings serves as proof congestion charging does reduce urban traffic volume.

## 7.2.2.2 Distributional effects

Congestion charging affects different income groups in different ways in respect of who pays the charge and who obtains the benefits as well as some other factors discussed below. The survey results reflected specific relationships between the identified gaps which have helped explain the bigger picture of how road pricing affects peoples' income. The discussion in this section starts by addressing the perceived affect on the incidence of road pricing.

### 7.2.2.2.1 Incidence of road pricing

The question to be answered here is whether the rich or the poor pay proportionally more when entering the congestion zone, in relation to the ability to pay principle. In terms of this principle the higher income groups have a definite advantage over the lower income group because a direct relationship exists between an increase in income and the ability to pay. The lower income group pays proportionally more to enter the zone if the charge to income ratio is considered. Hence, the smaller the income, the larger the ratio and the worse off the road user would be. This would suggest the higher income groups carry less of a tax burden and the lower income group a higher tax burden, corresponding to the suggestions of Arnott et al. (1994), Langmyher (1997:27) and Parry and Bento (2001:1) in that the charge is shifted one way or the other. Additionally, low income users might be made worse off and suffer a reduction in welfare by paying tolls if they value a similar reduction in journey time less than the increase in the toll rate as Button and Pearman (1983:24) suggest.

One way of decreasing the tax burden would be to allow employees to shift the tax burden to their employers through wage negotiation as Layard (1977:302) and Jones and Hervik (1992:140) suggest. The results reported in paragraph 6.3.2.2, page 107, indicate however that only 2.5% of respondents are able to achieve the shift, suggesting it is not the most effective and achievable way of reducing an increased tax burden. The other option suggested was that of revenue recycling through tax credits or an annual discount on car tax. Currently these more specific tax relief measures are not built into the congestion charging scheme. Only residents living in the congestion zone are able to claim a 90% discount. The important point to remember here is the 90% discount is available to everyone living in the zone irrespective of their income, hence, benefiting all income groups.

#### 7.2.2.2.2 Perceived benefits and disbenefits

Invariably the congestion charge will have benefits as well as disbenefits which accrue to respondents. It is useful to interpret how respondents consider the impact of congestion charging in terms of the benefits and disbenefits it has on their daily lives. In terms of the overall results obtained respondents believe accessibility in the congestion zone has increased. On the subject of visiting family and friends, respondents expected this to have become more difficult once the scheme has been introduced rather than easier. Additional perceived benefits are that of an improved urban area to live, work and shop in. The level of pollution and traffic related noise is perceived to have been reduced. The efficiency, availability and reliability of public transport is perceived to have increased. Respondents also noted an observed reduction in traffic volume, further enhancing their travel experience with more comfort and safety and less hassle, stress, crowding and time spent waiting. In terms of disbenefits respondents also expressed concern about the likely effect on businesses profitability and the way in which the increased transport cost to businesses will be shifted to them as consumers.

The results reported in paragraph 6.3.2.2, page 107 also suggested these benefits (and in some cases disbenefits) do not only arise because revenue is being recycled as Johansson and Mattsson (1995:9-10), Levine and Garb (2000:4-5), Morrison (1986:87-91), Jones and Hervik (1992:138) and Dawson (1986:79) suggest, but are due to the impact of other factors. These points recognise and demonstrate the public's awareness of the likely benefits and or disbenefits which may arise from congestion charging.

#### 7.2.2.2.3 Value of time

One of the principal components of the benefit element in congestion charging is the time saved by allowing faster journeys. The purpose of the survey was to establish to what extent the respondents perceived the value of time to differ between 29 occupational classes. Unlike the reports by Button and Pearman (1983:20), Cohen (1987:242) and Oort (1969:282), the results suggest the value of time between different individuals or occupational classes do not differ that significantly. Those with a higher value of time are more often individuals who drive to central London in a business or work related capacity and/or those who are forced to use their own or company vehicles to carry out their daily work. Road users with a low value of time will most possibly be discouraged from continuing to drive and transfer to alternative modes of transport. These observations are supported by that of Levine and Garb (2000:20,23-24) and Holland and Watson (1978:16).

#### 7.2.2.2.4 Income and substitution effect

23.5% of the residents responding indicated a perceived decrease in their income in real terms because of the charge. These results are an average across all income groups. The charge induces an income effect irrespective of income levels. In respect of different income groups the low income group appears to be the most significantly affected. It shows the strongest signs of an income effect. It is also observed that a inverse relationship exists here, in that the significance of being affected decreases as income increases. Thus, the high income group are the least affected.

However this also means 86.5% of respondents suggest they have not observed a significant income effect (or loss of earnings due to the charge). This is quite possible as 39% of respondents have shifted mode to using the buses and 32% to the Tube and also various other forms of public and private transport which is less costly. These findings are confirmed by observations made by Madsen and Jensen-Butler (2001:11). Again the shift in mode is indicative of a substitution effect whereby road users have switched their demand from one mode of transport to another the price of which has at least remained constant.

#### 7.2.2.2.5 Equity and fairness

In terms of the perceived fairness of road pricing, the results have suggested respondents perceive "fair road use" as a situation where all road users of differing income groups contribute an equal financial share towards the use of roads. Others stated that fair road usage can only be accomplished if congestion charging was more equitable i.e. it should financially affect all road users in the same way. This translates to road users not only being willing to pay if they know they will receive a benefit but also road pricing should not have a disproportionate effect on different income groups as Jones (2001:1) suggests. This objective is however very difficult to achieve as the income groups contributing or paying most does not necessarily stand to gain most from the transport improvements. Everyone entering the zone as road users or not will gain from the benefits the scheme has brought about.

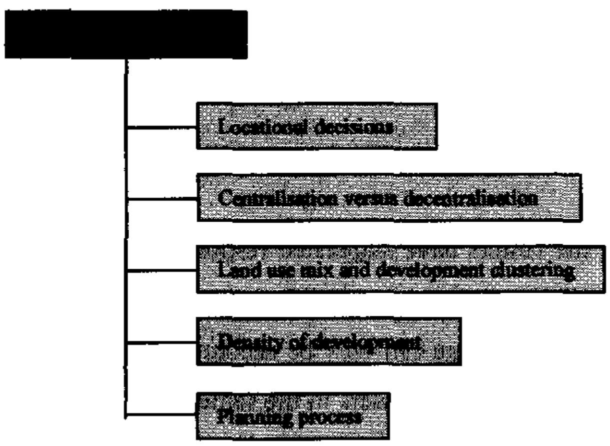
**Summary of discussion**

- Road user behaviour adapted in response to congestion charging.
- 39% of road users transferred to buses.
- 32% of road users transferred to Tube.
- 41.6% of respondents diverted around congestion zone accounting for traffic displacement.
- Carpooling has not seen a significant increase.
- Significant percentage of road users made adjustments to their departure times.
- Small percentage of road users have changed their destinations to outside the congestion zone.
- Lower income group pays proportionally more than the higher income group to enter the congestion zone and carries a larger tax burden as a result.
- The lower income group's income is affected to a greater extent than the higher income group.
- Respondents are unable to shift their tax burden onto their employees.
- Respondents are aware of the benefits and disbenefits arising from congestion charging.
- Road users with a low value of time will be discouraged from driving into central London.
- Congestion charging has caused an income and substitution effect which is most apparent in the lower income group.
- Congestion charging will be equitable if "everyone pays their fair share".

## 7.2.3 Land use

The results obtained from the survey addressed five issues namely, (1) the locational effects of road pricing, (2) centralising vs decentralising effects of road pricing, (3) land use mix and development clustering, (4) density of development and (5) how road pricing may affect the planning process. These are illustrated in Diagram 7.4 below and will be discussed in turn.

**Diagram 7.4 Effect on land use**



### 7.2.3.1 Locational decisions

Against the backdrop of transportation being a "derived demand i.e. people travel in order to reach opportunities available at different destinations, as Martinez (1995, 317-321) cites, it is analogous that land use patterns will critically affect travel patterns. When congestion charging is imposed, it complicates matters as travel behaviour will now adjust in order to maintain reaching opportunities at destinations or land use functions. When land use patterns alter as a result of congestion charging, again it influences travel patterns and behaviour. This occurrence is intrinsically linked to peoples locational decisions (where they live) and businesses' locational decisions.

In terms of residential respondents' locational decisions, 72% were reported to live within the congestion zone and 28% in the peripheral area. What seems of great importance is the finding that about 99% of respondents living in the peripheral area will not considering moving to the congestion charged area. 3% of the respondents in the congestion zone will however consider relocating to the peripheral area. This shows that more residents in the congestion zone wants to relocate than those who wants to move to the congestion zone. From this it can be deduced that road pricing has an influence on residents' locational preferences and decisions.

The fact that very little (only 3%) residents want to relocate to the peripheral area confirms the findings of Whitehead (2002:234), suggesting an increase in the popularity of urban living. This, coupled with more efficient public transport and a perceived healthier area to live in, enhances its attractiveness.

A similar picture emerges with respect to businesses. Paragraph 6.3.3.1, page 108, reported only 2% of businesses have indicated they would consider relocating to an area outside the congestion zone. These results portray a positive picture in that businesses located in the congestion zone are mainly considering staying. Additionally it confirms the observations made by Eliasson and Mattson (2001:417), in that although congestion charging has an effect on locational decisions it is small compared to the perceived effects on traffic volume, modal split and travel patterns.

### 7.2.3.2 Centralisation versus decentralisation

The impact of congestion charging on land use classes was investigated in terms of the centralising and decentralising effects of road pricing. The results reported in paragraph 6.3.3.1 suggested that Local Authorities are encouraging the higher order office function, leisure function, food and drink function and high density residential functions to centralise in the congestion zone. In comparing these findings to the percentage of businesses indicating they will stay in the congestion zone, it seems as though land use classes dependent on one-to-one meetings with clients will be more likely to relocate to a location outside the zone. In contrast, land use functions and businesses focussed on tourism, leisure and the food and drink industry will tend to centralise in the congestion zone.

The results illustrated in Table 6.9, page 109 also indicate that land use classes possibly decentralising from the congestion zone will most possibly be the retail, lower order office function and the manufacturing function. This is because, in the case of manufacturing, the industry is fairly insensitive to changes in road user numbers entering the congestion zone as they are production orientated not consumption orientated and because the function is largely disappearing from city centres, decentralising to areas with sufficient space, allowing unhindered industrial activity. The retail function will possibly be hit hardest by a reduction in road users entering the congestion zone because paying a charge discourages would-be shoppers from shopping in the zone which may undermine the economic vitality of businesses located within the congestion zone.

This suggests a preliminary "movement" in land use classes, as predicted and supported by the Local Authorities. No evidence was found however, confirming the occurrence of land use classes outside the congestion zone becoming more or less attractive and it giving rise to centralisation of some land uses as Eliasson and Mattson (2001:417) suggest. Admittedly they modelled this potential effect, qualifying their statement by suggesting it is a likely outcome "if the congestion charged area is large enough". However, it is too early in the life span of the London congestion charging scheme to observe clear and defined movement patterns, although the indication at this stage confirms the potential of this eventuality.

#### 7.2.3.3 Land use mix and development clustering

At this early stage, Local Authorities have confirmed that the occurrence of land use mix and development clustering can not be ascribed to the influence of congestion charging alone in central London, reiterating Komannoff (1997:1-2), in that no generalised conclusions can be drawn at this stage. However, it is envisaged that land use mix may be allowed to occur and/or encouraged over the long term and development clustering over the short term. It is also anticipated that similar land use classes would cluster in order to benefit from mutual inclusive characteristics, services and economies of scale. Other factors impacting on land use mix and development clustering may also be at work.

Although land use classes are currently not allowed to mix to a detrimental effect (on the local amenity) by Local Authorities' UDP's, development clustering is allowed to occur in isolated cases. This would suggest considerable potential for high-quality mixed-use centres encouraging the use of local facilities, public transport and walking. In addition there is considerable interest in transport development areas and pushing development into high-density transit-oriented corridors as a means of providing greater intensity of land use.

### 7.2.3.4 Density of development

The results reported in paragraph 6.3.3.3, page 110, have shown that density of development within the congestion zone has not increased as a result of the introduction of congestion charging, contradicting the modulation carried out by Arnott (1998:1) and Bell (1997:669). The intuition is that travel would be more costly with the congestion toll in place as it would discourage travel and encourage building at higher density. It is envisaged that the development density of high-density residential function and the high density mixed uses function will be allowed and encouraged to increase over the next few years, suggesting development density will increase in the not so distant future.

The notion is strengthened by Local Authorities specifically identifying these land use classes to be encouraged in the congestion zone. It would also be a manifestation of research by Stead and Banister (2001:317-321) in that higher density development will be associated with less personal travel, reduced reliance on motorized modes and increased levels of walking and cycling, these being benefits resulting form congestion charging.

Levine and Garb (2000:5-6) however, argue that by increasing the cost of access to the charged area, homes and jobs may be encouraged to migrate to locations outside the charged area thus reducing the relative attractiveness and density of development in central locations which contradicts Arnott and Bell's argument and also the findings of this research. This reflects the multi-directional effects of congestion charging as a response or reaction to congestion charging, differs between individuals and businesses, reflecting its differing effect on stakeholders.

### 7.2.3.5 Planning process

The results reported in paragraph 6.3.3.4 and table 6.10 indicate the adaptation of the planning process in accommodating changes in land use patterns as a result of congestion charging. It will be designed to attract those land use classes that help sustain the economic viability of central London. It will also encourage urban living through the identification of suitable high density residential and mixed use sites in central London. The implementation and creation of cycle lanes and walking networks within the congestion zone will also discourage road users especially if they are conveniently located, safe to use and complimentary to public transport.

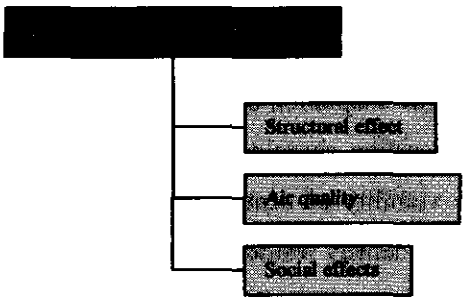
The planning process will assist in restraining traffic congestion in this way and also through the development of an integrated land use and transport planning strategy, conforming to the UK Government's planning policy guidance on transport (PPG13) as Chaterjee et al. (2001:11) report. The process will operate by shaping the pattern of development and influencing the location, scale, density, design and mix of land uses. Planning can help reduce the need to travel and the length of journeys. It can make it safer and easier for people to access jobs, shopping, leisure facilities and services by public transport, walking and cycling. This points to the complementary role existing between the planning process and congestion charging as a traffic reduction measure, suggested by Banister (1999:323) and Stead and Banister (2001:317-321). It also points to the much needed movement towards a plan-led system in the planning process.

| Summary of discussion |
| --- |
| • Businesses and residents have no significant intention to relocate to or from the congestion charging zone. |
| • Land use classes dependent on "one to one" meetings with clients likely to decentralise from the congestion zone. |
| • High order office function and high density residential function likely to centralise in the congestion zone. |
| • Land use mix and development clustering not taking place as a result of congestion charging – the planning process will however encourage land use classes with mutual inclusive characteristics to cluster and mix. |
| • Density of development has not changed as a result of congestion charging – it will be encouraged though by Local Authorities, allowing high density residential function and high density mix use functions. |
| • Planning process to adapt in facilitating the restraint of traffic congestion through the application of an integrated land use and transport strategy. |

## 7.2.4 Environment

The next issue to discuss is the perceived impact of congestion charging on the environment. Issues under discussion in this section briefly illustrated by Diagram 7.5, relate to the structural effects of road pricing, its effect on air quality and the effect it has on peoples' social welfare.

**Diagram 7.5 Effects on the environment**




### 7.2.4.1 Structural effect

In terms of the structural effect of road pricing, a key benefit is observed in that capacity expansion is suppressed as a result of congestion charging - a point recognised and supported by over 83% of respondents. In this regard the public appears to support the introduction of congestion charging as a traffic reduction measure as its "by-product" (reduction in vehicular traffic) induces a reduction in environmental decay.

A natural phenomenon when charging road users who wish to enter a charged zone is the occurrence of traffic displacement (Komanoff, 1997:4). Respondents recognised this concept and raised a valid point, suggesting that possible detrimental environmental impact will be shifted elsewhere outside the zone. The Local Authorities lodged a counter argument that traffic displacement could be kept to a minimum if an integrated land use and transport strategy with increased use and reliability of public transport coupled with stringent parking and traffic enforcement was introduced. These findings contained in paragraph 6.3.4.1, page 111, correlate with those of Chin (1996:787-788), Hillman (1992:228-230), Santos and Newbery (2002:3-5) and Santos et al. (2000a:9), suggesting that success in containing traffic congestion and related pollution problems does not lie with road pricing alone but also in applying legislative and fiscal measures, careful land use planning, investment in an efficient public transport system and integrated land use and transport initiatives.

### 7.2.4.2 Air quality

In relation to air quality, the expectation was that by reducing the amount of traffic in and around the charging zone, congestion would contribute to improving the general air quality in the zone. Although air quality was not scientifically measured in this research for the reasons reported by Common (1989:1297), the survey served as an instrument gauging any benefits and/or disbenefits arising from the charge. The results reported in paragraph 6.3.4.2, page 112, support the notion that congestion charging has the ability to reduce vehicle emissions, leading to a cleaner environment. These results also confirm those of Otterström (1995:315), Santos et al. (2000a:1-9) and Santos and Newbery (2002:14), because the public and businesses perceive road pricing to reduce the level of traffic induced emissions. Hence their perception may serve as a gauge measuring the change in traffic related emission levels. The consequent increase in the level of acceptability of road pricing decreases the reluctance of road users to pay a charge to enter the zone. Thus, willingness to pay increases because road users are mindful of the benefits accruing as Otterström (1995:315) suggests.

The results observed in paragraph 6.3.4.2 also recognised the difference between "perceptual" and "scientific" evidence. For example, the evidence from direct scientific measurement of air quality (provided by the Environment Agency) does not correlate significantly close to the perception of the respondents. This is interesting but not entirely unexpected. People's perception of air quality may be based more on the numbers of slow moving vehicles in the immediate vicinity than actual prevailing particle levels. This may account for the residential respondents perceiving a 95% reduction in vehicle emissions and the environmental focus group a 75% reduction. The discrepancy is potentially explained by the statistically unusual weather patterns prevailing for much of 2003 which may have influenced the respondents' judgement regarding air quality.

The resulting traffic changes induced by the charge has also led to a reported (approximate) 19% saving in traffic related emissions and a reported saving of 20% in fuel consumption, reflecting the financial benefit accruing to road users and non road users. Apart from the financial savings made these changes may also be expected to affect air quality in the following ways:

1. Reduced volume of traffic means that less fuel will be consumed and less polluting emissions produced which will have an impact on the local economy
2. Faster vehicle speeds and reduced congestion means that the (reduced) volume of traffic is moving around more efficiently, generating less emissions per unit distance travelled
3. Different vehicle types produce different levels of emissions per unit distance travelled. This means that the impact of changes to cars will be smaller, in relative terms, as compared to equivalent changes in heavier vehicles such as buses and lorries.

As well as these direct effects, changes brought about by congestion charging, takes place against a backdrop of changes to all other factors affecting air quality. Key examples are:

1. Improvements in vehicle technologies and emission/fuel standards have specific impacts on vehicles being progressively renewed over time; this particularly affects bus fleets. In this regard, the results revealed that cleaner vehicle technology is consistently ranked as a first choice for reducing vehicle emissions. This does not only not only reflect the stakeholders' viewpoint of curbing emissions at source but also, points to it being preferred above congestion charging as a policy instruments to jointly reduce traffic congestion and traffic emissions.
2. The weather, which can significantly affect the way in which primary emissions from road traffic are "translated" into air pollution which is measured at air quality monitoring sites.
3. Changes in emissions caused by other sources such as domestic and commercial heating, both within London and further a field.

### 7.2.4.3 Social welfare

A large proportion of respondents expressed their support for congestion charging in terms of the way in which it affects people's social welfare in relation to its environmental benefits. This is because congestion charging has the ability to reduce noise levels, vehicle induced dust, accidents and other forms of degradation, giving rise to a better quality of life, creating a more pleasant environment in which to work, live and do business.

In establishing the effect of traffic congestion on the social welfare of local residents, respondents were asked whether they perceive the use of green taxes and regulation or cleaner vehicle technology more equitable or favourable than congestion charging. The respondents ranked cleaner vehicle technology as most equitable and green taxes as second most equitable. Although cleaner vehicle technology is cited by Proost and Calthrop (2002:149) as an effective alternative to reducing emissions, it is important to realise that as vehicle technology increases their levels of emission will fall irrespective of the effect of road pricing on traffic volume. The disadvantage of advocating cleaner vehicle technology, coupled with emission reduction subsidies is that it will actually induce drivers to undertake journeys rather than curbing them as the vehicles are environmentally cleaner. However, cleaner vehicle technology still remains the most equitable instrument in reducing traffic congestion and emissions as perceived by residents and businesses because it does not target their income directly.

In relation to introducing various types of policies to reduce traffic congestion, the introduction of a green tax instead of congestion charging was also put to the public. The results reported in paragraph 6.3.4.3, page 113, and illustrated in Table 6.11, indicated that if green taxes were to be introduced, they must be clearly distinguished from other taxes and charges, making them more acceptable - a notion supported by Rufolo and Bertini (2003:40). The downside of introducing green taxes as an alternative to congestion charging (in equity terms) is that green taxes are usually applied not only to local road users but also at regional or national level, which tends to shift the tax burden beyond the local setting. Hence green taxes have the advantage of drawing revenue from a much wider revenue pool than road pricing, making them an attractive revenue source. Unfortunately, in terms of the benefit principle only the local community will benefit where the congestion charge is in operation and not everyone contributes to the green tax.

Environmental degradation and other negative environmental impacts resulting from traffic congestion can be overcome if businesses take full account of all the costs involved in their decision making process and adopt policies and instruments which reduce environmental degradation at source, necessitating a mix of fiscal and command and control tools which is enforceable. Hence, in answering the more specific research question posed: "What effect do residents, businesses and environmental agencies think road pricing would have on the environment?" it can confidently be said that road pricing has a perceived positive effect on the environment.

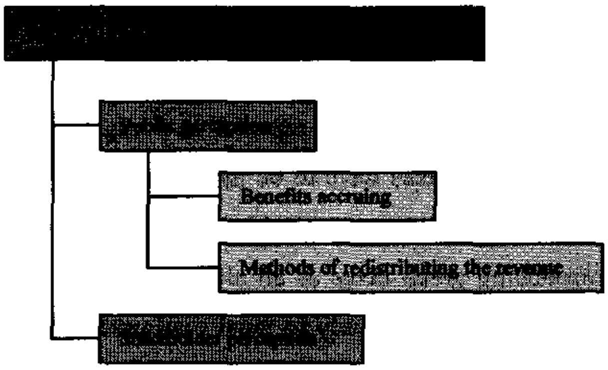
**Summary of discussion**

- Congestion charging inhibits the structural effect of capacity expansion in the congestion zone but may shift vehicles to the peripheral area, hence transferring environmental decay to that location.
- Congestion charging reduces emission levels and enhances air quality leading to a cleaner environment.
- Air quality has also improved as a result of factors other than congestion charging - notably as a result of improved vehicle technology, the weather and domestic heating sources.
- Congestion charging has a positive effect on peoples' welfare gauged against a reduction in noise levels, dust particles and fewer accidents.
- Cleaner vehicle technology is rated as the most preferred and equitable policy option by residents in reducing traffic congestion in terms of environmental improvements.

## 7.2.5 Revenue recycling

Road pricing does not only have the ability to alleviate traffic congestion but also to finance road maintenance and improvement schemes and enhance the efficiency of public transport and bring about a degree of fairness to the tax system. Diagram 7.6 outlines how this section has been divided into two sub-sections, the first relating to the public perception and the second to the perception of the identified transport providers.

**Diagram 7.6 Public perception and revenue recycling**




### 7.2.5.1 Public perception

#### 7.2.5.1.1 Benefits accruing

Viewed against the results reported in paragraph 6.3.5.1, page 115, respondents are overwhelmingly in favour of and will support congestion charging if the revenue is recycled into improving public transport conditions and efficiency and if it reduces their income tax contributions. As Parry and Bento (2001:3) suggest, if the revenues are used to reduce labour taxes, it reduces the deadweight costs of the tax system by encouraging labour force participation, in addition to off-setting the externality distortion caused by congestion. The increase in predicted labour participation arises because the combination of reduced congestion and reduced labour taxes should theoretically more than compensate commuters for the congestion fee leading to an increase in returns to work.

In establishing whether the public perceives a reduction in labour taxes as being more beneficial than using the revenue towards improving public transport, about 80% indicated they favour an improvement to the reliability and efficiency of public transport services, rather than earmarking it to reduce labour taxes. This does not prove Parry and Bento (2001) wrong, it merely suggests the respondents in the survey assigned a greater importance to improving public transport services. However, recycling the revenues in public transport, maintenance and improvements rather than reducing labour taxes is less efficient according to Parry and Bento (2001:22-23) and the relative welfare discrepancy between these two alternatives widens as the amount of traffic reduction grows.

Litman (1999:8) and Newbery and Santos (1999:104) suggested that if out the public perceives reducing labour taxes more beneficial than improving public transport and the increase in the Pigouvian efficiency gains from internalising the congestion externality is larger than the resulting efficiency losses in the labour market, the policy may be well worth pursuing. The findings reported in paragraph 6.3.5.1, page 115, revealed the opposite holds true - the public perceives improving public transport as more beneficial. This does not suggest however that congestion charging is not a policy worth pursuing based upon an efficiency argument.

#### 7.2.5.1.2 Methods of redistributing the revenue

The respondents indicated that they wanted the revenue spent on subsidising public transport fares to achieve cheaper public transport for all. Improving the frequency, efficiency and reliability of public transport came next. In third place was their preference for an integrated land use and transport planning strategy. The choice of spending reflects the public's need to observe visual improvements to public transport and changes in the level of traffic congestion. As Adler and Cetin (2001:448) and Roth (2000:36) suggest, it is important to use the revenue in a manner that is economically efficient, promotes equity and is politically acceptable. For this reason the public will invariably accept an observable method demonstrating and reflecting the "results of the charge". This possibly explains why respondents favour using the revenue for improving public transport rather than reducing labour taxes.

Because the proceeds from the congestion charge are earmarked for local expenditure on roads and public transport improvements and not elsewhere, the benefits accrue directly to the local and peripheral residents in central London. Therefore earmarking is justified in the absence of a strong positive relationship between the beneficiaries of public expenditure and those who pay the tax or charge. In terms of horizontal equity (the benefit principle) this suggests the charging scheme will benefit those who pay as well as those who do not pay. In terms of vertical equity (the ability to pay principle), earmarking may not be an equitable method of redistributing the revenue.

### 7.2.5.2 Stakeholder perception

In achieving TfL's objective of creating a world class public transport system, the proceeds of the charging scheme has to be spent very wisely, albeit efficiently. Although TfL does not hypothecate revenues for particular types of expenditure in general, the proceeds from the congestion charge are earmarked for expenditure on roads and public transport improvements. This has the benefit of preventing the average road user perceiving road pricing as just another general form of taxation, thereby increasing its acceptability as Jones and Hervik (1992:139) suggest.

Of the six public transport providers in the stakeholder group, two have received no revenue to increase their service reliability or efficiency or indeed for any other purpose. The buses have demonstrated the most significant gain in patronage as a result of their increased reliability and efficiency in service. The Tube and Rail services have not reported a significant change, upwards or downwards, in their patronage and reported no major changes to scheduling in order to improve the services' cost efficiency and reliability, despite revenue being allocated to them.

Although the DLR has received financial assistance, the money was invested in their entire network, thereby not diverting it to improving the service at the two stations within the congestion zone. Subsequently DLR saw a decrease in patronage during normal operating hours and a 1% increase during peak hours – deemed as an insignificant change. Taxi and River boat services received no funding, but reported business as usual despite being refused the much needed funding.

This would suggest that the buses gained the most ground in terms of service reliability, efficiency and patronage and is congruent to data obtained in the survey which suggests a 39% modal shift from those using the car to those using the bus. Despite the Tube reporting a bad economic season respondents reported a 32% shift in mode from private car use to using the Tube. Respondents also reported a perceived 21% increase in the use of Train services into and from central London, contradicting the reported 1% increase by the stakeholders.

In sum, revenue recycling has had a positive impact on public transport in as much as the realisation of reliability, efficiency and improvements to the central London road network. These improvements are also coupled with behavioural adjustments and flexible working conditions being made possible, facilitating modal shift. Taking these considerations together it appears as though road pricing in conjunction with revenue recycling has the ability to increase the efficient use of resource allocation (road space) as suggested by Litman (1991:1) and Hyman (1999:54-56). It can confidently be said that revenue recycling is definitely perceived as a factor influencing the acceptance of congestion charging and one which may prove to help sustain the congestion charging scheme in London.

| Summary of discussion |
| --- |
| • Respondents in favour of congestion charging subject to revenue being recycled into public transport. |
| • Respondents favours revenue recycling into public transport above it being earmarked to reduce their income tax, although it is a less efficient policy option. |
| • Earmarking revenue to be used locally in London justified despite equity concerns. |
| • Revenue recycling enhances road user acceptance of congestion charging. |

### 7.2.6 Work schedule flexibility

Arnott et al. (1992:72) and Hendrickson and Plank (1984) identified a possibly fundamental relationship and inter-dependency between work schedule flexibility and congestion charging since allowing employees more flexibility in their work start time may support road pricing as a traffic reduction measure. This relationship has been explored and will be discussed in the following sub-sections.

#### 7.2.6.1 Perception towards work schedule flexibility

The results observed in Paragraph 6.3.6, page 120, have shown a significant (83%) percentage of respondents already having a reasonable degree of flexibility in their work start time, with employers allowing employees to arrive up to 15 minutes late for work. In addition employees as a group are fairly (58%) satisfied with their work start time in relation to avoiding traffic congestion. More importantly though, is the perception of so many respondents that work schedule flexibility can be a very useful tool in relieving traffic congestion.

As expected, the lower the income the less flexibility and satisfaction have been reported in the work start time. High income respondents on the other hand appears to have more flexibility in their work start time which corresponds to the findings of Emmerink and Van Beek (1997:222-223). It is generally assumed in theory that the lower income group adds a low monetary value to its time and is invariably unwilling to pay a charge (tax) if the cost of the trip exceeds the benefits obtained from undertaking the journey. Members of this group would prefer to adjust their work schedule and depart early in order to avoid paying the charge. For the higher income group the opposite holds true. The majority of respondents in the survey indicated they are fairly indifferent to the value of time, indicating fairly similar values of time between the 29 occupational classes. This would suggest that work schedule flexibility is more dependent and influenced by net income than perceived value of time.

Another significant finding illustrated by Table 6.15, page 121, was that of higher educational levels and age corresponding to more flexibility in the work start time. Interestingly, males appear to be more flexible in their work start time than females possibly because the latter are tied to a more socially demanding schedule. Family-life and work conditions are factors which may constrain their work start time. In particular, it is difficult to relax such constraints by means of government regulations. Although employees may be afforded flexible work conditions as Emmerink and Van Beek (1997:217) contends, the road users do not always fully use the flexibility allowed for by the employer because of built in behavioural patterns and other social factors as mentioned above and as Hendrickson and Plank (1984:35) indicate. However such flexibility does at least recognise peoples' differences by allowing them to choose between alternative departure times, modes, delay and the penalty they must pay for using a congestion charged road as Daganzo (1995:152-153) and Burris and Pendyala (2002:241) point out.

In relation to the regressiveness or progressiveness of congestion charging, the results did not report any significant relationship between travel distance and high income, suggesting the cost of commuting does not significantly affect this income group. In terms of taxation principles and social welfare, the high income group would rather pay the congestion charge and avoid traffic congestion or alternatively adjust their travel behaviour by altering their work schedule. This would imply that road pricing is likely to be a regressive policy instrument as high-income earners have more flexibility in adjusting their departure times and have greater ability to pay in comparison to the middle and lower income groups.

#### 7.2.6.2 Relationship between work schedule flexibility and congestion charging

As Sim et al. (2001:339) and Chang and Cheng (2002:2) reported, work schedule flexibility equates to a TDM strategy. Their research suggests that when both road pricing and work schedule flexibility are combined, it becomes a powerful and inexpensive tool in reducing traffic congestion as road users shift their departure times to avoid traffic congestion by adopting a more flexible approach to their work schedule policy where feasible.

For road users to adopt a flexible approach they have to adjust their behavioural patterns to facilitate flexibility. Ott et al. (1974:1) suggest that the behavioural patterns of road users do change when realising flexi-time. These changes include not only alteration to the work schedule but also travel behaviour, non-work activities and attitudes. The survey results suggest respondents are more satisfied with their newly adopted travel choices, presumably because having the flexibility to adapt with respect to route choice, departure time and mode gives tem some scope for behavioural adjustments.

This would indicate that a sufficient fraction of employers provide their employees with freedom to adapt their work start time. The respondents also perceive their ability to adjust their work schedule in conjunction with road pricing as a positive and useful mechanism to help reduce traffic congestion, save time and reduce journey costs. Despite these positive indications the analysis has also revealed that some respondents perceive their flexibility more restrictive. Although the employer provides sufficient opportunities and incentives to adopt flexible working hours, the respondents are not always making or willing to make full use of the options provided for social, personal and domestic reasons.

| Summary of discussion |
|---|
| • A significant percentage of respondents feel work schedule flexibility can be a useful tool in relieving traffic congestion. |
| • Lower income group not so flexible in terms of adjusting departure times to avoid being charged. |
| • The high income group have more flexibility in their work start time and potential for adjusting their departure times. |
| • Work schedule flexibility more dependent and influenced by net income than perceived value of time. |
| • High level of education and age corresponds to more flexibility in the work start time. |
| • Road users do not always use the flexibility afforded. |
| • Work schedule flexibility and congestion charging when combined forms a powerful and inexpensive tool to reduce traffic congestion through forced behavioural adjustments. |

### 7.2.7 Driver information provision

Traffic congestion causes delay and inefficient use of existing road networks as Emmerink et al. (1994:365) reports. Not only does it lead to a waste of travel time but also to an increase in distance travelled. By providing driver information the uncertainty of facing traffic congestion will be reduced if traffic patterns are less unpredictable (Arnott et al., 1994:311).

A very significant percentage of driving respondents indicated they would divert from congested areas when pre-warned or warned en-route. This is due to driver information provision being perceived to improve a driver's decision making ability and judgement since it provides the road user with real time knowledge of road network conditions in and around the congestion zone (Ben-Akiva, 1991:251). This finding reported in paragraph 6.3.7, page 122, is quite important as it confirms the argument cited by Arnott et al. (1991:309-310,317) that if road users receive traffic information and divert, thus points to a change in road user behaviour and the occurrence of induced traffic flow. The change in pre-trip and en-route behaviour or reaction to the information is usually manifested in an adjustment in departure time, mode, decision to travel, choice of destination and route choice in an attempt to avoid traffic congestion. Hence, the behavioural adjustment reported is not only attributable to congestion charging alone but also to the provision of driver information.

Of equal importance is the point made by Arnott et al. (1991:309) in that driver information provision does not necessarily improve traffic conditions, because it affects the general equilibrium of the informed to uninformed driver ratio, which in turn influences the effect of driver information provision. It is quite possible that those drivers not receiving any traffic information will also divert as they observe other drivers doing so, adjusting their travel behaviour until a saturation point has been reached where none of the informed and uninformed drivers will be willing to change their behaviour.

One of the gaps identified is in relation to the extent to which pre-trip and en-route driver information provision affects road user behaviour. The results reported in paragraph 6.3.7 indicate that slightly more driving respondents will react to en-route driver information than pre-trip information. This is explained against driving respondents being more inclined to divert to another route following information provided by radio. Although a number of driver information provision systems exist as cited by El Sanhouri and Bernstein (1994:44-47), De Palma and Lindsey (1988:667), Arnott et al. (1991:317) and Al-Deek and Kanafani (1993:303-304) their use and effectiveness varies to differing degrees. The survey results have shown driving respondents are more inclined to divert to another route following information provided by radio.

This is possibly due to radio traffic reports being a more effective instrument in reaching drivers and having a larger "audience" than a pre-trip information provision instrument such as variable message signs, ATIS or reports on National Television. Drivers are generally more aware of their driving conditions and circumstances whilst en-route and therefore more sensitive to information provided via this method.

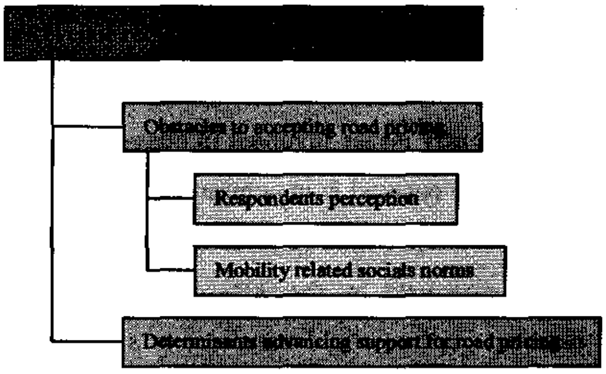
It is also quite possible as Emmerink et al. (1988:77) suggests that drivers will not always respond to the information provided. Drivers who are familiar with the road network are more likely to ignore guidance as they do not perceive it being applicable to their journey or because they perceive it to lack credibility. As a consequence these authors urge policy makers to guard against deliberate manipulation of drivers' decision making so as to maximise information system performance rather than individual benefits because it is unlikely to succeed in the long term. However the results observed in paragraph 6.3.7 have suggested respondents perceive driver information provision as being beneficial in terms of reducing traffic congestion. The general rule that should apply is that if drivers want to avoid traffic congestion more accurate information is more beneficial than no information at all.

De Palma and Lindsey (1998:667-670) and Emmerink et al. (1988:71-73) suggests that if some driver information is provided, drivers will respond to varying degrees, but that any diversion made to avoid traffic congestion will point to a more efficient use of the road network. The findings support these authors' notion that driver information provision is perceived by respondents to increase efficiency in road usage. This argument is joint to the prevailing perception among respondents that providing driver information in conjunction with congestion charging may reduce urban traffic congestion even further. Integrating these two instruments or having them operate in tandem is therefore a policy worth pursuing as Emmerink et al. (1998) suggest, as it will lead in the very least to benefits in time savings and savings in journey distance travelled, thereby recognising the complementary role between congestion charging and driver information provision.

| Summary of discussion |
| --- |
| • A significant percentage of drivers will divert following en-route and pre-warning of traffic congestion. |
| • The provision of driver information provision influences the road user behaviour of those responding to warning or not. |
| • Radio traffic reports are the most effective tool in distributing driver information provision. |
| • The provision of driver information leads to a more efficient use of the road network. |
| • Providing driver information in conjunction with congestion charging may reduce urban traffic congestion. |

## 7.2.8 Public and political acceptance

**Diagram 7.7 Public and political acceptance**




Road pricing is an intrinsically unpopular policy, which will always meet opposition from different angles as Emmerink et al. (1995b:590) reports. The obvious question is why it remains an unpopular instrument despite a thorough theoretical background and proponents demonstrating its economic and welfare benefits. The research has identified some gaps in exploring the public mood and susceptibility towards such a congestion reducing instrument. The results have been divided and will be explained in two separate subsections as illustrated by Diagram 7.7. The first addresses the issues perceived as obstacles to the introduction of road pricing and the second the determinants advancing the credibility and acceptability of road pricing.

### 7.2.8.1 Obstacles to accepting road pricing

#### 7.2.8.1.1 Respondents' perception

Transport strategies aimed at reducing traffic congestion have to be publicly accepted to avoid public protest. It is quite important that the public perceive or concede to the fact that traffic congestion is a serious problem in London. The reported 57.8% of residential and 62.4% of business respondents conceding that traffic congestion is a problem in London confirms just that. This is significant as Schade (2003:3) and Rienstra et al. (1999:181) suggest in order to solve the traffic problem it first has to be perceived as a problem as is the case in London.

#### 7.2.8.1.2 Mobility related social norms

Mobility provides opportunities to engage in spatially dispersed activities. Road pricing or other measures infringing on mobility are perceived as unwelcome obstacles, possibly due to so many people having built their life-styles around the car, despite being very aware and greatly concerned about the problems which cars can cause.

The results illustrated in Table 6.18 have shown respondents to be mainly opposed to congestion charging for the following reasons:

1. Respondents feel they are being charged for the use of a resource that had up to very recently been free
2. Concern about the effects it may have on business profitability and competitiveness
3. The fear of the charge being shifted onto prices of consumables
4. The effect it may have on respondents' welfare
5. Uncertainty about the effects of the charge.

Respondents have shown that they regard the **fairness or equity** issues involved in congestion charging as a fairly unimportant reason for opposing the charge. This in contrast is in contrast to work by Vickrey (1963), Richardson (1974), Foster (1974:186-187), Small (1983), Cohen (1987:239), Jones, (1998) and Oberholzer-Gee and Weck-Hannemann (2002). This is explained by the 90% discount received by residents living in the congestion zone. The 90% discount per household translates to a tax relief or a direct benefit in kind to every resident receiving the discount, irrespective of income. To this end the tax burden is almost neutralised, overcoming the obstacle of its perceived unfairness at the very least to those residents living in the zone as Jones (1998:280-283) confirms.

Another barrier to implementing congestion charging is **scepticism and uncertainty**. Giuliano (1992:335-336) and Jones (1998:280-283) have identified these two factors as further barriers to implementing road pricing. In contrast to their findings, the results in paragraph 6.3.8, page 124, suggest the public is not as sceptical about road pricing as initially predicted by TfL (2003a). Proponents of congestion charging also thought that additional obstacles needing to be overcome were: (i) the notion of the "right to travel", whereby road users perceive congestion charging as an infringement on this right and (ii) the invasion of privacy. Surprisingly these obstacles were not the respondents' biggest concerns contrary to the findings and concern of Giuliano (1992:335-336) and Jones (1998:280-283). The lack of concern in terms of the invasion of road user privacy may be ascribed to vehicle specific enforcement and not so much CCTV (closed circuit television) monitoring which infringes more specifically on the privacy of individual movement.

Unsurprisingly, businesses are **concerned about their profits, competitiveness** and means of staying attractive to customers. The results suggest that businesses perceive congestion charging will reduce their customer base or clientele. Having said that, should it not be shoppers and clients who should be informed of the benefits of shopping in a less congested area? The results in paragraph 6.3.4.2, page 112, indicate that respondents perceive a decrease in traffic congestion in inner London and the related decline in vehicle emissions as conducive attributes in attracting shoppers and clients. When the benefits of congestion charging are realised they manifest themselves in a positive relationship between the perceived reduction in congestion coupled with a more pleasant and stress-free shopping experience. This confirms respondents' susceptibility to change, in that behavioural adaptations are being made willingly to adapt to new circumstances and in the occurrence of modal shift.

Finally two remaining gaps were explored in relation to the public acceptance of the **role of politicians** in alleviating traffic congestion. It appears as though the public recognises the important role politicians play in advancing traffic reduction schemes in the knowledge that without their support implementation would be impossible as Giuliano (1992:355) and Schade (2003:2) confirm. Although Transport for London as the Local Authority, is responsible for the imposition and operation of London's congestion charging scheme, it is also seen as a political entity. The public does not seem to perceive the judgement of politicians and interest groups as credible and convincing. A large percentage will not support them in their efforts to increase the acceptability of a congestion charging scheme through direct democratic approval.

This would suggest that although 80.1% and 71% of the residential respondents and businesses respectively accept congestion charging, very little of this acceptance may be due to political persuasion. It is due rather to the respondents having adapted because of top down imposition. The level of acceptance can therefore also be attributed to a certain degree to respondents reacting and adapting in overcoming many of the obstacles to introducing congestion charging. Therefore unwillingness to accept urban congestion charging can not be advanced as a significant reason for non-implementation.

## 7.2.8.2 Determinants advancing support for road pricing

Having discussed the respondents' perception of the obstacles to introducing congestion charging, it is equally important to determine which determinants they perceive as conducive to enhancing road pricing's acceptability.

From the preceding section the most obvious determinants would be to overcome scepticism, uncertainty and other concerns, to have environmentalist support and political will. This argument is supported by amongst others Small and Gomez-Ibanez (1998:213-214), Flowerdew (1993), Oberholzer-Gee and Weck Hannemann (2002:364) and Gomez-Ibanez (1992:359-360). Schlag and Schade (2000) also argue in favour of advancing a psychological approach to increasing acceptance. Their argument is based on hypothecating the positive effects of road pricing. These include: (i) discussing the externalities arising from road usage to create awareness of the problem, (ii) citing some positive aims and solutions, (iii) providing a trial period for people to change their mode of transport, (iv) pointing out to what use the revenue would be put, (v) allowing the freedom of choice, (vi) creating new mobility related social norms on a collective and a personal level.

Hence, by altering the cognition about the situation and by observing the benefits first-hand, the road user may adapt his behaviour and overcome some scepticism. Additionally Goodwin (1989:495-496, 1990:6-7) advances the argument of Schlag and Schade (2000:314-317) by suggesting the "Rule of Three" should be applied in advancing public acceptability. The important point to recognise here is that the policy maker has to inform the voter of exactly how the revenue will be put to use and which benefits will accrue to him or her.

Only a small percentage of respondents (13.5%) have knowledge of alternative transport demand management strategies and even fewer know or have suggested which strategy they perceive to be most acceptable. This is not surprising as TDM strategies are technical and specialised instruments about which the general public often has very little knowledge. This presents some scope, for politicians to educate the public in alternative options to attack the congestion problem and at the same time raise awareness and possibly increase acceptance. In doing so a balance will have to be struck between the obstacles and the determinants or the means to overcome the obstacles.

The results have also shown (generalising from the respondents to the public) that the public recognises the need for clearly stated objectives such as: (i) the regulation of traffic demand management, (ii) the achievement of environmental benefits, (iii) the raising of revenue for investment in transport systems and also (iv) reassurance that public transport will be reliable once road pricing has been introduced. It is also important to road users to understand how road pricing will be integrated with other congestion and traffic management measures, how the scheme will be enforced, and how the revenue will be utilised. As long as this information is communicated to the road user it would increase acceptance as Truelove (2000:15-17), Jakobson et al. (2000:158-157) and Ison (2000:276) suggest.

**Summary of discussion**

- A significant percentage of respondents perceive traffic congestion as a serious problem in London.
- Fairness or equity arguments are not perceived as an important reason for opposing congestion charging.
- Scepticism, uncertainty, the notion of the "right to travel" and the invasion of privacy are significant barriers to implementing road pricing strategies.
- The public is sceptical about the role of politicians in advancing mechanisms to reduce traffic congestion.
- Despite public and business sector concerns, a significant percentage of these stakeholders accept congestion charging.
- Mechanisms have to be put in place to overcome scepticism, uncertainty and concerns about the invasion of privacy.
- Public acceptance will increase if they are kept in the picture as to how revenue is being spent and how congestion charging together with other traffic congestion combating measures are used in sync.

# 7.3 Locally perceived problem areas or obstacles

Having discussed, interpreted and briefly summarised the results, several problem areas, concerns and obstacles have been collectively identified, which obstruct the efficient and sustainable implementation of road pricing. These are reported on page 157 in no particular order of importance and form the basis for developing options or policy alternatives to overcome these problems and obstacles.

| Problem areas, concerns and obstacles |
|---|
| • Concerns about business profitability and competitiveness |
| • Concerns about the government's ability to spend revenue wisely |
| • The incidence of congestion charging |
| • A need for the promotion of an integrated land use and transport strategies |
| • Lacking stringent parking enforcement |
| • Not enough is being done about the promotion of emission abatement |
| • Lack of transparency in revenue recycling |
| • Revenue not satisfactorily being spent on public transport improvements and road maintenance |
| • There is a need to advocate the beneficial link between flexible working hours and congestion charging |
| • There is a need to advocate the beneficial link between driver information provision and congestion charging |
| • A significant level of scepticism towards the acceptance of congestion charging, uncertainty, the notion of the "right to travel" and the invasion of privacy |
| • The public is sceptical towards the role of politicians in demand management |
| • The benefits and impacts of the scheme in London is not communicated sufficiently to the stakeholders. |

# 7.4 Appropriateness of the methodology and data collections methods

The method of study involved an exploratory and descriptive investigation as a means of obtaining the desired data to fill identified gaps. In hindsight, the strategy followed proved quite useful in terms of accessing data from various stakeholders. Having identified a number of key stakeholders it was envisaged that a large volume of data would be obtained and it would be a demanding task to report and analyse the data. Fortunately the selected computer software made this task less daunting and provided efficient and accurate results.

The identification of the population and obtaining of the required statistical data enabling random selection, went ahead without encountering any difficulties or obstacles and would suggest it was possibly the most efficient data collection procedure to set the stage for the survey. Although a fairly good response rate was attained in both the residential and business questionnaires, enabling generalisation, a higher response rate may have been achieved if the questionnaires had been shorter.

This may have been facilitated by programming the different sections in both questionnaires over some months and sending each section of the current questionnaires as a separate questionnaire. The response rate may have been increased had the questionnaire been shorter but, in order to meet deadlines in relation to the study program, this was not possible. In general, both structured and semi-structured instruments served their purposes adequately. The research design has also promoted the internal and external validity of the findings, strengthening the case for generalising the findings from the respondents to the public.

# 7.5 Conclusion

Having discussed the scope of the effects and factors supporting road pricing, the findings were briefly summarised at the end of each section. Because the research design promoted internal and external validity of the findings and a good response rate were achieved, the findings can be generalised from the respondents to the general public. Whilst interpreting the results, the remaining problem areas and concerns were also collectively identified and reported. The remaining problems and concerns form the basis for developing various options or policy alternatives for consideration to ultimately formulate and implement plausible recommendations on how to present road pricing as a viable and sustainable policy instrument. These options and policy alternatives will be developed and explained in more detail in the next chapter.

# Chapter 8 Multi criteria analysis

## 8.1 Introduction

As part of the purpose of the research it was necessary to identify the effects road pricing had on the local economy, peoples' welfare, land use and the environment and to identify the factors which may prove to sustain its viability. In doing so a number of gaps in the current knowledge were identified. The survey explored these gaps and following the discussion and interpretation of the results, gave useful results in bridging the gaps and in exposing Londoners' perception. It also identified a number of remaining problem areas, concerns and obstacles.

Against this background and through having access to a more holistic picture, the stage is set to identify various options for overcoming these problems and to develop and recommend feasible ways of implementing a viable and sustainable road pricing scheme. Multi Criteria Analysis (MCA) is used in establishing preferences between options by reference to an explicit set of policy objectives which had been identified, and for which measurable criteria have been established in order to assess the extent to which the options may contribute to achieving the objectives.

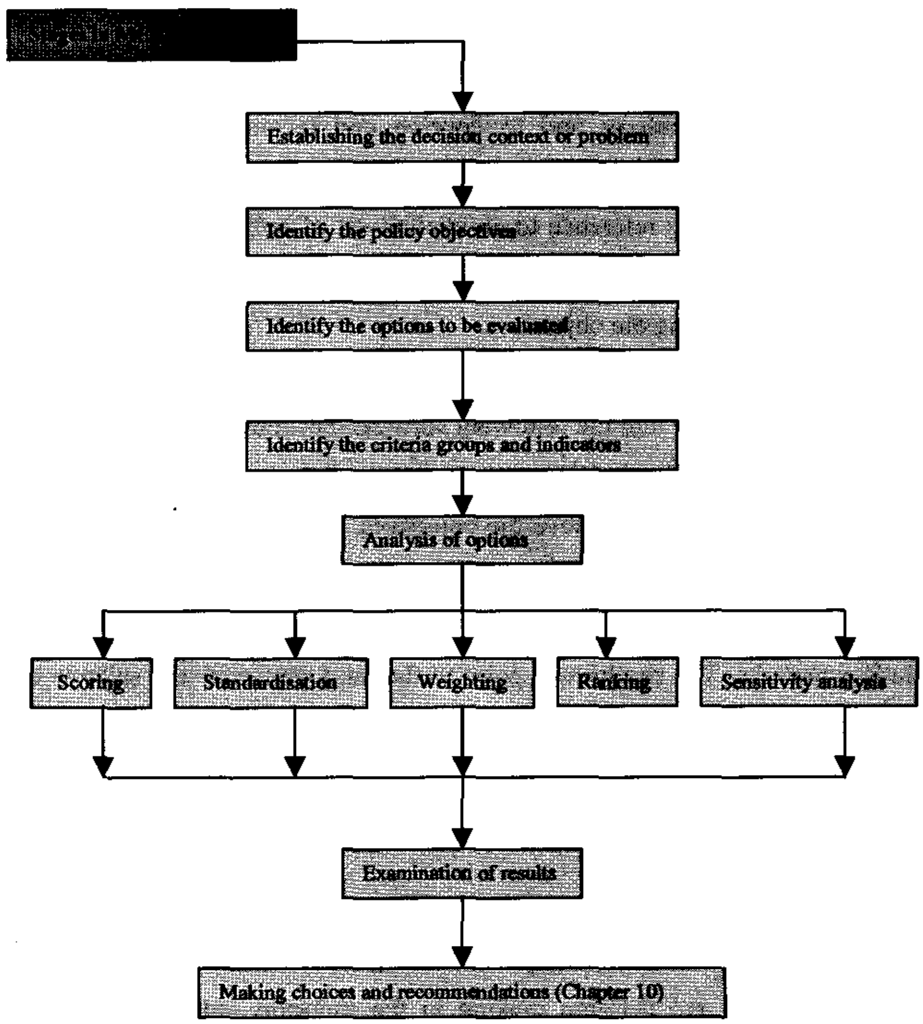
The remaining part of this chapter is divided into the following sections. Section 8.2 gives a brief account of the MCA approach. Section 8.3 explains the decision context, Section 8.4 reports the policy objectives, Section 8.5 reports various options identified to achieve the objectives, Section 8.6 reports the identified performance criteria groups and indicators, Section 8.7 describes the analysis and reports the findings, Section 8.8 summarises the results obtained after using the MCA software package BOSDA and Section 8.9 provides some concluding remarks. The results will point to the most preferred and suitable options for overcoming problems and concerns and will allow the formulation of recommendations.

## 8.2 MCA approach

The DETR (2003:6) provides guidance for undertaking and making the best use of MCA in order to evaluate alternative options for policy and decision making in the transport industry. The approach followed here is to identify a number of policy options from a pool of options for subsequent appraisal and to establish acceptable possibilities. In this regard MCA is quite useful in dealing with the difficulties of having to appraise and evaluate a large amount of complex information in a consistent way.

The approach advocated by the DETR involves procedures using quantitative and qualitative data inputs. Although the DETR (2003:22) takes the view of reliable and transparent decision making being more effectively achieved by using quantitative data (using numerical weights and scores), it also acknowledges an alternative approach, largely developed in the Netherlands whereby MCA allows for the input of "imprecise" qualitative data (referring to the use of BOSDA). The DETR feels BOSDA is most applicable in the area of urban and regional planning. Because the results obtained in the survey comprise both quantitative and qualitative data, BOSDA is a suitable software package for undertaking the analysis and examination of alternative options. Diagram 8.1, illustrates the steps involved in the MCA process. These steps and the aspects they cover are discussed in greater detail in the sections that follow.

**Diagram 8.1 MCA process**




# 8.3 Establishing the decision context

It is important to measure and decide upon the success of London's congestion charging scheme and the extent to which road pricing affects the local economy, peoples' welfare, land use and the environment and also the extent to which the sustaining factors are or could be successfully implemented. Decisions will be made against the background of the **policy goal**, which is to reduce urban traffic congestion through the development and implementation of road pricing as a viable and sustainable policy instrument. To this end, a number of policy objectives will be developed based upon the problem areas and concerns identified in section 7.3, page 156.

Once the policy objectives have been developed, the next stage is to identify, develop and evaluate various policy options in achieving these objectives. Following the identification of policy options, criteria and indicators measuring the extent to which the options contribute to achieving the objectives, will be analysed by use of BOSDA. This enables trade-offs to be made between policy options when deciding which should aggressively be pursued and which should be nurtured in the formulation of an approach to reducing traffic congestion.

## 8.4 Identifying the policy objectives

| Policy objectives |
| --- |
| i) Increase the reliability of public transport encouraging modal shift |
| ii) Adapt the planning process to encourage traffic reduction |
| iii) Emission regulation |
| iv) Invest in transport infrastructure |
| v) Managing the road network by coordinating its use and maintenance |
| vi) Provide road users with up to date travel information |
| vii) Obtain public and political support and will. |

Good decisions needs clear objectives. The **policy objectives** on the left set out the aspects that need to be addressed in overcoming the remaining problems and in achieving the policy goal. The policy objectives in the current context are aimed at identifying and developing options which will contribute towards road pricing reducing urban traffic congestion. Having a set of objectives and options leads on to the necessity to analyse identified policy options with the aid of a multi criteria analysis to establish which options will best answer the objectives and will be best suited to reduce traffic congestion and under what circumstances this will be achieved.

## 8.5 Identify the options

| Options/Policy alternatives |
| --- |
| 1. Promote public acceptability through transparency, consultation and democratic choice. |
| 2. Promote the integration of land use and transport strategies. |
| 3. Promote efficient and equitable use of revenue. |
| 4. Deploy a portfolio of fiscal and command and control instruments to abate environment damaging emissions. |

In achieving or striving towards the achievement of the objectives it is necessary to identify and develop options that may contribute to the objectives. Four options have been developed against (i) the background of the objectives problems, concerns and obstacles identified in section 7.3 and (ii) by consulting the current literature in terms of international experience and (iii) through self-selection. The arguments for the inclusion of each policy option to the selection pool will briefly be put forward below.

## 8.5.1 Arguments for selecting options

### 8.5.1.1 Promote public acceptability through transparency, consultation and democratic choice

The operation of the congestion charging scheme must provide proper opportunities for all interested parties to comment on every detail of the scheme based on adequate and balanced information provided and by allowing proper debate and discussion among all stakeholders. In overcoming the acceptability obstacle, a number of key elements has to be phased over time allowing the appropriate authority to explain the mechanics of the scheme, its likely effects, costs and benefits in order to gain public backing and acceptance.

Part of the consultation process should provide the business community with an opportunity to voice their concerns. Although only a small percentage of businesses believed their profitability and competitiveness would be affected by congestion charging, arguing that other economic forces and non economic influences have also been at work during 2003, it is important to identify and implement instruments which may contribute to sustaining business competitiveness and profitability. Additionally, consultation will present the opportunity for employers and employees to discuss the role of having a reasonable degree of flexibility in their work start time so as to contribute to reducing traffic congestion but also as a recognition of peoples' different life styles and behavioural patterns.

### 8.5.1.2 Promote the integration of land use and transport strategies

The results have recognised the need to co-ordinate land use mix, development density, development clustering and the land use process with transport needs. In planning transport facilities and predicting trends in transport planning and land-use planning, it is important that the consequences of trends be borne in mind. If vehicular traffic is to grow, then unless the growth is restricted to areas and to times of day when and where additional traffic can be accommodated, land-use structures must change.

Integrated planning of transport strategies, infrastructure, urban and regional planning can help reduce the need to travel and decrease emissions, land take, resource consumption and other nuisances. In the context of sustainable development, strategic integrative planning which involves impact assessment (i.e. the application of strategic environmental assessment) helps to create land use patterns that place activities close to each other, therefore reducing the need to travel. The emphasis in planning should be placed on accessibility rather than on mobility i.e. the aim of planning should be to carry out everyday activities with less need to travel. Fundamentally, an approach must be followed that recognises the role of spatial planning, how it interacts with public transport, manages the road network and the beneficial use of information technology leading in the very least to benefits in time savings and savings in journey distance travelled.

#### 8.5.1.3 Promote efficient and equitable use of revenue

Revenue recycling is another key option requiring careful consideration and implementation. In assigning or distributing revenue to various objectives three prerequisites have to be borne in mind. They are economic efficiency, equity and public and political feasibility. One of the most publicly sensitive issues surrounding the use of revenue concerns whether priority is going to be given to its investment in public transport and infrastructure maintenance. Additionally sufficient public transport capacity has to be provided in and around the congestion zone to cater for modal shift.

The introduction of the scheme without a significant improvement in commuter journeys (particularly by rail) risks leading to further public frustration. Income generated by the scheme where it is being targeted and the results of the monitoring programme should be made public to allow a degree of transparency into the financial aspects of the scheme. The use of the revenue should also particularly address equity issues via the distribution of the revenue, increasing vertical equity and approximating the benefit principle in taxation. Hence it is important to consider alternative ways of decreasing the tax burden to the lower income group and disabled road users when addressing the social effect of congestion charging on the poor and vulnerable.

#### 8.5.1.4 Deploy a portfolio of fiscal and command and control instruments to abate environment damaging emissions

Congestion charging is expected to change the volumes and patterns of traffic in and around the charging zone resulting in changes to road vehicle emissions, which will in turn affect concentrations of pollutants in the atmosphere. This relationship is not a direct one, however, and the changes in local pollutant concentrations resulting directly from the scheme are small and hence difficult to detect using conventional assessment methods in the short or medium-term. However small such a contribution may be, the deployment of a portfolio of fiscal and command and control instruments to abate environment damaging emissions in conjunction with congestion charging will serve a dual purpose in decreasing vehicle emissions and vehicular traffic. Typically, some of these instruments may include cleaner vehicle technology, green taxes, vehicle regulation and/or the regulation of technology.

# 8.6 Identifying the criteria and indicators

**Table 8.1 Criteria and indicators for assessing the options or policy alternatives**

| Criteria | Indicators |
|---|---|
| **Impact on traffic congestion** | Mode shift<br>Reduction in traffic<br>Carpooling<br>Change route<br>Not undertaking trip |
| **Spatial impact** | Centralising impact<br>Decentralising impact<br>Extent of land use mix<br>Extent of development clustering<br>Extent of development density<br>Influencing planning process<br>Scope for transport and land use integration |
| **Public perception** | Reliability of public transport<br>Investment in public transport<br>Business impact<br>Invasion of privacy<br>Scepticism<br>Fairness<br>Environmental benefits<br>Information provision |
| **Implementation cost** | High<br>Medium<br>Low |
| **Contribution to efficient and equitable use of revenue** | Cheaper transport fares<br>Increased frequency and reliability of public transport<br>Cash rebates<br>Vehicle tax subsidy<br>Earmarking<br>Investment in public transport |
| **Contribution to investment in transport** | Expansion of road capacity<br>Safe cycle and walking network<br>Frequent and reliable public transport<br>Park and ride sites |

Once the decision context has been established and various policy options for evaluation have been identified, the next stage is to decide on how to compare the different options' contribution to meeting the policy objectives. This requires the selection of criteria and indicators, reflecting the performance of the options in meeting the objectives. Each criterion is measurable, in the sense that it will be possible to assess, at least in a qualitative sense, how well a particular option is expected to perform in relation to the criteria and indicators.

Table 8.1, illustrates the selected criteria and indicators and is followed by a synopsis of the chosen criteria in sections 8.6.1 to 8.6.6 below, explaining the reason for their selection.

## 8.6.1 Impact on traffic congestion

The first and foremost criterion policy options must meet is for it to contribute towards reducing traffic congestion. This criterion is at the heart of the debate when policy makers make a case for congestion charging – if a policy options does not contribute towards reducing traffic congestion it will undoubtedly be rejected and be based on a flawed foundation.

## 8.6.2 Spatial planning

When considering an option's contribution to meeting the objectives, it is important to measure its usefulness in terms of spatial planning and its land use impact. If the emphasis in planning is placed on accessibility rather than on mobility, the options most conducive to this purpose should not have an adverse impact on land use but rather contribute towards integrating transport strategies that aim to reduce the need to travel or at least make it more convenient.

### 8.6.3 Public perception

Possibly the biggest obstacle to successfully implementing congestion charging is gaining public acceptance and having it backed by politicians. That is why public and political acceptance is a key criterion when measuring the extent to which alternative policy options contribute to achieving the policy objectives. It also highlights the importance of public consultation and of giving all interested parties the opportunity to comment on every detail of the scheme based on adequate and balanced information provided allowing proper debate and discussion among all stakeholders.

### 8.6.4 Implementation cost

Cost is always a factor when bidding for projects or considering government programs. Since a road pricing program is no exception the cost of implementation has to be considered carefully in terms of a cost benefit analysis. In measuring several policy options' contribution to achieving predetermined objectives, the cost and choice between each option is inevitably a fundamental element in the decision making process.

### 8.6.5 Contribution to investment in transport

When imposing a congestion charge on road users it is important to provide alternative reliable modes of transport, catering for those who have been priced off the road and enabling modal shift. When the policy goal is to reduce traffic congestion, improvements to the provision of public transport are essential. When the policy options are measured against this criterion, the extent to which they contribute to achieving this goal will be revealed.

### 8.6.6 Contribution to efficient and equitable use of revenue

A major concern for policy makers is the effect of the £5 charge on household income, saving, consumption and employee productivity. It is feared that the charge does not take income into account and therefore may particularly disadvantage those on low incomes who have a legitimate need to use their car in central London. Even if it is assumed that the majority of people in the lowest income group in inner London cannot afford a car and are largely dependent on public transport, it still leaves the remaining income groups with an unwelcome tax burden. Revenue raised should be applied to decreasing the tax burden so as to increase equity and also to provide some efficiency in the distribution of the revenue. It is therefore important for alternative policy options to be measured in terms of their use of the revenue to ensure they do not have a detrimental effect on peoples' welfare.

## 8.7 Analysis of options

Once the criteria and indicators have been identified, the next stage in the process is carrying out the analysis as illustrated in Diagram 8.1 using BOSDA. The process and results are discussed and reported as follows: section 8.7.1 explains the scoring process and reports the scores assigned to criteria and indicators. Section 8.7.2 explains and reports the standardisation of the scores. Section 8.7.3 explains how weights are assigned to the standardised criteria and indicators. Section 8.7.4 reports the ranking of the options following the BOSDA MCA. Finally, in section 8.7.5, the ranking of the options will undergo a sensitivity test ensuring that the findings are reliable and identifying any irregularities in the data. First, the purpose of the scoring process is explained and the scores assigned to criteria and indicators are reported.

### 8.7.1 Scoring

**Table 8.2 Score origins**

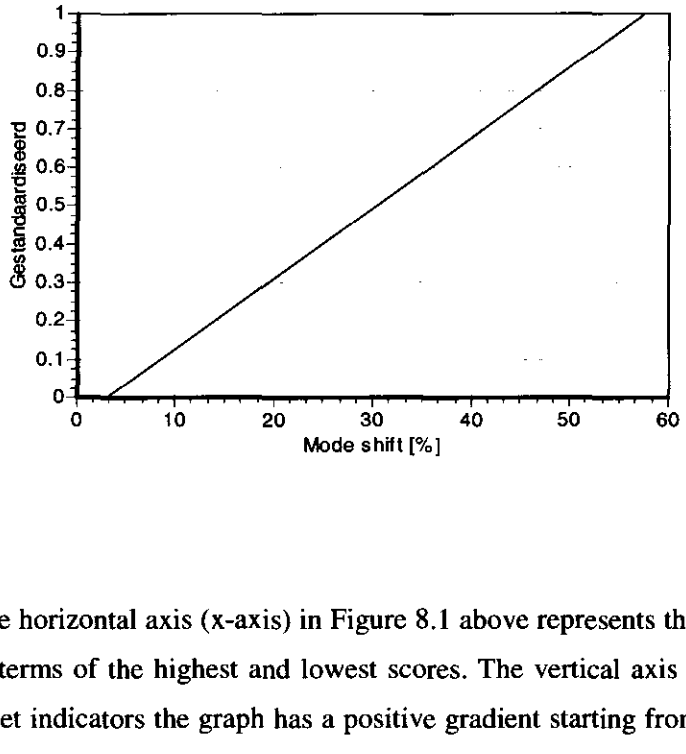
| Score origin | Page Number, Chapter |
|---|---|
| **Impact on traffic congestion** | |
| Mode shift | 105, Chapter 6 |
| Reduction in traffic | 97, Chapter 6 |
| Carpooling | 106, Chapter 6 |
| Change route | 105, Chapter 6 |
| Not undertaking trip | 105, Chapter 6 |
| **Spatial impact** | |
| Centralising impact | 98, Chapter 6 |
| Decentralising impact | 98, Chapter 6 |
| Extent of land use mix | 109, Chapter 6 |
| Extent of development clustering | 110, Chapter 6 |
| Extent of development density | 110, Chapter 6 |
| Influencing planning process | 110, Chapter 6 |
| Scope for transport and land use integration | 110, Chapter 6 |
| **Public perception** | |
| Reliability of public transport | 124, Chapter 6 |
| Investment in public transport | 124, Chapter 6 |
| Business impact | 124, Chapter 6 |
| Invasion of privacy | 124, Chapter 6 |
| Scepticism | 125, Chapter 6 |
| Fairness | 124, Chapter 6 |
| Environmental benefits | 124, Chapter 6 |
| Information provision | 122, Chapter 6 |
| **Implementation cost** | |
| High | TfL, 2003a |
| Medium | TfL, 2003a |
| Low | TfL, 2003a |
| **Contribution to efficient and equitable use of revenue** | |
| Cheaper transport fares | 116, Chapter 6 |
| Increased frequency and reliability of public transport | 116, Chapter 6 |
| Cash rebates | 65-66, Chapter 4 |
| Vehicle tax subsidy | 65-66, Chapter 4 |
| Earmarking | 65-66, Chapter 4 |
| Investment in public transport | 116, Chapter 6 |
| **Contribution to investment in transport** | |
| Expansion of road capacity | 116, Chapter 6 |
| Safe cycle and walking network | 116, Chapter 6 |
| Frequent and reliable public transport | 116, Chapter 6 |
| Park and ride sites | 116, Chapter 6 |

Before electronic analysis of the inputs can start, the expected performance of each quantitative and qualitative option has to be assessed against the identified criteria and indicators by scoring the options i.e. assessing their value. For the purpose of data input indicators are identified as "costs" and others as "assets". The expected consequences or performance of each quantitative option are assigned a numerical score on a preference scale extending from 0 to 100, for each indicator. The value assigned reflects the extent to which the option may contribute to achieving the policy objectives. Cost indicators will have negative values and asset indicators will have positive values. This will result in more preferred options scoring higher on the scale and less preferred options scoring lower. Hence, all options considered in the MCA would then fall between 0 and 100 in terms of assigned value. Qualitative data on the other hand is dealt with by categorising the performance of each criterion into three or four categories (++++, +++, ++ and +) in descending order of quality.

The score assigned to each indicator has been extracted from the survey results reported in Chapter 6, the literature survey reported in chapter 4 and TfL results from 2003. The origin of the scores is illustrated in Table 8.2, page 166. The complete scoring results used in the BOSDA analysis are reported in Appendix K, page 264. Where a zero value has been assigned against an option, it means there is no available data whereby to assign a score or the indicator has no relation to the option.

## 8.7.2 Standardisation

**Figure 8.1 Score standardisation**




Next the scores observed in Appendix K are standardised or transformed from quantitative and qualitative scores to standardised scores ranging between 1 and 0. Interval standardisation has been chosen to standardise the scores for simplicity. Once the quantitative and qualitative scores have been standardised, their values are graphically interpolated on a linear line, reflecting the minimum and maximum values of the criteria and their respective indicators similar to the linear line presented in Figure 8.1 for the "mode shift" indicator.

The horizontal axis (x-axis) in Figure 8.1 above represents the original quantitative and qualitative scores in terms of the highest and lowest scores. The vertical axis (y-axis) shows the standardised values. For asset indicators the graph has a positive gradient starting from the origin of the graph, where the x and y axis meet, implying that a low quantitative and qualitative score will have a low standardised value. For cost indicators the graph has a negative gradient, implying that a low quantitative and qualitative score are assigned a high standardised value. Once the quantitative and qualitative scores have been standardised, the data is presented in a table format as shown by Appendix L, page 265, reflecting the minimum and maximum values assigned to each indicator. The data is now in an appropriate format to be weighted.

### 8.7.3 Weighting

Next, numerical weights are manually assigned to each criteria and indicator using pairwise comparisons, defining each criterion and the relative valuations of a shift between the top and bottom of the chosen scale to reflect their relative importance in the decision making process. Pairwise comparisons are made between alternative criteria and indicators by valuing (qualitatively) a pair at a time, indicating which criterion and/or indicator is the most important of the two in terms of the comparison. Criterion importance assessments are qualitative and restricted to seven categories coded 1 = no difference in importance, to 7 = always more important than, in descending order of importance. Depending on the difference in assessed performance, each comparison might be at one extreme a major positive difference, assigned a weight, coded as 7. At the other extreme, where both compared criteria are of equal importance they are coded 1. Intermediate differences are coded between assessments 2 and 6.

In Appendix M, page 266 the weights assigned to criteria are illustrated in column Weight Niveau 1. The largest weight has been assigned to the impact on traffic congestion, being 0.200, reflecting its importance to the public. It is fundamental that any option selected reduces traffic congestion. Then, public perception and the contribution to investment in transport have been weighted second heaviest with weights of 0.190 respectively. Both of these criteria are identified as being important to the public and other stakeholders concerned. Spatial impact and implementation cost have been weighted 0.160 respectively. The contribution to efficient and equitable use of revenue has been weighted only 0.100 as this criteria was of least concern to respondents. The separate weights assigned to the criteria combined equates to 1.

Similarly, the weights assigned to the indicators are illustrated in column Weight Niveau 2. The indicators weighted heaviest for each criteria are:

- Reduction in traffic (weight: 0.300)
- Scope for transport and land use integration (weight: 0.300)
- Reliability of public transport (weight: 0.300)
- Low implementation cost (weight: 0.400)
- Investment in public transport (weight: 0.300)
- Frequent and reliable public transport (weight: 0.300).

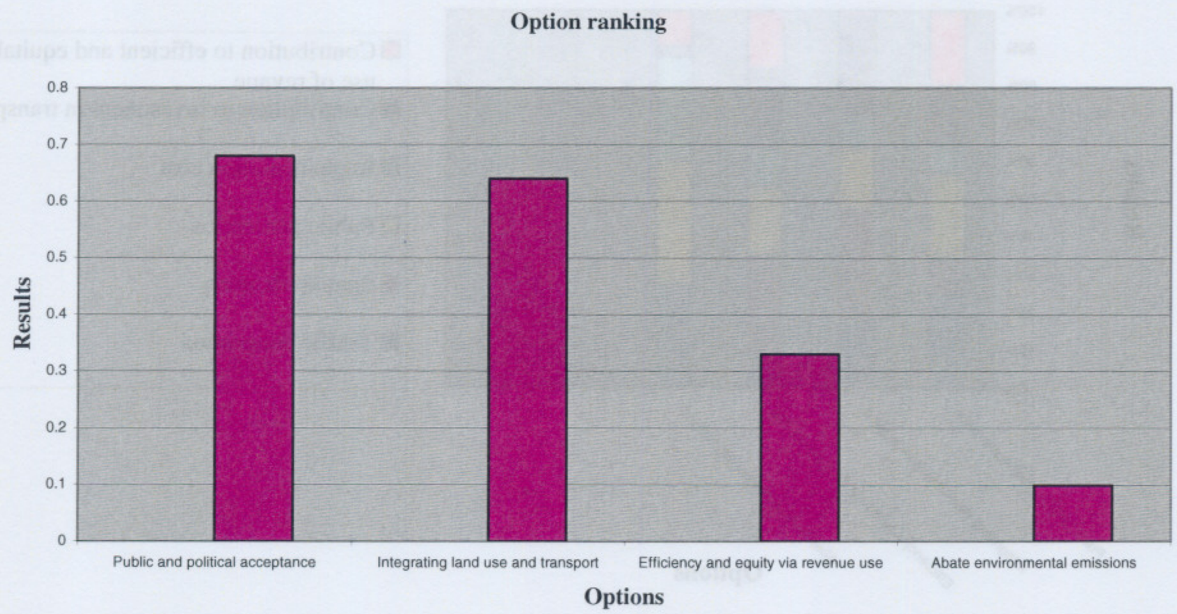
These indicators have been identified as the most important and influential in terms of the results as indicated by the respondents. Again the separate weights combined for each indicator equates to 1. Once pairwise comparisons have been made, BOSDA weights the data electronically and quantitative weights are assigned to the criteria and indicators. The column to the far right of Appendix M, weight, illustrates the final weight to each indicator reflecting its respective importance and contributions to achieving the policy objectives. The weighted data is also electronically checked for inconsistencies to ensure the validity of the results.

## 8.7.4 Ranking of options

| Ranking | Policy option |
|---|---|
| 1 | Promote public acceptability through transparency, consultation and democratic choice. (Score: 0.68) |
| 2 | Promote the integration of land use and transport strategies. (Score: 0.64) |
| 3 | Promote efficient and equitable use of revenue. (Score: 0.33) |
| 4 | Deploy a portfolio of fiscal and command and control instruments to abate environment damaging emissions (Score: 0.10) |

Once the criteria and indicators have been scored, standardised and weighted, the next stage in the MCA process is ranking the options in terms of the criteria and indicators, reflecting which options contribute most to achieving the policy goal and objectives. Again, this process is dependent on using BOSDA. The results are textually illustrated to the left and graphically illustrated in Chart 8.1. The horizontal axis (x-axis) represents the options, whereas the vertical axis (y-axis) shows the ranking. The height of each bar reflects the option's preference, hence, the higher the bar, the more preferred it is.

**Chart 8.1 Option ranking**




The results in Chart 8.1 (base results) suggest that of the policy options considered the one most likely to achieve the policy objectives is the promotion of public acceptability through transparency, consultation and democratic choice. This is followed in the second position by the option of promoting the integration of land use and transport strategies and in third place that of promoting efficient and equitable use of revenue. Deploying a portfolio of fiscal and command and control instruments to abate environment damaging emissions is the least preferred option and will make the smallest contribution to achieving the policy objectives.

**Chart 8.2 Criteria weights**

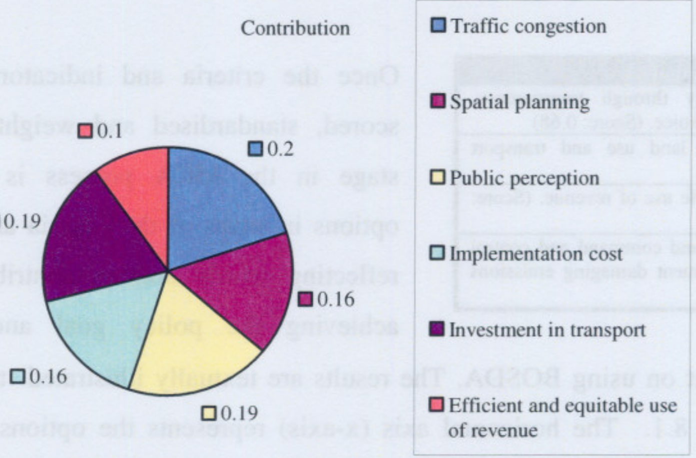



Chart 8.2 illustrates the relative weights assigned to each criteria. It is apparent that traffic congestion has been weighted heaviest, being the most influential criteria. Weighted second heaviest is public transport and investment in transport. The contribution to efficient and equitable use of revenue has been weighted only 0.100.

**Diagram 8.2 Contribution of criteria to options**

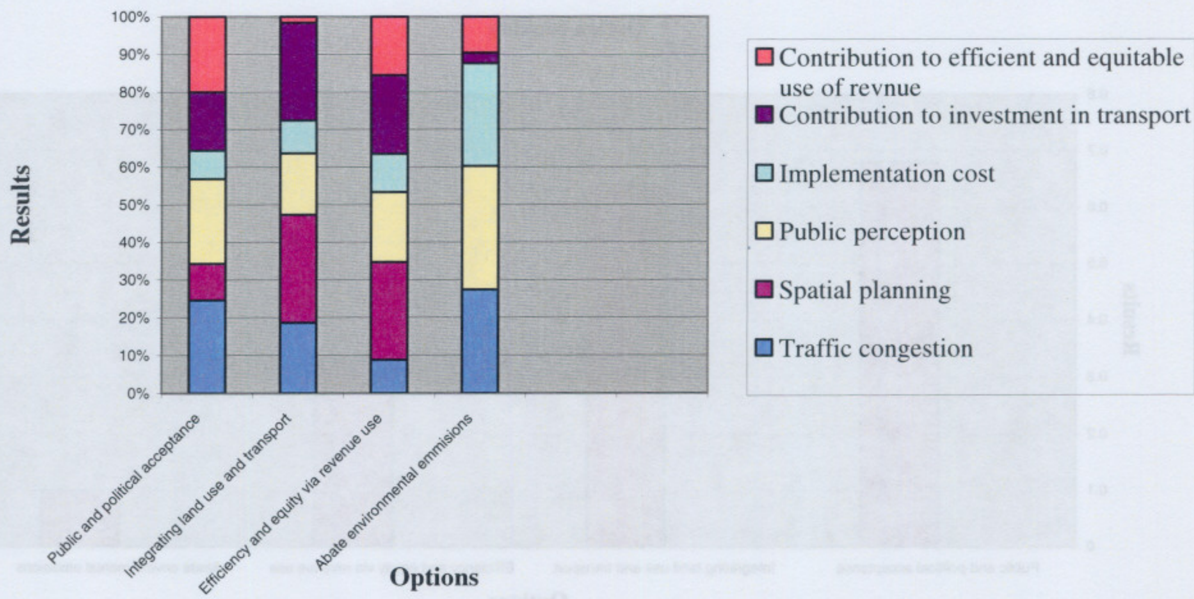



Diagram 8.2 illustrates the contribution or influence of each criterion to the end score of each option or policy alternative. Unsurprisingly traffic congestion, spatial planning, public transport improvements and public and political perception contribute most to the end scores of the different options. However, the criterion contribution to equity and efficiency does not appear to be an influential criterion in achieving integrated land use and transport strategies. Neither does the contribution of the investment in transport criterion, appear very influential in terms of the abatement of environment damaging emissions option.

## 8.7.5 Sensitivity analysis of the option ranking

A natural question arising during and following analysis is the reliability of the findings of the BOSDA MCA and the ranking of the options. This question is answered by performing an electronic sensitivity analysis as a means of examining the extent to which vagueness about the inputs can be overcome and identified and also in assessing the influence of each criteria weight (Weight Niveau 1). By electronically varying the weights and scores of each criterion it is possible to assess the extent to which the expected performance and ranking of each option will change as a result. If the differences between the options under different weighting systems is small, it reflects the reliability of the initial analysis. The results of the sensitivity analysis are illustrated in Figure 8.2a-f and are examined and explained in the sub-sections to follow.

**Figure 8.2a Sensitivity analysis for criteria – traffic congestion**

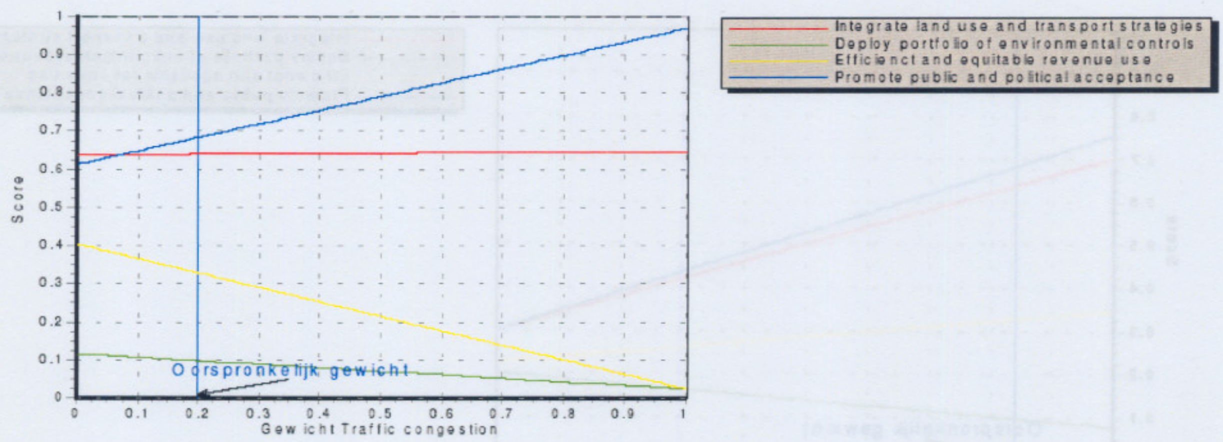



**Figure 8.2b Sensitivity analysis for criteria – spatial planning**

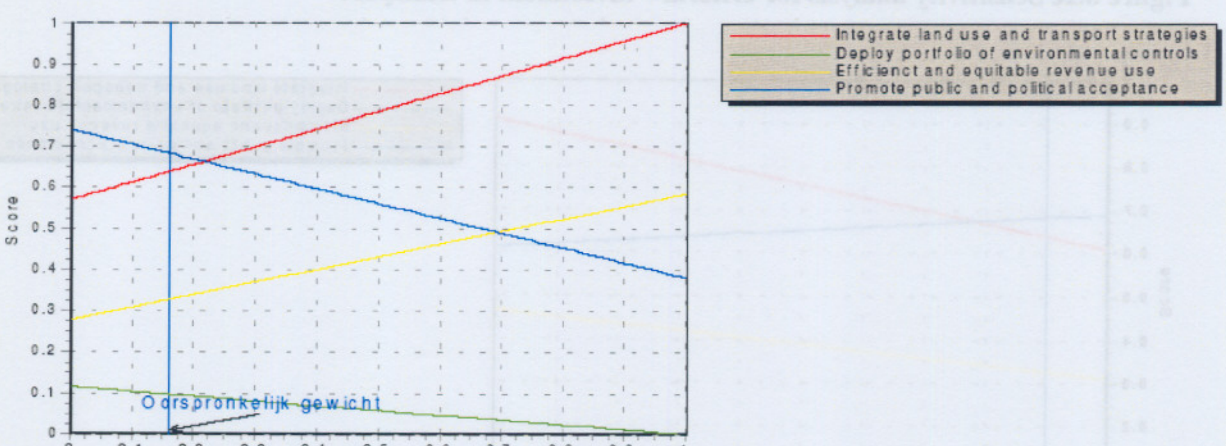


**Figure 8.2c Sensitivity analysis for criteria – public perception**

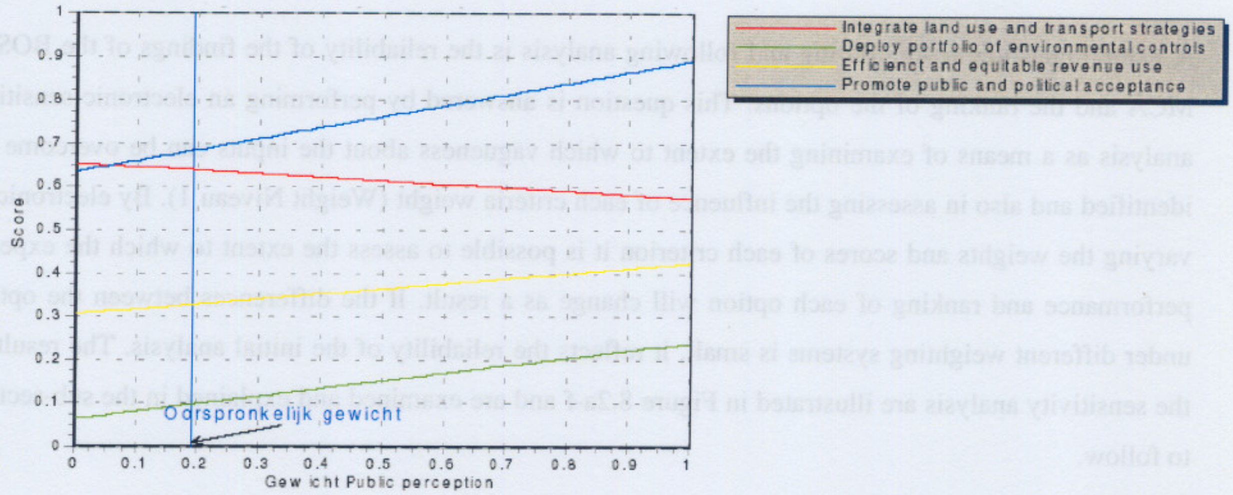



**Figure 8.2d Sensitivity analysis for criteria – implementation cost**

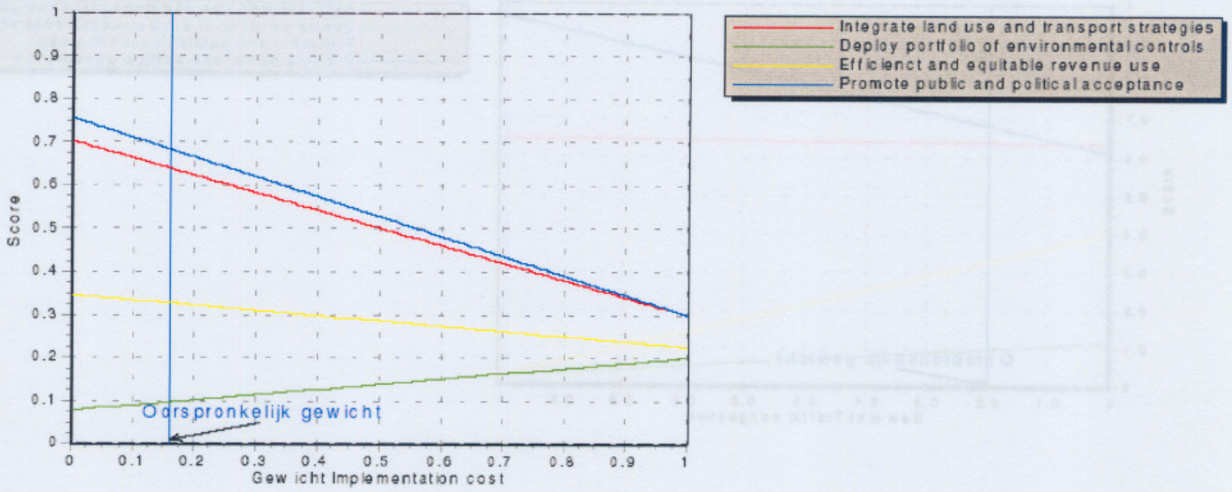



**Figure 8.2e Sensitivity analysis for criteria – investment in transport**

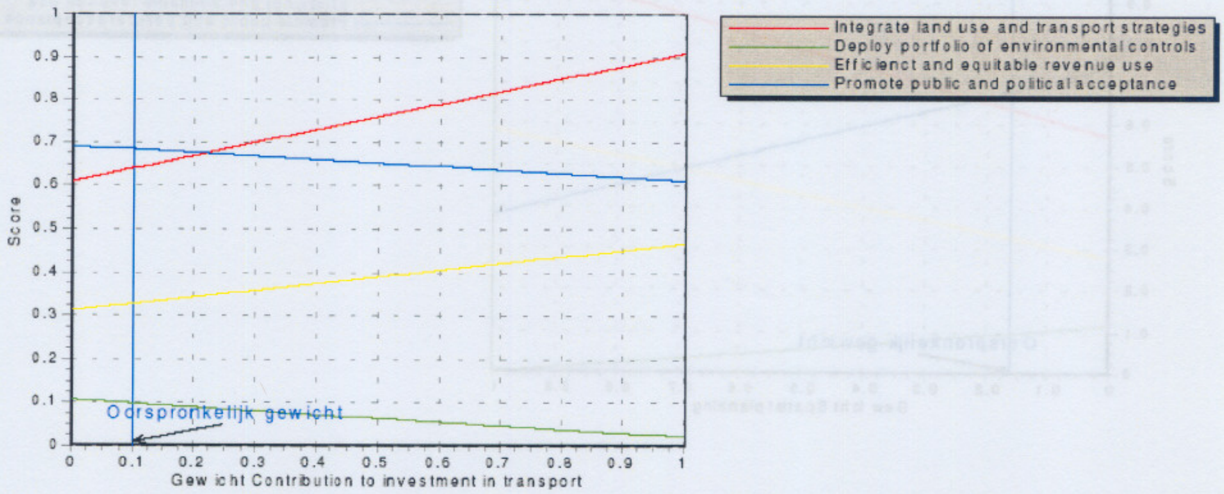
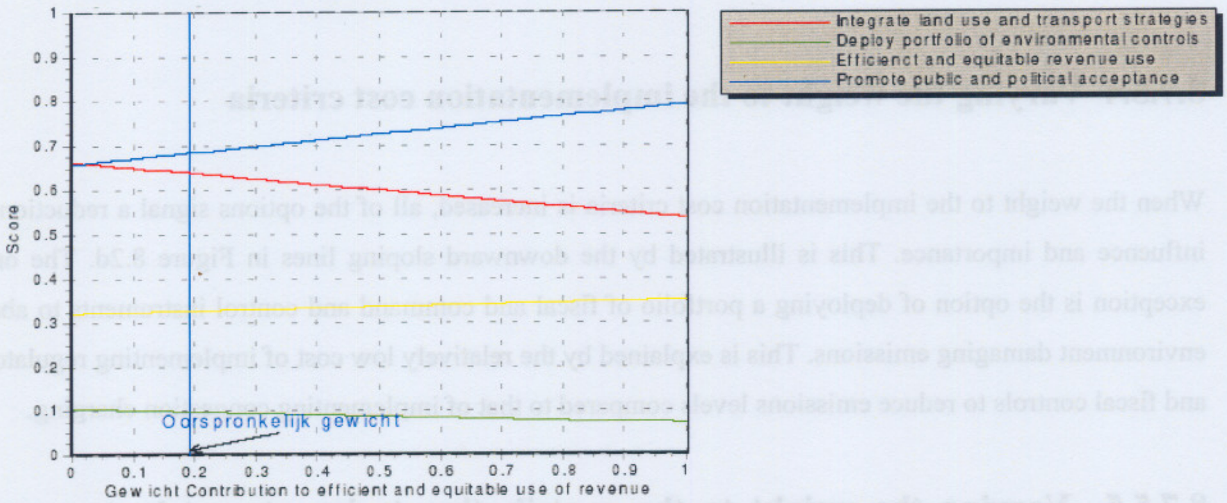


**Figure 8.2f Sensitivity analysis for criteria – efficient and equitable use of revenue**




### 8.7.5.1 Varying the weight to the traffic congestion criteria

In Figure 8.2a, the vertical axis (y-axis) illustrates the ranking of each option and the horizontal axis (x-axis) represents the selected criteria with an electronically assigned increased weight. The blue vertical line crossing the diagonal option lines illustrates the ranking of the options where the unadjusted weights have been used.

When the weight to the traffic congestion criterion is increased the promotion of public acceptability through transparency, consultation and democratic choice remains the first choice option. In fact the ranking of the options from the base results have stayed the same as before undergoing the sensitivity analyses.

### 8.7.5.2 Varying the weight to the spatial planning criteria

When the weight to the spatial planning criteria is increased, as illustrated in Figure 8.2b above, promoting the integration of land use and transport strategies are in the first position followed by the promotion of the efficient and equitable use of revenue. The promotion of public acceptability through transparency, consultation and democratic choice have now moved to the third position.

### 8.7.5.3 Varying the weight to the public perception criteria

When the weight to public and political acceptance criteria is increased the ranking of the option remains the same. Figure 8.2c also illustrates how the weight has increased each option's influence, reflected by the rising positive lines across the figure for all the options except the promotion of an integrated land use and transport strategy. This is explained by the public not recognising the potential of this option.

#### 8.7.5.4 Varying the weight to the implementation cost criteria

When the weight to the implementation cost criteria is increased, all of the options signal a reduction in influence and importance. This is illustrated by the downward sloping lines in Figure 8.2d. The only exception is the option of deploying a portfolio of fiscal and command and control instruments to abate environment damaging emissions. This is explained by the relatively low cost of implementing regulatory and fiscal controls to reduce emissions levels compared to that of implementing congestion charging.

#### 8.7.5.5 Varying the weight to the contribution to investment in transport criteria

When the weight to the contribution to investment in transport criteria is increased, Figure 8.2e illustrates a slight change in the ranking. The promotion of an integrated land use and transport strategy is now in first position. The promotion of public acceptability through transparency, consultation and democratic choice has moved up to the second position and the two remaining options have held onto their base result positions.

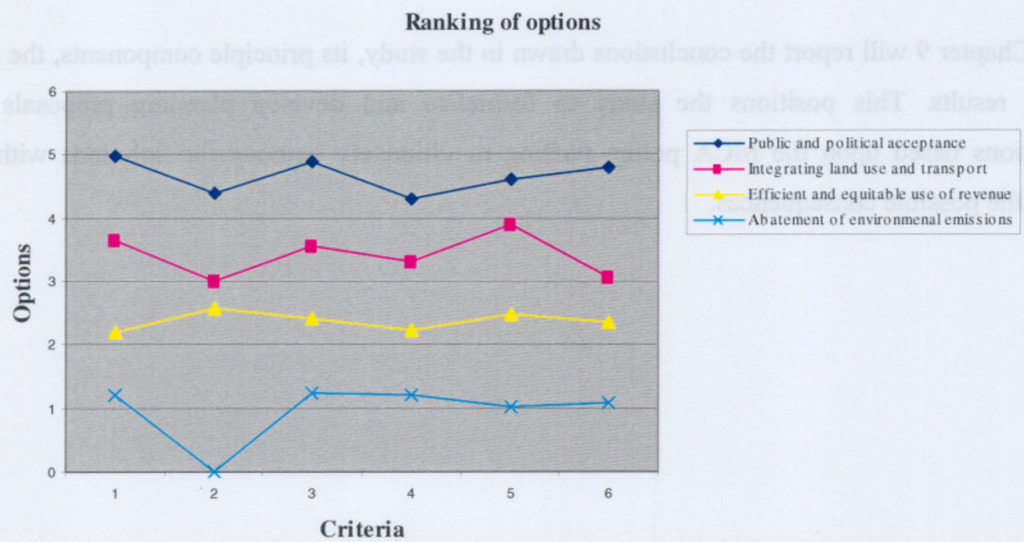
#### 8.7.5.6 Varying the weight to the efficient and equitable use of revenue criteria

When the weight to the efficient and equitable use of revenue criteria is increased, Figure 8.2f illustrates how the base result ranking stays unchanged. This is amidst the integration of land use and transport strategies option seeing a decline in influence and the efficient and equitable use of revenue option extending its upward curvature and strengthening its position. The decline in influence observed in the integration of land use and transport strategies option is explained by the criteria and indicators not being significantly concerned with equity and efficiency considerations. The promotion of public acceptability through transparency, consultation and democratic choice remains the first ranked option.

#### 8.7.5.7 Summary of sensitivity analysis

When varying the weights assigned to each criterion, the options rank differently to varying degrees as expected taken on an individual premise. However, overall, the ranking has remained the same as reported in section 8.7.4 confirming their accuracy and reliability. Figure 8.3, page 175, confirms this finding reflected by the similar ranking of options following the sensitivity analysis. The sensitivity analysis proves that under circumstances where the weights to each individual criterion have been increased, the ranking of the options remains the same as those obtained in the base results with the promotion of public acceptability, the promotion of the integration of land use and transport strategies still being ranked as the first and second most preferred options for achieving the policy objectives.

**Figure 8.3 Ranking of options following sensitivity analysis**




# 8.8 Summary of MCA analysis

A part of the purpose of the MCA was to decide upon the most preferable and suitable set of options to contribute to achieving predetermined policy objectives to overcome the identified problems, concerns and obstacles. The electronic analysis ranked the options from most to the least preferable and suitable. The reliability and validity of the ranking was also confirmed with a sensitivity analysis, with the ranking of the options illustrated below.

| Ranking | Policy option |
|---|---|
| 1 | Promote public acceptability through transparency, consultation and democratic choice. (Score: 0.68) |
| 2 | Promote the integration of land use and transport strategies. (Score: 0.64) |
| 3 | Promote efficient and equitable use of revenue. (Score: 0.33) |
| 4 | Deploy a portfolio of fiscal and command and control instruments to abate environment damaging emissions (Score: 0.10) |

# 8.9 Conclusion

Following the establishment of the decision context, policy goals and objectives necessary to achieve the research goals and ultimately solve the research problem, the MCA ranked four policy options holding the key to implementing road pricing with greater acceptance and sustainability. This is particularly significant because the policy options formulated are extrapolated from survey data and representative of public perceptions.

Now, having identified the effects of road pricing, factors sustaining its viability and acceptability, interpreted the survey results, remaining concerns and policy options to overcome these concerns, the next chapter reports the extent to which the research question has been answered, the research aims and objectives have been achieved and the research problem addressed.

To this end, Chapter 9 will report the conclusions drawn in the study, its principle components, the main findings and results. This positions the study to formulate and develop planning proposals and recommendations based upon the MCA policy ranking to ultimately embody the solutions with full awareness of the possible consequences.

# Chapter 9 Conclusions

## 9.1 Introduction

This chapter presents a summary of the findings, conclusions, viewpoints and insights which have been made - it reports the essence of the empirical investigation.

In considering and summarising these elements, the chapter is structured as follows. Section 9.2 provides a summary of the principle components of the study. Section 9.3 outlines the main findings and conclusions. Section 9.4 reports the extent to which the research objectives have been achieved. Section 9.5 summarises the main results of the research. Section 9.6 suggests some further work that may be considered as the basis for future research. Finally, section 9.7 provides some concluding remarks positioning the study for the final stage where plausible planning recommendations will be made.

## 9.2 Principle components of the study

Finding answers to such an involved and compound problem has forced the research into several directions in an attempt to capture the essence and reality of road pricing's effects. Several components were built into the study to obtain realistic results, reflecting not only the case for road pricing and its effects, but also investigating and evaluating the means to sustain road pricing through existing transport infrastructure, transport planning know how and other factors playing an integral part in completing the full picture. The following principle components of the study have emanated from this:

- **Identifying the key elements of congestion charging** - To focus the research in the right direction is was necessary to identify background theory in relation to:
  - The historic implementation of road pricing against international experience
  - The effects of congestion charging
  - Potential mechanisms which may prove to sustain congestion charging following its introduction.
- **Compile, structure and report the case for road pricing** – Once it is recognised that traffic congestion causes a loss in income to the economy, creates externalities such as air pollution, noise and accidents, impacts on individuals and the environment we live in and is publicly perceived as a serious problem, it merits the implementation of instruments curbing its existence. Road pricing as a fiscal measure is one such instrument, justified on the basis of

forcing road users off the road by taxing them at the margin, reflecting the overall social cost of congestion, environmental damage and accidents.

- **Report the effects of road pricing** - The effects of road pricing were explained and the gaps in the current literature identified and those to be explored, highlighted.
- **Report the factors proving to sustain road pricing** - The next component of the study was to identify and explore the factors or means which may prove to sustain road pricing. The process also identified gaps in the current literature and those to be explored.
- **Conduct an empirical investigation** – Once the gaps were identified an exploratory and descriptive investigation was undertaken, primarily using a survey as a data collection instrument.
- **Analysis of survey data and reporting the results** – The survey results were statistically analysed and the results reported in a structured form.
- **Interpreting the results** – The results were subsequently interpreted, conclusions were drawn and the inferences made were reported. This part of the study also identified any remaining problem areas, gaps, further concerns and publicly perceived obstacles, which had to be overcome and taken into account, before any recommendations could be made.
- **Multi criteria analysis** – Having a more holistic picture of the effects of road pricing and public perceptions, various options were identified to help overcome these remaining concerns or obstacles. The options developed were ranked using MCA, positioning the research to decide upon the most feasible way of implementing the options using a package approach.

# 9.3 Main findings and conclusions

The basis of the findings reported in the study rests on a good response rate for both the residential and business surveys, 63.8% and 61% respectively. The remaining stakeholder interviews served an equally useful purpose in terms of identifying perceptions, concerns and problem areas and by bridging the gaps. The main findings below illustrate that the gaps identified in the research have been addressed to a great extent.

**9.3.1 Congestion charging has had a very insignificant effect on the micro and macro economy of London.** Businesses consulted indicated no apparent change in their competitiveness or profitability apart from the retail and distribution sectors which have also indicated they are most likely to decentralise. Overall, only a small percentage admitted to considering relocating outside the congestion zone as a result of the detrimental impact on their long-term competitiveness and profitability. Strikingly, these businesses form part of the natural "churn rate" of businesses leaving the area due to leases expiring, internal business plan related reasons and other factors.

Interpreting the effects of congestion charging *per se* has proven rather difficult as non-economic influences, other negative global economic impacts and adverse wheather conditions have influenced business performance in general terms in 2003. The findings are somewhat contrary to mainstream evidence and modulation, reflecting the difficulties involved in mapping the actual effects of road pricing. Residents have indicated a small income effect but a more significant substitution effect which – accounts for the significant modal shift. Their income, savings consumption and labour productivity have largely been unaffected by congestion charging because adjustments have been made to overcome the additional tax burden.

9.3.2 **A significant finding, which was not entirely unexpected was that the charge significantly altered road user behaviour, being responsible for extensive modal shift in the capital.** A significant level of modal shift has been reported and verified for journeys undertaken by car to using public transport such as buses, underground services and overland railway services. The remaining road users paying the charge and continuing to travel have made adaptations to their travel behaviour manifested most strongly in adjusted departure times and route deviations. Alternatives to motorised travel such as walking and cycling remain unpopular mainly due to commuting distances not being practical in all circumstances. Respondents are still not keen to use car pools which confirms previous research.

The charge does affect the lower income group proportionally more than the higher income group – but no income group is able to shift the tax burden imposed by the charge to their employers. Additionally all road users paying the charge, irrespective of income, have fallen prey to the income and substitution effects of the charge.

9.3.3 **Land use planning must integrate with transport strategies.** No significant trend or evidence could be found confirming the effects of congestion charging on land use planning, density of development, clustering and or land use mix. Land use functions which are greatly dependent on one-to-one business contact were found likely to decentralise from the congestion zone. Planning Authorities have recommended that higher order office functions and high-density residential functions in close proximity be encouraged within the congestion charging area. A great need has been expressed and identified for a plan led integrated land use planning and transport strategy approach whereby land use discourages the need to travel or helps to shorten the distances travelled.

9.3.4 **Pro-environmental stakeholders have concurred with the emission and accident-reducing capabilities of road pricing** on the grounds that it reduces land take and increases air quality and leads to a cleaner environment. However the environmentalists have warned of other factors, such as climatical change, improving vehicle technology and domestic heating patterns having a more significant impact on the environment than congestion charging. Although the beneficial qualities and side effects of road pricing have been recognised, the effect road pricing has on the environment is only part of the picture in terms of environmental improvements. Road pricing's potentially positive side effects have, however, been embraced by environmentalists as another instrument in the spectrum of problem solving solutions.

9.3.5 The investment of the **revenue from congestion charging** in road network improvements, public transport and maintenance was perceived as an important condition to the introduction of road pricing and one which would undoubtedly sustaining its acceptability and viability. Respondents would rather see the revenue earmarked to public transport improvements than to reducing their income tax contributions or indeed used for any other purpose.

9.3.6 **Many respondents felt work schedule flexibility is a useful tool to help relieve traffic congestion.** Amongst the lower income group this supporting factor was less favoured because of problems with more flexibility in terms of departure times and domestic and social arrangements. Even though employers allow flexible working conditions, this does not trigger automatic use, but it is perceived and recognised as a feasible and inexpensive tool when combined with road pricing for reducing traffic congestion through forced behavioural adjustments.

9.3.7 **A significant percentage of road users divert from their normal route following en-route and pre-route warning of traffic congestion ahead.** The provision of driver information facilitates more efficient use of the existing road network. By developing information technology instruments even greater efficiency gains in road use will be achieved and should therefore be encouraged. Again, providing driver information is a good example of forcing behavioural adjustments to achieve reduced traffic levels.

9.3.8 **The main obstacle to implementing congestion charging is to make it agreeable and acceptable to the majority of the public.** Their opposition is based upon scepticism, uncertainty, fears regarding invasion of privacy and the notion that their "right to travel" will be violated. Apart from the negative publicity congestion charging has received, it has fundamentally been accepted by a large percentage of respondents who recognise that traffic congestion is a serious problem in their capital and that the only solution is to take drastic measures. The backing of politicians was identified as being necessary in order to overcome these obstacles and scepticism. Although politicians are the mechanism mobilising democratic choices and in this case supporting road pricing, it will prove to be a difficult task as the majority of respondents will not support politicians in their pursuit lobbying road pricing and neither do they find political judgement credible and convincing. The only sensible option in these circumstances is to have open and accountable public and stakeholder consultation. This would prevent road pricing being seen as an instrument forced upon the public.

9.3.9 These primary findings answered the researched objectives and filled a significant amount of gaps with only a small amount of problem areas, concerns and obstacles remaining. To overcome these, **multi criteria analysis** was used to formulate a number of options in pursuit of solutions. Measured against determined criteria, the options were ranked according to stakeholder perceptions, thereby identifying publicly perceived options as solutions to identified problems. Subsequently four options were identified in formulating a publicly and politically acceptable solution. These were:

- Promoting public acceptability through transparency, consultation and democratic choice
- Promoting the integration of land use and transport strategies
- Promoting efficient and equitable use of revenue
- Deploying a portfolio of fiscal and command and control instruments to abate environment damaging emissions.

# 9.4 Achievement of objectives

A number of objectives were identified at the outset of the study, positioning the research to arrive at informed decisions in recommending and considering a package approach to congestion relief. The paragraphs below report the success achieved.

i) **Determining whether road pricing is perceived to, and to actually reduce urban traffic congestion levels**. The survey results strongly suggested respondents acknowledge a perceived reduction in traffic congestion within the congestion zone. TfL traffic surveys carried out in 2003 also confirmed these results.

ii) **Determining the effects road pricing has as a fiscal instrument in reducing urban traffic congestion in the local setting.** It was determined that road pricing did not have a significant effect on primary or secondary economic indicators up to the point at which the survey was undertaken. Investment, saving and consumption remained unchanged and economic growth and employment figures were also reported to be unaffected. The financial impact of the tax had a most significant effect in relation to road users' income and behaviour measured in terms of the incidence of the tax.

iii) **Exploring factors such as revenue recycling, work schedule flexibility, public and political acceptance and information provision in support of road pricing sustainability.** This objective has been achieved and the relationship to road pricing and their interaction has been demonstrated in the recommendations.

iv) **Comprehensively reviewing the current literature on urban congestion charging and more specifically road pricing**. Reviewing the literature sharpened the focus of the study and gave structure to the results. Connecting the empirical results with the literature review then positioned the research to confirm or disprove the findings and helped interpret the results.

v) **Answering the general and more specific research questions.** These questions have been answered within the context of the identified stakeholder perceptions.

vi) **Identifying locally perceived problem areas or obstacles.** This aim has been achieved through meticulous scrutiny of the results.

vii) **Identifying, evaluating and ranking options to overcome locally perceived problem areas or obstacles using multi criteria analysis (MCA).** The MCA achieved this objective.

# 9.5 Main results of the research

The research has gained some valuable ground in terms of perception formation. A range of gaps identified in the study pertained to a lack of empirical evidence. The study has filled these gaps in terms of the London experience and evidence. It is quite possible though, to obtain completely different results and conclusions in another part of the world. Nonetheless, the results have also contributed towards theory formation in more general terms.

The study has demonstrated congestion charging's ability to reduce traffic congestion in urban areas, without severely penalising anyone, while increasing the net social welfare of society as a whole. A link was established between road pricing and its effects on people's welfare and the environment. In overcoming public and political opposition to road pricing and in investing the revenue effectively it is recognised, a package approach must be formulated relying on those policy options identified in the MCA.

Increasing the acceptance of road pricing will not be easy but it will be more achievable if an integrated land use and transport strategy is implemented and if measures are introduced to involve the public directly in consultation, and the decision making process. Recycling the revenue in a transparent and sustainable way coupled with equity and efficiency enhancing measures may result in road pricing being more acceptable than at present (although the results here have shown good support).

The recommendations must highlight the appropriate circumstances under which road pricing should be introduced and the criteria which need to be satisfied when policy makers formulate a sensible approach to alleviate urban traffic congestion. It must also show the importance of consulting different stakeholders, not only for the purpose of research but to gain support for such an unpopular instrument - the best way of addressing the problem is by healthy debate and consultation.

# 9.6 Recommendations for future research

As the London congestion charge has only been in operation since February 2002, some significant effects and influences will only pan out over the next 5 – 10 years. It is therefore sensible to suggest that all of the effects have not taken their full affect and will require some closer investigation over that time.

**There are seven obvious directions for future research on the effects of road pricing. These include the following:**

9.6.1 At present very little effect has been reported in terms of the micro and macro economic impacts of road pricing. In 10 years time a more holistic and stabilised picture of the likely consequences for the economy may be identifiable. Quantifying the relationship between congestion charging and its direct effects on the economy is unfortunately coupled to various non-economic forces. Decoupling those from investigating what results from the charge will be difficult but a long-term investigation will prove or disprove the findings reported here. Of equal importance is monitoring and investigating the way in which businesses are likely to adapt in the face of the charge in terms of competitiveness, profitability, growth, employment, investment, savings and locational decision making.

9.6.2 Congestion charging in London has had a limited impact on land use patterns up until the survey was carried out in 2004. By the very nature of the planning process, physical changes in the urban environment will not appear and thus be observable for quite some time. Any new developments and initiatives will take time to manifest themselves in proposed land use functions, dictated by the instigating Authority. More challenging however, is finding a direct relationship between land use movement, change of use and congestion charging. Again the planning process is said to be reacting to the way in which congestion charging may possibly influence land use by encouraging shorter journeys, achieved through planning residential and business functions in close proximity and by mixing and clustering land use. As this process will undoubtedly take some time to manifest over the long term, it is worth researching the evolution of the planning process in response to changing land use needs as a consequence of congestion charging.

9.6.3 Londoners' current perception of the link between air quality and congestion charging is that it is a positive relationship. The evidence presented here is based on perceptions. No technological or electronic techniques have been employed to verify these perceptions apart from the TfL and environmental stakeholder evidence. Inner city climates are influenced by a magnitude of factors. To remove those from the equation and ask how congestion *per se* affects air quality, noise levels etcetera in urban London, needs technological testing over a long period of time. Such testing and further research must consider other small-scale local climate changes and anomalies impacting on London's climate.

9.6.4 Economic theory suggests that investing the revenue from congestion charging in public transport and road maintenance will provide a basis for a more efficient use of the road network. Although suggestions have been made in the package approach to increase the equitable use of the revenue, it will be useful to consider and investigate alternative ways of utilising the funds in a politically feasible and sustainable way.

9.6.5 The contribution made by cleaner vehicle technology in reducing emissions in aid of congestion charging requires further investigation.

9.6.6 The extent to which traffic congestion will benefit from coordinating and managing traffic and road and street works in the congestion charging zone requires more investigation.

9.6.7 Researching the role of information technology (IT) and information provision in reducing traffic congestion in the absence of congestion charging would be worthwhile.

# 9.7 Conclusion

A clear link exists between transport and the economy – as transport facilitates economic activity. In congested conditions additional vehicles on the road impose marginal costs on other road users. When traffic congestion causes a loss in income to the economy and impacts on individuals and the environment we live in and is publicly perceived as a serious problem, it merits the use of curbing instruments. One such instrument is road pricing, advocated both by economists and members of the transportation community as an effective tool for alleviating traffic congestion. It provides a mechanism for spreading demand over time, space and mode primarily by altering road user behaviour. Implementation on a wide scale still eludes most world cities which suffer from traffic congestion as many oppose the notion of road pricing. Equity issues in particular are of major concern too much of the public.

A number of specific issues have been raised in this study which address the heart of the challenge facing those attempting to develop solutions to congestion problems. Road pricing forms part of this solution - it is not a panacea for solving congestion and other urban transport problems. The introduction of road pricing will force road users and the public in general to revise their attitudes to both car use and public transport. Almost certainly this will lead to strengthening the support for better and more reliable public transport. However, it must also be recognised that land use planning can address the real causes of the congestion problems, rather than their symptoms or consequences. Planning should aim at encouraging fewer journeys to be undertaken through smarter spatial planning. Although land use changes appear to be slow, once they are realised they are going to be around for a long time, reiterating the important role spatial planning plays in a sustainable environment.

To achieve the final research objective, a package approach will be developed next in Chapter 10 as the most effective mechanism when considering the implementation of road pricing. The package approach will aim to overcome public and political aversion and to involve as many stakeholders as possible, allowing the implementation to be as open and accountable as possible. The approach will follow a logical sequence starting with problem recognition, public and stakeholder consultation and considering democratic approval through to implementation.

To achieve even greater acceptance, the integration of land use and transport strategies has to be implemented in tandem with public consultation. To this end, at the very least, alternative public transport options must be available to those road users priced off the road. The argument is also connected to how the revenue is spent – preferably on public transport improvements, maintenance and to relieve the burden on those in need of tax relief. The approach will be incomplete if measures recognising the positive impact of road pricing on the environment were to be omitted. It is the successful interaction and implementation of these initiatives that will ultimately render road pricing an attractive and sustainable policy instrument.

# Chapter 10 Recommendations

## 10.1 Introduction

This chapter focuses on developing and formulating recommendations in order to present road pricing as a viable and sustainable policy instrument in urban areas experiencing traffic congestion. The recommendations made are a culmination of the MCA objectives – making decisions about proposals for future action and the actual choice of options. The four options ranked in section 8.8 of the MCA forms the very basis for formulating the recommendations.

The chapter is structured as follows. Section 10.2 discusses the contextual framework of the recommendations. Section 10.3 discusses the proposals. Section 10.4 provides a guide for phasing the proposals over the short, medium and long term and Section 10.5 provides some concluding remarks.

## 10.2 Contextual framework

A world-class transport system will not come easily, but achieving it is not impossible if bold and imaginative solutions such as congestion charging are tried and tested and the political will to carry them out exists. It is important to succeed because a high standard of transport efficiency enhances the quality of life, is good for economic growth and helps maintain the competitive advantage cities experience. Whatever the individual preferences of commuters and the various transport choices cities offer, the overall land use and transport system must provide high quality public transport services which are reliable, convenient to use, accessible, comfortable, safe, speedy and affordable for the majority of users. Money must be spent wisely - this means providing commuters with a wide spectrum of transport choices while ensuring that they are effectively integrated.

Recommendations are made within a contextual framework, formulating a package approach based upon the identified options, encouraging the reduction of traffic congestion and addressing the effects of congestion charging. The approach is formulated by considering the following elements:

- Residential integration
- Environmental awareness
- Traffic planning
- Urban design
- Infrastructure maintenance
- Economic growth
- Accessibility
- Stakeholder consultation

By incorporating these elements into the approach, sensible and feasible initiatives are formulated and developed whilst recognising the relationship between sustainable transport initiatives, integrated land use and transport strategies, infrastructure investment and economic activity.

# 10.3 Approach to successful charging

An extensive public transport network already exists in central London and TfL in conjunction with other public transport providers, has implemented a wide range of capacity and operational enhancements to ensure that public transport capacity is sufficient to accommodate new customers as a result of the scheme. Admittedly a range of other improvements to public transport services have been and continue to be implemented, making public transport easier to use, cheaper, faster and more reliable so as to accommodate modal shift. However the success of the central London congestion charging scheme and indeed any other charging program is not only directly related to these measures, but also other **initiatives** rendering the scheme acceptable and sustainable. For congestion charging and especially road pricing to be successful, acceptable and sustainable a package approach combining the initiatives below (extrapolated from the MCA option ranking), have to be implemented or at the very least considered. They are:

- Promote public acceptability through transparency, consultation and democratic choice.
- Promote the integration of land use and transport strategies.
- Implement efficient and equitable use of revenue.
- Deploy a portfolio of fiscal and command and control instruments to abate environment damaging emissions.

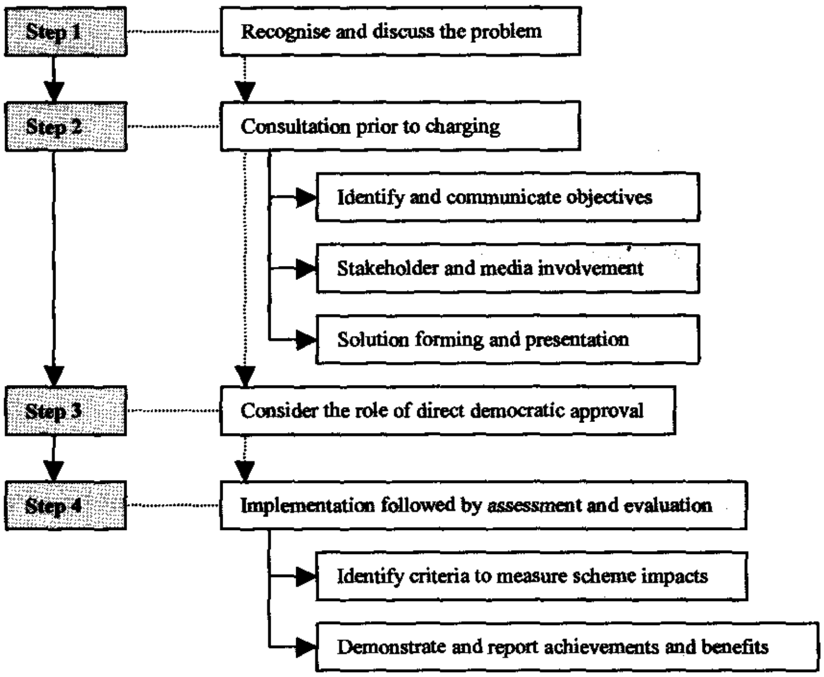
These initiatives will be explained and discussed in turn below.

## 10.3.1 Promote public acceptability through transparency, consultation and democratic choice

Economists and transport professionals have favoured the use of congestion charging in regulating traffic congestion for decades. However, with few exceptions, congestion charging and more specifically road pricing is rare, even though arguments of economic efficiency and welfare gains are cited. The empirical evidence presented here has demonstrated that there are numerous concerns and barriers to implementation. Road users are the most important source as they are most affected by the measure. Politicians are the key decision-makers. Other groups can be determined i.e. authorities, the business sector, lobbies of those affected, transport stakeholders and environmentalists.

To overcome this deadlock, the first initiative is to plan, develop and implement a procedure that takes into account the difficulties expressed. To this end public and stakeholder acceptability is likely to be increased by implementing an initiative incorporating the four steps illustrated in Diagram 10.1.

**Diagram 10.1 Steps to increase the public acceptability of road pricing**




The remainder of this section explains the steps in more detail and is sub divided into the following sub sections, Section 10.3.1.1 explains the role of recognising and discussing the problem. Section 10.3.1.2 explains the importance of consultation prior to charging and the elements that comprise it. Section 10.3.1.3 considers the role of direct democratic approval. Finally, Section 10.3.1.4 describes the role of assessment and evaluation following implementation.

## 10.3.1.1 Step 1: Recognise and discuss the problem

For a problem to be solved, it has first to be recognized as one. The perception of traffic congestion as a problem is a necessary precondition for regarding problem solving measures as important. It is generally assumed that high problem awareness will lead to increased willingness to accept solutions for the perceived problems. It is therefore essential to raise local traffic problems, which people experience with the stakeholders involved.

The responsibility for recognising the problem extends beyond that of the public. It is essentially a task for Local Highway Authorities, Planning Authorities, politicians, pressure groups, lobbies and environmentalists to identify and for them to respond to the difficulties. Identification of traffic-congested areas must be made in terms of traffic counts and analysis, taking historic trends into account as well as public and business opinion surveys. Once the obstacles and problems have been recognised, they must be discussed amongst the stakeholders thus creating greater awareness and providing them with the opportunity to discuss mutual concerns, differences in opinions, and to evaluate different measures to address the problems and potential solutions. The impression of having decided upon the solution prior to discussions taking place must be avoided. There must be consensus that traffic congestion is a serious problem and that demand management is part of the answer.

Based on the concerns expressed by the public and deliberation by the stakeholders involved, five general arguments have to be won before congestion charging can be put through public consultation. These are:

i. Identify the need to take some action to restrain traffic levels
ii. Consider alternative options if congestion charging are ineffective or insufficient based on the outcome of impact analysis, feasibility studies and environmental impact studies
iii. Agree that road pricing is a practical and effective measure
iv. Equity concerns can be addressed
v. The benefits of road pricing are significant, obvious and easily understood
vi. Alternative modes of public transport do exist.

#### 10.3.1.2 Step 2: Consultation prior to charging

It is critical that a visible consultation is conducted, typically by the Local Authority, to show that congestion charging will be designed having taken into account the views of all stakeholders and only if there is broad support in principle. Prior studies have suggested that the concept of congestion charging or road pricing is difficult to communicate. As a result, it is perceived as a tax with no obvious associated benefit and criticised as unfair and harmful to businesses. If road pricing is perceived as a tax it must be justified as a tax. By linking the charge to a revenue disposition program, benefits will be identified, which will focus public debate on a tangible item (i.e. receiving more efficient public transport in return), rather than on an intangible item (i.e. time savings). In this way the public comprehends its benefits more readily and this may increase acceptance. The consultation process may also identify new criteria and indicators or even options to be incorporated into the MCA process thereby providing feedback to the MCA, which may ultimately influence the choice of options retrospectively.

The following elements must be built into the public consultation process. **First**, the objectives of the proposed scheme must be identified. **Secondly,** stakeholder opinions must be reported and media involvement sought. **Finally**, acceptable solutions must be formed which recognize the concerns and obstacles identified, weighed against implementation cost. These elements will be discussed in turn.

#### 10.3.1.2.1 Identify and communicate objectives

There are different general aims connected to road pricing measures (e.g. financial aims, ecological aims, demand management, etc.). On the one hand, road users as well as others pursue certain mobility aims. The potential conflict between these perhaps different aims is crucial for the question of acceptability. The problem is that in principle a large number of competitive aims and interests are imaginable, derived from the concept of "social dilemma "vs." personal aims. It is assumed that more socially oriented aims, such as preference for bus and railway improvements are in accord with those of road pricing. On the other hand, personal aims of gain maximisation such as "I would like to use my car, whenever I want", compete with those of road pricing. It is to be expected that a higher valuation of common social aims will be positively related to the acceptability of road pricing, while pursuing personal and gain maximizing aims may lead to a refusal of road pricing because of a threatening restriction of personally important aims.

As individuals and stakeholders alike have different aims with respect to what they want to gain from road pricing, it is important to identify and communicate mutual inclusive objectives, that is, objectives that need to be collectively favoured by most of the public and stakeholders involved.

<u>The following **objectives** determining acceptance must be communicated in the consultation process.</u>

i. The public, interest groups and other stakeholders must know and understand the economic case for road pricing. Hence, they should made aware of the background e.g. to pay the true cost of transport, including external cost and the internalisation of an externality argument.

ii. Identify and agree on the most appropriate location for the program.

iii. Communicate the objectives of road pricing *per se*, such as:
   - To improve traffic conditions

- To reduce traffic congestion
- Maintaining and enhancing the economic attractiveness of urban areas
- Reducing the local environmental impact of traffic (in terms of noise levels, air pollution etc.)
- Reducing road traffic accidents
- Reducing $CO_2$ emissions
- Opportunities to improve public transport.

iv. Explain how the scheme will be implemented, administered and enforced.

v. Explain the scheme design and the structure of the charge. This involves:

- Who should pay
- How much should be paid
- Where should be charged
- The daily duration of the charge
- When should be charged
- How road users should be charged
- Who are exempt from the charge.

vi. Increase the awareness of different demand management options, by introducing and explaining some program alternatives. This should be seen as an opportunity to educate the public in general measures and enable them to evaluate the measures. Some typical measures which should be considered and evaluated include the following:

- Do nothing – let traffic (and congestion) find its own level
- Increase road capacity
- Encourage a shift from car to public transport
- Make changes to land use to make more even use of roads in space and time
- Encourage home working
- Reduce parking spaces
- Increase parking cost
- Regulate demand through cordon pricing (road pricing)
- Distance based pricing
- Congestion pricing
- Improve public transport
- Park and ride
- Impose access restriction at various city locations.

vii. Reassure the business community of minimal impact, but prepare them to make adjustments.

viii. Indicate how the revenue from the charge will be used and re-assure the public that public transport will be reliable once road pricing has been introduced.

ix. Explain and demonstrate how regulatory policies such as road pricing can be fair and equitable.

Full public acceptance can only be expected if people have confidence in the proposed measures and the use of revenues. From a marketing point of view the consultation should strive towards changing the cognition about congestion charging. To achieve this goal, the following guidelines have to be built in, in the consultation process:

i. Positive aims must be connected with most effective solutions
ii. Trial experiences are necessary for people to change their mode of transport
iii. Public transport must be improved prior to introducing a trial period or the scheme – revenues must be hypothecated or earmarked for improving services and maintenance purposes
iv. Point out the benefits of the scheme. Build up a convincing connection between push, pull and publicity measures
v. Regulation will only work if a great majority of people agrees with the measure
vi. Reassurance that road pricing will result in reduced traffic volumes – at levels of charging that are not viewed as punitive
vii. The scheme will not add to traffic problems elsewhere through traffic displacement
viii. The technology will be reliable and the system will be enforceable ensuring violations are effectively detected thereby maintaining the credibility of the program.

If these objectives and guidelines are communicated adequately at the consultation stage, road pricing stands a better chance of success as the opportunity presents a situation whereby practical and acceptable solutions can be formulated and implemented.

### 10.3.1.2.2 Stakeholder and media involvement

Stakeholder and media involvement are another essential ingredient in the consultation process. In considering alternative programmes to reduce traffic congestion, it is necessary to consider the complex interplay of other stakeholder groups and individuals who can exercise important influence over the way a scheme is received. Thus, the identification and analysis of all stakeholder audiences likely to have an impact on the ultimate success or failure of the project is very important. In this regard three major groups play an integral role in the way in which a proposed scheme is received and perceived. They are:

i. **The deliverers** – If Local Authorities are responsible for initiating public consultation they have to identify the audience, whom the program is intended affect and to bring together relevant stakeholders to discuss the issues and concerns at hand and commission necessary surveys, analysis and studies.
ii. **The influencers** – The media plays a powerful role in getting the deliverers' message across to all stakeholders. This has to take the form of an aggressive marketing campaign in raising awareness but has to be careful not to focus on the negatives of road pricing. At this stage, prior to implementation, the media must concentrate on "winning the hearts and minds of stakeholders" by communicating the objectives and positives direct to the different groups.
iii. **The recipients** – This group represent road users affected by the charge, the business community, interest groups and other groups directly affected. It is essential that the deliverers and influencers ensure the recipients are appraised of the various elements of the consultation process - what the program involves and the results of any surveys, analysis and studies undertaken. As road users are possibly the most difficult group to persuade that being charged for a resource, which is currently free is a good idea, consultation has to be an open process providing for public debate.

#### 10.3.1.2.3 Solution forming and presentation

Once comprehensive assessment studies have been undertaken generating alternative solutions, assessing different alternatives and identifying potential winners and losers, it is important to communicate conclusive results as comprehensibly as possible in an attempt to reach consensus. It is recognised that the nature of optimal solutions may vary from one city to another. Whatever approach is taken, in order to be acceptable to stakeholders and in particular the public, any restrictive measures forming part of a solution need to encompass some of the following elements as a package resembling some elements of the "Rule of three" cited by Goodwin (1989:495):

i. The method of vehicle restriction must be simple but fair
ii. Measurable and visible improvements to public transport services
iii. Consider earmarking revenue to maintain the road network
iv. Existing traffic management systems must ensure the most effective use of the existing road network
v. Integrate the proposed vehicle restriction program with transport planning and land use policies
vi. Re-claim and re-allocate road space – e.g. new cycle or bus facilities, extra space for pedestrians or for residents' parking and environmental improvement
vii. Employers should be encouraged to allow flexible working conditions where possible, to accommodate the different lifestyles of people and also to aid in alleviating traffic congestion
viii. Consider a limited amount of new road construction or capacity expansion projects.

Following a suitable solution being formulated it must then be communicated to all stakeholders. This process of public presentation should report the positives and benefits of the scheme as well as the points below:

i. The effect the intervention method will have on peoples' welfare
ii. The effect the intervention method will have on the environment
iii. The effect the intervention method will have on local businesses
iv. Communicate alternatives options available to tackle the problem and defend the choice of identifying road pricing as the most appropriate measure
v. Communicate the objectives to be achieved and explain how they will be achieved
vi. Address the issues of equity and fairness. Explain how balancing the need to control demand for road space has to take priority over doing nothing at all and how costs have been weighed up against benefits. Here, equity primarily refers to the distribution of costs and benefits (Giuliano, 1994). From a psychological point of view perceived justice, among others, is of major concern as a basic requirement for acceptability. Perceived justice may differ from objective distribution of costs and benefits but surely depends on it as one major parameter influencing personal perceptions. As with most personally mediated perceptions, it differs not only between different situations (intra-individual variance) but also between people in the same situation and even between people with comparable objective costs and benefits (inter-individual variance). Therefore, besides rational cost benefit calculations additional variables, which also influence the personal cost benefit ratio, must be taken into account. It is expected that the more people perceive advantages following the introduction of road pricing the more they will be willing to accept it.
vii. Communicate the characteristics of the program such as (i) the level of the charge, (ii) how policy makers have arrived at that level, (iii) the methods available for charging, (iv) enforcement issues and (v) revenue allocation.
viii. The cost of implementing the program.

### 10.3.1.3 Step 3: Consider the role of direct democratic approval

Following the consultation process the next step is to allow the public to decide openly and democratically to reject the program or to accept it. This brings to the fore direct democratic approval whereby voters have the final opportunity to reject the program or to commit themselves to it. However this is easier said then done, as without support of politicians as key decision-makers the introduction of any road pricing scheme is impossible. Therefore the politicians' opinions and their acceptance are of great importance for implementation.

It is common knowledge to the informed reader that politicians' actions in a democracy are strongly influenced by how such actions are likely to affect their popularity and re-election chances. A major disadvantage of congestion charging policies is that they are not directly attributed to the politicians' actions. Direct interventions, in contrast, directly benefit the politicians. In particular they indicate to the voters that the government is taking decisive action (even if such action in many cases proves to be ineffective or even counterproductive in the long run). The politicians therefore have an almost instinctive preference for direct interventions over anonymous pricing instruments.

When politicians use road pricing as an indirect intervention to solve congestion problems they relinquish some of their power. However, direct intervention enables the politicians to exert power to their own benefit. They may, for instance, issue permits for use on otherwise congested roads. They can give the permits to whichever individuals and groups they favour. This sets in motion rent seeking activities on the part of the people concerned. They then lobby the government to receive such permits and in exchange offer the governmental politicians support especially in the form of monetary donations at election time. Politicians are generally reluctant to relinquish power or side with interventions that will see them lose votes. Hence, having politicians sign up to the congestion charging agenda may prove quite difficult.

One way of overcoming this inherent barrier is through the Local Authority or Highway Authority forcing into effect direct voter participation, whereby voters are allowed a referendum and politicians are forced to engage in the "for and against arguments" of the program. Thorough preparation is essential in order to increase the likelihood of a positive referendum. This is one of the reasons why the consultation process is important in serving as a springboard, getting amongst others, politician on board to lobby their case and appreciate the concerns and difficulties which must be overcome. Alternatively, a top down approach must be followed where the program is implemented without direct democratic involvement, its implementation being based on balanced scientific, economic and planning arguments, which favour this action.

#### 10.3.1.4 Step 4: Implementation followed by assessment and evaluation

Once the program has been implemented it may have been predetermined to have a trial period so as to provide for people changing their mode of transport and generally adjusting to the program. It may also serve as an opportunity to monitor the likely impacts of the scheme. Implementation of the program must be assessed and evaluated in terms of business impacts, land use impacts, environmental impacts and the effect on people's welfare. This can be achieved by identifying criteria measuring the scheme impacts then reporting the results, achievements and benefits. These issues will be discussed in more detail below.

#### 10.3.1.4.1 Identify criteria to measure scheme impacts

In order to implement the economic principles of road pricing and evaluate the success or failure of the program they must be measured against performance criteria and indicators. Diagram 2.2, page 36, illustrates the criteria that produce a feasible, acceptable and effective charging scheme. In addition to these criteria, each group of stakeholders may have their own set of criteria which are also important to gauging the program's performance.

From the **road user's point of view**, the program must be measured against the following criteria:

1. User-friendliness and simplicity
2. Transparency
3. Protection from invasion of privacy
4. Option for prepayment or post-payment
5. Efficient Enforcement.

From the **Highway Authority's point of view**, the program must be measured against the following criteria:

6. Enhanced efficiency in road usage
7. Responsiveness to demand
8. Reliability of technology
9. Security and enforcement
10. Protection from theft
11. Protection from fraud
12. Provision for occasional visitors
13. Environmental impact
14. Business impact
15. Public transport efficiency and reliability.

From **society's point of view**, the program must be measured against the following criteria:

16. Minimum environmental intrusion
17. Provision for mixed traffic
18. Provision of a transitional phase
19. Compatibility with other transport demand management systems
20. Tolerance to varied geography

21. Fairness
22. The availability of alternatives
23. Improved public transportation
24. Reduction in traffic congestion
25. Limited or controlled traffic displacement.

### 10.3.1.4.2 Demonstrate and report achievements and benefits

A continuous monitoring or follow-up assessment of the program is essential in reporting and providing a comprehensive summary of the entire programme. Reports must be made public to provide a picture of its likely effects, achievements and failures. By a continuous reassessment of the choices made in the past, decision makers may learn lessons to serve as feedback into the MCA, again influencing future decisions. The monitoring programme must be guided by the following principles:

i. Monitoring should robustly detect and characterise the main expected effects of congestion charging
ii. Monitoring should enable unexpected or unanticipated effects to be determined
iii. Monitoring should seek to understand as well as measure
iv. Monitoring should aim to meet the legitimate needs of all stakeholders for information
v. Monitoring should provide best value.

The output from the monitoring programme is of utmost importance. Stakeholders will undoubtedly be interested in the output and effects of the program as results are made public over time. To this end, the following results must be made public:

i. The change in the level of traffic congestion
ii. Adaptations and trends in traffic patterns in and around the congestion zone
iii. Whether public transport efficiency and reliability have improved and how revenue is being spent
iv. Change in travel behaviour and secondary transport effects
v. Economic impacts
vi. Benefits and disbenefits
vii. Social impacts
viii. Environment and amenity impacts.

By demonstrating the achievements of the program, public and stakeholder acceptability may be increased. If the results reflect that the objectives of road pricing are being met, no adverse impacts occurs and if revenues are invested in public transport marked by a measured increase in reliability, society as a whole may be more inclined to sign up to the congestion charging agenda.

## 10.3.2 Promote the integration of land use and transport strategies

People are travelling more and they will want to continue to do so in the future. In aspiring to a world-class land transport system - one that is integrated, efficient, affordable, with smooth-flowing traffic and which will meet the people's needs and support economic and environmental goals, the challenge is to balance these competing aspirations.

In finding suitable and sustainable solutions to overcome persistent traffic congestion problems, a multi-pronged approach or initiative is devised below to achieve this without prejudging the relative contributions of different modes of transport. Faced with congestion and other environmental considerations, longer term planning and land use policies must provide choices which allow people to reduce their need to travel and the distances they travel. Where local government is faced with such challenges in decision making the approach must be led by the objectives identified for the program as well as taking into account local circumstances, the government transport strategy and local travel plans.

The second initiative as part of the package approach is explained in the following sub-sections. Section 10.3.2.1 explains the role of planning, public transport and promoting choice. Section 10.3.2.2 explains the importance of managing the road network for road users and Section 10.3.2.3 discusses the role of information technology in integrated land use and transport strategies.

### 10.3.2.1 Planning, public transport and promoting choice

#### 10.3.2.1.1 Spatial planning

The integration of land use and transport is central to the achievement of sustainable development. Spatial planning does matter and it is equally important in determining patterns of travel as direct action in the transport sector. People only travel because of the benefits they achieve at their destinations, hence trips should be as short as possible to minimise cost. The development plan of local authorities is the key statement with clear objectives made to cover policy directions, with quantitative environmental and transport targets, taking into consideration the character of the area, including the quality of life and local disincentives. At the level of implementation two objectives need to be considered – (i) to reduce the amount of travel and (ii) to reduce the reliance on the car (and promote public transport). With this borne in mind, three key elements should be considered in promoting the relationship between land use planning and transport in achieving reduced urban traffic congestion.

The **first** is *land use mix and clustering*.

Mixing complementary land uses and clustering should be encouraged by Local Authorities' development plans in the area of operation. The evidence presented elsewhere in this study indicates considerable potential for high-quality mixed-use centres encouraging the use of local facilities, public transport and walking. In addition, new transport developments and land use must concentrate on developing high-density, transit-oriented corridors as a means of providing a greater intensity of land use.

The mixing of housing with other land uses through zoning should be encouraged as it can reduce travelling distances for everyday activities. As well as positive transport implications, facilities that are well used by local residents will help foster a more inclusive society where people living close together integrate more freely. A note of caution needs to be made though. The availability of facilities near to where people live does not on its own guarantee that people will use them.

The **second** is *density of development.*

In terms of development density the aim must be to promote developments where the services we need to access are closer to us. This reduces the need to travel and increases choice of travel, particularly where journeys become short enough for walking or cycling. As the density of development increases the average trip length, the use of the car, and the distance travelled all reduce.

To achieve greater density in development Local Authorities must aim to:

i. manage urban growth to make the fullest use of public transport and balance it with available land
ii. focus major generators of travel demand such as shops, leisure, entertainment and offices in city, town and district centre near to major public transport interchanges
iii. locate day to day facilities in local centers
iv. accommodate housing principally within existing urban areas
v. ensure that development comprising jobs, shopping, leisure and services offers a realistic choice of access by public transport, walking and cycling
vi. use parking policies to promote sustainable transport choices and reduce reliance on the car for work and other journeys
vii. encourage higher density development in urban areas, such as the high density residential function and a high density mix use function.

The **third** is the *planning process.*

The planning process must adapt to accommodate changing land use demands as a results of congestion charging and sensibly alter land use patterns to aid in reducing the need to travel. The urban environment of London imposes serious constraints on the opportunities for increasing the capacity of the road network, through road widening schemes, grade separation or augmentation of the existing road network. By implementing a process with policies, regulations and standards which attract complementary land use classes, the economic and social viability of central London can be maintained without restricting road users and business activities.

Urban living should be encouraged through the identification of suitable high density residential and mixed use sites in central London. Land use and transport policies must aim to ensure that where people need or wish to travel, they can do so easily and efficiently. The implementation and creation of cycle lanes and walking networks within the congestion zone will also discourage the road user, especially if they are conveniently located, safe to use and complementary to public transport.

The area in which the program operates is also a place of work and leisure. To this end high order office functions which do not rely on a one-to-one customer contact basis in the congestion area should be encouraged. If one-to-one customer contact is unavoidable, land use must be zoned in pockets of land adjacent to transport nodes or hubs in order to decrease the need for onward travel on an alternative mode of transport.

The planning process must operate by shaping the pattern of development and influencing the location, scale, density, design and mix of land uses. A plan-led approach can help reduce the need to travel, reduce the length of journeys and make it safer and easier for people to access jobs, shopping, leisure facilities and services by public transport, walking and cycling. In planning the integration of land use and congestion reducing transport initiatives the following elements should be considered:

i. Stakeholders should play an integral role in the entire life cycle of problem identification, solution formulation, implementation and evaluation
ii. The reliability of the transport system and its operation should be regarded as a fundamental system management goal
iii. Land use efficiency should be maximised and net land taken by the transport system minimised
iv. The absolute level of resource use for transport activities should be controlled and the resource efficiency of mobility should be maximised
v. Users should pay the full internal and external costs of transport and these should be made transparent to establish an understanding for congestion charging

vi. In the provision and operation of transport systems the adverse effects on the environment should be minimised according to agreed principles and targets.

### 10.3.2.1.2 Measures reducing the need to travel and offering choices

In addition to planning for improved land use and space, other measures and opportunities have to be employed to reduce the need for travel by car and to provide alternative means of transportation. Alternative options has to be considered by Local Government, the Highway Authority and businesses in addition to traffic restraint as a means of reducing traffic congestion. It is important to develop alternatives prior to introducing congestion charging and subsequently implementing them. The following measures should be considered:

**First,** *workplace travel plans.*

Businesses and/or organisations should consider implementing travel plans, promoting car sharing and establishing other ways to travel to work in collaboration with Government consultation and investment and Local Authority travel plans.

**Second,** *school travel plans.*

A significant percentage of morning rush hour traffic during weekdays is traffic doing a school run. As with employers, the Local Authority has to play a promoting role in school travel plans. These plans must essentially achieve modal shift through developing a broader package of proposals reducing car dependency on the school run.

**Third,** *bus quality partnerships.*

The Government must play a significant role in encouraging and investing in partnerships to increase the quality, reliability and efficiency of buses. With better vehicles and more frequent and reliable journeys, ridership can increase significantly catering for 30% of road users switching to public transport.

**Fourth,** *cycling.*

Local authorities must take the lead in considering and evaluating alternative cycle plans to improve facilities for cyclists. In this regard local provision of cycle facilities must be coordinated with the National Cycling Strategy Board. The Government has to consider providing dedicated funding of some very small scale projects in providing infrastructure.

**Fifth**, *walking.*

Where land use proximity allows walking, it should be encouraged at local level to demonstrate the potential cumulative benefits from an integrated package of sustainable travel initiatives, including investment in cycling lanes, higher quality pedestrian areas and bus priority measures.

**Finally**, *teleworking.*

Teleworking is an attractive alternative to travelling to work and could possibly reduce car commuting. The downside of this option is people's social commitments and employment commitments – many people have no choice but to commute to get to work and do not have the luxury of working from home.

### 10.3.2.1.3 Investing in public transport

If people are to be induced to give up driving into the city they must have other means of getting there. Car sharing, switching to motor cycles, bicycles and walking will take care of some of the modal shift. In most circumstances, however, the main alternative is public transport, usually in the form of buses, trains and underground services. Most of these essential services are privately operated but are reliant and dependent on public funding or subsidisation. Prior to implementation of congestion charging, the Highway Authority in conjunction with Central Government has to initiate measures in terms of local integrated land use and transport plans in order to ensure public transport capacity has been sufficiently increased to absorb the increased patronage (as a result of modal shift). If they do not do so the public reaction could force the program to be abandoned. The funding of this investment initiative should primarily come from the revenue raised by the charge.

### 10.3.2.1.4 Traffic control

Another element in integrating land use and transport strategies is to give due consideration to the role of traffic control. Traffic control can play an essential part in easing the flow of existing traffic, regulating the use of road space and contributing to relieving traffic congestion. Three measures are proposed to help achieve these objectives. They are: (i) parking control and enforcement, (ii) traffic signals and control systems and (iii) traffic calming. These will be discussed in turn.

**First**, *parking control and enforcement.*

Parking control and enforcement may help to reduce the free flow of traffic. Local Authorities must be encouraged by Central Government to devise effective and radical packages of parking control measures to detect and deal with parking contraventions. The most significant strategy will be removing on street parking facilities altogether and allowing parking in urban areas in dedicated "car parks" only. The assumption made is that the availability of parking spaces at the destination of a journey is a major influence in determining how and where people choose to travel. Illegally parked vehicles in urban areas, especially those parked in dedicated bus lanes slows up traffic and contributes to congestion. If traffic authorities are seen to tackle the problem actively, it may serve as a deterrent. Revenue from legitimate parking on and off the road and fixed penalty notices will ensure that it is at least a self-financing project with the benefit of demonstrating to the public that action is being taken.

**Second,** *signals and control systems.*

Technology for systems controlling traffic flow have been developed in the UK and have been trialed in London with some success. Two systems, SCOOT and CLAIRE have been developed to recognise and deal with congestion (TfL, 2003a) by making tactical decisions on links that are close together. Additionally, they aim to:

i. improve conditions for pedestrians and cyclists
ii. give more priority to public transport
iii. restrain traffic in sensitive areas
iv. manage traffic to reduce its impact on air quality.

This form of technology is beneficial because it reduce and manages traffic congestion and the Highway Authority implementing congestion charging should consider its use in conjunction with congestion charging.

**Finally,** *traffic calming.*

The objective of traffic calming is to develop guidance on measures to ensure vehicular speed is controlled and preferably reduced to less than posted speed limits in a manner that is safe, economical and without adverse environmental effects. Traffic calming measures to be considered in conjunction with congestion charging are:

i. Speed control humps
ii. On road horizontal deflection features
iii. On road vertical deflection features
iv. On road mechanical deflection devices
v. Vehicle activated speed limit reminder signs

vi. Innovative cycle schemes.

## 10.3.2.2 Managing the road network for road users

Active and coordinated management of the road network is a key step in tackling congestion and an essential supporting instrument to congestion charging. This is an area where land use legislation is unable to contribute much in terms of regulating the use of existing roads. In planning transport, however highway authorities must attempt to coordinate, regulate and manage the use of roads within the charged area to contribute to reducing traffic congestion. Road users are quite aware of the following typical problems often encountered in using a road network:

i. the repairs to the road where no one seems to be working or which are uncoordinated in their timing
ii. the seemingly endless interruptions to traffic flow from utility companies digging up the road to renew their distribution systems or connect up new customers
iii. the delays resulting from accidents and other incidents which are exacerbated because no one is planning ahead to get the traffic moving as soon as it is safe to do so
iv. the days when the weather seems to defeat us.

This section explains the actions that can be taken to avoid such occurrences only adding to traffic congestion.

### 10.3.2.2.1 Better management of roadworks

Any road network is a physical asset of immense value, therefore strategic roads and those managed by local authorities, must be kept in good condition to:

- contribute to the safety, efficiency and comfort of journeys
- reduce vehicle wear and tear
- minimise whole life costs to the taxpayer.

While it is important to maintain the road network, it is also critical to ensure it is delivered in a way which minimises its impact on traffic. To ensure this maintenance of defective lanes and other features of the public highway must be carried out with the least possible disruption and at off peak traffic times. In this regard all Highway Authorities within the geographical area of the congestion zone must take account of traffic sensitivity in their maintenance strategies and in work programmes for principal road maintenance and bridges. To achieve this the Highway Authority must consider:

- using latest traffic management techniques such as lane closures which more accurately match the work in hand and so maximizing lane availability
- carrying out more roadworks outside peak hours through contracts that provide incentives to encourage efficient working and minimize disruption to road users
- improving the management of street works by utility companies.

#### 10.3.2.2.2 Better management of works by utility companies ("street works")

The privatisation and deregulation of many utility operations in the UK has brought substantial benefits to utility consumers. These have in turn been reflected in exacting standards by the relevant regulators, both for the prompt connection of new consumers and – in some cases in association with the Health and Safety Executive – for the renewal of mains supply infrastructure. Most of these utilities make substantial use of the road, or rather the ground under the road, for their distribution networks. As a result customer connections and network renewals also have an impact on road users. This impact can become very significant when different companies dig up neighbouring stretches of roads at the same time or the same stretch in quick succession. There are also wider scheduling issues between utilities' work and the relevant Highway Authority's work on road maintenance. For these reasons it is essential to:

- coordinate and manage highway maintenance and street works;
- establish a programme to provide better computer based mechanisms for collecting information on all proposed works on and under roads. This is a critical step in enabling authorities and utilities to plan their works in a way which minimises the disruptive impact on road users
- implement powers to charge them when works overrun the agreed timetable;

#### 10.3.2.2.3 Incident management

Incidents such as collisions and spillages on roads are inevitable with the volume of traffic carried by urban roads. The overwhelming priority and response in such cases is safety: getting medical care quickly to the injured, managing hazards in affected vehicles and ensuring that the traffic behind doesn't become part of the incident in front. But too often it takes far too long before someone addresses the needs of the road users caught up in the jam behind an incident. Incidents need to be strategically managed to reduce the resulting congestion. This can be achieved by implementing the following traffic planning actions:

i. Establish a network of regional traffic control centre operated by an appointed highway agency to monitor the condition of the road network and to implement evasive action as required following an incident.
ii. Recruit, train and deploy a uniformed patrol service, operating during the operating hours of congestion charging with powers to deal with incidents and get the traffic flowing.

#### 10.3.2.2.4 Preparing for adverse weather conditions

Poor weather is a fact of life at certain times of the year with localised flooding or snow very possible. Highways Authorities must ensure that roads are open for safe and efficient travel whenever possible. The congestion zone is not excluded form potential adverse weather conditions and contingency plans such as the following need to be in place to deal with resulting delays to road users and traffic congestion:.

i. review operating and response procedures
ii. review and strengthen emergency contact procedures, which will be kept under constant review
iii. put in hand a strengthening of contingency planning procedures including better liaison with Police forces, local authorities and other emergency services
iv. identify of robust diversion routes and turnaround sites
v. give legislative powers to Local Authorities within the congestion zone so they can deal with the results of adverse weather conditions under the provisions of the Environmental Protection Act 1990.

### 10.3.2.3 Information technology

Promoting and providing driver information in conjunction with congestion charging forms a critical element in integrating transport strategies. The provision of clear, accurate and relevant driver information is an important factor in encouraging drivers to divert from traffic congestion and ensure more efficient use of existing road capacity. It also enables road users to plan their journeys more effectively, and to make more informed decisions. If traffic congestion is to be reduced drivers need to be given up to date information before and during their journeys, about:

- the current state of the road network
- where traffic congestion is
- weather conditions
- incidents/collisions.

The Department for Transport (Central government) must recognise these interactions and set in motion the implementation of instruments not only within the congestion zone but also at locations from and along the outer ring round of London (M25 - motorway). Road users are service users and need to be treated accordingly.

The following proven efficient and acceptable instruments should be considered and added to existing measures:

i. variable message signs
ii. radio
iii. internet
iv. media – in terms of advance warning of planned delays such as road closures
v. in-vehicle driver information technology such as satellite navigations systems
vi. vehicle derived network information.

## 10.3.3 Implement efficient and equitable use of revenue

Revenue recycling refers to the use and application of revenue generated from congestion charging and the spending of such revenue on elements contributing to its sustainability. By contrast, government expenditure such as national education, national health, social security, national defence and civil services are funded through the public purse. In considering how to spend the revenue three prerequisites have been identified which must be adhered to if the money is to be spent to a socially optimum level. They are:

- economic efficiency
- equity
- political feasibility.

Based on these prerequisites, the third initiative suggests methods of revenue dedication and redistribution. These measures are explained in the following sub sections. Section 10.3.3.1 explains how economic efficiency should be promoted in transport. Section 10.3.3.2 explains the implementation of the benefit principle of taxation. Section 10.3.3.3 explains the implementation of the ability to pay principle of taxation and Section 10.3.3.4 mentions the role of achieving public and political feasibility.

### 10.3.3.1 Promote economic efficiency in transport

Economic efficiency is concerned with the use of society's resources to achieve maximum net benefit. Road pricing increases efficiency by rationing road capacity with less waste than queuing. In terms of making traffic flow more efficient by reducing travel demand it does not matter how road pricing revenue is allocated. From an overall *economic efficiency* perspective the revenue must be used to benefit society and the greater the benefit, the more economically efficient the program. There is no requirement, however, that the money be allocated in any particular way from an efficiency point of view.

Although public transport improvements are one potential use of road pricing revenue, there is no economic efficiency requirement that congestion charges be spent on roads or public transport in general. Road pricing revenue *should not* be reimbursed to individuals in proportion to how much they pay. If drivers pay to use a road on Monday knowing that the money will be returned on Friday they have little incentive to change their travel behavior and will certainly not be discouraged. Hence it will be inefficient if revenue were returned in proportion to road use.

In promoting greater economic efficiency in public transport, the use of existing infrastructure and transport management, the following actions to be implemented at Local Government and Highway Authority level, should be considered:

i. Undertake investment in infrastructure through maintenance and improvements as it enhances political and public acceptance
ii. Invest in public transport services to enhance reliability, safety and quality
iii. Improve fairness among beneficiaries via benefit taxation
iv. Use revenue to improve the efficiency of managing public transport and demand management measures.

### 10.3.3.2 Implement the benefit principle of taxation

Following supportive arguments by Jones and Hervik (1992:139), Newbery and Santos (1999:129-130) and those by Hau (1998:68), earmarking road pricing revenue "is a useful device in principle to approximating benefit taxation as a way of satisfying a commonly accepted notion of "fairness"". That is, the beneficiaries of the increased travel time should pay the tax or charge. The distinguishing feature of earmarking is to link revenue from a specific source to a specific expenditure. By assigning the revenue to specific purposes, the Highway Authority can facilitate agreement about both revenue generation and expenditure, thus avoiding the revenue being diverted to other government programs and thereby targeting equity considerations. Because road users are left with an excess tax burden, dedicating the revenue selectively to low income groups and other end users may contribute to limiting the incidence of the charge on lower income groups adding to the program's attractiveness and acceptance.

Based on these arguments road pricing revenue must be earmarked to meet predetermined objectives, collectively formulated in integrating land use and transport strategies. Meeting the following conditions will ensure earmarking revenue will contribute to rendering road pricing successful. These are:

i. There must be a strong link between the beneficiaries and the payers of the charge
ii. Earmarking is necessary in addition to benefit taxation
iii. The revenue must be sufficient to finance the proposed expenditure and to cope with present and expected levels of demands on the program
iv. The proposed charge must have significant distortionary effects – causing deadweight losses and tax shifting
v. The program is supported by the government's transport plan or strategy
vi. There must be an agency with the capacity to plan, evaluate and implement the program .

Once these conditions are met earmarking must be implemented in terms of the following guidelines:

i. A public agency or decentralised government authority with demonstrated capacity and effective management controls to carry out the program, must implement the program
ii. A clear and appropriate investment program must be devised, setting rules to regulate investment, spending on maintenance and administrative overheads
iii. Accounting and auditing safeguards must be built into the program to prevent and detect misuse and diversion of the funds
iv. The public agency or decentralised governmental authority must publicly demonstrate and report the use of expenditure of revenue to overcome public scepticism and resistance
v. 75% of funds raised must be dedicated and recycled into the maintenance of the road network and invested in public transport services. The responsible agency or government authority must ensure economic priorities, public transport service performance indicators and other objectives are met.
vi. 25% of the revenue must be spent to benefit the lower income group directly, identified by road users undertaking a means test establishing who needs to receive a tax credit.
vii. There must be clear controls and regulation of the funds to prevent diversion to other local government or central government programs.

If these conditions and guidelines are followed, the revenue raised by congestion charging will not only encourage public and political support but it will be used as an instrument to address equity issues, fund investment in public transport and safeguard the social welfare of the lowest income group.

#### 10.3.3.3 Implement the ability to pay principle of taxation

The ability-to-pay principle suggests that taxes should be collected according to the capacity of the tax payer to pay them. The principle is connected to the notions of horizontal and vertical equity as explained in, Section 2.6.2.1, page 34. In terms of allocating or distributing revenue to road users the same principles should be applied as explained below:

***Horizontal equity***

Horizontal equity is concerned with fairness between individuals and classes with comparable needs and resources. It assumes that "like should be treated alike." In terms of redistribution, horizontal equity is often interpreted as meaning that individuals should be reimbursed according to how much they pay. This being the case, road pricing revenues should be dedicated (earmarked) to road improvements or to provide other benefits to those people who pay the fee.

The problem then arising is who deserves the benefit according to this criterion? Economic theory suggests:

i. those who actually pay the charge
ii. those who change their travel patterns in response to the charge.

Therefore, the most equitable option is to consider promoting horizontal equity via investment in alternative modes of public transport benefiting all paying road users and thereby neutralising externalities.

***Vertical equity***

Vertical equity is concerned with the treatment of individuals and classes who are not similar. By this principle, the distribution of revenue should reflect people's needs and abilities and should be identified by a needs tests. Promoting vertical equity often requires that disadvantaged people receive more public resources (per capita using road pricing revenue) than those who are advantaged in order to accommodate their greater need.

Vertical equity is often a contentious issue. Proponents of vertical equity argue that society is defined morally according to how it treats disadvantaged members, while others point out that providing extra resources to disadvantaged people reduces the incentive for individuals to overcome such disadvantages. Although vertical equity is recognized as being a legitimate social goal there is little agreement as to what constitutes the correct allocation of resources by this criterion. The options below depict a mixture of possibly acceptable approaches (identified in the research) which should be evaluated by the relevant instigating authority and which are dependant on local acceptability and circumstances:

i. Consider cash rebates to the very lowest income group paying the charge

ii. Vehicle tax subsidy to the lowest income group paying the charge

iii. Consider reduced congestion charge payments

iv. VAT exemption on fuel in terms of a means test

v. Fund business centre transportation facilities and services for the disabled and elderly

vi. Proportionally refund those disabled and pensioners who pay the charge.

### 10.3.3.4 Achieving public and political feasibility

The final prerequisite which is possibly the most difficult to achieve, is public and political feasibility and acceptance. The way in which revenue is distributed is as important as the way in which it is collected. Achieving public and political feasibility means road pricing programs must be attractive and transparent to voters. The redistribution program must recognise and reflect popular perceptions and political will power. To be publicly feasible, the way in which revenues are spent must be perceived as significantly beneficial to people. Using revenues to fund transportation improvements and broad economic benefits to residents through reduced taxes, rebates or community programs may provide the greatest overall benefit and earn the widest political support. Section 10.3.1 above has explained the importance of this notion and also ways of achieving public and political feasibility in more detail.

### 10.3.4 Deploy a portfolio of fiscal and command and control instruments to abate environment damaging emissions

The fourth and final initiative to be perused as part of a package approach is that of reducing environment damaging emissions. Transport activities are inextricably linked with environmental damage. Road pricing reduces the number of vehicles entering an area thereby directly reducing not only traffic congestion but also emission and pollution levels and environmental damage. However, road pricing is not designed to primarily reduce emissions nor is it the premise for its success or failure.

Rather it should be complemented by the integration of emission reduction seeking initiatives. To this end a portfolio of integrated fiscal and command and control instruments should be considered or deployed to strengthen the case for road pricing.

It is necessary first of all to establish who is responsible for imposing such instruments. This question is answered in Section 10.3.4.1. Section 10.3.4.2 identifies criteria that may prove useful in deciding between alternative instruments and finally Section 10.3.4.3 describes some instruments to abate environment damaging emissions.

#### 10.3.4.1 Responsibility

The question who is responsible for introducing and deploying instruments reducing vehicle induced environmental damage is an important one. Incentives of this nature are best progressed and implemented by Central Government. Various statutory and voluntary initiatives have been put in place as part of the Air Quality Strategy for England, Wales and Northern Ireland as well as the Mayor's Air Quality Strategy - Cleaning London's Air. These are reflected in updated emissions factors and the overall motivation to reduce total emissions of both $NO_x$ and $PM_{10}$ levels.

#### 10.3.4.2 Criteria to choose between instruments

It is of equal importance for the decision maker to have a set of criteria to choose between available instruments. Common (1989:1299) cited useful criteria when making a decision between alternatives. They are amongst others:

i. The reliability and applicability of the instrument in achieving the objectives at hand

ii. The instrument must be of a permanent nature – not only effective in capturing public interest

iii. The instrument must be flexible enough to adapt to the normal expansion in economic growth or population growth

iv. The instrument must attempt to divide its financial burdens among individuals and businesses fairly

v. The instrument must encourage drivers to minimise environmental damage

vi. The instrument must achieve its objectives at a relatively low cost to society

vii. The instrument must be politically attractive

viii. The instrument must have a minimal interference with private decisions

ix. The instruments must be accepted locally.

It is evident that some of the criteria will not be met in choosing between alternative instruments. The important point to recognise is that the decision maker or policy maker has been given a set of criteria to establish the most feasible, effective and acceptable instruments for their local purposes.

### 10.3.4.3 Instruments to abate environment damaging emissions

#### 10.3.4.3.1 Incentive based instruments

A typical example of an incentive based instrument, is providing emission subsidies to reduce emission levels. An emission subsidy is awarded where cleaner vehicle equipment is used, for example in a transport fleet giving the designer and manufacturer strong incentives to adopt higher levels of emission abatement. Unfortunately the gain in reduced pollution may be neutralised by consumers driving longer distances and increasing the volume of transport activity with the knowledge that the vehicle causing very little harm to the environment. In terms of private vehicle use, an incentive based instrument is not particularly conducive to reducing traffic congestion. However, incentive based instrument s act as a useful and relevant tool in the provision of public transport and business fleets.

#### 10.3.4.3.2 Regulation of activity

The regulation of vehicle activity can be imposed via emissions technology (cleaner vehicle technology) and by imposing improved fuel efficiency for cars. Regulating emissions technology is another useful instrument to be considered by the decision maker in reducing vehicle emissions. It is achieved by various statutory and voluntary initiatives forced upon manufactures and designers – in the United Kingdom the Air Quality Strategy for England, Wales and Northern Ireland is set as a benchmark. This a very useful instrument in terms of integrating land use and transport strategies whereby the extensive use of public transport is encouraged.

The second method of regulating vehicle activity is to consider the imposition of a minimum fuel efficiency regulation. This option comes down to obliging manufacturers to invest in and design vehicles that save fuel with the obvious benefit of reduced emissions and pollution.

#### 10.3.4.3.3 Fiscal measures

A final instrument to be considered as part of an integrated emission reducing policy is that of fiscal measures i.e. taxing road users directly for the amount of pollution they cause. In this case the road user is taxed proportionally to the emission rate of the vehicle. Typical examples include the following:

1. Green taxes
2. Emission taxes
3. Product taxes
4. Fuel taxes.

Fiscal measures such as these are most effective over the short term in reducing traffic congestion and vehicle emissions. Over the long term however, incentive based instruments and regulation may prove more useful. This would suggest, congestion charging should initially be coupled to fiscal command and control measures and once the scheme is established and operational, medium to long term instruments such as incentive based instruments and regulation should be implemented.

## 10.4. Phasing the initiatives

In implementing the package approach it is necessary to differentiate between the short, medium and long term in phasing the initiatives into the overall program for achieving the objectives of the MCA. The short term refers to a duration of between 1 to 5 years, the medium term between 1 to 10 years and the long term between 1 to 15 years. Diagram 10.2 below illustrates reasonable time scales attached to each element of the initiative. It also indicates a list of relevant stakeholders and responsible Authorities involved in implementing and managing each initiative.

**Diagram 10.2 Package approach phasing**

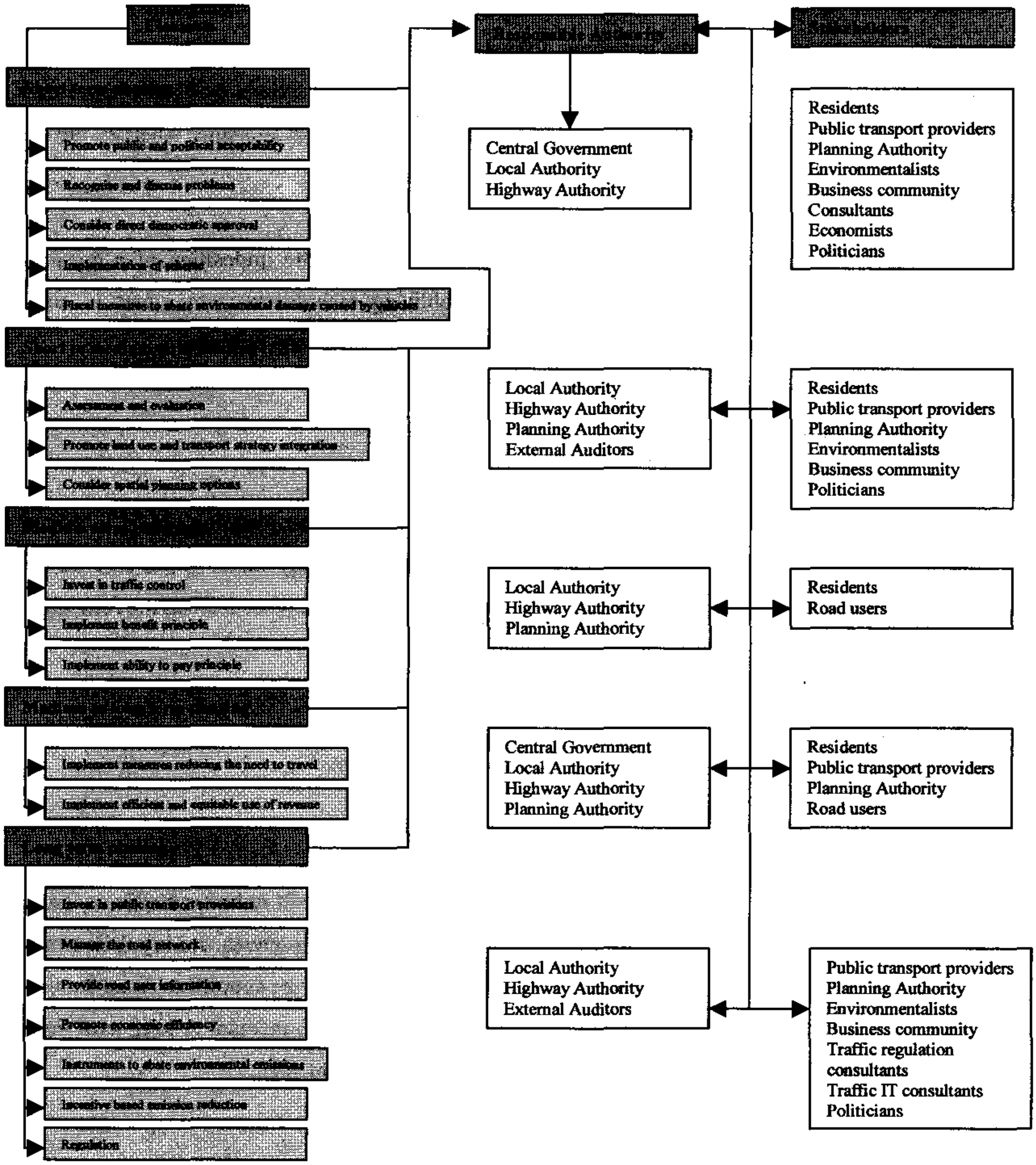



Diagram 10.2 demonstrates that short term phasing is primarily the task of the instigating and investigating Authority targeting primary stakeholders i.e. those potentially affected by the charge and those consulting the relevant Authority. It also identifies a mixture of disciplines being combined and pulled together in achieving and implementing the program goals.

# 10.5 Conclusion

The success of urban congestion charging does not only depend on the input and dedication of one stakeholder or instigating Authority but rather a multitude of stakeholders, Authorities and interest groups. The public is central to the achievement of a significant degree of acceptance. Without its support charge evasion and other negative side effects may occur. The package approach recognises these aspects and by amalgamating the initiatives discussed above, stands to overcome a great deal of pessimism and lead to real insight into the mechanics of road pricing. It sets the stage for positive problem solving thought through an open and accountable process.

**If there is a single, summary conclusion to this study it is that the key to dealing with the effects of road pricing, is developing strategies considering a range of differing initiatives, coordinating and managing them in the realm of the political-economic context in which they exist. Lobbying the public, integrating sustainable transport strategies with efficient and journey reducing land use patterns, subsidization and redistribution of revenues all hold promise as ways to gain public approval for road pricing. A concerted effort by Local Authorities, transport and planning professionals, interest groups and a change in public attitudes to the widespread changes in urban living has to be implemented and pursued. Fundamentally, an approach has to be developed, adopted and implemented, based upon recognising local perceptions, concerns, aspirations and locally acceptable solutions in addressing traffic congestion and the effects it has on the environment in which we live.**

# Appendices

# Appendix A: Environmental questionnaire

## Urban Congestion Charging Survey

**Please answer all of the questions below, marking the appropriate box reflecting your preferred choice with an "X" or a number where required. Alternatively write your answer in the space provided below the relevant question.**

## Section A: Your perception

1 ***Please indicate your level of agreement for each of the following statements, using a scale of 1 - 4 where:*** **1 = Strongly agree**
**2 = Agree**
**3 = Disagree**
**4 = Strongly disagree**

| Statement | Level |
|---|---|
| Traffic congestion is a serious problem in London | |
| Road user charging will reduce traffic congestion | |
| Road user charging is a good idea for London | |
| Road user charging will improve pedestrian safety | |
| Road user charging will induce traffic displacement | |
| Road user charging will lead to a cleaner environment | |
| Road user charging reduces vehicle emissions | |
| Policy-information about congestion charging will increase the public acceptance of congestion charging | |
| If all drivers had full information about congestion hotspots, they would be able to avoid it | |
| Revenue recycling will increase the public acceptance of congestion charging | |
| En route and pre-trip traffic and travel updates will reduce traffic congestion where applied in conjunction with congestion charging? | |

## Section B: Congestion charging and its effects on the environment

2 ***Will you support congestion charging if it reduces environmental decay?***

Yes ☐ No ☐

3 ***Rank the following policy options which you consider to be effective for reducing traffic congestion using numbers 1-12, where number 1 reflects your most preferred policy option and number 12 your least favourite option.***

| Policy option | Rank |
|---|---|
| Selective expansion of road construction in urban areas | |
| The encouragement of home working | |

The encouragement of car sharing
The creation of a comprehensive network of safe cycle and walking routes which do not involve the use of heavy trafficked roads
An increase in the price of petrol to £5 per gallon
Introduction or expansion of park and ride sites
Cheaper public transport fares
A doubling of parking charges in urban areas
An improvement in the frequency and reliability of public transport
The development of an integrated land use and transport planning strategy
The implementation of urban congestion charging
Banning/restricting vehicles in central areas

4 ***Rank the following policy options which you consider to be publicly acceptable for reducing traffic congestion using numbers 1-12, where number 1 reflects your most preferred option and number 12 your least favourite option.***

| **Policy option** | **Rank** |
|---|---|
| Selective expansion of road construction in urban areas | |
| The encouragement of home working | |
| The encouragement of car sharing | |
| The creation of a comprehensive network of safe cycle and walking routes which do not involve the use of heavy trafficked roads | |
| An increase in the price of petrol to £5 per gallon | |
| Introduction or expansion of park and ride sites | |
| Cheaper public transport fares | |
| A doubling of parking charges in urban areas | |
| An improvement in the frequency and reliability of public transport | |
| The development of an integrated land use and transport planning strategy | |
| The implementation of urban congestion charging | |
| Banning/restricting vehicles in central areas | |

## Section C: Revenue recycling

5 ***Do you think revenue recycling (the process where the funds raised by congestion charging is used to improve public transport and road conditions) will enhance the efficiency and reliability of public transport?***

Yes ☐ No ☐

6 ***Imagine you have 100 units of money to spend, which represents the total amount of money raised by urban congestion charging. How many units will you allocate to each policy?***

| **Policy option** | **Units** |
|---|---|
| Selective expansion of road construction in urban areas | |
| The encouragement of home working | |
| The encouragement of car sharing | |
| The creation of a comprehensive network of safe cycle and walking routes which do not | |

involve the use of heavy trafficked roads
An increase in the price of petrol to £5 per gallon
Introduction or expansion of park and ride sites
Cheaper public transport fares
A doubling of parking charges in urban areas
An improvement in the frequency and reliability of public transport
The development of an integrated land use and transport planning strategy
The implementation of urban congestion charging
Banning/restricting vehicles in central areas

## Section D: Public and political acceptance

7 ***If urban congestion charging was introduced and the money was spent in the way you suggested, how publicly acceptable would you think urban congestion charging would be?***

| Acceptance | Before revenue recycling % | After revenue recycling % |
|---|---|---|
| Totally/Fairly acceptable | | |
| Neither | | |
| Not very acceptable | | |
| Totally unacceptable | | |

8 ***If an urban congestion charging scheme was introduced, how concerned would you be about each of the following issues?***

| Issue | Very/fairly unconcerned (%) | Very/fairly concerned (%) |
|---|---|---|
| The fact that the introduction of road pricing would mean that in congested periods the road user would have to pay for the use of the road | | |
| Invasion of road user privacy | | |
| The impact of delivery vehicles and commercial traffic | | |
| Exemption for certain groups | | |
| How urban road pricing would be integrated with other congestion management measures | | |
| The cost of implementing an urban congestion charging scheme | | |
| Equity/fairness of an urban road pricing scheme | | |
| The reliability and accuracy of urban road pricing equipment | | |
| The economic impact on the urban area in which urban road pricing is introduced | | |
| Enforcement of an urban road pricing scheme | | |

The need for clearly stated objectives, such as, the regulation of traffic demand, the achievement of environmental benefits and the raising of revenue for investment in transport systems ☐ ☐

The reliability of public transport once urban road pricing has been introduced ☐ ☐

9 ***How acceptable do you find the following alternative methods of urban congestion charging? Write the number reflecting your level of acceptability for each alternative method in the box opposite***

**Level of acceptability**

| | |
|---|---|
| Totally unacceptable | 1 |
| Not very acceptable | 2 |
| Neither acceptable nor unacceptable | 3 |
| Fairly acceptable | 4 |
| Totally acceptable | 5 |

**Methods** **Level**

Cordon Charge which is levied each time a vehicle enters a designated urban area ☐

A daily, weekly or monthly Area License which once purchased allows you to drive within a designated urban area ☐

A meter installed in the motor vehicle which monitors journeys undertaken in the designated urban area. An itemised bill is then sent to the vehicles owner (like a telephone bill) ☐

A meter installed in the motor vehicle which accepts a smartcard which is purchased in advance and from which monetary units are deducted when average speeds (for example) fall beneath a selected threshold. ☐

10 ***Do you think there will be any benefits from congestion charging?***

Yes ☐ No ☐

11 ***If you have answered yes, please explain your answer***

________________________________________

________________________________________

________________________________________

________________________________________

12 ***Do you think there will be any disbenefits from congestion charging?***

Yes ☐ No ☐

13 ***If you have answered yes, please explain your answer***

________________________________________

________________________________________

***Thank you for taking the time in completing this questionnaire.***

# Appendix B: Business questionnaire

## Urban Congestion Charging Survey

**Please answer all of the questions below, marking the appropriate box reflecting your preferred choice with an "X" or a number where required. Alternatively write your answer in the space provided below the relevant question.**

## Section A: Your perception

1 ***Please indicate your level of agreement for each of the following statements, using a scale of 1 - 4 where:***

**1 = Strongly agree**
**2 = Agree**
**3 = Disagree**
**4 = Strongly disagree**

| Statement | Level |
|---|---|
| Traffic congestion is a serious problem in London | |
| Road user charging will reduce traffic congestion | |
| Road user charging is a good idea for London | |
| Road user charging will improve pedestrian safety | |
| Road user charging will induce traffic displacement | |
| Road user charging will lead to a cleaner environment | |
| Road user charging reduces vehicle emissions | |
| Policy-information about congestion charging will increase the public acceptance of congestion charging | |
| If all drivers had full information about congestion hotspots, they would be able to avoid it | |
| The non-implementation of congestion charging is mainly due to public unwillingness to pay for the use of roads | |
| My business is more accessible in the congestion charging zone | |
| By allowing employees more flexible working hours, it could make congestion charging more acceptable? | |
| Mobility is a right | |
| Congestion charging is an infringement on freedom of movement | |
| The judgement of politicians about congestion charging is credible and convincing | |

2 ***Do you oppose congestion charging?***

Yes ☐ No ☐

**3** ***Would you support politicians and interest groups pursuing road pricing as a traffic congestion reduction instrument?***

Yes ☐ No ☐

**4** ***Do you accept congestion charging as a instrument to reduce traffic congestion?***

Yes ☐ No ☐

**5** ***Do you know about the different instruments that could be used to reduce traffic congestion?***

Yes ☐ No ☐

## Section B: About your company

**6** ***What is your total annual turnover?***

less than £50 000 per annum ☐

between £50 000 and £100 000 ☐

between £101 000 and £200 000 ☐

between £201 000 and £300 000 ☐

between £301 000 and £500 000 ☐

more than £501 000 ☐

**7** ***How many employees do you employ?***

Less than 20 ☐ Between 61 – 80 ☐

Between 20-40 ☐ More than 81 ☐

Between 41- 60 ☐

**8** ***How many company vehicles do you have?***

Less than 3 ☐ Between 21 –30 ☐

Between 3 - 10 ☐ Between 31 –40 ☐

Between 11 - 20 ☐ More than 41 ☐

**9** ***In which London Borough is your company located?***

Westminster City Council ☐ Wandsworth Borough Council ☐

London Borough of Lambeth ☐ London Borough of Lewisham ☐

Southwark Council ☐ Greenwich Council ☐

Towerhamlets Borough Council ☐ Newham Council ☐

Camden Council ☐ London Borough of Redbridge ☐

Islington Council ☐ London Borough of Waltham Forest ☐

London Borough of Hackney ☐ Enfield Council ☐

City of London ☐ Haringey Council ☐

| | | | |
|---|---|---|---|
| The Royal Borough of Kensington and Chelsea | ☐ | Brent Council | ☐ |
| Hammersmith and Fulham Council | ☐ | London Borough of Barnet | ☐ |
| Hounslow Council | ☐ | Ealing Council | ☐ |

## Section C: Economics

10 ***How has the congestion charge affected your annual gross income?***

Reduce ☐ No change ☐
Increase ☐ Not sure ☐

11 ***Have you marked any of the following changes in your employee productivity following the imposition of congestion charging?***

Reduce ☐ No change ☐
Increase ☐ Not sure ☐

12 ***Has the introduction of congestion charging forced you to increase or reduce the number of hours you do business?***

Increase ☐ Decrease ☐

13 ***How does congestion charging affect your business profitability and competitiveness?***

Reduce ☐ No change ☐
Increase ☐ Not sure ☐

14 ***Do you have your own goods delivery vehicles?***

Yes ☐ No ☐

15 ***Do you meet the increased cost of the deliveries as a result of the charge?***

Yes ☐ No ☐

16 ***Do you shift the increased cost of deliveries to consumers through higher product, service or consumable prices?***

Yes ☐ No ☐

17 ***Does the congestion charge have a detrimental impact on your business as a result of increased transport costs?***

Yes ☐ No ☐

18 ***Have you considered to have or make deliveries after 1830 or before 0700?***

Yes ☐ No ☐

19 ***Would deliveries after 1830 or before 0700 present any operational difficulties to you?***

Yes ☐ No ☐

20 ***How does congestion charging affect your business in relation to the following factors? (Mark the appropriate indicator for each factor)***

| Factors | Indicators | | |
|---|---|---|---|
| | Increase | Decrease | No change |
| Demand for your service | ☐ | ☐ | ☐ |
| Annual turnover | ☐ | ☐ | ☐ |
| Amount of employees employed | ☐ | ☐ | ☐ |
| Saving | ☐ | ☐ | ☐ |
| Investment in own business or to expand | ☐ | ☐ | ☐ |
| Growth | ☐ | ☐ | ☐ |

21 ***Have you had staff retention problems following the imposition of congestion charging?***

Yes ☐ No ☐

## Section D: Welfare

22 ***Have you increased the cost of your products, services or consumables as a result of congestion charging?***

Yes ☐ No ☐

23 ***Are you in the manufacturing industry?***

Yes ☐ No ☐

***If you have answered yes, go to the next question, if you have answered no, go to question 26***

24 ***Have you decreased production in an attempt to drive the price of your products, services or consumables down?***

Yes ☐ No ☐

25 ***Have you increased or decreased the price of your goods, services and or consumables to maintain your profitability?***

Increase ☐ Decrease ☐

26 ***Dou you think you have less customers or clients following the imposition of congestion charging?***

Yes ☐ No ☐

27 ***What type of goods and services do you think is most likely to be affected?***

________________________________________

________________________________________

## Section E: Land use issues

28 ***Do you intend to move to a location outside the congestion zone within the next***

*5 years?*

Yes ☐ No ☐

29 ***Have or will you consider to move to an area within the congestion charging zone where clustering of similar businesses takes place if you are not located in the congestion zone already?***

Yes ☐ No ☐

## Section F: Congestion charging and its effects on the environment

30 ***Will you support congestion charging if it reduces environmental decay?***

Yes ☐ No ☐

31 ***Rank the following policy options which you consider to be effective for reducing traffic congestion using numbers 1-12, where number 1 reflects your most preferred policy option and number 12 your least favourite option.***

| Policy option | Rank |
|---|---|
| Selective expansion of road construction in urban areas | ☐ |
| The encouragement of home working | ☐ |
| The encouragement of car sharing | ☐ |
| The creation of a comprehensive network of safe cycle and walking routes which do not involve the use of heavy trafficked roads | ☐ |
| An increase in the price of petrol to £5 per gallon | ☐ |
| Introduction or expansion of park and ride sites | ☐ |
| Cheaper public transport fares | ☐ |
| A doubling of parking charges in urban areas | ☐ |
| An improvement in the frequency and reliability of public transport | ☐ |
| The development of an integrated land use and transport planning strategy | ☐ |
| The implementation of urban congestion charging | ☐ |
| Banning/restricting vehicles in central areas | ☐ |

32 ***Rank the following policy options which you consider to be publicly acceptable for reducing traffic congestion using numbers 1-12, where number 1 reflects your most preferred option and number 12 your least favourite option.***

| Policy option | Rank |
|---|---|
| Selective expansion of road construction in urban areas | ☐ |
| The encouragement of home working | ☐ |
| The encouragement of car sharing | ☐ |
| The creation of a comprehensive network of safe cycle and walking routes which do not involve the use of heavy trafficked roads | ☐ |
| An increase in the price of petrol to £5 per gallon | ☐ |
| Introduction or expansion of park and ride sites | ☐ |
| Cheaper public transport fares | ☐ |
| A doubling of parking charges in urban areas | ☐ |
| An improvement in the frequency and reliability of public transport | ☐ |

The development of an integrated land use and transport planning strategy
The implementation of urban congestion charging
Banning/restricting vehicles in central areas

## Section G: Revenue recycling

33 ***Indicate at each of the following statements whether you agree or disagree, by writing 1 in the box when you agree and 2 if you disagree.***

**Statement**

I will support congestion charging if businesses received tax rebates

I will support congestion charging if I pay less duty on fuel

I will support congestion charging if the road fund license were reduced

I will support congestion charging if the revenue raised was earmarked to improve road conditions and public transport

34 ***Imagine you have 100 units of money to spend, which represents the total amount of money raised by urban congestion charging. How many units will you allocate to each policy?***

| **Policy option** | **Units** |
|---|---|
| Selective expansion of road construction in urban areas | |
| The encouragement of home working | |
| The encouragement of car sharing | |
| The creation of a comprehensive network of safe cycle and walking routes which do not involve the use of heavy trafficked roads | |
| An increase in the price of petrol to £5 per gallon | |
| Introduction or expansion of park and ride sites | |
| Cheaper public transport fares | |
| A doubling of parking charges in urban areas | |
| An improvement in the frequency and reliability of public transport | |
| The development of an integrated land use and transport planning strategy | |
| The implementation of urban congestion charging | |
| Banning/restricting vehicles in central areas | |

35 ***Do you think revenue recycling (the process where the funds raised by congestion charging is used to improve public transport and road conditions) would enhance the efficiency and reliability of public transport?***

Yes ☐ No ☐

## Section H: Work schedule flexibility

36 ***Do you provide flexible working hours to employees?***

Yes ☐ No ☐

37 ***How many minutes do you allow employees being late without it mattering very much?***

1 – 5 min ☐ 16 – 20 min ☐
6 – 10 min ☐ more than 20 min ☐
11 – 15 min ☐

## Section I: Driver information provision

38 ***Will/have you changed your preferred route when driver information systems warn you in advance of possible delays ahead on your normal journey?***

Yes ☐ No ☐

39 ***If you answered yes, how familiar were you with the alternative route?***

Used more than three times before ☐
Between one and three times ☐
Never used it before ☐

40 ***How did you judge the conditions on your alternative route before taking it?***

Traffic report ☐
Own observations ☐
Past experience ☐

41 ***Do you respond to pre-trip driver information in avoiding congestion?***

Yes ☐ No ☐

42 ***Do you respond to en route driver information in avoiding congestion?***

Yes ☐ No ☐

43 ***When you received travel and traffic information about delays/congestion on your normal route, were you:***

On your way from home - work ☐ At home ☐
On your way from work - home ☐ At work ☐

44 ***How much time do you normally loose due to delays to your journey?***

10 –20 min ☐ 41 – 50 min ☐
21 – 30 min ☐ more than 50 min ☐
31 – 40 min ☐

45 ***How did you receive the information about the delay?***

Variable message signs ☐ Radio traffic reports ☐
Own observations ☐ Other ☐

46 ***Would the provision of traffic and travel information benefit your business if it could induce time savings when travelling to and from work or clients or customers?***

Yes ☐ No ☐

## Section J: Public and political acceptance

47 ***If an urban congestion charging scheme was introduced, how concerned would you be about each of the following issues?***

| Issue | Very/fairly unconcerned (%) | Very/fairly concerned (%) |
|---|---|---|
| The fact that the introduction of road pricing would mean that in congested periods the road user would have to pay for the use of the road | ☐ | ☐ |
| Invasion of road user privacy | ☐ | ☐ |
| The impact of delivery vehicles and commercial traffic | ☐ | ☐ |
| Exemption for certain groups | ☐ | ☐ |
| How urban road pricing would be integrated with other congestion management measures | ☐ | ☐ |
| The cost of implementing an urban congestion charging scheme | ☐ | ☐ |
| Equity/fairness of an urban road pricing scheme | ☐ | ☐ |
| The reliability and accuracy of urban road pricing equipment | ☐ | ☐ |
| The economic impact on the urban area in which urban road pricing is introduced | ☐ | ☐ |
| Enforcement of an urban road pricing scheme | ☐ | ☐ |
| The need for clearly stated objectives, such as, the regulation of traffic demand, the achievement of environmental benefits and the raising of revenue for investment in transport systems | ☐ | ☐ |
| The reliability of public transport once urban road pricing has been introduced | ☐ | ☐ |

48 ***How acceptable do you find the following alternative methods of urban congestion charging? Write the number reflecting your level of acceptability for each alternative method in the box opposite***

| Level of acceptability | |
|---|---|
| Totally unacceptable | 1 |
| Not very acceptable | 2 |
| Neither acceptable nor unacceptable | 3 |
| Fairly acceptable | 4 |
| Totally acceptable | 5 |

**Methods** **Level**

Cordon Charge which is levied each time a vehicle enters a designated urban area ☐

A daily, weekly or monthly Area License, which once purchased, allows you to drive within a designated urban area ☐

A meter installed in the motor vehicle which monitors journeys undertaken in the designated urban area. An itemised bill is then sent to the vehicles owner (like a telephone bill) ☐

A meter installed in the motor vehicle which accepts a smartcard which is purchased in advance and from which monetary units are deducted when average speeds (for example) fall beneath a selected threshold. ☐

49 ***Would you accept road pricing if it is backed by politicians?***

Yes ☐ No ☐

50 ***What do you think is the main reasons for opposing congestion charging? (Tick one option only)***

| | | | |
|---|---|---|---|
| Pricing what was free | ☐ | Scepticism | ☐ |
| Tax resistance | ☐ | Equity/fairness | ☐ |
| Harmful to businesses | ☐ | Right to travel | ☐ |
| Invading privacy | ☐ | | |

51 ***Do you think there will be any benefits from congestion charging?***

Yes ☐ No ☐

52 ***If you have answered yes, please explain your answer***

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

53 ***Do you think there will be any disbenefits from congestion charging?***

Yes ☐ No ☐

54 ***If you have answered yes, please explain your answer***

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

***Thank you for taking the time in completing this questionnaire.***

# Appendix C: Local Authority questionnaire

## Urban Congestion Charging Survey

**Please answer all of the questions below, marking the appropriate box reflecting your preferred choice with an "X" or a number where required. Alternatively write your answer in the space provided below the relevant question.**

## Section A: Your Perception

1 ***Please indicate your level of agreement for each of the following statements, using a scale of 1 - 4 where:***

**1 = Strongly agree**
**2 = Agree**
**3 = Disagree**
**4 = Strongly disagree**

| Statement | Level |
|---|---|
| Traffic congestion is a serious problem in London | ☐ |
| Road user charging will reduce traffic congestion | ☐ |
| Road user charging is a good idea for London | ☐ |
| Road user charging will improve pedestrian safety | ☐ |
| Road user charging will induce traffic displacement | ☐ |
| Road user charging will lead to a cleaner environment | ☐ |
| Road user charging reduces vehicle emissions | ☐ |
| The current level of traffic related pollution in London is a serious problem | ☐ |
| Policy-information about congestion charging will increase the public acceptance of congestion charging | ☐ |
| If all drivers had full information about congestion hotspots, they would be able to avoid it | ☐ |
| The non-implementation of congestion charging is mainly due to public unwillingness to pay for the use of roads | ☐ |
| By compensating those who loose from congestion charging it may enhance its acceptability | ☐ |

## Section B: Land use

2 ***Please indicate your level of agreement for each of the following statements, using a scale of 1 - 4 where:***

**1 = Strongly agree**
**2 = Agree**
**3 = Disagree**
**4 = Strongly disagree**

| Statement | Level |
|---|---|

Congestion charging will/have influenced the planning process

Some land use classes are decentralising from the congestion zone due to the charge

Congestion charging causes land use classes to mix

Congestion charging causes an increase in development density in the congestion zone

3 ***Will you consider using the planning process as an instrument to restrain traffic congestion?***

Yes No

4 ***Do you think congestion charging will/have influenced the planning process?***

Yes No

5 ***If you have answered yes, how has congestion charging influenced the planning process?***

6 ***Dou you think the following land use classes will/have centralised in the congestion zone as a result of the congestion charge?***

| | Yes | No |
|---|---|---|
| Retail | | |
| Higher order office function | | |
| Lower order office function | | |
| Leisure | | |
| Food and Drink | | |
| Residential | | |
| Manufacturing | | |

7 ***Which land use classes do you think will decentralise from the congestion zone?***

8 ***Will/have you considered allowing congestion charging to cause land use classes to mix?***

Yes No

9 ***Rank the following policy options which you consider to be effective for reducing traffic congestion using numbers 1-12, where number 1 reflects your most preferred policy option and number 12 your least favourite option.***

**Policy option** **Rank**

Selective expansion of road construction in urban areas

The encouragement of home working

The encouragement of car sharing

The creation of a comprehensive network of safe cycle and walking routes which do

not involve the use of heavy trafficked roads
An increase in the price of petrol to £5 per gallon
Introduction or expansion of park and ride sites
Cheaper public transport fares
A doubling of parking charges in urban areas
An improvement in the frequency and reliability of public transport
The development of an integrated land use and transport planning strategy
The implementation of urban congestion charging
Banning/restricting vehicles in central areas

10 ***Rank the following policy options which you consider to be publicly acceptable for reducing traffic congestion using numbers 1-12, where number 1 reflects your most preferred option and number 12 your least favourite option.***

| **Policy option** | **Rank** |
|---|---|
| Selective expansion of road construction in urban areas | |
| The encouragement of home working | |
| The encouragement of car sharing | |
| The creation of a comprehensive network of safe cycle and walking routes which do not involve the use of heavy trafficked roads | |
| An increase in the price of petrol to £5 per gallon | |
| Introduction or expansion of park and ride sites | |
| Cheaper public transport fares | |
| A doubling of parking charges in urban areas | |
| An improvement in the frequency and reliability of public transport | |
| The development of an integrated land use and transport planning strategy | |
| The implementation of urban congestion charging | |
| Banning/restricting vehicles in central areas | |

## Section C: Revenue recycling

11 ***Imagine you have 100 units of money to spend, which represents the total amount of money raised by urban congestion charging. How many units will you allocate to each policy?***

| **Policy option** | **Units** |
|---|---|
| Selective expansion of road construction in urban areas | |
| The encouragement of home working | |
| The encouragement of car sharing | |
| The creation of a comprehensive network of safe cycle and walking routes which do not involve the use of heavy trafficked roads | |
| An increase in the price of petrol to £5 per gallon | |
| Introduction or expansion of park and ride sites | |
| Cheaper public transport fares | |
| A doubling of parking charges in urban areas | |
| An improvement in the frequency and reliability of public transport | |
| The development of an integrated land use and transport planning strategy | |

The implementation of urban congestion charging

Banning/restricting vehicles in central areas

12 ***Do you think revenue recycling (the process where the funds raised by congestion charging is used to improve public transport and road conditions) would enhance the efficiency and reliability of public transport?***

Yes ☐ No ☐

## Section D: Public and political acceptance

13 ***If urban congestion charging was introduced and the money was spent in the way you suggested, how publicly acceptable would you think urban congestion charging would be?***

| Acceptance | Before revenue recycling % | After revenue recycling % |
|---|---|---|
| Totally/Fairly acceptable | ☐ | ☐ |
| Neither | ☐ | ☐ |
| Not very acceptable | ☐ | ☐ |
| Totally unacceptable | ☐ | ☐ |

14 ***If an urban congestion charging scheme was introduced, how concerned would you be about each of the following issues?***

| Issue | Very/fairly unconcerned (%) | Very/fairly concerned (%) |
|---|---|---|
| The fact that the introduction of road pricing would mean that in congested periods the road user would have to pay for the use of the road | ☐ | ☐ |
| Invasion of road user privacy | ☐ | ☐ |
| The impact of delivery vehicles and commercial traffic | ☐ | ☐ |
| Exemption for certain groups | ☐ | ☐ |
| How urban road pricing would be integrated with other congestion management measures | ☐ | ☐ |
| The cost of implementing an urban congestion charging scheme | ☐ | ☐ |
| Equity/fairness of an urban road pricing scheme | ☐ | ☐ |
| The reliability and accuracy of urban road pricing equipment | ☐ | ☐ |
| The economic impact on the urban area in which urban road pricing is introduced | ☐ | ☐ |
| Enforcement of an urban road pricing scheme | ☐ | ☐ |
| The need for clearly stated objectives, such as, the regulation of traffic demand, the | | |

achievement of environmental benefits and the raising of revenue for investment in transport systems ☐ ☐

The reliability of public transport once urban road pricing has been introduced ☐ ☐

15 ***How acceptable do you find the following alternative methods of urban congestion charging? Write the number reflecting your level of acceptability for each alternative method in the box opposite***

**Level of acceptability**

| | |
|---|---|
| Totally unacceptable | 1 |
| Not very acceptable | 2 |
| Neither acceptable nor unacceptable | 3 |
| Fairly acceptable | 4 |
| Totally acceptable | 5 |

| **Methods** | **Level** |
|---|---|
| Cordon Charge which is levied each time a vehicle enters a designated urban area | ☐ |
| A daily, weekly or monthly Area License which once purchased allows you to drive within a designated urban area | ☐ |
| A meter installed in the motor vehicle which monitors journeys undertaken in the designated urban area. An itemised bill is then sent to the vehicles owner (like a telephone bill) | ☐ |
| A meter installed in the motor vehicle which accepts a smartcard which is purchased in advance and from which monetary units are deducted when average speeds (for example) fall beneath a selected threshold. | ☐ |

16 ***Do you think there will be any benefits from congestion charging?***

Yes ☐ No ☐

17 ***If you have answered yes, please explain your answer***

______________________________
______________________________
______________________________
______________________________
______________________________

18 ***Do you think there will be any disbenefits from congestion charging?***

Yes ☐ No ☐

19 ***If you have answered yes, please explain your answer***

______________________________
______________________________
______________________________

***Thank you for taking the time in completing this questionnaire.***

# Appendix D: Public transport provider questionnaire

## Urban Congestion Charging Survey

**Please answer all of the questions below, marking the appropriate box reflecting your preferred choice with an "X" or a number where required. Alternatively write your answer in the space provided below the relevant question.**

### Section A: Your perception

1 ***Please indicate your level of agreement for each of the following statements, using a scale of 1 - 4 where:***

**1 = Strongly agree**
**2 = Agree**
**3 = Disagree**
**4 = Strongly disagree**

| Statement | Level |
|---|---|
| Traffic congestion is a serious problem in London | ☐ |
| Road user charging will reduce traffic congestion | ☐ |
| Road user charging is a good idea for London | ☐ |
| Road user charging will improve pedestrian safety | ☐ |
| Road user charging will induce traffic displacement | ☐ |
| Strategic spending by the government will increase the public use of your service | ☐ |
| Road user charging will lead to a cleaner environment | ☐ |
| Road user charging reduces vehicle emissions | ☐ |
| Policy-information about congestion charging will increase the public acceptance of congestion charging | ☐ |
| If all drivers had full information about congestion hotspots, they would be able to avoid it | ☐ |
| The non-implementation of congestion charging is mainly due to public unwillingness to pay for the use of roads | ☐ |
| By compensating those who loose from congestion charging it may enhance its acceptability | ☐ |

### Section B: Economics

2 ***Have you marked one of the following changes in your employee productivity?***

Increase ☐ No change ☐

Reduce ☐ Not sure ☐

3 ***How has/will the introduction of congestion charging influence the number of hours you do business or operate?***

Increase ☐ No change ☐

Reduce ☐ Not sure ☐

4 ***How does congestion charging affect your profitability and competitiveness?***

Increase ☐ No change ☐

Reduce ☐ Not sure ☐

5 ***Has/will congestion charging force you to consider relocating your office(s) within the congestion zone to an area outside of the zone?***

Yes ☐ No ☐

6 ***If you have answered yes in the previous question, which factors have influenced your decision?***

____________________________________________

____________________________________________

____________________________________________

7 ***How does congestion charging affect your business in relation to the following factors? (Mark the appropriate option)***

| **Factor** | **Indicator** | | |
|---|---|---|---|
| | **Increase** | **Decrease** | **No change** |
| Demand for your service | ☐ | ☐ | ☐ |
| Annual turnover | ☐ | ☐ | ☐ |
| Amount of employees employed | ☐ | ☐ | ☐ |
| Saving | ☐ | ☐ | ☐ |
| Investment in own business or to expand | ☐ | ☐ | ☐ |
| Growth | ☐ | ☐ | ☐ |

## Section C: Welfare

8 ***Have/will you lower the price of your service to customers in an attempt to counter a reduction in use?***

Yes ☐ No ☐

9 ***Have/will you reduce the number of employees you employ following the imposition of congestion charging?***

Yes ☐ No ☐

## Section D: Revenue recycling

10 ***Have you received financial assistance from the government to improve your service reliability during the past 12 months?***

Yes ☐ No ☐

11 ***Imagine you have 100 units of money to spend, which represents the total amount of money raised by urban congestion charging. How many units will you allocate to each policy?***

| **Policy option** | **Units** |
|---|---|
| Selective expansion of road construction in urban areas | ☐ |
| The encouragement of home working | ☐ |
| The encouragement of car sharing | ☐ |
| The creation of a comprehensive network of safe cycle and walking routes which do not involve the use of heavy trafficked roads | ☐ |
| An increase in the price of petrol to £5 per gallon | ☐ |
| Introduction or expansion of park and ride sites | ☐ |
| Cheaper public transport fares | ☐ |
| A doubling of parking charges in urban areas | ☐ |
| An improvement in the frequency and reliability of public transport | ☐ |
| The development of an integrated land use and transport planning strategy | ☐ |
| The implementation of urban congestion charging | ☐ |
| Banning/restricting vehicles in central areas | ☐ |

12 ***If urban congestion charging was introduced and the money was spent in the way you suggested, how publicly acceptable would you think urban congestion charging would be?***

| **Acceptance** | Before revenue recycling % | After revenue recycling % |
|---|---|---|
| Totally/Fairly acceptable | ☐ | ☐ |
| Neither | ☐ | ☐ |
| Not very acceptable | ☐ | ☐ |
| Totally unacceptable | ☐ | ☐ |

13 ***If an urban congestion charging scheme was introduced, how concerned would you be about each of the following issues?***

| **Issue** | Very/fairly unconcerned (%) | Very/fairly concerned (%) |
|---|---|---|
| The fact that the introduction of road pricing would mean that in congested periods the road user would have to pay for the use of the road | ☐ | ☐ |
| Invasion of road user privacy | ☐ | ☐ |
| The impact of delivery vehicles and commercial traffic | ☐ | ☐ |
| Exemption for certain groups | ☐ | ☐ |
| How urban road pricing would be integrated with other congestion management measures | ☐ | ☐ |
| The cost of implementing an urban congestion charging scheme | ☐ | ☐ |

Equity/fairness of an urban road pricing scheme ☐ ☐

The reliability and accuracy of urban road pricing equipment ☐ ☐

The economic impact on the urban area in which urban road pricing is introduced ☐ ☐

Enforcement of an urban road pricing scheme ☐ ☐

The need for clearly stated objectives, such as, the regulation of traffic demand, the achievement of environmental benefits and the raising of revenue for investment in transport systems ☐ ☐

The reliability of public transport once urban road pricing has been introduced ☐ ☐

14 ***How acceptable do you find the following alternative methods of urban congestion charging? Write the number reflecting your level of acceptability for each alternative method in the box opposite***

| **Level of acceptability** | |
|---|---|
| Totally unacceptable | 1 |
| Not very acceptable | 2 |
| Neither acceptable nor unacceptable | 3 |
| Fairly acceptable | 4 |
| Totally acceptable | 5 |

| **Methods** | **Level** |
|---|---|
| Cordon Charge which is levied each time a vehicle enters a designated urban area | ☐ |
| A daily, weekly or monthly Area License which once purchased allows you to drive within a designated urban area | ☐ |
| A meter installed in the motor vehicle which monitors journeys undertaken in the designated urban area. An itemised bill is then sent to the vehicles owner (like a telephone bill) | ☐ |
| A meter installed in the motor vehicle which accepts a smartcard which is purchased in advance and from which monetary units are deducted when average speeds (for example) fall beneath a selected threshold. | ☐ |

15 ***Have your service reliability improved in the last 12 months?***

Yes ☐ No ☐

## Section E: Work schedule flexibility

16 ***Do you provide flexible working hours to employees?***

Yes ☐ No ☐

17 ***How many minutes do you allow employees to be late for work without it mattering***

***very much?***

1 – 5 min ☐ 16 – 20 min ☐
6 – 10 min ☐ more than 20 min ☐
11 – 15 min ☐

18 ***How many of your employees use flexi-time arrangements?***

1 – 25% ☐ 51 – 75% ☐
26 – 50% ☐ 76 – 100% ☐

## Section F: Public and political acceptance

19 ***What do you think is the main reasons for the public opposing congestion charging? (Tick one option only)***

Pricing what was free ☐ Scepticism ☐
Tax resistance ☐ Equity/fairness ☐
Harmful to businesses ☐ Right to travel ☐
Invading privacy ☐

20 ***Do you think there will be any benefits from congestion charging?***

Yes ☐ No ☐

21 ***If you have answered yes, please explain your answer***

________________________________________
________________________________________
________________________________________

22 ***Do you think there will be any disbenefits from congestion charging?***

Yes ☐ No ☐

23 ***If you have answered yes, please explain your answer***

________________________________________
________________________________________
________________________________________

24 ***Would you support politicians and interest groups pursuing congestion charging in reducing traffic congestion?***

Yes ☐ No ☐

***Thank you for taking the time in completing this questionnaire.***

## Appendix E: Residential questionnaire

# Urban Congestion Charging Survey

**Please answer all of the questions below, marking the appropriate box reflecting your preferred choice with an "X" or a number where required. Alternatively write your answer in the space provided below the relevant question.**

## Section A: About you

1 ***What gender are you?***

Male ☐ Female ☐

2 ***In which age category are you?***

18 or under ☐ 36 - 50 ☐
19 - 35 ☐ over 51 ☐

3 ***What is your ethnic background?***

White ☐ Black ☐
Chinese ☐ Mixed ☐
Asian ☐ Other ☐

4 ***In which occupational class are you?***

| | | | |
|---|---|---|---|
| Accountancy/Finance | ☐ | Logistics | ☐ |
| Admin and office support | ☐ | Media & Marketing | ☐ |
| Architecture | ☐ | Other | ☐ |
| Banking | ☐ | PA/Secretarial | ☐ |
| Construction | ☐ | Planning | ☐ |
| E-commerce/New media | ☐ | Property & surveying | ☐ |
| Education | ☐ | Public sector | ☐ |
| Engineering | ☐ | Purchasing & supply | ☐ |
| Executive | ☐ | Sales | ☐ |
| Facilities management & maintenance | ☐ | Taxation | ☐ |
| Graduate/student | ☐ | Telecoms | ☐ |
| Human resources | ☐ | Treasury | ☐ |
| IT | ☐ | Tradesmen | ☐ |
| Insurance & financial services | ☐ | Transportation | ☐ |
| Legal | ☐ | | |

5 ***What level of education do you have?***

No formal education ☐ First Degree level ☐

School Level ☐ Post graduate level ☐

National diploma ☐

6 ***Tick the item describing your employment status***

Self-employed ☐ Pensioner ☐

Employed ☐ Unemployed ☐

Student/Trainee ☐ Other ☐

7 ***What is your total annual income?***

less than £10 000 per annum ☐ between £31 000 and £40 000 ☐

between £10 000 and £20 000 ☐ More than £41 000 ☐

between £21 000 and £30 000 ☐

8 ***Do you drive?***

Yes ☐ No ☐

9 ***If you have answered yes, how many vehicles do you have in your household?***

One ☐

Two ☐

Three or more ☐

10 ***In which London Borough do you live?***

| | | | |
|---|---|---|---|
| Westminster City Council | ☐ | Wandsworth Borough Council | ☐ |
| London Borough of Lambeth | ☐ | London Borough of Lewisham | ☐ |
| Southwark Council | ☐ | Greenwich Council | ☐ |
| Towerhamlets Borough Council | ☐ | Newham Council | ☐ |
| Camden Council | ☐ | London Borough of Redbridge | ☐ |
| Islington Council | ☐ | London Borough of Waltham Forest | ☐ |
| London Borough of Hackney | ☐ | Enfield Council | ☐ |
| City of London | ☐ | Haringey Council | ☐ |
| The Royal Borough of Kensington and Chelsea | ☐ | Brent Council | ☐ |
| Hammersmith and Fulham Council | ☐ | London Borough of Barnet | ☐ |
| Hounslow Council | ☐ | Ealing Council | ☐ |

## Section B: Your perception

11 ***Please indicate your level of agreement for each of the following statements, using a scale of 1 - 4 where:***

**1 = Strongly agree**
**2 = Agree**
**3 = Disagree**
**4 = Strongly disagree**

**Statement** **Level**

Traffic congestion is a serious problem in London

Road user charging will reduce traffic congestion

Road user charging is a good idea for London

Road user charging will improve pedestrian safety

Road user charging will lead to a cleaner environment

Road user charging reduces vehicle emissions

The current level of traffic related pollution in London is a serious problem

By compensating those who loose from congestion charging it may enhance its acceptability

The non-implementation of congestion charging is mainly due to public unwillingness to pay for the use of roads

Mobility is a right

Road user charging is an infringement on freedom of movement

Road user charging will increase the price of consumables, goods and services in the congestion zone

Revenue recycling will enhance the efficiency and reliability of public transport

Greater work schedule flexibility will enhance the sustainability of congestion charging

The judgement of politicians about congestion charging is credible and convincing

12 ***How acceptable do you find the following alternative methods of urban congestion charging? Write the number reflecting your level of acceptability for each alternative method in the box opposite***

Level of acceptability

| | |
|---|---|
| Totally unacceptable | 1 |
| Not very acceptable | 2 |
| Neither acceptable nor unacceptable | 3 |
| Fairly acceptable | 4 |
| Totally acceptable | 5 |

**Methods** **Level**

Cordon Charge which is levied each time a vehicle enters a designated urban area

A daily, weekly or monthly Area License which once purchased allows you to drive within a designated urban area

A meter installed in the motor vehicle which monitors journeys undertaken in the designated urban area. An itemised bill is then sent to the vehicles owner (like a telephone bill)

A meter installed in the motor vehicle which accepts a smartcard which is purchased in advance and from which monetary units are deducted when average speeds (for example) fall beneath a selected threshold.

13 ***Do you oppose congestion charging?***

Yes ☐ No ☐

14 ***Would you support politicians and interest groups pursuing congestion charging as a traffic congestion reduction instrument?***

Yes ☐ No ☐

15 ***If you had a direct vote on approving or disproving congestion charging, would you exercise that vote?***

Yes ☐ No ☐

## Section C: Economics

16 ***Do you live within the congestion zone boundary?***

Yes ☐ No ☐

17 ***If you have answered yes, do you consider congestion charging to have increased or decreased the level of satisfaction you derive from journeys you undertake to and from and within central London? If you have answered no, please go to the next question.***

Increase user satisfaction ☐ Decrease user satisfaction ☐

18 ***How will congestion charging affect your finances in relation to the following issues? Write the number (1-4) reflecting your choice for each alternative issue in the box opposite.***

Choose 1 if there is no change
Choose 2 if there is a reduction
Choose 3 if there is an increase
Choose 4 if you are not sure

**For example; if congestion charging has no affect on your savings, write 1 in the box opposite.**

Affect on income ☐

Affect on savings ☐

Affect on consumption ☐

Affect on investment ☐

19 ***Do you think the consumption of goods, services and consumables will increase in the peripheral areas adjacent to the congestion zone?***

Yes ☐ No ☐

20 ***Do you think the price of consumables have been reduced in the congestion zone so businesses could stay profitable and competitive?***

Yes ☐ No ☐

21 ***How will congestion charging affect your decisions to investment money where you live?***

No change ☐ Increase ☐

Reduce ☐ Not sure ☐

22 ***Do you think congestion charging will increase or decrease your work productivity?***

Increase ☐ Decrease ☐

23 ***Will you work more or less hours following the introduction of congestion charging?***

More ☐ Less ☐

24 ***If the government was to use the revenue raised from congestion charging to improve the reliability and service of public transport and road conditions, would you:***

Increase the number of hours you work ☐ No change ☐

Decrease the number of hours you work ☐ Not sure ☐

## Section D: Welfare

25 ***What type of goods and services are you least likely to buy or use in the congestion zone?***

________________________________________

________________________________________

________________________________________

26 ***Will you undertake less shopping journeys to the congestion zone?***

Yes ☐ No ☐

27 ***Will you avoid shopping or doing business in the congestion zone?***

Yes ☐ No ☐

28 ***How will congestion charging affect your travel behaviour if you have to enter the congestion zone? (Mark as many options as is applicable to you)***

Continue to travel with your normal mode of transport ☐
Avoid travelling along charged route for some trips ☐
Avoid travelling along charged route for most trips ☐
Unaffected ☐
Affected by displaced traffic ☐
Make no change to preferred route ☐
Change route ☐
Change destination ☐
Change the time of departure ☐
Change vehicle occupancy ☐
Change the frequency of the trip ☐
Do not undertake the trip any longer ☐

29 ***Do you consider congestion charging as a source or cause of traffic displacement? (By traffic displacement is meant, drivers following a rat-run around the congestion zone to avoid being charged)***

Source ☐ Cause ☐

30 ***Do you work within the London congestion charging zone?***

Yes ☐ No ☐

31 ***If you have answered yes, will you change your preferred mode of transport and unplanned journeys to the congestion zone? If you have answered no, please go to question 36.***

Yes ☐ No ☐

32 ***Will you change your route to and from work to avoid being charged?***

Yes ☐ No ☐

33 ***Will congestion charging encourage you to change your travel departure time?***

Yes ☐ No ☐

34 ***Will congestion charging encourage you to increase your vehicle occupancy when travelling to and from a congestion charged area?***

Yes ☐ No ☐

35 ***Will you be able to negotiate your wage with your employer to compensate you for the loss of earnings due to the charge?***

Yes ☐ No ☐

36 ***If you consider the value of your time and consider the value to differ between income groups, number the following occupational classes according to the value of their time as you perceive it to be. Rank the class with the highest value of time as 1 and that of the lowest value with 26.***

| | | | |
|---|---|---|---|
| Accountancy/Finance | ☐ | Logistics | ☐ |
| Admin and office support | ☐ | Media & Marketing | ☐ |
| Architecture | ☐ | Other | ☐ |
| Banking | ☐ | PA/Secretarial | ☐ |
| Construction | ☐ | Planning | ☐ |
| E-commerce/New media | ☐ | Property & surveying | ☐ |
| Education | ☐ | Public sector | ☐ |
| Engineering | ☐ | Purchasing & supply | ☐ |
| Executive | ☐ | Sales | ☐ |
| Facilities management & maintenance | ☐ | Taxation | ☐ |
| Graduate/student | ☐ | Telecoms | ☐ |
| Human resources | ☐ | Treasury | ☐ |
| IT | ☐ | Tradesmen | ☐ |
| Insurance & financial services | ☐ | Transportation | ☐ |

Legal

37 ***Does the value of your time influence your decision to undertake a journey or not?***

Yes ☐ No ☐

38 ***Would you enter a congestion charging zone less because you have to pay for it and because it would reduce your income?***

Yes ☐ No ☐

39 ***Would you switch from your current mode of transport to enter the zone to a more affordable mode if available?***

Yes ☐ No ☐

40 ***Will congestion charging affect the frequency of journeys you undertake to such an area?***

Yes ☐ No ☐

41 ***Would you be prepared to pay more to enter a congestion charged zone to visit shops, leisure facilities and to do business?***

Yes ☐ No ☐

42 ***Will your willingness to pay to enter a congestion charged area affect your consumption in a congestion charged area?***

Yes ☐ No ☐

43 ***What do you think is meant by the concept of "fair" road use ?***

________________________________________

________________________________________

44 ***Do you perceive congestion charging to be more equitable if you were to receive exemptions or discounts when entering the zone?***

Yes ☐ No ☐

## Section E: Land use

45 ***Which of the following statements describes your perception best?***

I live in central London because it would increase the value of my property ☐

I do not live in central London because it would decrease the value of my property ☐

Neither ☐

46 ***Rank the following policy options which you consider to be effective for reducing traffic congestion using numbers 1-12, where number 1 reflects your most preferred policy option and number 12 your least favourite option.***

| **Policy option** | **Rank** |
|---|---|
| Selective expansion of road construction in urban areas | ☐ |
| The encouragement of home working | ☐ |
| The encouragement of car sharing | ☐ |

The creation of a comprehensive network of safe cycle and walking routes which do not involve the use of heavy trafficked roads
An increase in the price of petrol to £5 per gallon
Introduction or expansion of park and ride sites
Cheaper public transport fares
A doubling of parking charges in urban areas
An improvement in the frequency and reliability of public transport
The development of an integrated land use and transport planning strategy
The implementation of urban congestion charging
Banning/restricting vehicles in central areas

47 ***If you do not live in the congestion zone, but are employed there, will you consider to relocate in avoiding 90% of the charge?***

Yes ☐ No ☐

48 ***What type of goods and services provided in a congestion charging area do you consider would be most effected by a change in consumption?***

Food and drink services ☐ Leisure ☐
Professional services ☐ Other ☐
Business ☐

## Section F: Congestion charging and it's effects on the environment

49 ***Will you support congestion charging if it reduces environmental decay?***

Yes ☐ No ☐

50 ***Rank the following instruments you are willing to support in reducing traffic congestion, with 1 reflecting strongest agreement and 4 reflecting strongest disagreement.***

Regulation ☐ Cleaner vehicle technology ☐
Congestion charging ☐ Incentive based instruments ☐

51 ***Which of the following instruments do you consider most equitable (Tick one option only)***

Regulation ☐ Cleaner vehicle technology ☐
Congestion charging ☐ Incentive based instruments ☐

## Section G: Revenue recycling

Revenue recycling represent the process where the funds raised by congestion charging is used to improve public transport and road conditions.

52 ***Would you support congestion charging if the revenue raised by the congestion charging scheme was earmarked to improve road conditions and public transport reliability?***

Yes ☐ No ☐

53 ***Would you support congestion charging if the revenue raised was used to reduce your income tax contributions?***

Yes ☐ No ☐

54 ***Would you support congestion charging if you were to receive tax rebates?***

Yes ☐ No ☐

55 ***Would you support congestion charging if you were to pay less fuel tax?***

Yes ☐ No ☐

56 ***Would you support congestion charging if your road fund license was reduced?***

Yes ☐ No ☐

57 ***If public transport was available, fast and reliable, would you be prepared to use it rather than your own transport?***

Yes ☐ No ☐

Yes ☐ No ☐

58 ***Imagine you have 100 units of money to spend, which represents the total amount of money raised by urban congestion charging. How many units will you allocate to each policy?***

| **Policy option** | **Units** |
|---|---|
| Selective expansion of road construction in urban areas | ☐ |
| The encouragement of home working | ☐ |
| The encouragement of car sharing | ☐ |
| The creation of a comprehensive network of safe cycle and walking routes which do not involve the use of heavy trafficked roads | ☐ |
| An increase in the price of petrol to £5 per gallon | ☐ |
| Introduction or expansion of park and ride sites | ☐ |
| Cheaper public transport fares | ☐ |
| A doubling of parking charges in urban areas | ☐ |
| An improvement in the frequency and reliability of public transport | ☐ |
| The development of an integrated land use and transport planning strategy | ☐ |
| The implementation of urban congestion charging | ☐ |
| Banning/restricting vehicles in central areas | ☐ |

## Section H: Work schedule flexibility

59 ***Will congestion charging induce you to change your morning and afternoon departure times from home and work if you have to enter a congestion zone?***

Yes ☐ No ☐

60 ***Do you work within the London congestion charging zone? (Repeat of question 30)***

Yes ☐ No ☐

**If you have answered yes, please go to the next question, if you have answered no, go to question 75.**

61 ***Does your employer allow you a reasonable degree of flexibility in your work start time?***

Yes ☐ No ☐

62 ***If Yes, How many minutes late can you arrive at work without it mattering very much?***

1 – 5 min ☐ 16 – 20 min ☐

6 – 10 min ☐ more than 20 min ☐

11 – 15 min ☐

63 ***Are you allowed flexi-time?***

Yes ☐ No ☐

64 ***Dou you drive to work?***

Yes ☐ No ☐

**If you have answered yes, please go to the next question, if you have answered no, go to question 70.**

65 ***What is you departure time in the morning?***

Before 07:15 ☐ 08:15-08:45 ☐

07:15-07:45 ☐ After 08:45 ☐

07:45-08:15 ☐

66 ***What is you departure time in the afternoon?***

Before 16:00 ☐ 17:00-17:30 ☐

16:00-16:30 ☐ After 17:30 ☐

16:30-17:00 ☐

67 ***How many passengers accompany you during your journey to and from work?***

0 ☐ 3 ☐

1 ☐ 4+ ☐

2 ☐

68 ***What distance do you commute to work?***

0,1 miles – 10 miles ☐ 31 miles – 40 miles ☐

11 miles – 20 miles ☐ More than 40 miles ☐

69 ***How long does your journey take?***

10 – 30 minutes ☐ 61 – 75 minutes ☐

31 – 45 minutes ☐ more than 75 minutes ☐

46 – 60 minutes ☐

70 ***What mode of transport do you use to travel to the London congestion charging zone?***

Tube ☐ Walking ☐

| | |
|---|---|
| Motorcycle/Scooter ☐ | Taxi ☐ |
| Commercial vehicle ☐ | Train ☐ |
| Bus ☐ | Car pool ☐ |
| Cycling ☐ | Other ☐ |

71 ***Will the introduction of congestion charging change the mode of transport you use when travelling to central London?***

Yes ☐ No ☐

72 ***If you answered yes, will you change to:***

| | |
|---|---|
| Car ☐ | Walking ☐ |
| Car pool ☐ | Taxi ☐ |
| Commercial vehicle ☐ | Train ☐ |
| Bus ☐ | Tube ☐ |
| Cycling ☐ | |

73 ***Have you saved any time by visiting the congestion charged area?***

Yes ☐ No ☐

74 ***Have the introduction of congestion charging changed the frequency with which you visit the London congestion zone?***

Yes ☐ No ☐

75 ***How often do you visit the London congestion charging area?***

| | |
|---|---|
| every day of the week ☐ | once or twice a week ☐ |
| four to five times a week ☐ | infrequently ☐ |
| three times a week ☐ | hardly ever or never ☐ |

76 ***What would the purpose of your trip be? (mark as many as appropriate)***

| | |
|---|---|
| Employment ☐ | Tourism ☐ |
| Business ☐ | Residential ☐ |
| Shopping ☐ | Other ☐ |
| Leisure ☐ | |

## Section I: Information provision

77 ***Do you think that by providing clear policy-information about congestion charging and the alternative modes of transport available it would lead to greater public acceptance of congestion charging?***

Yes ☐ No ☐

78 ***Will you change your preferred route when driver information warns you about possible delays ahead on your normal journey?***

Yes ☐ No ☐

79 ***Will you respond to pre-trip driver information in avoiding congestion?***

Yes ☐ No ☐

80 ***Will you respond to en route driver information in avoiding congestion?***

Yes ☐ No ☐

81 ***When you received travel and traffic information about delays/congestion, were you on your way:***

home – work ☐ work - home ☐

82 ***How much time do you normally loose as a result of delays to your journey?***

10 –20 min ☐ 41 – 50 min ☐

21 – 30 min ☐ more than 50 min ☐

31 – 40 min ☐

83 ***How do you get information about traffic delays?***

Radio traffic reports ☐ Variable message signs ☐

Own observations ☐ Other ☐

84 ***Do you take the alternative route after receiving information about delays to your usual route?***

Yes ☐ No ☐

85 ***If you have answered yes, how familiar were you with the alternative route?***

Used more than three times before ☐

Between one and three times ☐

Never used it before ☐

86 ***How do you judge the conditions on your alternative route before taking it?***

Traffic report ☐

Own observations ☐

Past experience ☐

## Section J: Public and political acceptance

87 ***If an urban congestion charging scheme was introduced, how concerned would you be about each of the following issues?***

| **Issue** | Very/fairly unconcerned (%) | Very/fairly concerned (%) |
|---|---|---|
| The fact that the introduction of road pricing would mean that in congested periods the road user would have to pay for the use of the road | ☐ | ☐ |
| Invasion of road user privacy | ☐ | ☐ |
| The impact of delivery vehicles and commercial traffic | ☐ | ☐ |

| | | |
|---|---|---|
| Exemption for certain groups | ☐ | ☐ |
| How urban road pricing would be integrated with other congestion management measures | ☐ | ☐ |
| The cost of implementing an urban congestion charging scheme | ☐ | ☐ |
| Equity/fairness of an urban road pricing scheme | ☐ | ☐ |
| The reliability and accuracy of urban road pricing equipment | ☐ | ☐ |
| The economic impact on the urban area in which urban road pricing is introduced | ☐ | ☐ |
| Enforcement of an urban road pricing scheme | ☐ | ☐ |
| The need for clearly stated objectives, such as, the regulation of traffic demand, the achievement of environmental benefits and the raising of revenue for investment in transport systems | ☐ | ☐ |
| The reliability of public transport once urban road pricing has been introduced | ☐ | ☐ |

**88** ***Would you accept congestion charging if it is backed by politicians?***

Yes ☐  No ☐

**89** ***What do you think is the main reasons for opposing congestion charging? (Tick only one option)***

| | | | |
|---|---|---|---|
| Pricing what was free | ☐ | Scepticism | ☐ |
| Tax resistance | ☐ | Equity/fairness | ☐ |
| Harmful to businesses | ☐ | Right to travel | ☐ |
| Invading privacy | ☐ | | |

**90** ***If urban congestion charging was introduced and the money was spent in the way you suggested, how publicly acceptable do you think it would be?***

| **Acceptance** | Before revenue recycling % | After revenue recycling % |
|---|---|---|
| Totally/Fairly acceptable | ☐ | ☐ |
| Neither | ☐ | ☐ |
| Not very acceptable | ☐ | ☐ |
| Totally unacceptable | ☐ | ☐ |

**91** ***Do you think there will be any benefits from congestion charging?***

Yes ☐  No ☐

**92** ***If you have answered yes, please explain your answer***

________________________________________

________________________________________

93 ***Do you think there will be any disbenefits from congestion charging?***

Yes ☐ No ☐

94 ***If you have answered yes, please explain your answer***

***Thank you for taking the time in completing this questionnaire.***

# Appendix F: Business questionnaire cover letter

31 Vellum Drive
Carshalton
Surrey
SM5 2TN

Tel: 020 8773 8834
Date: 14-04-2004
E-mail: wernerheyns@aol.com

«Company_Name»
«Address_1»
«Address_2»
«Address_3»
«Address_4_»

Dear Sir/Madam,

**RE: Urban Congestion Charging Questionnaire**

I am a final year M. Art. et Scien. (Planning) student studying the effects of urban congestion charging and potential factors, which may prove to sustain it as a transport demand management instrument.

You may be aware that road users require access to expensive road infrastructure, and impose a variety of external costs (congestion, accident risks etc.) on each other and on non-road users. In an attempt to curb this phenomenon, some cities are increasingly, considering implementing various types of road pricing (a type of congestion charging) as has been successfully introduced in Singapore, Oslo and other cities and now London as an instrument to reduce traffic congestion.

Research in, and implementation of urban congestion charging, acknowledges the possibility of reducing urban traffic congestion levels through road pricing; subject to an efficient modal shift, revenue recycling and general public acceptance. It is normally justified as a fair means of financing improved transport systems for motorists and the public. However well intended such a charging scheme might be, it will most certainly be accompanied by inevitable effects on the economy, the welfare of individuals, the environment and land use patterns of the urban landscape.

The general approach of my study is to explore these effects and factors which may prove to sustain road pricing, against international experience. This will allow me to expand knowledge in the subject field and to develop plausible recommendations on how to present road pricing as a viable and sustainable policy instrument in urban areas experiencing traffic congestion.

In my research I have identified some gaps, unanswered questions and uncertainties which have not been resolved in previous research. In addressing these unresolved issues I need to know what you think about congestion charging and how it is perceived by you. You, along with 404 other businesses, have been randomly selected to participate in the survey. This questionnaire, forming part of my dissertation, is intended to give you the opportunity to express your views and opinions. I strongly encourage you to participate in the survey as it will give me an important insight into how you view congestion charging and what needs to be done to make it more acceptable. Your information will enable me to determine and evaluate:

i. whether road pricing is perceived to, and actually reduce urban traffic congestion levels;
ii. the effects road pricing has as a fiscal instrument in reducing urban traffic congestion in London;
iii. whether the sustainability of congestion charging can be improved if it is subject to a number of pre-determined conditions, and;
iv. how your views and opinions compare or differ from those reported in previous research.

Please complete the questionnaire and return to the address overleaf within the next three weeks. Once received, the information will be coded, enumerated and quantified into nominal and ordinal data. By coding and enumerating your information, your identity and anonymity will be safe guarded. The data will then be analysed with the aid of a software program. Be assured that your information will be treated with the strictest of confidentially and will only be used for the purpose of this research. The findings and conclusions will remain my property and will not be misused in any way or form.

The final research results will be reported in a dissertation kept by the University of Potchefstroom in South Africa. As it would be kept in a University library, you would be allowed to read the final dissertation on request from the library if you were interested in the findings and recommendations.

Thank you for your help and time in completing the questionnaire and be assured that your anonymity will be maintained at all times.

Yours Faithfully,

Werner Heyns

# Appendix G: Environmental questionnaire cover letter

31 Vellum Drive
Carshalton
Surrey
SM5 2TN

Tel: 020 8773 8834
Date: 06-04-2004
E-mail: wernerheyns@aol.com

Address line 1
Address line 2
Address line 3
Address line 4
Post Code

Dear Sir/Madam,

**RE: Urban Congestion Charging Questionnaire**

I write further to our recent telephone conversation, where we agreed to meet on the **22nd April 2004** to discuss your thoughts and perception of urban congestion charging.

You may be aware that road users require access to expensive road infrastructure, and impose a variety of external costs (congestion, accident risks etc.) on each other and on non-road users. In an attempt to curb this phenomenon, some cities are increasingly, considering implementing various types of road pricing (a type of congestion charging) as has been successfully introduced in Singapore, Oslo and other cities and now London as an instrument to reduce traffic congestion.

Research in, and implementation of urban congestion charging, acknowledges the possibility of reducing urban traffic congestion levels through road pricing; subject to an efficient modal shift, revenue recycling and general public acceptance. It is normally justified as a fair means of financing improved transport systems for motorists and the public. However well intended such a charging scheme might be, it will most certainly be accompanied by inevitable effects on the economy, the welfare of individuals, the environment and land use patterns of the urban landscape.

The general approach of my study is to explore these effects and factors which may prove to sustain road pricing, against international experience. This will allow me to expand knowledge in the subject field and to develop plausible recommendations on how to present road pricing as a viable and sustainable policy instrument in urban areas experiencing traffic congestion.

Appendix G Environmental questionnaire cover letter

In my research I have identified some gaps, unanswered questions and uncertainties which have not been resolved in previous research. In addressing these unresolved issues I need to know what you think about congestion charging and how it is perceived by you. You have purposively been selected to participate in the survey. I have included a questionnaire which forms part of my dissertation. Please read the questionnaire before we meet on the 22nd April 2004 as we agreed. When we meet, we will discuss the questionnaire in more detail and you will have the opportunity to raise any concerns and ask about questions which is unclear to you. The purpose of the questionnaire and meeting is to give you the opportunity to express your views and opinions and it will give me an important insight into how you view congestion charging and what needs to be done to make it more acceptable. Your information will enable me to determine and evaluate:

i. whether road pricing is perceived to, and actually reduce urban traffic congestion levels;
ii. the effects road pricing has as a fiscal instrument in reducing urban traffic congestion in London;
iii. whether the sustainability of congestion charging can be improved if it is subject to a number of pre-determined conditions, and;
iv. how your views and opinions compare or differ from those reported in previous research.

Once the questionnaire has been completed, the information will be coded, enumerated and quantified into nominal and ordinal data. The data will then be analysed with the aid of a software program. Your information will be treated with the strictest of confidentially and will only be used for the purpose of this research. The findings and conclusions will remain my property and will not be misused in any way or form.

The final research results will be reported in a dissertation kept by the University of Potchefstroom in South Africa. As it would be kept in a University library, you would be allowed to read the final dissertation on request from the library if you were interested in the findings and recommendations.

Thank you for your help and time and I look forward to meeting you on the **22nd April 2004**.

Yours Faithfully,

Werner Heyns

# Appendix H: Local Authority questionnaire cover letter

31 Vellum Drive
Carshalton
Surrey
SM5 2TN

Tel: 020 8773 8834
Date: 06-04-2004
E-mail: wernerheyns@aol.com

Address line 1
Address line 2
Address line 3
Address line 4
Post Code

Dear Sir/Madam,

**RE: Urban Congestion Charging Questionnaire**

I write further to our recent telephone conversation, where we agreed to meet on **21st April 2004** to discuss your thoughts and perception of urban congestion charging.

You may be aware that road users require access to expensive road infrastructure, and impose a variety of external costs (congestion, accident risks etc.) on each other and on non-road users. In an attempt to curb this phenomenon, some cities are increasingly, considering implementing various types of road pricing (a type of congestion charging) as has been successfully introduced in Singapore, Oslo and other cities and now London as an instrument to reduce traffic congestion.

Research in, and implementation of urban congestion charging, acknowledges the possibility of reducing urban traffic congestion levels through road pricing; subject to an efficient modal shift, revenue recycling and general public acceptance. It is normally justified as a fair means of financing improved transport systems for motorists and the public. However well intended such a charging scheme might be, it will most certainly be accompanied by inevitable effects on the economy, the welfare of individuals, the environment and land use patterns of the urban landscape.

The general approach of my study is to explore these effects and factors which may prove to sustain road pricing, against international experience. This will allow me to expand knowledge in the subject field and to develop plausible recommendations on how to present road pricing as a viable and sustainable policy instrument in urban areas experiencing traffic congestion.

Appendix H Local Authority questionnaire cover letter

In my research I have identified some gaps, unanswered questions and uncertainties which have not been resolved in previous research. In addressing these unresolved issues I need to know what you think about congestion charging and how it is perceived by you. You, along with a number of other Local Authorities, have purposively been selected to participate in the survey. I have included a questionnaire which forms part of my dissertation. Please read the questionnaire before we meet on the 21st April 2004 as we agreed. When we meet, we will discuss the questionnaire in more detail and you will have the opportunity to raise any concerns and ask about questions which is unclear to you. The purpose of the questionnaire and meeting is to give you the opportunity to express your views and opinions and it will give me an important insight into how you view congestion charging and what needs to be done to make it more acceptable. Your information will enable me to determine and evaluate:

i. whether road pricing is perceived to, and actually reduce urban traffic congestion levels;
ii. the effects road pricing has as a fiscal instrument in reducing urban traffic congestion in London;
iii. whether the sustainability of congestion charging can be improved if it is subject to a number of pre-determined conditions, and;
iv. how your views and opinions compare or differ from those reported in previous research.

Once the questionnaire has been completed, the information will be coded, enumerated and quantified into nominal and ordinal data. The data will then be analysed with the aid of a software program. Your information will be treated with the strictest of confidentially and will only be used for the purpose of this research. The findings and conclusions will remain my property and will not be misused in any way or form.

The final research results will be reported in a dissertation kept by the University of Potchefstroom in South Africa. As it would be kept in a University library, you would be allowed to read the final dissertation on request from the library if you were interested in the findings and recommendations.

Thank you for your help and time and I look forward to meeting you on the 21st April 2004.

Yours Faithfully,

Werner Heyns

# Appendix I: Public transport provider questionnaire cover letter

31 Vellum Drive
Carshalton
Surrey
SM5 2TN

Tel: 020 8773 8834
Date: 06-04-2004
E-mail: wernerheyns@aol.com

Address line 1
Address line 2
Address line 3
Address line 4
Post Code

Dear Sir/Madam,

**RE: Urban Congestion Charging Questionnaire**

I write further to our recent telephone conversation, where we agreed to meet on **14th April 2004** to discuss your thoughts and perception of urban congestion charging.

You may be aware that road users require access to expensive road infrastructure, and impose a variety of external costs (congestion, accident risks etc.) on each other and on non-road users. In an attempt to curb this phenomenon, some cities are increasingly, considering implementing various types of road pricing (a type of congestion charging) as has been successfully introduced in Singapore, Oslo and other cities and now London as an instrument to reduce traffic congestion.

Research in, and implementation of urban congestion charging, acknowledges the possibility of reducing urban traffic congestion levels through road pricing; subject to an efficient modal shift, revenue recycling and general public acceptance. It is normally justified as a fair means of financing improved transport systems for motorists and the public. However well intended such a charging scheme might be, it will most certainly be accompanied by inevitable effects on the economy, the welfare of individuals, the environment and land use patterns of the urban landscape.

The general approach of my study is to explore these effects and factors which may prove to sustain road pricing, against international experience. This will allow me to expand knowledge in the subject field and to develop plausible recommendations on how to present road pricing as a viable and sustainable policy instrument in urban areas experiencing traffic congestion.

Appendix I Public transport provider questionnaire cover letter

In my research I have identified some gaps, unanswered questions and uncertainties which have not been resolved in previous research. In addressing these unresolved issues I need to know what you think about congestion charging and how it is perceived by you. You, along with a number of other public transport providers, have purposively been selected to participate in the survey. I have included a questionnaire which forms part of my dissertation. Please read the questionnaire before we meet on the 14th April 2004 as we agreed. When we meet, we will discuss the questionnaire in more detail and you will have the opportunity to raise any concerns and ask about questions which is unclear to you. The purpose of the questionnaire and meeting is to give you the opportunity to express your views and opinions and it will give me an important insight into how you view congestion charging and what needs to be done to make it more acceptable. Your information will enable me to determine and evaluate:

i. whether road pricing is perceived to, and actually reduce urban traffic congestion levels;
ii. the effects road pricing has as a fiscal instrument in reducing urban traffic congestion in London;
iii. whether the sustainability of congestion charging can be improved if it is subject to a number of pre-determined conditions, and;
iv. how your views and opinions compare or differ from those reported in previous research.

Once the questionnaire has been completed, the information will be coded, enumerated and quantified into nominal and ordinal data. The data will then be analysed with the aid of a software program. Your information will be treated with the strictest of confidentially and will only be used for the purpose of this research. The findings and conclusions will remain my property and will not be misused in any way or form.

The final research results will be reported in a dissertation kept by the University of Potchefstroom in South Africa. As it would be kept in a University library, you would be allowed to read the final dissertation on request from the library if you were interested in the findings and recommendations.

Thank you for your help and time and I look forward to meeting you on the 14th April 2004.

Yours Faithfully,

Werner Heyns

# Appendix J: Residential questionnaire cover letter

31 Vellum Drive
Carshalton
Surrey
SM5 2TN

Tel: 020 8773 8834
Date: 14-04-2004
E-mail: wernerheyns@aol.com

Address line 1
Address line 2
Address line 3
Address line 4
Post Code

Dear Sir/Madam,

**RE: Urban Congestion Charging Questionnaire**

I am a final year M. Art. et Scien. (Planning) student, studying the effects of urban congestion charging and potential factors, which may prove to sustain it as a transport demand management instrument.

You may be aware that road users require access to expensive road infrastructure, and impose a variety of external costs (congestion, accident risks etc.) on each other and on non-road users. In an attempt to curb this phenomenon, some cities are increasingly, considering implementing various types of road pricing (a type of congestion charging) as has been successfully introduced in Singapore, Oslo and other cities and now London as an instrument to reduce traffic congestion.

Research in, and implementation of urban congestion charging, acknowledges the possibility of reducing urban traffic congestion levels through road pricing; subject to an efficient modal shift, revenue recycling and general public acceptance. It is normally justified as a fair means of financing improved transport systems for motorists and the public. However well intended such a charging scheme might be, it will most certainly be accompanied by inevitable effects on the economy, the welfare of individuals, the environment and land use patterns of the urban landscape.

The general approach of my study is to explore these effects and factors which may prove to sustain road pricing, against international experience. This will allow me to expand knowledge in the subject field and to develop plausible recommendations on how to present road pricing as a viable and sustainable policy instrument in urban areas experiencing traffic congestion.

In my research I have identified some gaps, unanswered questions and uncertainties which have not been resolved in previous research. In addressing these unresolved issues I need to know what you think about congestion charging and how it is perceived by you. You, along with 999 other participants, have been randomly selected to participate in the survey. This questionnaire, forming part of my dissertation, is intended to give you the opportunity to express your views and opinions. I strongly encourage you to participate in the survey as it will give me an important insight into how you view congestion charging, the concerns you may have and what needs to be done to make it more acceptable. By completing the attached questionnaire, you will make a valuable contribution, not only to my research, but research in general in the subject field.

Your information will enable me to determine and evaluate:

1. whether road pricing is perceived to, and actually reduce urban traffic congestion levels;
2. the effects road pricing has as a fiscal instrument in reducing urban traffic congestion in London;
3. whether the sustainability of congestion charging can be improved if it is subject to a number of pre-determined conditions, and;
4. how your views and opinions compare or differ from those reported in previous research.

Please complete the questionnaire and return to the address overleaf within the next three weeks. Once received, the information will be coded, enumerated and quantified into nominal and ordinal data. By coding and enumerating your information, your identity and anonymity will be safe guarded. The data will then be analysed with the aid of a software program. Be assured that your information will be treated with the strictest of confidentially and will only be used for the purpose of this research. The findings and conclusions will remain my property and will not be misused in any way or form.

The final research results will be reported in a dissertation kept by the University of Potchefstroom in South Africa. As it would be kept in a University library, you would be allowed to read the final dissertation on request from the library if you were interested in the findings and recommendations.

Thank you for your help and time in completing the questionnaire and be assured that your anonymity will be maintained at all times.

Yours Faithfully,

Werner Heyns

# Appendix K: Option scores

| Criteria and options | Cost or asset | Unit | Int. of LU and transport strategies | Deploy portfolio of environmental controls | Efficient and equitable revenue use | Promotion of public acceptance |
|---|---|---|---|---|---|---|
| **Impact on traffic congestion** | | | | | | |
| Mode shift | A | % | 3.00 | 10.00 | 57.60 | 57.60 |
| Reduction in traffic | A | % | 35.50 | 12.50 | 50.00 | 68.50 |
| Carpooling | A | % | 1.00 | 0.00 | 4.00 | 1.00 |
| Change route | A | % | 23.60 | 5.00 | 35.00 | 41.60 |
| Not undertaking trip | A | % | 31.50 | 10.00 | 47.00 | 27.50 |
| **Spatial impact** | | | | | | |
| Centralising impact | A | % | 45.00 | 5.00 | 12.00 | 10.00 |
| Decentralising impact | A | % | 32.00 | 0.00 | 0.00 | 2.00 |
| Extent of land use mix | | ---/+++ | ++ | 0 | + | + |
| Extent of development clustering | | ---/+++ | ++ | 0 | + | + |
| Extent of development density | | ---/+++ | ++ | 0 | + | 0 |
| Influencing planning process | | ----/++++ | +++ | 0 | ++ | ++ |
| Scope for transport and land use integration | | ----/++++ | +++ | + | +++ | ++ |
| **Public perception** | | | | | | |
| Reliability of public transport | A | % | 89.00 | 3.00 | 76.00 | 93.80 |
| Investment in public transport | A | % | 15.50 | 2.00 | 73.00 | 95.50 |
| Business impact | C | % | 5.20 | 19.50 | 23.00 | 15.10 |
| Invasion of privacy | A | % | 0.00 | 0.00 | 0.00 | 11.50 |
| Scepticism | C | % | 4.50 | 0.00 | 24.00 | 14.35 |
| Fairness | A | % | 53.50 | 75.00 | 67.00 | 86.40 |
| Environmental benefits | A | % | 7.89 | 95.00 | 2.00 | 95.50 |
| Information provision | A | % | 68.00 | 0.00 | 10.00 | 68.00 |
| **Implementation cost** | | | | | | |
| High | | ----/++++ | ++++ | 0 | +++ | 0 |
| Medium | | ----/++++ | 0 | ++ | 0 | +++ |
| Low | | ----/++++ | 0 | 0 | 0 | 0 |
| **Contribution to efficient and equitable use of revenue** | | | | | | |
| Cheaper transport fares | A | % | 80.00 | 21.00 | 5.00 | 78.40 |
| Increased frequency and reliability of public transport | A | % | 81.60 | 6.00 | 5.00 | 78.40 |
| Cash rebates | | ---/+++ | 0 | 0 | ++ | +++ |
| Vehicle tax subsidy | | ---/+++ | 0 | + | ++ | +++ |
| Earmarking | A | ---/+++ | ++ | ++ | ++ | ++ |
| Investment in public transport | A | % | 75.00 | 0.00 | 48.00 | 78.40 |
| **Contribution to investment in transport** | | | | | | |
| Expansion of road capacity | A | % | 21.20 | 2.00 | 0.00 | 4.20 |
| Safe cycle and walking network | A | % | 45.80 | 0.00 | 0.00 | 7.80 |
| Frequent and reliable public transport | A | % | 81.60 | 13.00 | 78.00 | 81.60 |
| Park and ride sites | A | % | 4.40 | 0.00 | 6.00 | 7.40 |

# Appendix L: Standardised scores

| Criteria and indicators | Cost/Asset | Unit | Minimum | Maximum |
|---|---|---|---|---|
| **Impact on traffic congestion** | | | | |
| Mode shift | A | % | 3.00 | 57.60 |
| Reduction in traffic | A | % | 12.50 | 68.50 |
| Carpooling | A | % | 0.00 | 4.00 |
| Change route | A | % | 5.00 | 41.60 |
| Not undertaking trip | A | % | 10.00 | 47.00 |
| **Spatial impact** | | | | |
| Centralising impact | A | % | 5.00 | 45.00 |
| Decentralising impact | A | % | 0.00 | 32.00 |
| Extent of land use mix | | ---/+++ | 0 | ++ |
| Extent of development clustering | | ---/+++ | 0 | ++ |
| Extent of development density | | ---/+++ | 0 | ++ |
| Influencing planning process | | ----/++++ | 0 | +++ |
| Scope for transport and land use integration | | ----/++++ | + | +++ |
| **Public perception** | | | | |
| Reliability of public transport | A | % | 3.00 | 93.80 |
| Investment in public transport | A | % | 2.00 | 95.50 |
| Business impact | C | % | 5.20 | 23.00 |
| Invasion of privacy | A | % | 0.00 | 11.50 |
| Scepticism | C | % | 0.00 | 24.00 |
| Fairness | A | % | 53.50 | 86.40 |
| Environmental benefits | A | % | 2.00 | 95.50 |
| Information provision | A | % | 0.00 | 68.00 |
| **Implementation cost** | | | | |
| High | | ----/++++ | 0 | ++++ |
| Medium | | ----/++++ | 0 | +++ |
| Low | | ----/++++ | 0 | 0 |
| **Contribution to efficient and equitable use of revenue** | | | | |
| Cheaper transport fares | A | % | 5.00 | 80.00 |
| Increased frequency and reliability of public transport | A | % | 5.00 | 81.60 |
| Cash rebates | | ---/+++ | 0 | +++ |
| Vehicle tax subsidy | | ---/+++ | 0 | +++ |
| Earmarking | | ---/+++ | ++ | ++ |
| Investment in public transport | A | % | 0.00 | 78.40 |
| **Contribution to investment in transport** | | | | |
| Expansion of road capacity | A | % | 0.00 | 21.20 |
| Safe cycle and walking network | A | % | 0.00 | 45.80 |
| Frequent and reliable public transport | A | % | 13.00 | 81.60 |
| Park and ride sites | A | % | 0.00 | 7.40 |

# Appendix M: Weighted standardised data

| Criteria and indicators | Cost/Asset | Unit | Minimum | Maximum | Weight niveau 1 | Weight niveau 2 | Weight |
|---|---|---|---|---|---|---|---|
| **Impact on traffic congestion** | | | | | 0.200 | | |
| Mode shift | A | % | 3.00 | 57.60 | | 0.190 | 0.038 |
| Reduction in traffic | A | % | 12.50 | 68.50 | | 0.300 | 0.060 |
| Carpooling | A | % | 0.00 | 4.00 | | 0.170 | 0.034 |
| Change route | A | % | 5.00 | 41.60 | | 0.170 | 0.034 |
| Not undertaking trip | A | % | 10.00 | 47.00 | | 0.170 | 0.034 |
| **Spatial impact** | | | | | 0.160 | | |
| Centralising impact | A | % | 5.00 | 45.00 | | 0.110 | 0.018 |
| Decentralising impact | A | % | 0.00 | 32.00 | | 0.110 | 0.018 |
| Extent of land use mix | | ---/+++ | 0 | ++ | | 0.110 | 0.018 |
| Extent of development clustering | | ---/+++ | 0 | ++ | | 0.110 | 0.018 |
| Extent of development density | | ---/+++ | 0 | ++ | | 0.110 | 0.018 |
| Influencing planning process | | ----/++++ | 0 | +++ | | 0.150 | 0.024 |
| Scope for transport and land use integration | | ----/++++ | + | +++ | | 0.300 | 0.048 |
| **Public perception** | | | | | 0.190 | | |
| Reliability of public transport | A | % | 3.00 | 93.80 | | 0.300 | 0.057 |
| Investment in public transport | A | % | 2.00 | 95.50 | | 0.180 | 0.034 |
| Business impact | C | % | 5.20 | 23.00 | | 0.110 | 0.021 |
| Invasion of privacy | A | % | 0.00 | 11.50 | | 0.082 | 0.016 |
| Scepticism | C | % | 0.00 | 24.00 | | 0.082 | 0.016 |
| Fairness | A | % | 53.50 | 86.40 | | 0.082 | 0.016 |
| Environmental benefits | A | % | 2.00 | 95.50 | | 0.082 | 0.016 |
| Information provision | A | % | 0.00 | 68.00 | | 0.082 | 0.016 |
| **Implementation cost** | | | | | 0.160 | | |
| High | | ----/++++ | 0 | ++++ | | 0.300 | 0.048 |
| Medium | | ----/++++ | 0 | +++ | | 0.300 | 0.048 |
| Low | | ----/++++ | 0 | 0 | | 0.400 | 0.064 |
| **Contribution to efficient and equitable use of revenue** | | | | | 0.100 | | |
| Cheaper transport fares | A | % | 5.00 | 80.00 | | 0.125 | 0.024 |
| Increased frequency and reliability of public transport | A | % | 5.00 | 81.60 | | 0.125 | 0.024 |
| Cash rebates | | ---/+++ | 0 | +++ | | 0.125 | 0.024 |
| Vehicle tax subsidy | | ---/+++ | 0 | +++ | | 0.125 | 0.024 |
| Earmarking | | ---/+++ | ++ | ++ | | 0.200 | 0.038 |
| Investment in public transport | A | % | 0.00 | 78.40 | | 0.300 | 0.057 |
| **Contribution to investment in transport** | | | | | 0.190 | | |
| Expansion of road capacity | A | % | 0.00 | 21.20 | | 0.225 | 0.023 |
| Safe cycle and walking network | A | % | 0.00 | 45.80 | | 0.250 | 0.250 |
| Frequent and reliable public transport | A | % | 13.00 | 81.60 | | 0.300 | 0.030 |
| Park and ride sites | A | % | 0.00 | 7.40 | | 0.225 | 0.230 |

# Bibliography

ADLER, J.L. & CETIN, M. 2001. A direct redistribution model of congestion pricing. *Transportation research part B: methodological,* 35(5):447-460, June.

AI-DEEK, H. & KANAFANI, A. 1993. Modelling the benefits of advanced traveller information systems in corridors with incidents. *Transportation research part C,* 1(4):303-324.

ALFA, A.S. 1986. A review of models for the temporal distribution of peak traffic demand. *Transportation research part B: methodological,* (6):491-499.

ANON. 2004. London postal district. (*In* Wikipedia: the free encyclopaedia.) [Available on Internet:] http://en.wikipedia.org/wiki/London_postal_district [Date of access: 28 February 2004].

ARNOTT, R. 1998. Congestion tolling and urban spatial structure. Boston, Mass. : Boston College, Department of Economics. [Available on Internet:] http://fmwww.bc.edu/ec-p/wp389.pdf [Date of access: 27 July 2003]. (Working papers, 389.)

ARNOTT, R., DE PALMA, A. & LINDSEY, R. 1988. Schedule delay and departure time decisions with heterogeneous commuters. *Transportation research record,* 1197:56-67.

ARNOTT, R., DE PALMA, A. & LINDSEY, R. 1990. Departure time and route choice for the morning commute. *Transportation research part B,* 24(3):209-228.

ARNOTT, R., DE PALMA, A. & LINDSEY, R. 1991. Does providing information to drivers reduce traffic congestion? *Transportation research part B,* 24(3):209-228.

ARNOTT, R., DE PALMA, A. & LINDSEY, R. 1992. Route choice with heterogeneous drivers and group-specific congestion costs. *Regional science and urban economics,* 22(1):71-102.

ARNOTT, R., DE PALMA, A. & LINDSEY, R. 1994. The welfare effects of congestion tolls with heterogeneous commuters. *Journal of transport economics and policy,* 28:139-161.

ARNOTT, R., DE PALMA, A. & LINDSEY, R. 1998. Recent developments in the bottleneck model. (*In* Button, K.J. & Verhoef, E.T., *eds.* Road pricing, traffic congestion and the environment: issues of efficiency and social feasibility. Cheltenham : Edward Elgar. p. 79-110.)

ASCHAUER, D.A. 1989. Is public expenditure productive? *Journal of monetary economics,* 23(2):177-200.

BANISTER, D. 1999. Planning more to travel less: land use and transport. *Town planning review*, 70(3):313-338.

BAYLISS, D. 1994. Electronic road pricing for public transport. *Economic affairs*, 14(2):29-33.

BAYLISS, D. 1998. Road pricing and the "new deal for transport". *Economic affairs*, 18(4):26-30.

BEAMON, B.M. 1996. Quantifying the effects of road pricing on roadway congestion and automobile emissions. *Transportation research part A: policy and practice*, 30(1):65, January.

BELL, G.H. 1997. Does traffic restraint concentrate or disperse activities? *Traffic engineering and control*, 38(12):666-669.

BEN-AKIVA, M., DE PALMA, A. & KAYSI, I. 1991. Dynamic network models and driver information systems. *Transportation research part A*, 25:251-266.

BODEN, R. J. 1999. Flexible working hours, family responsibilities, and female self-employment: gender differences in self-employment selection. *American journal of economics and sociology*, 58(1):71-83.

BURKELL, J. 2003. The dilemma of survey nonresponse. *Library and information science research*, 25(3):239-263, Autumn.

BURRIS, M.W. & PENDYALA, R.M. 2002. Discrete choice models of traveller participation in differential time of day pricing programs. *Transport policy*, 9(3):241-251, July.

BUTTON, K.J. 1975. An economist's solution to the urban transport problem. *Economica*, 11:15-22.

BUTTON, K.J. 1982. Road pricing: some practical and economic considerations for its introduction in Britain. *Logistics and transportation review*, 18:353-371.

BUTTON, K.J. 1994. Alternative approaches toward containing transport externalities: an international comparison. *Transportation research part A*, 28(4):289-305.

BUTTON, K.J. & PEARMAN, A.D. 1983. Road pricing - some of the more neglected theoretical and policy implications. *Transportation planning and technology*, 8:15-28.

CHANG, S-K. & CHENG, C.C. 2002. A time-varying congestion pricing model for optimization of transport corridor. Taipei : National Taiwan University. [Available on Internet:] http://www.wsdot.wa.gov/ppsc/research/TRB_Special/TRB2003-001037.pdf [Date of access: 27 July 2003].

CHATTERJEE, K., BEECROFT, M., LYONS, G. & MARSDEN, G. 2001. Transport visions: land use planning. London: Landor Publishing. 79 p.

CHIN, A.T.H. 1996. Containing air pollution and traffic congestion: transport policy and the environment in Singapore. *Atmospheric environment,* 30(5):787-801, March.

COHEN, Y. 1987. Commuter welfare under peak-period congestion tolls: who gains and who loses? *International journal of transport economics,* 14:238-266.

COMMON, M.S. 1990. The choice of pollution control instruments: why is so little notice taken of economists' recommendations? *Environment and planning*, 21A:1297-1314.

DAGANZO, C.F. 1995. A Pareto optimum congestion reduction scheme. *Transportation research part B*, 29(2):139-154.

DAGANZO, C.F. 1998. Queue spillovers in transportation networks with a route choice. *Transportation science*, 32(1):3-11, February.

DAGANZO, C.F. & GARCIA, R.C. 2000. A pareto improving strategy for the time-dependent morning commute problem. *Transportation science*, 34(3):303-311, August.

DAWSON, J.A.L. 1986. Electronic road pricing in Hong Kong. *Traffic engineering and control,* 27(2):79-83.

DE CORLA-SOUZA, P. 2000. Making pricing of currently free highway lanes acceptable to the public. *Transportation quarterly*, 54(3):1-20.

DE PALMA, A. & LINDSEY, R. 1998. Information and usage of congestible facilities under different pricing regimes. *Canadian journal of economics*, 31(3):666-692.

DEPARTMENT FOR TRANSPORT. see UNITED KINGDOM. Department for transport.

DICK, A.C. 1966. Speed-flow relationships within an urban area. *Traffic engineering and control*, 8:393-396.

DORNBUCSH, R, & FISCHER, S. 1994. Makro-ekonomie. 3rd ed. Johannesburg : Lexicon. 488 p.

DOWNS, A. 1962. The law of peak-hour expressway congestion. *Traffic quarterly*, 16:393-409, July.

DEPARTMENT OF THE ENVIRONMENT, TRANSPORT AND THE REGIONS, 2003. DTLR multi criteria analysis manual. London : HMSO. 145 p. [Available on Internet:] http://www.odpm.gov.uk/stellent/groups/odpm_about/documents/pdf/odpm_about_pdf_608524.pdf [Date of access: 27 June 2004].

EICHENBERGER, R. (reiner.eichenberger@unifr.ch) 2002. Road pricing - a political-economic perspective. [E-mail to:] Heyns, W. (Wernerheyns@aol.com) 21 April 2004.

ELIASSON, J. 2001. Road pricing with limited information and heterogeneous users: a successful case. *Annals of regional science*, 35(4):595-604.

ELIASSON, J. & MATTSSON, L-G. 2000. Location and transport effects of road pricing - a simulation approach. *Journal of transport economics and policy*, 35:417-456.

EL SANHOURI, I. & BERNSTEIN, D. 1994. Integrating driver information and congestion pricing systems. *Transportation research record*, 1450:44-50.

EMMERINK, R.H.M., AXHAUSEN, K.W., NIJKAMP, P. & RIETVELD, P. 1995. The potential of information provision in a simulated road transport network with non-recurrent congestion. *Transportation research part C: emerging technologies*, 3(5):293-309, October.

EMMERINK, R.H.M., NIJKAMP, P. & RIETVELD, P. 1995. Is congestion pricing a first-best strategy in transport policy?: a critical review of arguments. *Environment and planning B*, 22:581-602.

EMMERINK, R.H.M., NIJKAMP, P., RIETVELD, P. & AXHAUSEN, K.W. 1994. The economics of motorist information systems revisited. *Transportation review*, 14(4):363-388.

EMMERINK, R.H.M., NIJKAMP, P., RIETVELD, P. & VAN OMMEREN, J.N. 1996. Variable message signs and radio traffic information: an integrated empirical analysis of drivers' route choice behaviour. *Transportation research part A*, 30(2):135-153.

EMMERINK, R.H.M. & VAN BEEK, P. 1997. Empirical analysis of work schedule flexibility: implications for road pricing and driver information systems. *Urban studies*, 34(2):217-234, February.

EMMERINK, R.H.M., VERHOEF, E.T., NIJKAMP, P. & RIETVELD, P. 1988. Information policy in road transport with elastic demand: some welfare economic considerations. *European economic review*, 42(1):71-95.

EMMERINK, R.H.M., VERHOEF, E.T., NIJKAMP, P . & RIETVELD, P. 1997. Information in road networks with multiple origin-destination pairs. *Regional science and urban economics*, 27(3):217-240, June.

EMMERINK, R.H.M., VERHOEF, E.T., NIJKAMP, P. & RIETVELD, P. 1998. Information effects in transport with stochastic capacity and uncertainty costs. *International economic review*, 39(1):89-110, February.

EVANS, A.W. 1992a. Road congestion: the diagrammatic analysis. *Journal of political economy*, 100:211-217.

EVANS, A.W. 1992b. Road congestion pricing: when is it a good policy? *Journal of transport economics and policy*, 26:213-244.

FERRARI, P. 2002. Road network toll pricing and social welfare. *Transportation research part B: methodological*, 36(5):471-483, June.

FERRARI, P. 1995. Road pricing and network equilibrium. *Transportation research part B: methodological*, 29(5):357-372, October.

FERRARI, P. 1999. A model of urban transport management. *Transportation research part B: methodological*, 33(1):43-61, February.

FLOWERDEW, A.D. 1993. Urban traffic congestion in Europe: road pricing and public transport demand. [Available on Internet:] http://www.tis.pt/proj/Desincepannfinal.pdf [Date of access: 18 March 2003].

FOSTER, C. 1975. A note on the distributional effects of road pricing: a comment. *Journal of transport economics and policy:* 186-188, May.

FREY, B.S., SCHNEIDER, F. & POMMEREHNE, W.W. 1985. Economists' opinions on environmental policy instruments: analysis of a survey. *Journal of environmental economics and management*, 12:62-71.

GAKENHEIMER, R. 1999 . Urban mobility in the developing world. *Transportation research part A: policy and practice,* 33(7-8):671-689, September-November.

GIULIANO, G. 1992. An assessment of the political acceptability of congestion pricing. *Transportation*, 19:225-358.

GIULIANO, G. 1994. Curbing gridlock: peak-period fees to relieve traffic congestion. Washington, D.C. : National Academy Press. 279 p.

GLAZER, A. & NISKANEN, E. 1992. Parking fees and congestion. *Regional science and urban economics*, 22(1):123-132.

GÓMEZ-IBÁÑEZ, J.A. 1992. The political economy of highway tolls and congestion pricing. *Transportation quarterly,* 46(3):343-360, July.

GOODWIN, P.B. 1989. The rule of three: a possible solution to the political problem of competing objectives for road pricing. *Traffic engineering and control*, 30(10):495-497, October.

GOODWIN, P.B. 1990. How to make road pricing popular. *Economic affairs*, 10:6-7, June-July.

GRIECO, M. & JONES, P.M. 1994. A change in the policyclimate? Current European perspectives on road pricing. *Urban studies*, 31(9):1517-1533, November.

HARRINGTON, W., KRUPNICK, A. & ALBERINI, A. 2001. Overcoming public aversion to congestion pricing. *Transportation research part* A, 35(2):87-105.

HAU, T.D. 1992a. Economic fundamentals of road pricing: a diagrammatic analysis. Washington. D.C. : World Bank [Available on Internet:] http://www.econ.hku.hk/~timhau [Date of access: 18 June 2003]. (Working paper, 1070.)

HAU, T.D. 1992b. Congestion charging mechanisms for roads: an evaluation of current practice. Washington, D.C. : World Bank. [Available on Internet:] http://www.econ.hku.hk/~timhau [Date of access: 18 June 2003]. (Working paper, 1071.)

HAU, T.D. 1998. Congestion pricing and road investment. (*In* Button, K.J. & Verhoef, E.T. *eds*. Road pricing, traffic congestion and the environment: issues of efficiency and social feasibility. Cheltenham : Edward Elgar. p. 39-78.) [Available on Internet:] http://www.econ.hku.hk/~timhau [Date of access: 19 June 2003].

HENDERSON, J.V. 1974. Road congestion: a reconsideration of pricing theory, *Journal of urban economics*, 1:346-355.

HENDERSON, J.V. 1977. Economic theory and the cities. New York : Academic Press.

HENDERSON, J.V. 1981. The economics of staggered work hours. *Journal of urban economics*, 9:349-364.

HENDRICKSON, C. & KOCUR, G. 1981. Schedule delay and departure time decisions in a deterministic model. *Transportation science*, 15:62-77.

HENDRICKSON, C. & PLANK, E. 1984. The flexibility of departure times for work trips, *Transportation research part A*, 18(1):25-36.

HENSHER, D.A. & SULLIVAN, C. 2003. Willingness to pay for road curviness and road type. *Transportation research part D*, 8:139-155.

HIGGINS, T.J. 1979. Road pricing: should and might it happen. *Transportation*, 8:99-113.

HIGGINS, T.J. 1994. Congestion pricing: implementation considerations. *Transportation quarterly*, 48(3):287-298.

HILLMAN, M. 1992. Reconciling transport and environmental policy objectives: the way ahead at the end of the road. *Public administration*, 70(2):225-234.

HILLS, P. 1993. Road congestion pricing: when is it a good policy? A comment. *Journal of transport economics and policy*, 27:91-98.

HILLS, P. 1996. What is induced traffic? *Transportation*, 23(1):5-16.

HOLLAND, E.P. & WATSON, P.L. 1978. Traffic restraint in Singapore: 1: measuring the effects of the area license scheme; 2: some design factors in traffic pricing schemes. *Traffic engineering and control*, 19(1):14-25.

HYMAN, D. M. 1999. Public finance: a contemporary application of theory to policy. 6th ed. Fort Worth : Dryden Press. 682 p.

HYMAN, G. & MAYHEW, L. 2002. Optimizing the benefits of urban road user charging. *Transport policy*, 9(3):189-207, July.

ISON, S. 1998. The saleability of urban road pricing. *Economic affairs*, 18(4):21-25.

ISON, S. 2000. Local authority and academic attitudes to urban road pricing: a UK perspective. *Transport policy*, 7(4):269-277, October.

ISON, S. & RYE, T. 2003. Lessons from travel planning and road user charging for policy-making: through imperfection to implementation. *Transport policy*, 10(3):223-233, July.

JAKOBSSON, C., FUJII, S. & GÄRLING, T. 2000. Determinants of private car users' acceptance of road pricing. *Transport policy*, 7(2):153-158, April.

JANSEN, R., VAN HERWIJNEN, M. & BEINAT, E. 2000. BOSDA: Beslissingsondersteunend system voor discrete alternatieven. (*In* BOSDA 2000.) [CD-ROM.]

JOHANSSON, B. & MATTSSON, L-G. 1995. Principles of road pricing. (*In* Johansson, B. & Mattsson, L-G., *eds*. Road pricing: theory, empirical assessment and policy. Boston : Kluwer Academic Publishers. p. 7-33.)

JOHANSSON-STENMAN, O. & STERNER, T. 1998. What is the scope for environmental road pricing. (*In* Button, K.J. & Verhoef, E.T., *eds*. Road pricing, traffic congestion and the environment: issues of efficiency and social feasibility. Cheltenham : Edward Elgar. p. 150-170.)

JONES, P. 1998. Urban road pricing: public acceptability and barriers to implementation. (*In* Button, K.J. & Verhoef, E.T., *eds*. Road pricing, traffic congestion and the environment: issues of efficiency and social feasibility. Cheltenham : Edward Elgar. p. 263-284.)

JONES, P. 2001. Addressing equity concerns in relation to road user charging. London : Transport Studies Group, University of Westminster. [Available on Internet:] http://www.transport-pricing.net/jonel.doc [Date of access: 7 August 2003].

JONES, P. & HERVIK, A. 1992. Restraining car traffic in European cities: an emerging role for road pricing. *Transportation research part A,* 26(2):133-45.

JONES, P.M. 1991. Gaining public support for road pricing through a package approach. *Traffic engineering and control,* 4:194-196.

KHATTAK, A.J., SCHOFER, J.L. & KOPPELMAN, F.S. 1993. Commuters' en-route diversion and return decisions: analysis and implications for advanced traveler information systems. *Transportation research part A,* 27(2):101-111.

KOH, W.T.H. & LEE, D.K.C. 1994. The vehicle quota system in Singapore: an assessment. *Transportation research part A,* 27(1):31-47.

KOMANOFF, C. 1997. Environmental consequences of road pricing: a scoping paper for the Energy Foundation. [Available on Internet:] http://www.tstc.org/reports/ckdraft6.html [Date of access: 5 May 2003].

LAM, T. 2003. Evaluating value-pricing projects with both scheduling and route choices. *Regional science and urban economics,*34(2):225-240, March.

LANGMYHR, T. 1995. Planning for road pricing: a multi-rationality approach. *Scandinavian housing and planning research,* 12(2):73-91.

LANGMYHR, T. 1997. Managing equity: the case of road pricing. *Transport policy,* 4(1):25-39, January.

LANGMYHR, T. 2000. The rhetorical side of transport planning. *European planning studies,* 8(5):669-684, October.

LARSEN, O.I. 1995. The toll cordons in Norway: an overview. *Journal of transport geography,* 3(3):187-198.

LARSEN, O.I. 2001. Implementing congestion pricing. Oslo : Institute of Transport Economics, Molde University College. [Available on Internet:] http://www.transport-pricing.net/larsen.doc [Date of access: 7 Augustus 2003].

LAYARD, R. 1977. The distributional effects of congestion taxes. *Economica*, 44:297-304.

LEACH, G. 2001. More roads and road pricing - the way to go? Institute of Directors. [Available on Internet:] http://www.iod.com [Date of access: 7 March 2003].

LEONTARIDI, M.R. 1997. The economic case for road pricing. *Contemporary review*, 270(1577):283-291, June.

LEVINE, J. & GARB, Y. 2000. Evaluating the promise and hazards of congestion pricing proposals: an access centred approach. Tel Aviv : Floersheimer Institute for Policy Studies. [Available on internet:] http://www.vtpi.org/levgarb.pdf [Date of access: 18 May 2003].

LEVINE, J. & GARB, Y. 2002. Congestion pricing's conditional promise: promotion of accessibility or mobility? *Transport policy*, 9(3):179-188, July.

LEWIS, N.C. 1996. Traffic congestion and road pricing. *Proceedings of the Institution of Civil Engineers*, 117:122-135, May.

LI, M.Z.F. 2002. The role of speed–flow relationship in congestion pricing implementation with an application to Singapore. *Transportation research part B: methodological*, 36(8):731-754, September.

LINDSEY, C.R. & VERHOEF, E.T. 2000. Traffic congestion and congestion pricing. Amsterdam : Tinbergen Institute. [Available on Internet:] http://www.tinbergen.nl/home.html [Date of access: 6 March 2003]. (Discussion paper, TI 2000-101/3.)

LITMAN, T. 1999a. Using road pricing revenue: economic efficiency and equity considerations. Victoria : Victoria Transport Policy Institute. [Available on Internet:] http://www.vtpi.org/revenue.pdf [Date of access: 18 May 2003].

LITMAN, T. 1999b. Evaluating transportation equity. Victoria : Victoria Transport Policy Institute. [Available on Internet:] http://www.vtpi.org/0_equity.htm [Date of access: 18 May 2003].

LITMAN, T. 2001. Generated traffic and induced travel: implications for transport planning. Victoria : Victoria Transport Policy Institute. [Available on Internet:] http://www.vtpi.org/gentraf.pdf [Date of access: 14 May 2003].

LITMAN, T. 2003. London congestion pricing: implications for other cities. Victoria : Victoria Transport Policy Institute. [Available on Internet:] http://www.vtpi.org [Date of access: 14 May 2003].

MADSEN, B. & JENSEN-BUTLER, C. 2001. Modelling the local economic impacts of road pricing. Denmark : Institute of Local Government Studies. [Available on Internet:] http://www.akf.dk/som/pdf/som46.pdf [Date of access: 19 June 2003]. (SOM Publication, 46.)

MARCUCCI, E. 2001. Road pricing: old beliefs, present awareness and future research patterns. *International journal of transport economics*, 28(1):49-80.

MARTINEZ, F.J.C. 1995. Access: the transport-land use economic link. *Transportation research part B*, 29(6):457-470.

MAY, A.D. & MILNE, D.S. 2000. Effects of alternative road pricing systems on network performance. *Transportation Research Part A: policy and practice,* 34(6):407-436, August.

MAYERES, I. 1998. The distributional impacts of policies for the control of transport externalities: an applied general equilibrium model. Leuven : K.U. Leuven-CES. [Available on Internet:] http://www.econ.kuleuven.ac.be [Date of access: 1 August 2003]. (Working paper, 6/99.)

MAYERES, I. & PROOST. S. 2002. Reforming transport pricing: an economist's perspective on equity, efficiency and acceptability. Leuven : K.U. Leuven-CES. [Available on Internet:] http://www.econ.kuleuven.ac.be/ew/academic/energmil/ [Date of access: 1 August 2003]. (ETE Working paper, 2002-12.)

McCARTHY, P.S. & TAY, R. 1993. Pricing road congestion: recent evidence in Singapore. *Policy studies journal,* 21(2):296-308.

McCLEARY, W.A. 1991. The earmarking of government revenue: a review of some World Bank experience. *World Bank research observer*, 6(1):81-104, January.

McCUBBIN, D. & DELUCCHI, M. 1999. The health costs of motor-vehicle-related air pollution. *Journal of transport economics and policy,* 33(3):253-286, September.

MOGRIDGE, M. 1990. Road pricing and the edge worth paradox. *Economic affairs*, 10(5):11-14, 22.

MOGRIDGE, M.J.H. 1997. The self-defeating nature of urban road capacity policy: a review of theories, disputes and available evidence. *Journal of transport policy*, 4(1):5-23.

MOHRING, H. 1985. Profit maximization, cost minimization, and pricing for congestion-prone facilities. *Logistics and transportation review*, 21:27-36.

MORRISON, S.A. 1986. A survey of road pricing. *Transportation research part A*, 20:87-98.

MUSGRAVE, R.A. & MUSGRAVE, P.B. 1989. Public finance in theory and practice. 5th ed. New York : McGraw-Hill. 627 p.

NEWBERY, D.M. 1990. Pricing and congestion: economic principles relevant to pricing roads. *Oxford review of economic policy,* 6:22-38.

NEWBERY, D.M. & SANTOS, G. 1999. Road taxes, road user charges and earmarking. *Fiscal studies*, 20(2):103-132, June.

NEWBERY, D.M. & SANTOS, G. 2002. Estimating urban road congestion charges. London : Centre for Economic Policy Research. [Available on Internet:] http://www.cepr.org/pubs/dps/DP3176.asp [Date of access: 7 March 2003]. (CEPR discussion paper, 3176.)

NISKANEN, E. 1987. Congestion tolls and consumer welfare. *Transportation research part B,* 21(2):171-174.

NOLAND, R.B. & SMALL, K.A. 1995. Travel time uncertainty, departure time choice, and the cost of morning commutes. *Transportation research record,* 1493:150-158.

OBERHOLZER-GEE, F. & WECK-HANNEMANN, H. 2002. Pricing road use: politico-economic and fairness considerations. *Transportation research part D,* 7(5):357-371, September.

OFFICE OF NATIONAL STATISTICS. 2004. Statistics online. London, United Kingdom [Available on Internet:] http://www.statistics.gov.uk [Date of access: 14 May 2004].

OORT, C.J. 1969. The evaluation of travelling time. *Journal of transport economics and policy*, 3:279-286.

OTT, M., SLAVIN, H. & WARD, D. 1980. Behavioural impacts of flexible working hours. *Transportation research record*, 767:1-6.

OTTERSTRÖM, T. 1995. Pricing of environmental impacts of emissions from road traffic - recent and present research in Finland. *Science of the total environment*, 169(1-3):311-319, July.

PARRY, I.W.H. & BENTO, D.A.M. 2001. Revenue recycling and the welfare effects of congestion pricing. *Scandinavian journal of economics*, 103(4):645-671.

PRETTY, R.L. 1988. Road pricing: a solution for Hong Kong? *Transportation research part A*, 22:319-327.

PROOST, S. 2001. Achieving equity through urban transport pricing? Leuven : K U Leuven. [Available on Internet:] http://www.transport-pricing.net/proost.doc [Date of access: 7 August 2003].

PROOST, S. & CALTHROP, E. 2002. Environmental pricing and transport. Leuven : K.U. Leuven-CES. [Available on Internet:] http://www.econ.kuleuven.ac.be/ew/academic/energmil/ [Date of access: 1 August 2003]. (ETE Working paper, 2002-08.)

PROOST, S. & VAN DENDER, K. 2001. The welfare impacts of alternative policies to address atmospheric pollution in urban road transport. *Regional science and urban economics*, 31(4):383-412.

RAJÉ, F. 2003b. The impact of transport on social exclusion processes with specific emphasis on road user charging. *Transport policy*, 10(4):321-338, October.

RICHARDS, M., GILLIAM, C. & LARKINSON, J. 1996. The London congestion charging research program: the program in overview. *Traffic engineering and control*, 37:66-71.

RICHARDSON, H.W. 1974. A note on the distributional effects of road pricing. *Journal of transport economics and policy*, 8:82-85.

WALTERS, A. 1961. The theory and measurement of private and social cost of highway congestion. *Econometrica*, 29(10):676-699.

WATSON, P.L. & HOLLAND, E.P. 1976. Congestion pricing - the example of Singapore. *Finance and development*, 13:20-23.

WHITEHEAD, T. 2002. Road user charging and business performance: identifying the processes of economic change. *Transport policy*, 9(3):221-240, July.

WILLOUGHBY, C. 2001. Singapore's motorization policies 1960-2000. *Transport policy,* 8(2): 125-139, April.

YANG, H. & HUANG, H-J. 1998. Principle of marginal-cost pricing: how does it work in a general road network? *Transportation research part A: policy and practice,* 32(1):45-54, January.

YANG, H. & MENG, Q. 1998. Departure time, route choice and congestion toll in a queuing network with elastic demand. *Transportation research part B*, 32(4):247-260.

YANG, H., TANG, W.H., CHEUNG, W.M. & MENG, Q. 2002. Profitability and welfare gain of private toll roads in a network with heterogeneous users. *Transportation research part A: policy and practice,* 36(6):537-554, July.

OORT, C.J. 1969. The evaluation of travelling time. *Journal of transport economics and policy*, 3:279-286.

OTT, M., SLAVIN, H. & WARD, D. 1980. Behavioural impacts of flexible working hours. *Transportation research record*, 767:1-6.

OTTERSTRÖM, T. 1995. Pricing of environmental impacts of emissions from road traffic - recent and present research in Finland. *Science of the total environment*, 169(1-3):311-319, July.

PARRY, I.W.H. & BENTO, D.A.M. 2001. Revenue recycling and the welfare effects of congestion pricing. *Scandinavian journal of economics*, 103(4):645-671.

PRETTY, R.L. 1988. Road pricing: a solution for Hong Kong? *Transportation research part A*, 22:319-327.

PROOST, S. 2001. Achieving equity through urban transport pricing? Leuven : K U Leuven. [Available on Internet:] http://www.transport-pricing.net/proost.doc [Date of access: 7 August 2003].

PROOST, S. & CALTHROP, E. 2002. Environmental pricing and transport. Leuven : K.U. Leuven-CES. [Available on Internet:] http://www.econ.kuleuven.ac.be/ew/academic/energmil/ [Date of access: 1 August 2003]. (ETE Working paper, 2002-08.)

PROOST, S. & VAN DENDER, K. 2001. The welfare impacts of alternative policies to address atmospheric pollution in urban road transport. *Regional science and urban economics*, 31(4):383-412.

RAJÉ, F. 2003b. The impact of transport on social exclusion processes with specific emphasis on road user charging. *Transport policy*, 10(4):321-338, October.

RICHARDS, M., GILLIAM, C. & LARKINSON, J. 1996. The London congestion charging research program: the program in overview. *Traffic engineering and control*, 37:66-71.

RICHARDSON, H.W. 1974. A note on the distributional effects of road pricing. *Journal of transport economics and policy*, 8:82-85.

RIENSTRA, S.A., RIETVELD, P. & VERHOEF, E.T. 1999. The social support for policy measures in passenger transport: a statistical analysis for the Netherlands. *Transportation research part D*, 4(3):181-200.

ROTH, G. 2000. Road pricing in a free society. *Economic affairs*, 18(4):9-14.

ROTH, G. 1990. Road pricing and road ownership. *Economic affairs*, 11(1):36.

RUFOLO, A.M. & BERTINI, R.L. 2003. Designing alternatives to state motor fuel taxes. *Transportation quarterly*, 57(1):33-46, Winter.

SANTOS, G. 2000a. Road pricing on the basis of congestion costs: consistent results from two historic UK towns. *Transportation research record,* 1732:25-31.

SANTOS, G. 2000b. Congestion management using road pricing: would it be efficient? Cambridge : University of Cambridge, Department of applied economics. [Available on Internet:] http://www.econ.cam.ac.uk/dae/people/santos/ [Date of access: 7 March 2003].

SANTOS, G. 2002a. On the economic, technological and political aspects of road pricing as a tool for traffic demand management. [Available on Internet:] http://www.econ.cam.ac.uk/dae/people/santos/etc.pdf [Date of access: 20 March 2003].

SANTOS, G. 2002b. Double cordon tolls in urban areas to increase social welfare. [Available on Internet:] http://www.econ.cam.ac.uk/dae/people/santos/ [Date of access: 7 March 2003].

SANTOS, G. & NEWBERY, D.M. 2002. Urban congestion charging: theory, practice and environmental consequences. [Available on Internet:] http://www.cesifo.de/orcl/dbssi/index2.htm [Date of access: 7 March 2003]. (CESIfo working paper, 568.)

SANTOS, G., ROJEY, L. & NEWBERY, D.M. 2000a. The environmental benefits from road pricing. Cambridge : University of Cambridge, Department of applied economics. [Available on Internet:] http://www.econ.cam.ac.uk/dae/people/santos/ [Date of access: 7 March 2003]. (DAE working paper, 0020.)

SANTOS, G., ROJEY, L. & NEWBERY, D.M. 2000b. Traffic management with congestion charging in different English towns. Cambridge : University of Cambridge, Department of applied economics. [Available on Internet:] http://www.econ.cam.ac.uk/dae/people/santos/ [Date of access: 7 March 2003].

SCHADE, J. 2003. Public and political acceptability as criteria for implementation paths - urban and interurban road [Available on Internet:] http://www.strafica.fi/mcicam/handouts/3rdsem-sep2002/mcicam_helsinki_schade.pdf [Date of access: 19 April 2003].

SCHADE, J. & SCHLAG, B. 2003. Acceptability of urban transport pricing strategies. *Transportation research part F: traffic psychology and behaviour:* 1-17, March.

SCHLAG, B. & SCHADE, J. 2000. Public acceptability of traffic demand management in Europe. *Traffic engineering and control*, 41:314-318.

SCHOTTER, A.R. 2001. Microeconomics: a modern approach. 3rd ed. Boston : Addison-Wesley. 729 p.

SEAGAL, D. & STEINMEIER, T.L. 1980. The incidence of congestion and congestion tolls. *Journal of urban economics*, 7:42-62.

SHARP, C. 1966. Congestion and welfare - an examination of the case of a congestion tax. *Economic journal*, 76:806-817.

SHARP, C. 1968. Congestion and welfare reconsidered. *Journal of transport economics and policy*, 2:119-125.

SIM, L.L., MALONE-LEE, L.C. & CHIN, K.H.L. 2001. Integrating land use and transport planning to reduce work-related travel: a case study of Tampines Regional Centre in Singapore. *Habitat international,* 25(3):399-414, September.

SMALL, K.A. 1982. The scheduling of consumer activities: work trips. *American economic review*, 72:467-479.

SMALL, K.A. 1983. The incidence of congestion tolls on urban highways. *Journal of urban economics*, 13:90-111.

SMALL, K.A. & GOMEZ-IBANEZ, J. 1998. Road pricing for congestion management: the transition from theory to policy. (*In* Button, K.J. & Verhoef, E.T., *eds*. Road pricing, traffic congestion and the environment: issues of efficiency and social feasibility. Cheltenham : Edward Elgar. p. 213-246.)

SMEED, R.J. 1968. Traffic studies and urban congestion. *Journal of transport economics and policy*, 2:33-70.

STARKIE, D. 1986. Efficient and politic congestion tolls. *Transportation research part A*, 20:169-173.

STEAD, D. & BANISTER, D. 2001. Influencing mobility outside transport policy. *Innovation*, 14(4):315-330.

THOMSON, J.M. 1998. Reflections on the economics of traffic congestion. *Journal of transport economics and policy*, 32:93-112.

TOH, R.S. 1977. Road congestion pricing: the Singapore experience. *Malayan economic review*, 22(2):52-61.

TOH, R.S. 1992. Experimental measures to curb road congestion in Singapore: pricing and quotas. *Logistics and transportation review*, 23(3):289-317.

TOH, R.S. 1994. The high cost of motoring in Singapore. *Business horizons*, 37(2):68-74.

TOPP, H.H. 1995. A critical review of current illusions in traffic management and control. *Transport policy*, 2(1):33-42, January.

TRANSPORTATION DEMAND MANAGEMENT. see VICTORIA TRANSPORT POLICY INSTITUTE.

TRANSPORT FOR LONDON. 2003a. Central London congestion charging scheme: three months on. [Available on Internet:] http://www.tfl.gov.uk [Date of access: 24 June 2003].

TRANSPORT FOR LONDON. 2003b. TfL press release: 01 April 2003, congestion charging - summary of week six. [Available on Internet:] http://www.tfl.gov.uk/tfl/press_cc_news_latest.shtml [Date of access: 24 June 2003].

TRANSPORT FOR LONDON. 2003c. Congestion charging fact sheets. [Available on Internet:] http://www.tfl.gov.uk/tfl/cc_fact_sheet_other_schemes.shtml [Date of access: 24 June 2003].

TRUELOVE, P. 1998. The political feasibility of road pricing. *Economic affairs*, 18(4):15-20.

UNITED KINGDOM. Department for Transport. 2003b. Congestion Charging. [Available on Internet:] http://www.dft.gov.uk [Date of access: 10 August 2003].

VAN DENDER, K. & PROOST, S. 2001. Optimal urban transport pricing with congestion and economies of density. Leuven : K.U. Leuven-CES. [Available on Internet:] http://www.econ.kuleuven.ac.be/ew/academic/energmil/ [Date of access: 7 March 2003]. (ETE Working paper, 2001-19.)

VERHOEF, E.T. 1995. The demand curve under road pricing and the problem of political feasibility: a comment. *Transportation research part A: policy and practice*, 29(6):459-465, November.

VERHOEF, E.T. 1999. Time, speeds, flows and densities in static models of road traffic congestion and congestion pricing. *Regional science and urban economics*, 29(3):341-369, May.00

VERHOEF, E.T., LIJESEN, M. & HOEN, A. 1998. The economic effects of road pricing in the Randstad Area. Amsterdam : Tinbergen Institute. [Available on Internet:] http://www.tinbergen.nl/home.html [Date of access: 6 March 2003].

VERHOEF, E.T., NIJKAMP, P. & RIETVELD, P. 1997. The social feasibility of road pricing. *Journal of transport economics and policy*, 31(3):255-276.

VERHOEF, E.T., ROUWENDAL, J. & RIETVELD, P. 1999. Congestion caused by speed differences. *Journal of urban economics*, 45(3):533-556.

VICKREY, W.S. 1963. Pricing in urban and suburban transport. *American economic review*, 53(2):452-465.

VICKREY, W.S. 1969. Congestion theory and transport investment. *American economic review*, 59:251-261.

VICKREY, W.S. 1992. Principles of efficient congestion pricing. New York : Columbia University. [Available on Internet:] http://www.vtpi.org/vickrey.htm [Date of access: 18 May 2003].

VICTORIA TRANSPORT POLICY INSTITUTE. 2003. Online demand management encyclopedia. Victoria, Canada. [Available on Internet:] http://www.vtpi.org [Date of access: 16 May 2003].

WALTERS, A. 1961. The theory and measurement of private and social cost of highway congestion. *Econometrica*, 29(10):676-699.

WATSON, P.L. & HOLLAND, E.P. 1976. Congestion pricing - the example of Singapore. *Finance and development*, 13:20-23.

WHITEHEAD, T. 2002. Road user charging and business performance: identifying the processes of economic change. *Transport policy*, 9(3):221-240, July.

WILLOUGHBY, C. 2001. Singapore's motorization policies 1960-2000. *Transport policy,* 8(2): 125-139, April.

YANG, H. & HUANG, H-J. 1998. Principle of marginal-cost pricing: how does it work in a general road network? *Transportation research part A: policy and practice,* 32(1):45-54, January.

YANG, H. & MENG, Q. 1998. Departure time, route choice and congestion toll in a queuing network with elastic demand. *Transportation research part B*, 32(4):247-260.

YANG, H., TANG, W.H., CHEUNG, W.M. & MENG, Q. 2002. Profitability and welfare gain of private toll roads in a network with heterogeneous users. *Transportation research part A: policy and practice,* 36(6):537-554, July.