

Final Report for Publication

TransPrice

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TransPrice

Trans Modal Integrated Urban Transport **Pricing** for Optimum Modal Split

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Contents

	<u>Page No</u>
Contents	i
Partnership	iii
Executive Summary	iv
1. Introduction	1
1.1 Background	1
1.2 Project Objectives	3
1.3 Fundamental Principles	3
1.4 Project Approach and Methodology	4
1.5 Layout of the Final Report	6
2. Review of Options and Issues	7
2.1 Purpose and Definitions	7
2.2 Methods for Influencing Modal Split	8
2.3 Transport Pricing Framework	9
2.4 Socio-Economic Aspects of Pricing	11
2.5 Road Use Charging Technology and Integrated Payment Systems	14
2.6 Revenue Allocation Issues	17
2.7 Public and Political Acceptability Issues	17
2.8 Legal and Institutional Issues	19
3. Modelling the Impact of Pricing Measures	25
3.1 Modelling Methodology	25
3.2 Travel Behaviour Research	25
3.3 Modelling Results Cross-Site Comparisons	26
3.4 Pricing Elasticities Derived from Modelling	38
3.5 Modelling Results by Site	38
	<u>Page No</u>

4.	Specifications for Integrated Urban Transport Pricing Measures	42
	4.1 Road Use and Congestion Charging	42
	4.2 Charge Collection Technology	46
	4.3 Parking Management and Control	50
	4.4 Public Transport Improvements and Finance Requirements	52
	4.5 Intermodal Integration	54
	4.6 Land Use/Spatial Impacts	57
5.	Demonstration of Pricing Measures and Integrated Payment Systems	61
	5.1 General	61
	5.2 Athens	61
	5.3 Como	70
	5.4 Madrid	77
	5.5 Leeds	86
	5.6 York	92
6.	Public and Political Acceptability	99
	6.1 Approach to Acceptability Research	99
	6.2 Public Acceptability	99
	6.3 Political Acceptability	106
7.	Evaluation	108
	7.1 Evaluation Methodology	108
	7.2 Multi-Criteria Evaluation Results	110
	7.3 Sensitivity Analysis	116
8.	Conclusions and Recommendations for TransModal Integrated Urban Pricing Actions and Policies	119
	8.1 General	119
	8.2 Site-specific Evaluation Conclusions	119
	8.3 General Functional Evaluation Conclusions	120
	8.4 Multi-Criteria Evaluation Conclusions	121
	8.5 Recommendations	122
	8.6 Concluding Remarks	123
	References	125
	Project Deliverables List	132

Partnership

Project Co-ordinator: **euroTRANS Consulting Ltd**

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TransPrice

Trans Modal Integrated Urban Transport Pricing for Optimum Modal Split

Executive Summary

1. Introduction

1.1 Background

Researchers in nine European Union (EU) member states and authorities in eight European cities together with the European Commission Directorate-General for Transport initiated and co-funded the **TransPrice** project within the EU Transport RTD programme. **TransPrice** aims to address the issues of integrated *trans* modal transport *pricing*, towards achieving optimum modal split in urban areas, at pan-European level. The **TransPrice** project was launched in January 1996 with a three-year work programme. The project start coincided with the publication by the European Commission of the Green Paper “Towards Fair and Efficient Pricing in Transport: Policy Options for Internalising the External Costs of Transport in the European Union” (December 1995). Towards the end of the project period, the European Commission published a White Paper on “Fair Payment for Infrastructure Use: A phased approach to a common transport infrastructure charging framework in the EU” (July 1998).

The **TransPrice** project philosophy is to investigate a *trans* modal, integrated *pricing* and financing regime for urban transport that is based on three fundamental principles, viz:

- Having clear policy objectives of optimising Modal Split: Optimum is defined as the Modal Split at which the total generalised costs of both Public and Private Transport are minimised
- Aiming towards internalising the environmental and other external costs of transport systems
- Allowing for revenue allocation from road user charges to financing investment in public transport, non-motorised modes, road safety and environmental improvements.

1.2 Project Objectives and Approach

The objectives of the **TransPrice** project are as follows:

- Review and investigate technical and financial options for integrated *trans* modal *pricing*.
- Examine integrated *trans* modal *pricing* strategies, tariffs and generalised cost structures by mode of transport and their effects on modal split.
- Assess potential user response and operational, socio-economic, behavioural, financial, land use, environmental and energy impacts of demand management and mode choice-related *trans* modal *pricing* measures, including urban road use pricing.
- Specify and demonstrate *trans* modal *pricing* and integrated payment systems in selected European cities and assess effects on modal split, public and political acceptability.
- Evaluate *trans* modal *pricing* and integrated payment scenarios and actions using a common and comprehensive framework.

- Investigate ways of exploiting traffic data likely to be generated from integrated payment systems and disseminate the overall project results, including cities in Central and Eastern Europe.

TransPrice is based on actions and analyses in eight European cities: **Athens, Madrid, Como, Leeds, York, Goteborg, Helsinki and Graz**, thus covering a wide range of urban areas, in terms of both geography and typology. Demonstration of pricing measures by real life application and experimental initial limited field trials of systems and measures is included in **Athens, Como, Madrid, Leeds and York**. Dissemination of the project findings to European Union member states as well as to two Central and Eastern European sites in Budapest and Sofia is also included.

The integrated *trans* modal *pricing* measures examined in **TransPrice** comprise:

- Road Use Charging (Cordon Pricing, Area Licensing, Expressway Tolls)
- Integrated Public Transport Fares and Payment Systems
- Parking Charges (On-Street, Off-Street, Private Non-Residential)
- Intermodality (Park & Ride, Bus/Rail/Metro/Tram)
- Public Transport System Financing and Revenue Support
- Smart Card Payment Systems (Travel and Multi-Purpose Use)
- Combination with Other Measures (Access Control, Urban Traffic Control, HOV Lanes, Regulatory Traffic Restrictions, Public Transport Prioritisation, Pedestrianisation/Cycling Facilities).

Various combinations of the above are considered in each project site. The actions and analyses in the eight project sites are illustrated in Figure 1.

Figure 1: Specific Actions and Analyses in TransPrice Sites

ACTIONS	Athens	Como	Madrid	Leeds	York	Goteborg	Helsinki	Graz
Cordon Pricing	◆	❖			❖	❖	❖	❖
Area Pricing	❖			❖		❖		
Parking Pricing		◆		◆	◆			❖
HOV Lane Pricing Options			◆					
Public Transport Integrated Fares & Financing	◆		◆					
Smart Card Integrated Payment System		❖		◆	◆		❖	
Access Control		◆						
Park & Ride and Intermodality	◆		◆	❖	◆			

ANALYSES	Athens	Como	Madrid	Leeds	York	Goteborg	Helsinki	Graz
Mode Choice Analysis	◆	◆	◆	◆	◆	❖	❖	◆
Attitudes and Public Acceptability	◆	◆	❖	◆	◆	❖	◆	❖
Congestion Costs	❖		◆	❖				
Decision Making Process	❖					◆		
Environmental Analysis	◆	◆	❖				❖	
Dissemination Activities	❖	❖	❖	❖	❖	❖	❖	❖

◆ primary ❖ secondary

2. Definitions and Methodology

2.1 Trans Modal

The total urban transport system, involving all modes of transport, should be considered in a “Trans Modal” approach to pricing and financing. A **Trans Modal** approach requires that urban transport pricing measures and payment systems should be both **multimodal** and **intermodal**, viz:

- **Multimodal**, as they affect the characteristics of a number of competing modes (eg Car Vs Public Transport Vs Park & Ride), thus influencing user choice of travel mode.
- **Intermodal**, as they may influence the use of a number of modes for different legs of a single journey (eg Feeder Bus and Metro, or Park & Ride) with appropriate interchange, thus facilitating “seamless” service and enhancing intermodality.

In the **TransPrice** project, therefore, **trans modal pricing** is defined as combination and integration of multimodality (choice of mode) and intermodality (seamless service).

2.2 Integrated Transport Pricing

The objectives of “integrated transport pricing” are to:

Enable environmental improvements, alleviate congestion and facilitate cost recovery through optimising modal split and improving intermodality by means of internalising the external costs of transport.

The possible means or “elements” (ie building blocks) of a integrated transport pricing approach are:

- Road Use Charges (including Tolls)
- Public Transport Financial Structures (including Fare Structures, Ticketing Methods and Revenue Support Options),
- Parking Charges, and
- A System of Revenue Allocation between Transport Modes (eg from road use charges to funding public transport investments and environmental improvements)
- SmartCard-based Automatic Debiting and Multi-purpose Payment Systems can provide an important support to all of the above.

Regarding the latter (Integrated Payment Systems), their role in the integrated transport pricing approach is due to their advantages, viz:

- Marketing-related: Convenience for Users, Information on Usage, Differential Pricing, Discounts and Incentives
- Policy-related: Differential Pricing, Facilitating User Trading between Modes of Transport, Discounts and Incentives
- Accountability-related: Improved Accounting for Operators, Reduced Fraud.

2.3 Pricing Measures and Actions

The specified measures in each test-site are as follows (**demonstrations** are shown in **bold**):

- **Athens:** **road use pricing with Park & Ride and integrated payment** (main), and **(re)introduction of monthly pass for all public transport modes** (secondary), road use pricing options (modelling tests)

- **Como:** access control for residents and time-based parking pricing for visitors in a tourist area, parking pricing policy, road use pricing options (modelling tests)
- **Madrid:** Park & Ride with integrated ticketing, tariff integration by monthly pass for all public transport modes (10 years ex-post assessment), congestion costs and public transport subsidies, and HOV lane pricing option (modelling test)
- **Leeds:** multi-service smartcard pilot application for parking and public transport, attitudinal research into potential for modal change through changes to parking, Park & Ride and public transport prices, potential for cordon parking charges and charging for private spaces (modelling test)
- **York:** changes to central car park and Park & Ride tariffs, introduction of multi-use smartcards, and generalised cost changes through bus priorities (supporting measure), road use pricing options (modelling tests)
- **Goteborg:** cordon pricing with alternative fee structures, area pricing, examination of decision-making process
- **Helsinki:** cordon pricing with alternative rings
- **Graz:** cordon pricing with public transport bonus and shopping traffic bonus.

The cities involved have been classified into three groups:

- Large/Capital cities (Athens, Madrid, Helsinki)
- Medium cities (Leeds, Goteborg, Graz) and
- Small cities (Como, York).

The measures have been grouped into three categories:

- main pricing
- regulation (access control, intermodality) and
- complementary (smartcard integrated payment systems).

All of the important interactions of city type and measures category are covered in the specification, so that the project results can have a potential pan-European transferability.

2.4 Travel Behaviour Research

The potential changes in travel behaviour from pricing measures was assessed by means of a Stated Preference (SP) Survey in all eight sites with a Common Experimental Design involving combinations of the following attributes and alternative levels within each attribute:

- Mode Choice: Car Vs Public Transport Vs Park & Ride
- Car Costs: +50 and +100% from present operating and parking costs
- Car and Public Transport Times: -20% and +20% from present times
- Public Transport Costs: -20% and +20% from present costs.

In total, 2155 valid responses were obtained. The SP survey was targeted to current car users, mainly for commuting trip purpose, that would consider changing mode to public transport or Park & Ride through increases of car costs and/or time and cost improvements to the alternative modes of travel. This was the first time that such a survey was applied to several urban areas with a common experimental design. The analysis of the SP survey gave estimates of Value of Time (VoT) and mode-specific constants. The survey also included acceptability questions on the justification of road use pricing, the preferred allocation of revenues and the preferred method of payment. The results of the SP survey were used in modelling tests (see Section 3) and the additional questions were used in the public acceptability research (see Section 5).

2.5 Evaluation Methodology

The evaluation of the measures examined in the *TransPrice* project was based on a multi-criteria evaluation framework, involving the following evaluation criteria:

- Operational: Functional Analysis of Impacts
- Socio-Economic: Costs, Time Savings and Accident Savings
- Financial: Revenue Generation/Allocation, Profitability and Cost Recovery
- Land Use and Accessibility Impacts
- Environmental Impacts
- Energy Efficiency and Saving
- Social Equity and Public Acceptability.

A common evaluation framework was developed for all eight participating cities, in order to bring together the results from travel behaviour research and modelling tests with the results from the demonstrations, towards developing general guidelines at pan-European level.

3. Modelling Results

Cross-site comparisons of the modelling results have been made towards identifying guidelines at pan-European level for the implementation of transport pricing measures. In terms of cordon pricing (based on analysis for Athens, Como, Helsinki, Goteborg and Graz), these show that reductions of 5-20% in total distance travelled by private car are possible for cordon toll levels of between 1 and 3 EUR (after allowing for Purchase Power Parity differentials between EU member states). In terms of the number of private cars entering inner urban areas, reductions of between 5% (Helsinki) and 40-50% (Como, Athens) can be expected, depending on toll levels (around the 1-3 EUR range) and city characteristics. It is evident that the higher the present level of congestion, the more the scope for road use pricing. Regarding parking pricing measures, reductions in distance travelled by private car of 8-48% (and 8-49% reduction in the number of cars entering the controlled zones) can be expected for parking charges of 5-10 EUR (based on analysis for Leeds and Como).

4. Demonstration Results

The results from the demonstrations can be summarised as follows:

- In **Athens** the results of the road use pricing trial indicated that 25% of car users transferred to Park & Ride, 5.5% to Public Transport and 0.5% to other modes, for charge levels of 1.5-2.2 EUR. These results suggest that, on a network-wide basis, up to 15% of car drivers could transfer to Park & Ride with a 5:1 pricing regime in favour of Park & Ride. The price elasticity for road use pricing was estimated at -0.2 from the limited sample of users that took part in the road use pricing demonstration. Attitudinal research suggested that a vignette-based system of area pricing would be more acceptable to the public and politicians than electronic cordon charging. Demand for the all Public Transport modes travel card has stabilised at about 10% of all public transport ticket sales.
- In **Como** the demonstration results suggest that the introduction of parking charges reduced the traffic entering the designated area and corresponding improvements on congestion levels. There has been a positive change in modal split from cars to motor bikes and bicycles.
- In **Madrid** the multimodal travel card for Public Transport has encouraged greater use of public transport amongst captive groups and encouraged some modal shift, particularly amongst commuters (PT trips increased by 35% following a decade of decline).

Investigations into the effects of the Park & Ride and integrated ticketing showed that

around 300 extra cars used the Park & Ride and that 2.7% of the total Park & Ride users had changed mode from car to Park & Ride.

- In **Leeds** the introduction of the multi use smart card was not seen as a prime reason for modal shift, but it was seen as an important element when considered in conjunction with tariff increases for parking and improved public transport services.
- In **York** the differential changes in tariffs for city centre parking and Park & Ride have resulted in increased Park & Ride patronage. City Centre Parking tariffs increased by 20% while Park & Ride by 9%; this resulted in a 6% reduction in city centre parking demand and a 12% increase in Park & Ride demand. The introduction of a smart card with discounts for regular travellers resulted in about 5% of the car trips involved in the demonstration transferring to Park & Ride from city centre car parks.

5. Public and Political Acceptability

Public acceptability research was based on attitudinal questions as part of the Stated Preference survey in all eight cities and further behavioural research in a number of cities. Political acceptability was examined in relation to the demonstrations and in general based on current policy initiatives and developments.

The results of the public and political acceptability research showed that:

- Public perception of road traffic congestion and associated environmental problems is high.
- Public awareness of pricing measures is lower than that of other demand management measures, which is also generally low.
- Public acceptability of isolated pricing measures is low.
- Public acceptability of pricing measures can increase substantially when pricing is presented as the cornerstone of a package of measures including revenue allocation to public transport investments and non-motorised modes.
- Political acceptability of pricing measures is affected by perceived lack of public acceptability.
- Hypothecation of road use pricing revenues is becoming more politically acceptable and can lead to higher overall acceptability of pricing measures.

6. Evaluation Results

The main general conclusions from the functional evaluation results can be summarised as follows:

- Road use pricing is an effective way of changing modal split from private car to public transport and Park & Ride. The Athens road use pricing demonstration indicated diversion rates of 15-25% from car to Park & Ride and 5% to public transport. Modelling tests for five cities produced city centre traffic reduction of 5-20%, with associated environmental benefits. In the case of Athens where both demonstration and modelling was carried out, a reasonably close result between the two sources was found.
- The effectiveness of the type of road use pricing depends on the city characteristics: distance-based road use pricing was found more effective than time-based for Athens but for York and Como the finding was the other way round.

- Significant revenues can result from road use pricing.
- Parking pricing provides an effective way for restraining car trips (assuming that enforcement can be maximised; however, enforcement of road use pricing options is usually expected to be higher than past experience with enforcement of parking control, which is affected by free workplace parking facilities and significant violation rates).
- High Occupancy Vehicle (HOV) lane pricing options, ie High Occupancy Toll (HOT) lanes, have marginal impacts on modal split in a European setting (based on the analysis for Madrid).
- Modal split impacts from introducing integrated ticketing are small, but could be significant over time.
- Smartcard integrated payment systems can support trans modal pricing measures and can have small but significant modal split impacts on their own (especially for Park & Ride).
- Park & Ride facilities and Intermodality improvements can have a positive impact on the performance of pricing measures.

The above conclusions are based on both real life or experimental demonstrations and modelling activities in the **TransPrice** cities. Demonstrations provided actual, observed results of *trans* modal *pricing* impacts in user behaviour due to different pricing schemes, fee structures and payment methods. Modelling activities have provided the possibility of studying more scenarios, different pricing strategies, methods of charging, fee structures, etc.

The main results from the Multi-Criteria Evaluation show that in **absolute** terms:

- **HOV lane pricing** is effective for some indicators, but acceptable social utility is only achieved when congestion level is very high.
- **Parking pricing** is always effective but it must not be an isolated measure; it is rather an accompanying measure.
- **Cordon pricing** is clearly effective when it is applied to congested central areas and over peak-periods. To enlarge the cordon pricing scheme to a broader area or to a whole day does not provide much supplementary social benefits.
- **Other forms of Road use pricing (eg distance-based, time-based, area-based)** are very beneficial for most of the multicriteria indicators.

In a **comparative** way, the results from the Multi-Criteria evaluation show that:

- The highest level of the value function is achieved through cordon pricing (high end of the range).
- In terms of type of road use pricing, on average time-based road use pricing gives the highest level of the value function, followed by delay-based and cordon pricing.
- Parking pricing on average is found to have similar performance to cordon pricing and area pricing.
- Parking pricing is less effective than road use pricing by 17 percentage points when the maximum end of the range is considered; however, for the minimum end of the range the results show that parking pricing could achieve about the same level of effectiveness as cordon pricing and in some cases surpass the performance of other road use pricing options.
- HOV lane pricing options give the lowest range and therefore they are applicable in special cases only.

The main conclusion from these comparative analysis findings is that road use pricing options should be implemented when parking pricing measures alone have been proven to have exhausted their effectiveness. The selection of the method of road use pricing is dependent on city characteristics.

7. Conclusions and Recommendations

The following recommendations can be made on the basis of the evaluation results and the experiences with urban transport pricing measures examined in the **TransPrice** project:

- Transport pricing measures offer several possibilities of changing modal split in urban areas in favour of public transport, Park & Ride, and non-motorised modes; they can also provide significant revenues for financing appropriate transport systems and environmental improvements.
- Road use pricing should be considered when parking pricing measures alone have been found to have exhausted their effectiveness.
- Road use pricing should be considered as a part of a package of demand management measures, in order to increase its effectiveness and acceptability.
- Integrated payment systems should be implemented to support the implementation of transport pricing measures; they can have small but significant impacts on their own.
- Intermodality improvements, such as Park & Ride and integrated ticketing should be implemented together with transport pricing measures in order to enhance the impact of pricing measures.
- Use of the road use pricing revenues affects the acceptability of pricing measures; hypothecation of revenues for investments within the transport and environmental improvements sectors of a specific urban area substantially increases the potential public acceptability.

In conclusion, an effective *trans* modal integrated urban transport *pricing* strategy should combine packages of pricing measures, payment systems, intermodality and public transport improvements, in a comprehensive transport planning and management framework towards sustainable mobility.

TransPrice Project Partners:

EuroTrans Consulting Ltd (Project Co-ordinator), Trinity College Dublin (IE), Consorzio Universitario MIP (IT), Comune di Como (IT), Universidad Politecnica de Madrid (ES), Consorzio de Transportes de Madrid (ES), Anysma (GR), Athens Area Urban Transport Organisation OASA (GR), Leeds City Council (GB), University of Leeds ITS (GB), Technical University of Graz (AT), Magistrat Graz (AT), Chalmers University of Technology (SE), Technical University of Dresden (DE), University of York (GB), City of York Council (GB), Viatek (FI), Helsinki University of Technology (FI).

1. Introduction

1.1 Background

Several studies and previous research projects in various EU Member States and at pan-European level have considered urban transport pricing policies, actions and measures, towards changing modal split in favour of public transport and other sustainable modes, including road use charging options. However, there is still considerable reluctance by city authorities to implement integrated transport pricing policies due to a perceived lack of public acceptability, particularly related to road use pricing. Previous studies on road use pricing or congestion charging have concentrated on technology and operational issues, with the intermodality, financial, socio-economic, land use and environmental issues frequently not considered in detail. Demand or mobility management actions have concentrated on the implementation of physical, traffic control, public transport priority, communication and organisational measures which, although having a positive effect, have not produced the substantial modal split changes from private to public transport, Park & Ride and non-motorised modes, that are usually required.

The pricing mechanism could be a very effective means towards changing modal split. Pricing measures can be applied in conjunction with traditional demand management measures towards optimum modal split, in an integrated urban transport strategy with sustainable mobility and accessibility objectives.

The European Commission has an important role to play in the development of alternative pricing and financing regimes in urban transport, along the above lines, acting as a catalyst for new developments. It is important that the experience gained by several administrations and cities that have considered such regimes is well understood, analysed, assessed, exchanged and disseminated towards recommendations on best practice and eventual implementation. The issue of political and public acceptability is crucial to the success of such implementation.

The European Commission Transport Policy White Paper published in 1993 makes reference to transport pricing as a means of optimising modal split in congested and other environmentally sensitive areas (paragraph 100, page 25). Other pan-European initiatives concerning integrated urban transport pricing towards modal split optimisation include the "Car Free Cities" Network and the European Conference on Sustainable Cities and Towns. The EU Transport Telematics Programme (DRIVE/ATT, DG XIII) has included substantial work on automatic debiting technology and integrated payment systems, including assessment of potential user response, travel behaviour and inter-operability issues (CARD-ME initiative). Other EU relevant initiatives have included assessment of the energy saving impacts of urban road use pricing and of introduction of integrated payment systems (Programmes SAVE and THERMIE, DG XVII - Energy).

Researchers in nine European Union (EU) member states and authorities in eight European cities together with the European Commission Directorate-General for Transport (DG VII) initiated and co-funded the **TransPrice** project within the EU Transport RTD Programme. **TransPrice** aims to address the issues of integrated

trans modal transport *pricing*, towards achieving optimum modal split in urban areas, at pan-European level. The **TransPrice** project was launched in January 1996 with a three-year work programme.

The **TransPrice** project start coincided with the publication by the European Commission Directorate General for Transport (DG VII) of the Green Paper “Towards Fair and Efficient Pricing in Transport: Policy Options for Internalising the External Costs of Transport in the European Union” (December 1995).

The Green Paper points out at the current inconsistency between the actual costs of transport and the prices paid, particularly for road transport, and it explores policy options and ways of making transport pricing systems fairer and more efficient towards reducing congestion, accidents and environmental problems. The purpose of this policy is not to increase the overall costs of transport, but to reduce the negative side-effects of transport and the hidden costs they represent, towards decreasing the real costs of transport. In particular, the paper advocates road tolls in congested and/or sensitive areas and linking charges to infrastructure costs. Efficient infrastructure pricing, it is argued, would facilitate the introduction of public/private partnerships and relieve demands on tight public budgets. The combination of congestion charging and efficient infrastructure investment is seen as an essential precondition for a balanced transport system.

The above policy options and principles argued in the Green Paper are of direct relevance to **TransPrice** in terms of specification, demonstration and evaluation of integrated pricing measures towards changing modal split in urban areas.

Towards the end of the project period, the European Commission published a White Paper on “Fair Payment for Infrastructure Use: A phased approach to a common transport infrastructure charging framework in the EU” (July 1998). In this White Paper the Commission proposes a gradual and progressive harmonisation of charging principles for commercial transport in all modes. The users of transport infrastructure should pay for the costs they impose, including environmental and other external impacts, as close as possible to the point of use. It would be for the Member States to decide how to use the revenues. In terms of urban pricing matters, the Communication states: “Member States are encouraged to develop urban road pricing schemes to deal with the external costs, including congestion costs, of urban transport. It is not appropriate that such schemes be organised at Community level, though the Commission will continue to fund research and demonstration projects related to urban road pricing. Any Community legislation that may harm the implementation should be reviewed with the ambition to remove such obstacles”.

The Commission Communication “Developing the Citizen’s Network”, published in mid-1998, indicates that the introduction of urban pricing schemes can make an important contribution to the development of sustainable local and regional transport.

1.2 Project Objectives

The objectives of the **TransPrice** project are as follows:

- a) To review and investigate the technical and financial options for integrated *trans* modal *pricing* in urban areas and their potential acceptability by the public and politicians, including congestion charging, multi-travel payment cards (for parking, public transport, motorway tolls and urban road use charging), road pricing revenue allocation issues, as well as legal and institutional constraints.
- b) To examine the pricing strategies, tariffs and generalised cost structures, including journey times, by mode of transport (private car, bus and rail public transport, intermodal transport), in conjunction with present modal split in several European cities, towards ascertaining the determinants of mode choice in terms of transport pricing and the setting up of a common analytical framework (user response behavioural modelling and multicriteria evaluation) for *trans* modal *pricing* initiatives at pan-European level.
- c) To examine the potential user response and road traffic operational/socio-economic/financial/behavioural/land use/environmental and energy effects of several demand management and mode choice-related pricing measures (including congestion charging and integrated payment systems), by means of travel behaviour research and stated preference analysis, as well as traffic simulation modelling and forecasting travel demand for several alternative *trans* modal *pricing* and integrated payment scenarios.
- d) To carry out a comprehensive specification and demonstration of *trans* modal *pricing* and integrated payment system (including road use charging and integrated payment/automatic debiting systems for parking, public transport, Park & Ride) in selected European cities and examine effects on modal split, traffic operation, environment, land use and public and political acceptability.
- e) To evaluate the *trans* modal *pricing* and payment scenarios and actions by means of multi-criteria analysis including operational, social, economic, financial, land use, environmental and energy criteria, based on the results of both simulation analysis and demonstration monitoring (before and after evaluation).
- f) To investigate ways of exploiting traffic data likely to be generated from integrated payment systems and to exploit and disseminate the results of this project, including dissemination to Central and Eastern Europe.

1.3 Fundamental Principles

The **TransPrice** objectives imply a *trans* modal *pricing* and financing regime for urban transport that is based on three fundamental principles, viz:

- Having clear policy objectives of optimising Modal Split: Optimum is defined as the Modal Split at which the total generalised costs of both Public and Private Transport are minimised.
- Aiming towards pricing the environmental and other externalities of transport

systems.

- Allowing for revenue allocation from road user charges to financing investment in public transport, non-motorised modes, road safety and environmental improvements.

These principles form the basis for the project hypotheses, investigated by the research, viz:

- Pricing measures can achieve substantial modal split changes, namely from private car transport to more sustainable modes such as public transport, Park & Ride and non-motorised modes.
- Pricing measures are effective means of internalising the external costs of transport systems.
- Revenues from road user charges should be allocated to financing investments in sustainable modes and environmental improvements in order to maximise public and political acceptability at the local level.

1.4 Project Approach and Methodology

The **TransPrice** project addresses Task 5.4/24 in the Transport RTD Programme (Urban Pricing and Financing Section), within the EU 4th RTD&D Framework Programme. The project has links to other Urban Transport tasks within the Transport RTD Programme, namely on transport demand management and strategies for changing modal split. Moreover, **TransPrice** has direct links with Strategic Research tasks on valuation of externalities of transport and on pricing of transport systems (Tasks 1.2/14 and 1.2/15), as well as relevant projects within other EU programmes (Telematics Applications, JOULE-THERMIE, SAVE).

TransPrice is based on analysis and evaluation in eight urban sites throughout Europe, covering a wide range of cities and towns, and distinguished into demonstration and feasibility sites, as follows:

- **Demonstration** Sites, including demonstration of pricing measures by field trial or initial limited implementation of technology or systems, as well as analysis and evaluation:
 - ◇ Athens
 - ◇ Como
 - ◇ Madrid
 - ◇ Leeds
 - ◇ York.
- **Feasibility** Sites, focusing on analysis and evaluation only:
 - ◇ Goteborg
 - ◇ Helsinki
 - ◇ Graz.

Dissemination to EU Member States as well as to two Central and Eastern European sites is also included, viz:

- ◇ Budapest
- ◇ Sofia.

The integrated *trans* modal *pricing* measures comprise:

- Road Use Charging (Cordon Pricing, Area Licensing, Expressway Tolls)
- Integrated Public Transport Fares and Payment Systems
- Parking Charges (On-Street, Off-Street, Private Non-Residential)
- Intermodality (Park & Ride, Bus/Rail/Metro/Tram)
- Public Transport System Financing and Revenue Support
- Smart Card Payment Systems (Travel and Multi-Purpose Use)
- Combination with Other Measures (Access Control, Urban Traffic Control, HOV Lanes, Regulatory Traffic Restrictions, Public Transport Prioritisation, Pedestrianisation/Cycling Facilities).

Various combinations of the above are considered in each project site. The project sites and proposed actions are illustrated in Figure 1.1.

Figure 1.1: Specific Actions and Analyses in *TransPrice* Sites

ACTIONS	Athens	Como	Madrid	Leeds	York	Goteborg	Helsinki	Graz
Cordon Pricing	◆	❖			❖	❖	❖	❖
Area Pricing	❖			❖		❖		
Parking Pricing		◆		◆	◆			❖
HOV Lane Pricing Options			◆					
Public Transport Integrated Fares & Financing	◆		◆					
Smart Card Integrated Payment System		❖		◆	◆		❖	
Access Control		◆						
Park & Ride and Intermodality	◆		◆	❖	◆			
ANALYSES								
Mode Choice Analysis	◆	◆	◆	◆	◆	❖	❖	◆
Attitudes and Public Acceptability	◆	◆	❖	◆	◆	❖	◆	❖
Congestion Costs	❖		◆	❖				
Decision Making Process	❖					◆		
Environmental Analysis	◆	◆	❖				❖	
Dissemination Activities	❖	❖	❖	❖	❖	❖	❖	❖

◆ primary ❖ secondary

The project methodology involved the following activities, as means to achieve the objectives:

- Review of options and issues for trans modal integrated urban transport pricing.

- Develop a Common Analytical Framework (Modelling and Evaluation Tools) for all eight project sites based on available and appropriate data and tools.
- Model several pricing scenarios in all eight project sites and carry out cross-site comparisons, using behavioural mode choice and network simulation models.
- Specify the integrated pricing measures to be demonstrated and/or evaluated in each project site, as well as in generic form.
- Demonstrate pricing measures and integrated payment systems in five cities.
- Examine the public and political acceptability of pricing measures and payment systems.
- Evaluate the results from the demonstrations and the modelling tests by a common and comprehensive evaluation framework, including functional evaluation and multi-criteria analyses techniques.
- Disseminate the project approach, interim findings and final results through appropriate media and fora, including links with Central and Eastern Europe.

The **TransPrice** project became a member of the Joint Scientific Committee on Pricing, formed by representatives from the projects PETS, QUITTS, EUROTOLL and TRENEN, during 1997-1999.

1.5 Layout of the Final Report

A review of options and issues is given in Chapter 2. Modelling results are presented in Chapter 3. Specifications for integrated urban transport pricing measures are given in Chapter 4. Chapter 5 presents the demonstrations at the five designated sites of Athens, Madrid, Como, Leeds and York.

The potential public and political acceptability of pricing measures and systems is investigated in Chapter 6. The evaluation results are presented in Chapter 7. Finally, conclusions and recommendations for Trans Modal integrated pricing measures and policies in European cities are given in Chapter 8.

Relevant references are given at the end of the report. The list of **TransPrice** Deliverables is also included.

2. Review of Options and Issues

2.1 Purpose and Definitions

The purpose of this Chapter is to examine the options, opportunities and constraints for the implementation of trans modal integrated pricing regimes. These include technical, socio-economic, fiscal, financial, administrative, revenue allocation, legal and institutional, public and political acceptability issues. It is based on EU initiatives, research and actions at EU Member State level and other available experience.

The **TransPrice** project approach was to exploit previous work carried out in other EU programmes and initiatives as well as studies and actions promoted at Member State level. The aim was to integrate previous work and experience in related fields, towards a common framework for analysing, specifying, demonstrating, assessing, exchanging and disseminating relevant information.

Before proceeding, it is important to define the terms used in the **TransPrice** project, ie:

- **Trans Modal** Measures
- **Integrated** Transport Pricing Objectives and Elements
- **Optimum** Modal Split.

Trans Modal

The total urban transport system, involving all modes of transport, should be considered in a “**Trans Modal**” approach to pricing and financing. A **Trans Modal** approach requires that urban transport pricing measures and payment systems should be both multimodal and intermodal, viz:

- **Multimodal**, as they affect the characteristics of a number of competing modes (eg Car Vs Public Transport Vs Park & Ride), thus influencing user choice of travel mode.
- **Intermodal**, as they may influence the use of a number of modes for different legs of a single journey (eg Feeder Bus and Metro, or Park & Ride) with appropriate interchange, thus facilitating “seamless” service and enhancing intermodality.

In the **TransPrice** project, *trans modal pricing* is defined as combination and integration of multimodality (choice of mode) and intermodality (seamless service).

Integrated Transport Pricing

The objectives of “integrated transport pricing” are to:

Enable environmental improvements, alleviate congestion and facilitate cost recovery through optimising modal split and improving intermodality by means of internalising the external costs of transport.

The possible means or “elements” (ie building blocks) of a integrated transport pricing approach are:

- Road Use Charges (including Tolls)
- Public Transport Financial Structures (including Fare Structures, Ticketing Methods and Revenue Support Options),
- Parking Charges, and
- A System of Revenue Allocation between Transport Modes (eg from road use charges to public transport investments)
- SmartCard-based Automatic Debiting and Multi-purpose Payment Systems can provide an important support to all of the above.

Regarding the latter (Integrated Payment Systems), their role in the integrated transport pricing approach relates to their advantages, viz:

- Marketing-related: Convenience for Users, Information on Usage, Differential Pricing, Discounts and Incentives
- Policy-related: Differential Pricing, Facilitating User Trading between Modes of Transport, Discounts and Incentives
- Accountability-related: Improved Accounting for Operators, Reduced Fraud.

Optimum Modal Split

Optimum modal split is defined as the modal split level at which the total generalised costs by both private and public transport are minimised. This could coincide with the level at which the Net Social Benefit is maximised. It may be a theoretical optimum level which could be approximated in practice, but not exactly reached. The aim is to improve the performance of the whole urban transport system towards sustainable mobility by moving towards optimum modal split.

2.2 Methods for Influencing Modal Split

Several measures can be applied to influence modal split in cities and to reduce private car traffic:

- *physical/technical measures*, including street network changes to avoid through traffic and to establish pedestrian streets and separate lanes for public transport vehicles
- *administrative and organisational measures*, including allowance for delivery vehicles only, cars belonging to residents, etc, for a specific area, eg a city centre
- *informative measures*, including publicity, awareness-raising and marketing alternatives, and
- *pricing and fiscal measures*, including different fees and taxes for car ownership and use, parking charges and public transport fares incentives.

The measures can also be divided into the following two categories:

- *pull measures*, that means measures directed to offer alternatives which are more attractive (in costs, time, service) than car driving

- *push measures*, that means measures directed to make car driving less attractive (in costs, time, service).

The measures should be combined with at least:

- an attractive and accessible public transport system, and
- safe and comfortable walkways and bikeways, giving possibilities to avoid shorter car trips and promoting good access to public transport.

2.3 Transport Pricing Framework

Transport Pricing is defined as a set of methods of charging for the use of a ground transport system and its infrastructure. In literature, the term Road Pricing is often used in a similar way, but here we define Road Pricing to be one of several parts of the Transport Pricing concept.

Transport Pricing can be divided into five different categories according to the methods that are used for charging, viz:

- *Vehicle pricing*, including taxes and fees related to car ownership and usage
- *Road pricing*, including fees for use of a specific infrastructure or city area
- *Parking pricing*, including fees for use of parking spaces
- *Public transport pricing*, including fares for public transport service
- *Special taxes*, related to e.g. employment, real estate, location, etc.

The structure of the transport pricing concept is given in more detail in Table 2.1.

Table 2.1 Transport Pricing Framework

Transport pricing								
Vehicle pricing		Road pricing		Parking pricing		Public transport pricing		Special taxes
Acquisition and ownership fees	Direct and indirect fees related to use of vehicles	Off vehicle	On vehicle	Off vehicle	On vehicle	Off vehicle	On vehicle	
Sales tax Value added tax Transfer tax Registration fees Driving license fee Personal property tax Annual vehicle tax	Fuel tax Other taxes	Automatically metered tolls Weight-distance fees on heavy vehicles Roadway tolls Bridge tolls Cordon tolls Supplementary area licence Area entrance fee	Automatically metered tolls Roadway tolls Bridge tolls Cordon tolls	Private space parking Public space parking Parking taxes Parking cash out requirements Metered on-street parking Ticketed on-street parking	Private space parking Public space parking	Public transport pass Transport allowances Ride-sharing	Subsidised fares	Employment tax Real estate tax Location tax Personal property tax Innovative financing
Policy instruments related to ...								
National policy Local policy Vehicle type Environment User	National policy Local policy Environment Driver behaviour	Time of day Congestion Vehicle type Duration Weather Driver behaviour Occupancy	Time of day Congestion Vehicle type Duration Weather Driver behaviour Occupancy	Local policy Area/Zone Time of day Duration Vehicle type	Local policy Area/Zone Time of day Duration Vehicle type	Local policy Time of day User Duration Area/Zone	Local policy Time of day User Duration Area/Zone	

2.4 Socio-Economic Aspects of Pricing

It is very important to emphasise the fundamental difference between *economic* and *financial* aspects. Quite often these terms are mixed up in the discussions on the consequences of different pricing systems and other economic policy instruments. *Economic* aspects in this context deals with efficient use of limited resources, whereas *financial* aspects are concerned with the governmental monetary balance, ie, revenues minus costs. How the (local or national) government should (and should not) use this surplus is in itself an economic issue which will be discussed later under revenue allocation. The conceptual difference between economic and financial aspects is illustrated in Figure 2.1.

Figure 2.1 The difference between Economic and Financial aspects

<u>ECONOMIC ASPECTS</u>	<u>FINANCIAL ASPECTS</u>
+ Efficiency gains from pricing in better accordance with the true social costs including external costs	+ Revenues from the road-pricing system
- Investment and management costs	- Investment and management costs
= Socio-economic surplus	= Financial surplus

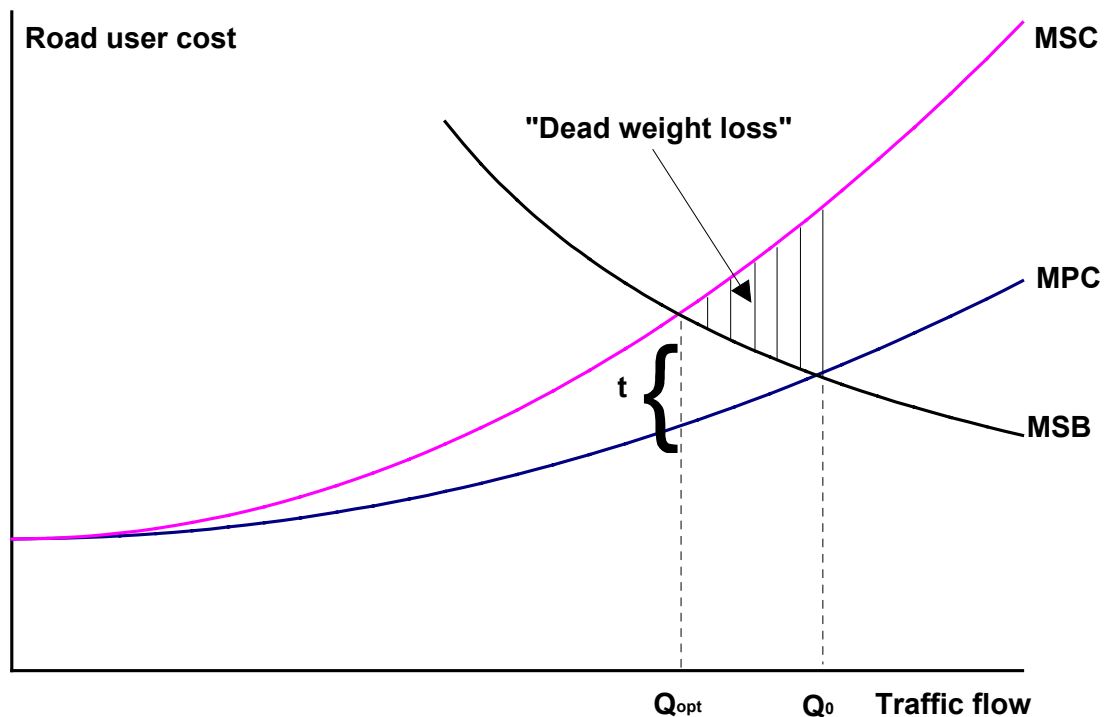
Figure 2.1 indicates that if the introduction of a road use pricing system would be socially profitable from a socio-economic point of view, we must have substantial impact from the system on the magnitude and composition of the road traffic. If, as is sometime proposed, a system is designed in order to raise revenues without affecting the traffic at all, we will end up with a socio-economic deficit from that system equal to the investment and management costs. The reason is that it would generally be very much cheaper to raise the same amount of revenue through the presently available tax system (eg through income tax or through VAT). This is not to say that large impacts are always preferable to small or negligible ones. A total prohibition of car traffic would for example be a policy instrument with a very large impact, although it would (at least in most circumstances) be socially unprofitable as it would not lead to economic efficiency. Clearly, we need some guidance concerning how to compare different impacts. The concept of external costs provides such guidance.

An economically efficient market is characterised by the fact that the economic surplus, or net benefit, ie total benefit minus total costs for the society (TSB-TSC), is maximised. In a market without any external costs¹, this will occur when the marginal benefit, ie the benefit from consuming one unit more of a specific good (such as a vehicle kilometre), exactly equals the marginal cost. In a perfect competitive market, this will be the spontaneous result without any influence from the authorities. In the presence of external costs, however, this will not be the case, and the consumption

¹By external costs we mean negative direct (ie, not through the market mechanism) influences on the well-being of others, which are not paid for by the individual him/herself.

will typically be non-optimally large. One such example is pollution by cars which obviously will affect others than the driver. This is represented in Figure 2.2 where MPC is the marginal private cost (or the private cost the driver normally considers per km driven) including time costs, MSC is the marginal social cost which is the MPC plus the marginal external cost and MSB is the social marginal benefit (the benefit per kilometre for the road user). For the market to be efficient, ie $MSB(Q) - TSC(Q)$ is maximised, we must clearly have that $MSB = MSC$.

**Figure 2.2 Social welfare loss in a market with external costs.
Efficient tax to deal with the problem.**



However, it is possible to internalise the external costs through an imposition of a tax equal to the marginal external cost. With such a tax, the consumption would spontaneously move to the optimal level. It is important to stress that the optimal charge should equal the *marginal* external cost and not the *average* external cost. The concepts would coincide only when the marginal external cost is constant. An example when this might not be the case, and the marginal external cost instead is an increasing function of the emission (or flow) as in Figure 2.2, is the environmental damage when the eco-system can handle low pollution levels quite well but breaks down for sufficiently high levels. Another typical example is the external congestion costs. Thus, it is not generally correct, from an efficiency point of view, to say that the total amount of tax paid should necessarily equal the total amount of damage done. Furthermore, many of the external marginal costs from traffic will vary considerably with respect to geographical location, type of vehicle, time etc, which ideally should be reflected in the charge structure.

In principle, external benefits should be internalised in a similar manner through subsidies. However, the benefits from the transportation sector are almost entirely internal and if there exist any external benefits, these are generally believed to be small (at least in industrialised countries), see Rothengatter (1994). Hence, the marginal social benefit equals the marginal private benefit.

Important effects of road transport which imply external costs are:

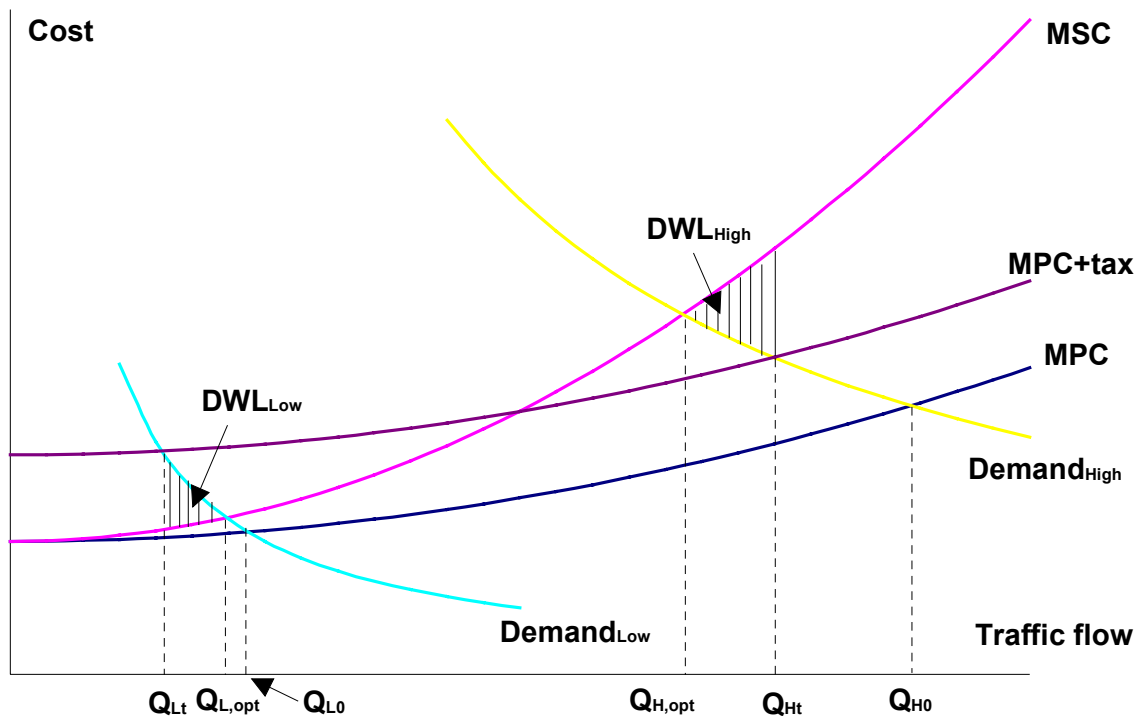
- Local environmental effects (health effects)
- Regional environmental effects (e.g. acidification)
- Global environmental effects (e.g. global warming)
- Congestion
- Accidents
- Noise
- Road wear and tear.

Sometimes it is argued that land use is an external effect as well, since the space used for roads has an alternative value. However, although the latter is correct, land use is not an externality from an economic point of view. This is because when the road is already built, the alternative value is gone. In other words, the loss in alternative land values will not increase when traffic increases. Still, the alternative land-use values should be taken into account in the social cost-benefit analysis which, ideally, should be made before the road investment. The point is that alternative land-use values does not affect the efficient pricing.

Congestion costs vary probably more than any other external costs with respect to location and time of the day. In most networks, congestion occur during a few hours of the day and primarily at some links. This situation reflects the poor efficiency of the current price structure. With more efficient pricing, it would be possible to use the road network in a more cost-efficient way. When the number of cars in a given network increases the average speed will decrease, and the level of congestion will increase.

Since the external congestion cost varies strongly during the day, so does the efficient charges. Consider for instance the following situation (Figure 2.3) where the demand is shifting during the day. During high demand, congestion increases and the optimal congestion charge should increase correspondingly and be equal to the difference between the marginal social cost (MSC) and the marginal private cost (MPC). If instead average congestion pricing during the day is used, the traffic level would be Q_{Lt} instead of $Q_{L,opt}$ during low demand, hence a non-optimal too low flow, and Q_{Ht} instead of $Q_{H,opt}$ during rush hour which is a non optimal too high flow. The corresponding welfare costs related to this non optimal pricing are shown as the "dead weight loss" areas in the diagram. It should, however, be noted that the welfare costs would be considerably higher if no congestion charge at all was used which, unfortunately, is the current practice.

Figure 2.3 Social welfare costs of applying average congestion pricing during the day instead of peak pricing.



It has been argued that road use pricing should not primarily be viewed as a way of collecting public funds for investment in road infrastructure, but as a means to achieve economic efficiency by managing travel demand and controlling road traffic growth. There are several other modes for raising funds which probably are better suited, such as income taxes and VAT. Such general taxes can generally be collected with a considerably lower administrative cost compared to various forms of road use pricing. Instead, the pricing strategy should be based on a socio-economic perspective where the overall goal is to maximise social welfare (and not financial revenues). Hence, the transport pricing should as closely as possible correct for the negative externalities caused by road transport. Consequently we would obtain a socially more efficient transport market, including a more **optimal modal split**. Advanced road use pricing has a large potential advantage compared to conventional modes (such as fuel taxes), since it can be differentiated in time, space and with respect to the characteristics of the vehicle. A distance-related road use charge is in principle superior to a fuel-based system.

2.5 Road Use Charging Technology and Integrated Payment Systems

The policies and measures of *trans* modal integrated urban transport *pricing* that are considered within the **TransPrice** project require that:

- There should be some form of road use charges that reflect as far as possible the real road infrastructure and road traffic congestion costs, including externalities.

- There should be an integrated payment system, involving all modes of travel and transport-related payments (public transport, parking, congestion charges, expressway tolls).
- There should be a system of revenue allocation between modes towards promoting optimum modal split; this implies that a proportion of road pricing revenues could be allocated to public transport finance (eg for fare subsidies, new public transport infrastructure and systems), non-motorised sustainable modes (ie cycling and walking) and other improvements (including environmental protection and upgrading).

Until recently, transport pricing systems had to rely on manual payment methods (eg windscreen sticker or “vignette” for supplementary licensing of motor vehicles, parking meters or “pay and display” for parking charges, multi-travel card such as “Card Orange” in Paris, TravelCard in London or Monthly Pass in Madrid and in Athens, etc). This tended to restrict the use of the facility to a single mode (eg car) or a number of related modes (eg public transport modes).

The potential for *trans* modal *pricing* applications has been substantially increased with the advances in automatic debiting based on smart card technology since the early to mid-1990s. It is now possible to achieve almost complete interoperability between several transport-related uses with a single smart card. In fact, the same smart card could be used for other payments such as telephones, municipal facilities (swimming pools, libraries, etc), and even as an electronic purse for multi-service applications. This allows for efficient accounting and revenue allocation between operators and modes of transport.

Charging and payment systems can be both multimodal and intermodal:

- **Multimodal**, as they may be used for a number of competing modes (eg Metro Vs Bus), thus ensuring user choice of travel mode.
- **Intermodal**, as they may be used for a number of modes for different legs of a single journey (eg Feeder Bus and Metro, or Park & Ride) thus facilitating “seamless” service and enhancing intermodality.

In the **TransPrice** project, by *trans* modal *pricing* we mean combination and integration of multimodality (choice of mode) and intermodality (seamless service).

The European Commission Green Paper “Towards Fair and Efficient Pricing in Transport”, includes reference to electronic fee collection systems and a review of relevant, available technologies (Microwave, Infrared and GSM/GPS). Key issues identified in the Green Paper are multi-lane automatic debiting, enforcement (exception handling), vehicle classification, transaction processing, legal and institutional problems, problems related to financial institutions, and interoperability (see Annex 4 of the Green Paper).

The EC Green Paper “The Citizens’ Network” (paragraphs 43-44) makes reference to integrated ticketing, fare systems and multi-service payment cards. The Green Paper points out that where integrated ticketing systems have been introduced, this has also been accompanied by increases in public transport use (eg Card Orange in Paris, TravelCard in London). Examples of integrated ticketing cited in the Green paper are

smart ticket in Brussels, Regional Environmental Card in Freiburg and integrated tariff in the Rhein-Main Verkehrsverbund.

The EC White Paper on “Fair Payment for Infrastructure Use” states that “it is now technologically possible and economically feasible to implement electronic road charges that can reflect with reasonable accuracy the marginal costs of road use”. Although CEN pre-standards have been adopted, further effort is needed to establish European standards. Compared to microwave technology, GPS and GNSS systems have the advantage that they do not require roadside equipment and in the long run they may prove less costly.

In December 1998, the European Commission presented a Communication on “Interoperable Electronic Fee Collection Systems in Europe”. The Communication examines the issues for developing interoperable systems in Europe, able to support the implementation of current and future agreed charging policies while allowing national and regional variations. It deals with technical and contractual interoperability, non-equipped users, classification, enforcement and proposes a phased strategy and actions for convergence.

The most promising relevant systems and technologies in urban transport are:

- Integrated Payment Systems (IPS) based on smart cards, including contactless systems and multi-service, electronic purse systems.
- Electronic road use pricing and fee collection systems based on automatic debiting telematics using standard radio frequencies, or GPS/GNSS.

Higher benefits are expected from an combined system covering all transport modes and related payments: road use charging, expressway tolls, parking charges (on street and off-street, private and public), public transport fares, access control, as well as other essential and municipal services (telephones, etc). Such systems are likely to increase user acceptability as they will assist “seamless” travel.

Smartcard-based IPS may also be used to support transport policy objectives. For example, a city authority may issue a citizen card with a fixed number of monetary units as a social service allowing a basic mobility for a fixed period (eg equivalent of four single trips per day by public transport, thus permitting access to workplace and to one recreational activity each working day and to two recreational activities during the weekend). The same units may be used for private transport in terms of congestion charging, expressway tolls, or parking charges. It follows that private transport charges should be substantially higher than public transport fares (by say a ratio of 1 to 3 or higher), so that marginal social costs are taken into account and modal split changes are induced, in a *trans modal pricing* strategy that aims to optimise modal split by pricing private transport externalities.

Units may be accumulated if a user chooses to walk/cycle to work, telecommute or forego the recreational trips for a certain period. The units may also be made transferable to other municipal payments, such as leisure centres, or rates and local taxes. These measures may enhance the public acceptability of road use charging.

However, the above arrangement assumes that there will be a proper, comprehensive, integrated and unified card issuing, accounting and revenue allocation system between all operators involved (private parking lots, expressway

authority/concession company, public transport companies, road use pricing agency, municipality, etc).

2.6 Revenue Allocation Issues

Integrated pricing policies including road use pricing may have a number of objectives which will affect the amount of revenue available and the decision about how it should be allocated. Revenue allocation may also be constrained to some degree by the impacts of legal and institutional issues regarding which authorities at which levels of government control the revenue collection and allocation processes. However, in practice the most important issue is likely to be public and political acceptability, regarding which of the potential uses are perceived by the public and elected politicians, alongside a range of interest groups, to be fair and most beneficial.

Both attitudinal and modelling research have shown that the hypothecation of revenue to improving the transport system may be extremely important, both in helping to gain public support for the system and to achieve optimum economic benefits. Evidence from the UK in both areas of this research has identified investment in public transport as a particularly important use of revenue. There is also significant support for compensatory measures, which involves revenue being returned to travellers and businesses through tax reductions and subsidies to offset any negative impacts of introducing a transport pricing system.

There is currently no consensus on the balance which should be struck between compensation and investment. At one extreme, Goodwin (1990) suggests a revenue allocation based heavily on investment in transport systems, which may even involve no revenue allocated for compensation purposes. At the other is the concept of an Eco-Bonus, where all revenue is returned to users and no investment occurs.

2.7 Public and Political Acceptability Issues

The most difficult urban transport pricing policy in terms of public and political acceptability is road use pricing. Some principles of public and political acceptability are given below (based on the research review of findings from other relevant projects such as MIRO in the Telematics Application Programme and the MobilPass scheme trial in Stuttgart), from a traffic psychology point of view:

- The objectives of the road use pricing scheme have to meet main public concerns.

Traffic problems are regarded as a major problem by both politicians and the public. Cities are actively searching for acceptable solutions and thus transport pricing should give rise to benefits and congestion reduction (and these have to be communicated to the public); safety and other advantages should be perceived by the public.

- Transport pricing measures have to be perceived as very effective solutions, if not as the only effective solution for the perceived traffic problems.

People are used to regard public roads as “free“ goods, therefore there will be strong emotional resistance to any attempt to charge for them. If we want people to accept charging for road use or parking, there must be very good and convincing reasons. Perhaps the best reason is, that this is the best way of solving perceived urgent problems.

- Revenues must be hypothecated and transport alternatives have to be provided.

People want to get something for their money. Thus, there must be a package solution, combining traffic restraints and road use charging with a set of transport and environmental improvements.

- The full and reliable functioning of the system must be guaranteed from the start.

This includes also that the implemented system should be as user-friendly and simple as possible. The early perception of the whole package will strongly influence later behaviour. Beneath reliability there should be mentioned other aspects as compatibility with other systems and to add-on-options (eg automatic route guidance), no additional load on the driver and so on. And the system must be free from the possibility of fraud and evasion, both deliberate and unintentional.

- Equity needs have to be considered very carefully.

The system must be perceived as fair at least in three ways: first relating to the personal cost-benefit-relation, second related to social comparisons between road users, and third concerning possible disadvantages between neighbouring cities. The benefits people see for themselves must balance their costs at least in an immaterial way (by reaching other valuable objectives). In addition people should not feel to be treated unjust in comparison to others. An important role plays in this context the use of the revenues. With the help of the raised charges it is possible to influence the distributional impacts in the desired direction. There must be a package solution, combining travel demand management measures with a set of transport and environmental improvements. Hypothecation of the revenues must result in guaranteeing a desired level of mobility for all (even supporting mobility chances for some groups), thus meeting equity issues for the whole population.

- Public acceptance can only be expected if people have confidence among others in the effectiveness of the measure, the use of the revenues, the fairness and anonymity of the system.

That privacy is not affected and anonymity is guaranteed must be communicated in a credible and convincing way.

- The necessary publicity calls for an intelligent marketing strategy.

Publicity campaigns should include information on the transparency of the whole system, the hypothecation principle, and the objectives for which the revenues are used. People want to know what their charges are used for and what is the benefit for them. Thus the marketing strategy has to deal with the whole package and particularly point at the benefits. This marketing message has to be communicated by very credible communicators (credible from the point of view of car drivers). Some principles could be:

- All the issues have to be discussed in advance: creating awareness for the problem, then presenting a package of credible solutions.
- Transport pricing has to be communicated as a very effective means to reach commonly shared goals.

- There must be personally positive experiences in first trials of changing transport mode, for instance time savings, less parking problems, environmental benefits, the possibility to participate in solving traffic problems, improving the attraction of inner-cities. If the first experiences with a newly implemented road use pricing system have to be positive, then investments in public transport must go ahead before the system is introduced to have the required capacities available.
- People must feel to have a choice, even if the choice alternatives are restricted. If they only feel to be forced to compliance, some of them will show reluctance, a strong motive to change the situation for themselves and to restore former perceived possibilities to choose between alternatives. Crucial is the *perceived freedom of choice*.
- Enforcement of the measures has to be very high. This will only work if a great majority of people generally agree with the measures and wants that offenders are punished. The conviction of a great majority is not only a precondition for the acceptance of the measure, but also a precondition for the acceptance of the control against offenders.
- New behaviour must be made favourable: there must be real travel alternatives to the private car and these alternatives must be well known and attractive in terms of price, convenience, availability, accessibility and so on. Constraints which prevent the change of behaviour should be removed or minimised.

It should be noted that the arguments on enhancing public and political acceptability through allocating the road pricing revenues to public transport and other improvements is not consistent with the economic efficiency case which suggests that revenues must be allocated to the most beneficial projects through cost-benefit analysis (eg CAPRI Deliverable 2). The decision on what to do with the road pricing revenues will be in the end a political one as indeed many decisions on allocation of financial resources do not necessarily follow a theoretically economic optimum case. In this respect, a conflict of theoretical objectives regarding optimal pricing and measures to enhance public and political acceptability of road use pricing has been identified.

2.8 Legal and Institutional Issues

In most European countries the financing of transport, apart from the fares revenue of public transport systems that generally does not cover costs, is met from general tax receipts at national level, distributed to the cities via a financial agreement. Some of the taxes are transport-related, such as fuel tax, vehicle road tax, vehicle purchase tax and so on, but they are not normally devoted exclusively to transport expenditure. These taxes have only a low control effect on mobility or choice of means of transport. Collection of these taxes takes place on the basis of national legislation.

Among European cities, only in Oslo, Trondheim and Bergen, Norway, there is road use pricing which has a certain controlling effect on road traffic. Outside cities, national roads (motorways) and some privately-funded roads are subject to tolls in some countries, for example in France, Italy, Austria, Greece. This toll charge is set on the basis of national legislation. Some European countries have the intention to implement or expend road use pricing on national roads, mainly for financing new infrastructure.

In all countries of the EU, cities have implemented parking management and control schemes by means of parking charges, which have a noticeable controlling effect.

This is mainly directed towards reducing commuter car traffic and perhaps facilitating car-oriented business and shopping traffic. In many countries (Ireland, Finland for example) this parking management is regulated by a national law, or as in Austria by regulation at local level.

Since at present there is no road use pricing in most countries of the EU, the legal foundations also do not exist. Exceptions to this are Italy, Britain, Greece and France.

In **Italy**, the “Decreto Legislativo n.285” of 30.04.1992 on “Nuovo Codice della Strada” (New Highway Code), allows Municipalities to control the entry and circulation in restricted areas (Zone a Traffico Limitato, ZTL) by payment of a toll (Article 7, paragraph 9). A law (Direttiva 3816/1997 of the Ministry of Public Works) establishes which Municipalities are allowed to do so, the way of collecting charges and the authorised vehicles. A latest development is a regulation of the Studies and Legislation Bureau of the Ministry of Public Works (Ref 38/400/31 of 14 January 1999), which deals with equipment to be used in historical centres (defined as Zone A of Decreto 1444/68; almost all Municipalities have classified their city centres as Zone A), or restricted access zones (ZTL, defined as above). This new regulation states that equipment for automatic access control can be used also for road use pricing, that there is no longer a requirement for the presence of a policeman, and every kind of electronic, optical, transponder, photo/video system can be used for identifying vehicles. These legislative developments practically introduced the possibility for Municipalities to implement urban road use pricing schemes at the local level. However, no city authority in Italy has implemented such scheme yet.

In **Britain**, the previous Government had considered the option (in October 1995) for local authorities to implement road use pricing schemes in urban areas and to be able to keep some of the resulting revenue for funding local transport improvements (“ring fencing” or hypothecation of revenues), but no action was taken at that time. The then British Government effectively ruled out any schemes at least until the end of the century, insisting that any local authority wishing to carry forward road pricing must first satisfy the Government that it had overcome all technological and administrative hurdles. Urban road pricing would still require either Government legislation or a private Bill brought forward by an authority wishing to implement any scheme. The Private Finance Initiative (PFI) in Britain provides the legal and institutional framework for the financing (or co-financing) of transport infrastructure projects by the private sector. The main candidates for PFI funding are toll roads (both inter-urban and peri-urban); more recently, the PFI is being applied to the introduction of Smart Cards for the London Underground. Another development in Britain concerns the “Road Traffic Reduction Bill”. According to this law, it is a statutory requirement for every highway authority to prepare a report containing both assessments of current traffic levels and a forecast of future growth in the area. Authorities will also be expected to specify targets for reducing road traffic, or cutting the rate of growth (by possibly including pricing measures).

A major recent development in Britain was the publication of a White Paper in July 1998 on “A New Deal for Transport: Better for Everyone”. The White Paper commits the present Government to “introduce legislation to allow local authorities to charge road users so as to reduce congestion, as part of a package of measures in a local transport plan that would include improving public transport”. The White Paper implies that revenues from urban road pricing would be hypothecated for local transport investment and promises to issue a consultation document with proposals for how road user charging schemes should operate (covering electronic schemes, permit

schemes and schemes using tollbooths). It also suggests ways of charging for workplace parking spaces, promising legislation to enable local authorities to levy a new parking charge on workplace parking.

The British government has more recently (mid-December 1998) published a consultation paper on its legislation proposals regarding the introduction of road user charging ("Breaking the Logjam"). In that consultation paper, two principal forms of charging are proposed: either cordon/screenline point charging or area licence; charging based on speed or time has been discounted on the bases of research findings that such forms encourage dangerous driving and evidence of driver preference on knowing in advance what the charge to be paid would be. The British government proposes that local authorities that bring forward pilot road user charging schemes should be able to retain 100% of the net revenue generated for at least 10 years from the implementation of a scheme, provided that there are worthwhile transport-related projects to be funded. Special legislation for London sets up a Greater London Authority and an executive Mayor of London, that will have direct powers to introduce road use pricing schemes in the British capital and use the revenues within the London transport sector. Legislation for city authorities outside London to introduce pilot road use pricing schemes is expected to follow.

The UK government has recently announced that Leeds (one of the **TransPrice** cities) will be the location of a year long trial of road user charging technology and the city has submitted proposals to the government for pilot city status, ie to implement a full road user charging system within five years.

In **Greece**, legislation was introduced for the construction of a major expressway around Greater Athens as a toll road co-funded by a private sector consortium (Attiki Odos) under a BOT concession in 1996. According to the concession agreement which has been approved by Parliament, the concessionaire company (Attiki Odos) is responsible for the implementation of an automatic tolling system alongside the manual toll collection option. In legislating for the Attiki Odos project, it has been recognised that cost recovery by road users should be a target and that traffic that benefits from reduced journey times and higher levels of service should pay a toll.

More recently, (in April 1998), the Athens Area Urban Transport Organisation, OASA (a public agency under the Ministry of Transport and a partner in the **TransPrice** project), published, under the aegis of the Ministry of Transport, a (consultative) Green Paper on Urban Transport for Athens. The OASA Green Paper includes a specific section on a proposal for funding of public transport through the charging of the use of private cars. This is the first time that a public organisation makes such a radical proposal, which has generated a debate. The managing director of OASA was quoted by the Sunday newspaper "To Vima" to propose a vignette system of charging private cars within the congested inner area of Athens. The OASA Green Paper also proposes institutional changes, investment policies, improvements to the Public Transport pricing policy, fares subsidies and ticketing systems, the setting up of a Public Transport Special Fund, Public Transport priority measures, provision of Park & Ride facilities and intermodality improvements.

Following the publication of the OASA Green Paper and the ensuing debate, recent legislation (December 1998) includes a provision for allocation of a proportion of revenues from bus lane violation fines to public transport, thus establishing the principle of hypothecation of revenues from car user charges to public transport improvements. This has been accepted politically by the Parliament. A White Paper

and further legislation are planned for the future, which are expected to deal with the more controversial issues of road user charges and resulting revenue allocation to public transport and environmental improvements. These developments provide a vital link between EU research and policy options formulation at the local level.

Several authorities in Greece had introduced systems of on-street parking charges and enforcement, operated by private companies under concession agreements with Municipalities. Organised objectors, however, have appealed to the high court against this system and the court decision has led to suspension of the charge collection and enforcement by private companies. Currently, only Municipal police and special parking guards have the right to monitor and enforce on-street parking charge systems. This shows the importance of proper legislation in the implementation of pricing measures.

In **France**, apart from specific legislation governing inter-urban motorways, there is the Law of the 19 August 1986 and Decree of the 28 April 1988 which state that road use pricing in urban areas is possible only for financing urban road infrastructure. The law allows local authorities to implement a road use pricing scheme only with regard to some conditions: its objective must only be to cover investment and operating costs of the infrastructure. Thus, road use pricing cannot be implemented on an area, network, or as a cordon. In France, from a legal point of view, road use pricing cannot be applied in urban areas to manage demand, but only to help the building of road infrastructure by minimising demand on the public budget (through Public-Private Partnerships, PPPs). A recent court case concerning a toll road in Lyon, brought about by objectors, led to suspension of toll collection by a private company which shows the need for watertight legal framework concerning the implementation of pricing measures (as in the case of the private sector concession companies for on-street parking charges in Greece, mentioned earlier).

In all other EU Member States, a coherent legal framework for urban road use pricing must be created at the national or regional level. There is a potential conflict of interests, as sometimes decision makers for such legislation represent those sections of the population that live in the city suburbs, who would be the main losers from any form of urban road use pricing. This could be a main reason why decision making processes for the creation of the legal foundations for urban road use pricing may be difficult and lengthy.

According to the procedures agreed by the European Union (EU) Council of Ministers, decisions for the implementation of urban transport pricing policies have to be taken at a local level and by the individual Member States (in line with the principle of “subsidiarity”). This is also stated in the recent EC White Paper. The EU however provides outline directives such as:

- Specification of minimum reserve ratio for motor vehicle and mineral oil taxes - specification of maximum rates for road haulage charges for road transport - legal directives for the specification of toll fees.
- The Euro-Vignette directive approved by the Council of Ministers in October 1993 (Ref/89/EC). This directive dealt with road haulage charges, but Article 10 had explicit references that permitted local authorities to introduce road user charges specifically designated to combat time and place-related traffic congestion. This would have allowed member states to legislate for urban road use pricing schemes without the possibility of action being taken against them at the EU level (eg by

objectors, motoring associations, retailers, etc). This directive has been annulled by the European Court of Justice but it is still in force till new arrangements are made. The Commission has prepared new proposals which are currently for consideration of the EU Council of Ministers. The new Council Directive is based on two Articles of the EU Treaty, ex75 (Transport) and ex99 (Taxation). The new Directive does not prevent the application of regulatory charges specifically designed to combat time- and place-related traffic congestion (Article 9.1.c). A common position on the Directive has been reached by the EU Member States (EC No 14/1999, OJ C 58/1 of 01.03.1999).

Nearly all European countries are aiming at the deregulation and/or privatisation of public transport, in order to make the market mechanisms of cost and price formation effective (eg Great Britain, Germany, Austria, Sweden). The legislation created for this purpose also has impacts on other aspects of urban public transport, including pricing policies and financing options. For example, a Public Private Partnership (PPP) that may be set up to provide the required funding for the modernisation of the London Underground system could be linked to supplementary licensing or other forms of road user charges to provide additional revenues.

In most countries of the EU there are as yet no appropriate legal and institutional conditions for the introduction of an integrated urban transport pricing strategy. In the field of road infrastructure there is generally a division of responsibilities into national, regional and local levels. This is an obstacle to a common co-ordinated procedure in many cities and countries. In addition, major conurbations often consist of several Municipalities with different decision-making structures, which hinders an integrated transport pricing and financing approach at city-region level.

In many conurbations public transport is provided by a variety of operators split up between various public and private proprietors. Only in some cases there is an overall strategic planning and co-ordinating organisation (eg CTM in Madrid, OASA in Athens, STP in Paris). The lack of such a strategic planning and co-ordinating body hinders the implementation of an integrated pricing strategy for public transport.

The main conclusion from the above review of legal and institutional issues is that the legal foundations for an integrated urban transport pricing do not as yet exist in most EU countries. These missing legal and institutional preconditions, however, are no insurmountable obstacle to the introduction of an integrated urban transport pricing policy, but may considerably delay its progress. These missing preconditions are also a reflection of the present limited political and public acceptance of transport pricing measures.

The European Commission evidently pursues a general strategy that the implementation of *trans* modal integrated urban transport *pricing* measures should not be hindered by its legal outline directives, but rather be fostered. However, the implementation of such measures is the responsibility of urban and regional authorities and the legal and institutional arrangements have to be made by national governments and parliaments.

3. Modelling the Impact of Pricing Measures

3.1 Modelling Methodology

The *TransPrice* modelling methodology comprised:

- User response and travel behaviour analysis through a common Stated Preference (SP) survey in all eight project sites.
- Analysis and assessment of the determinants of mode choice, particularly related to price-related variables.
- Simulation modelling, integrating the SP analysis results with strategic and/or disaggregate mode choice modelling (using existing models where available) and detailed traffic management modelling.

The purpose of the modelling was two-fold:

- firstly to inform the specification and demonstration design for the five demonstration sites and
- secondly to inform the comprehensive evaluation by providing estimates of full-scale implementation impacts of several pricing scenarios.

3.2 Travel Behaviour Research

The potential changes in travel behaviour from pricing measures was analysed by means of a Stated Preference (SP) Survey in all eight sites with a Common Experimental Design involving combinations of the following attributes and alternative levels within each attribute:

- Mode Choice: Car Vs Public Transport Vs Park & Ride
- Car Costs: +50 and +100% from present operating and parking costs
- Car and Public Transport Times: -20% and +20% from present times
- Public Transport Costs: -20% and +20% from present costs.

In total, 2155 valid responses were obtained. The SP survey was targeted to current car users, mainly for commuting trip purpose that would consider changing mode to public transport or Park & Ride through increases of car costs and/or time and cost improvements to the alternative modes of travel. This was the first time that such a survey was applied to several urban areas with a common experimental design.

The analysis of the SP survey gave estimates of Value of Time (VoT) and mode-specific constants. The survey also included acceptability questions on the justification of road use pricing, the preferred allocation of revenues and the preferred method of payment. The SP survey data were analysed by the Helsinki University of Technology.

The results of the SP survey were used in modelling tests and the additional questions were used in the public acceptability research (see Chapter 6).

3.3 Modelling Results Cross-Site Comparisons

Various demand management measures employing pricing as a lever were modelled for the cities involved in **TransPrice**. Table 3.1 shows the pricing measures tested for each site. This cross-site comparison will concentrate on cordon pricing, time-based pricing, distance-based pricing and parking pricing measures.

Table 3.1: The pricing measures modelled in each city

PRICING MEASURE	Athens	Como	Madrid	Leeds	York	Goteborg	Helsinki	Graz
Cordon Pricing	◆	◆				◆	◆	◆
Area Pricing	◆					◆		
Parking Pricing		◆		◆	◆			
P&R fares					◆			
Congestion costs and PT subsidy			◆					
Time based charging	◆	◆		◆	◆			
Distance based charging	◆	◆		◆	◆			
HOV lane pricing			◆					

Purchasing Power Parities (PPP)

To ensure comparability with regard to the cordon and parking prices charged in each city, the values of the prices were adjusted to allow for Purchasing Power Parity (PPP). Purchasing Power Parities are the rates of currency conversion that equalise the purchasing power of different currencies by eliminating the differences in price levels between countries. This means that, a given sum of money, when converted into different currencies at PPP rates, will buy the same basket of goods and services in all countries.

Exchange rates, on the other hand, do not reflect the relative purchasing powers of different currencies because they do not eliminate the differences in price levels between countries. Hence, a given sum of money converted into different currencies using exchange rates will not buy the same quantity of goods and services in all countries. PPPs and not exchange rates are the appropriate currency conversion rates with which to make international comparisons of volume.

Cordon Pricing Cross-Site Comparison

The cordon pricing results used in the cross site comparison are presented in Figure 3.1 and Table 3.2. The trend exhibited in the data is a general reduction in trips as a result of cordon pricing. In the case of Athens three conditions are presented: an internal cordon, an external cordon and a combination of both. In the case of Como, three charge levels in the peak period and three levels for all periods. The higher impact is as a result of the former where transfer of trips from the peak period to the off-peak period contributes to greater trip reduction in the peak period. In the case of the Leeds simulations, the scenario involving three concentric cordons results in the highest level of impact. In summary, most results lie in the range 1-20% reduction in trips for the charge range level 0.3-3 EUR.

When travel time on the network is examined in Figure 3.2 and Table 3.3 as a result of the Cordon pricing, one can observe a decrease in travel time for Helsinki and Como. In the case of Leeds, there is an increase for some of the internal cordon pricing levels, as in the case of Athens. The revenue data associated with cordon pricing is presented in Figure 3.3 and Table 3.4.

Distance-based Pricing Cross-site Comparison

Total network travel time data for distance-based pricing is presented in Figure 3.4 and Table 3.5. There is a general reduction for the tests in Athens, Como and Leeds but in the case of York there is little impact on total network travel time as a result of distance-based charging. When the impact of distance-based charging on distance travelled on the network is examined in Figure 3.5 and Table 3.6 one can observe that the trend is again a reduction. The revenue data for distance-based charging is presented in Figure 3.6 and Table 3.7.

Time-based Pricing Cross-site Comparison

Total travel time on the network, total distance travelled and revenue are examined again in the case of time-based pricing. The impact on total travel time is presented in Figure 3.7 and Table 3.8 and on total travel distance in Figure 3.8 and Table 3.9. Revenue generated is presented in Figure 3.9 and Table 3.10.

Parking Pricing Cross-Site Comparison

As mentioned earlier, parking pricing measures were modelled for three sites: Leeds, Como and York. In the case of York, the pricing was location and time specific and so it is difficult to include the results in a cross-site comparison. Comparisons are made in the case of Leeds and Como in Figures 3.10 and 3.11. The relationship between parking charge in EUR and the percentage decrease in distance travelled in the city is presented in Figure 3.10 followed by the impact of pricing level on the percentage decrease in cars entering the city in Figure 3.11. The data is limited in this case due to the inclusion of only two cities and so general relationships are difficult to establish. It appears that geographical and site specific parameters have an impact here which increases the difficulty in making cross-site comparisons.

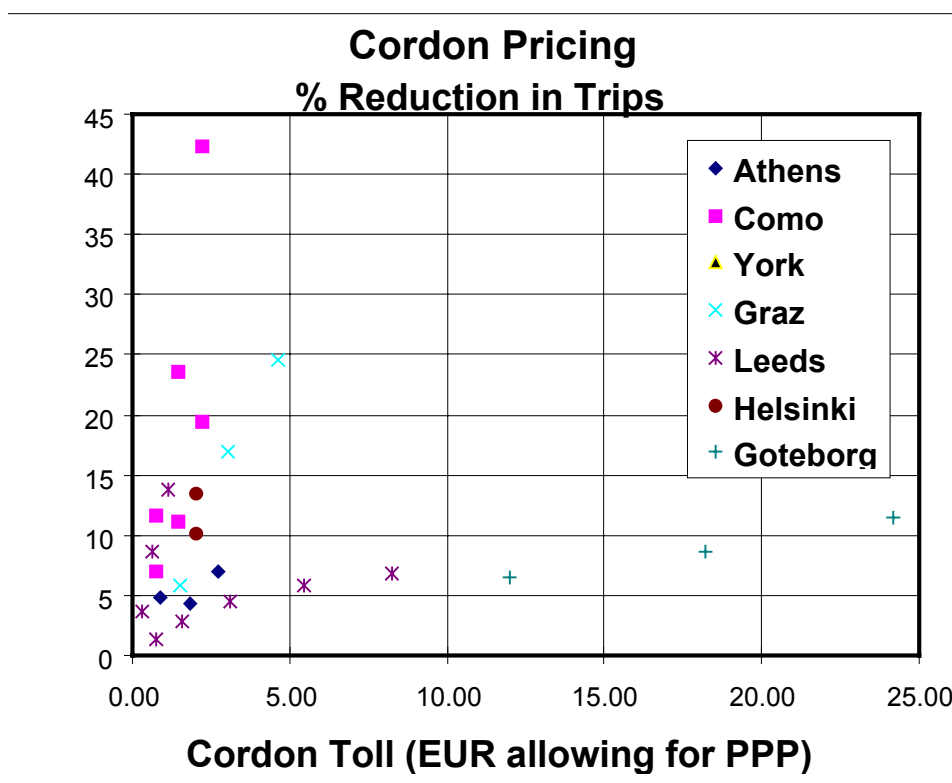


Figure 3.1 % Reduction in trips – Cordon pricing

Table 3.2: % Reduction in trips – Cordon Pricing

City	Cordon Toll (EUR, PPP)	% Reduction in Trips	City	Cordon Toll (EUR, PPP)	% Reduction in Trips
Athens	0.92 (Outer)	4.8	Leeds	0.3 (Outer)	3.7
	1.83 (Inner)	4.4		0.66 (Outer)	8.7
	2.75 (Both)	7.0		1.13 (Outer)	13.8
Como	0.73	7.0		0.78 (Inner)	1.3
	1.46	11.2		1.57 (Inner)	2.8
	2.19	19.5		3.13 (Inner)	4.5
	0.73 (Peak)	11.7	5.48 (Inner)	5.7	
	1.46 (Peak)	23.6	8.22 (Inner)	6.8	
Graz	3.08 (Peak)	17.0	Helsinki	2.0 (Outer)	10.2
	1.54 (Peak)	5.8	2.0 (Inner)	13.4	
	4.62 (Peak)	24.5	Goteborg	12	6.5
		18.2		8.7	
		24.4		11.5	

PPP = Purchase Power Parity

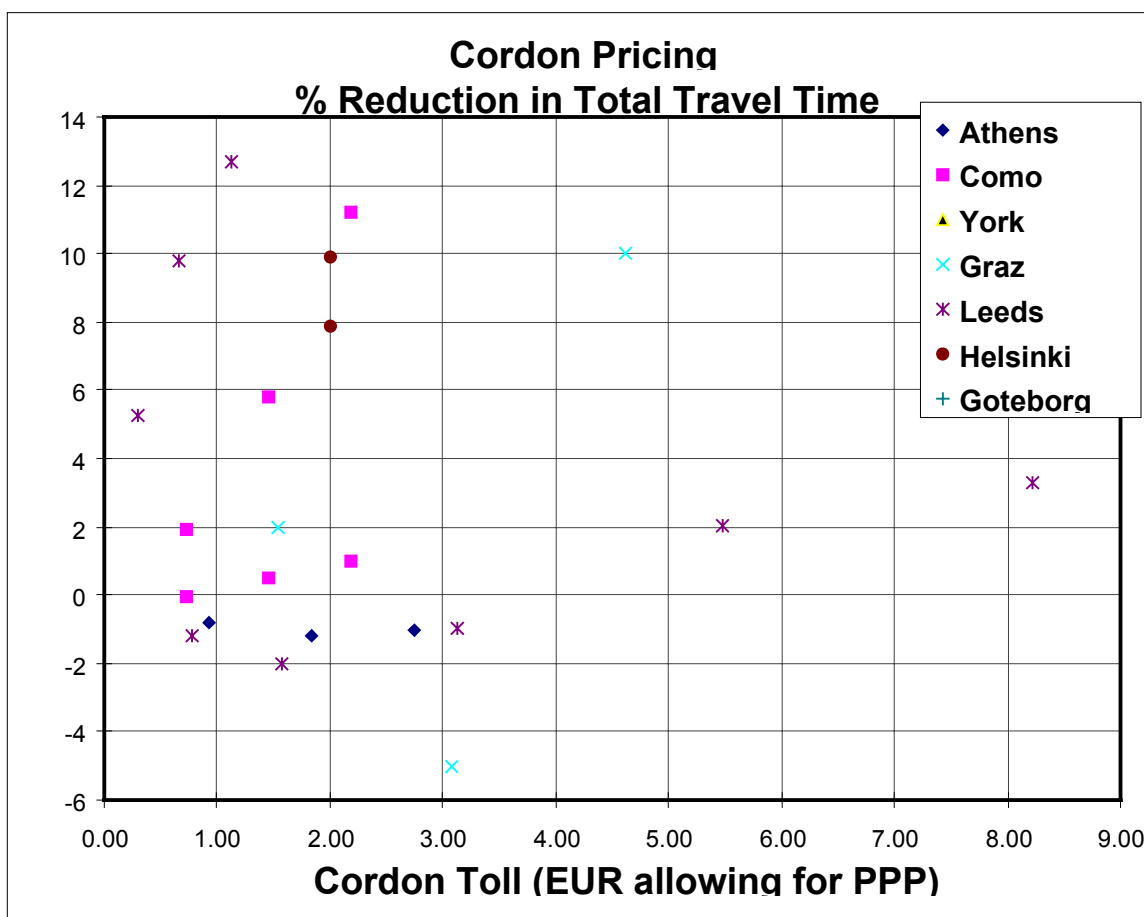


Figure 3.2 % Reduction in travel time on network – Cordon pricing

Table 3.3: % Reduction in travel time on network – Cordon pricing

City	Cordon Toll (EUR, PPP)	% Reduction in Total Network Travel Time	City	Cordon Toll (EUR, PPP)	% Reduction in Total Network Travel Time
Athens	0.92 (Outer)	-0.8	Leeds	0.3 (Outer)	5.2
	1.83 (Inner)	-1.2		0.66 (Outer)	9.8
	2.75 (Both)	-1.0		1.13 (Outer)	12.7
Como	0.73	-0.1	0.78 (Inner)	-1.2	
	1.46	0.5	1.57 (Inner)	-2.0	
	2.19	1.0	3.13 (Inner)	-1.0	
	0.73 (Peak)	1.9	5.48 (Inner)	2.0	
	1.46 (Peak)	5.8	8.22 (Inner)	3.3	
Graz	2.19 (Peak)	11.2	Helsinki	2.0 (Outer)	9.9
	3.08 (Peak)	-5.0		2.0 (Inner)	7.9
	1.54 (Peak)	2.0			
	4.62 (Peak)	10.0			

PPP = Purchase Power Parity

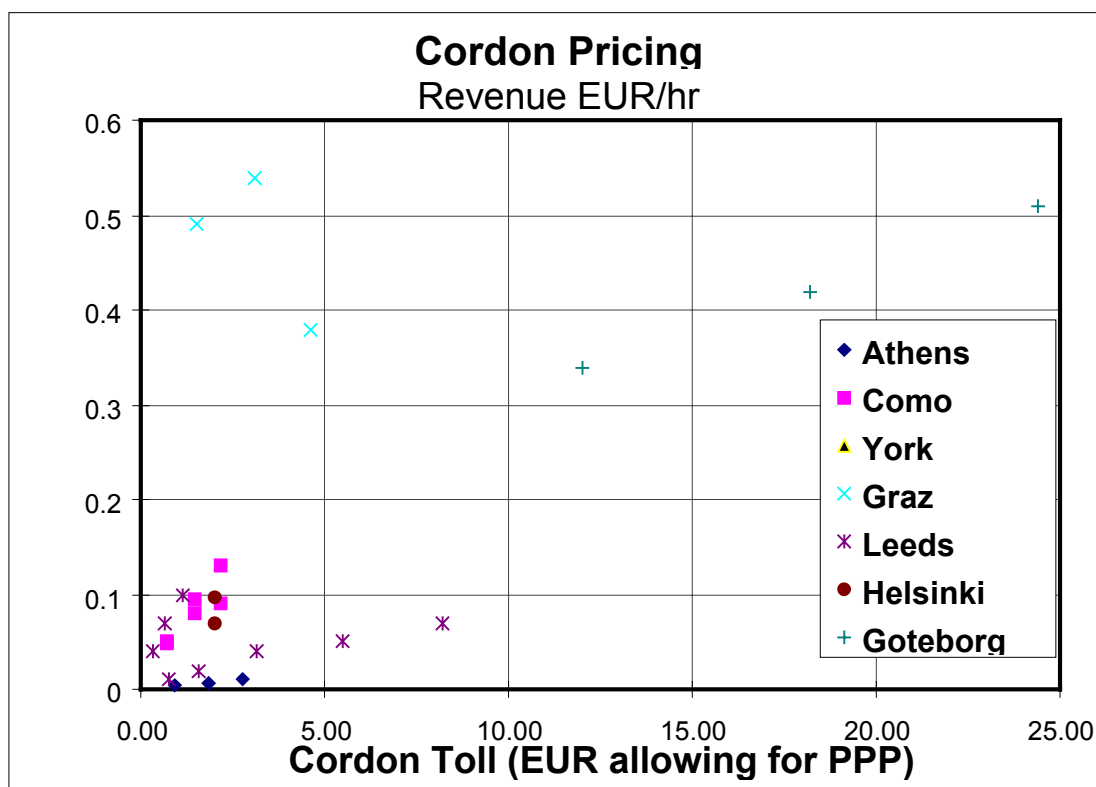


Figure 3.3 Revenue generated per person – Cordon pricing

Table 3.4: Revenue generated per person – Cordon pricing

City	Cordon Toll (EUR, PPP)	Revenue Generated (EUR/hr/per)	City	Cordon Toll (EUR, PPP)	Revenue Generated (EUR/hr/per)
Athens	0.92 (Outer)	0.004	Leeds	0.3 (Outer)	3.7
	1.83 (Inner)	0.006		0.66 (Outer)	8.7
	2.75 (Both)	0.01		1.13 (Outer)	13.8
Como	0.73	0.05		0.78 (Inner)	1.3
	1.46	0.09		1.57 (Inner)	2.79
	2.19	0.13		3.13 (Inner)	4.55
	0.73 (Peak)	0.05		5.48 (Inner)	5.75
	1.46 (Peak)	0.08		8.22 (Inner)	6.77
Graz	2.19 (Peak)	0.09		Helsinki	2.0 (Outer)
	3.08 (Peak)	17	2.0 (Inner)	13.4	
	1.54 (Peak)	5.8	Goteborg	12	6.5
4.62 (Peak)	24.5	18.2		8.7	
		24.4		11.5	

PPP = Purchase Power Parity

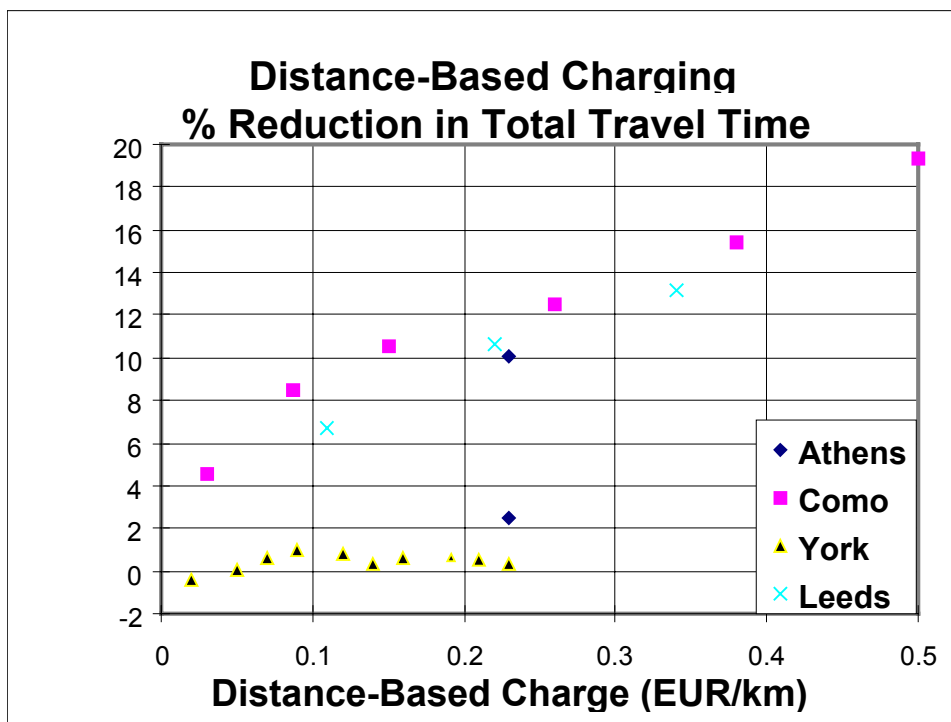


Figure 3.4 % Reduction in Total Travel Time as a result of Distance-Based Charging

Table 3.5: % Reduction in Total Travel Time – Distance Based Charging

City	Distance-Based Charge Rate (EUR/km)	% Reduction in Total Travel Time
Athens	0.23 (No P&R)	2.5
	0.23(With P&R)	10.1
Como	0.03	4.6
	0.09	8.5
	0.15	10.5
	0.26	12.5
	0.38	15.4
	0.5	19.3
York	0.02	-0.4
	0.05	0.04
	0.07	0.6
	0.09	1.0
	0.12	0.8
	0.14	0.3
	0.16	0.6
	0.19	0.5
	0.21	0.5
	0.23	0.3
Leeds	0.11	6.7
	0.22	10.7
	0.34	13.2

PPP = Purchase Power Parity

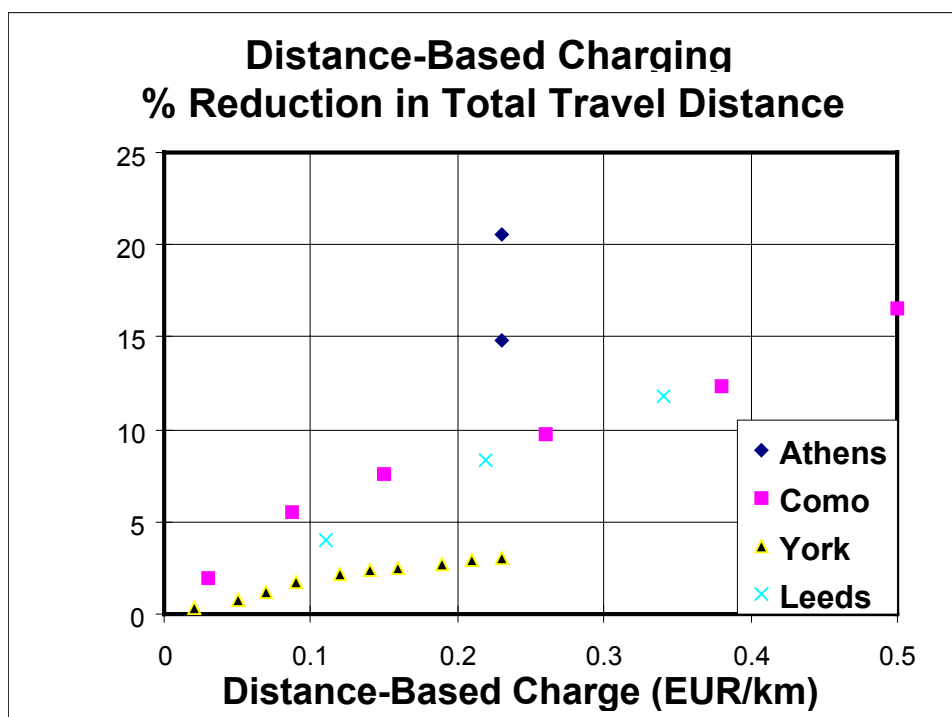


Figure 3.5 % Reduction in Travel Distance for Distance-Based Charging

Table 3.6: % Reduction in Travel Distance for Distance-Based Charging

City	Distance-Based Charge Rate (EUR/km)	% Reduction in Total Travel Distance
Athens	0.23 (No P&R)	14.8
Athens	0.23 (With P&R)	20.6
Como	0.03	1.9
Como	0.09	5.5
Como	0.15	7.6
Como	0.26	9.7
Como	0.38	12.3
Como	0.5	16.6
York	0.02	0.3
York	0.05	0.8
York	0.07	1.2
York	0.09	1.7
York	0.12	2.2
York	0.14	2.3
York	0.16	2.5
York	0.19	2.7
York	0.21	2.9
York	0.23	3.0
Leeds	0.11	4.0
Leeds	0.22	8.4
Leeds	0.34	11.8

PPP = Purchase Power Parity

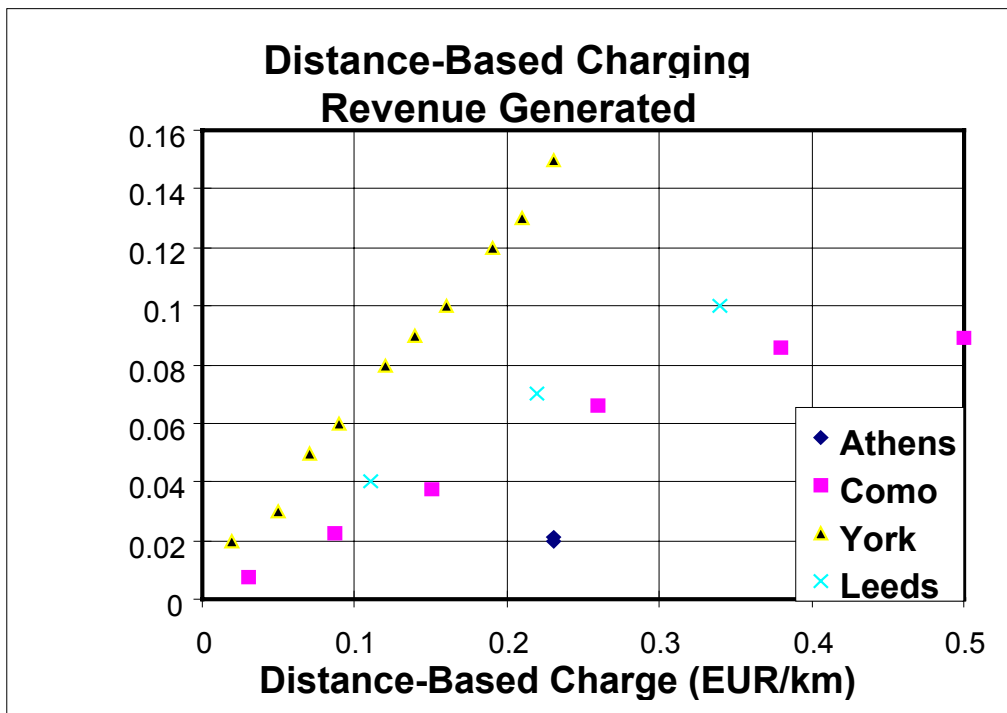


Figure 3.6 Revenue generated per person (pop) – Distance-Based Charging

Table 3.7: Revenue generated per person (pop) – Distance-Based Charging

City	Distance-Based Charge Rate (EUR/km)	Revenue Generated (EUR/hr/per)
Athens	0.23 (No P&R)	0.02
	0.23 (With P&R)	0.02
Como	0.03	0.01
	0.09	0.02
	0.15	0.04
	0.26	0.07
	0.38	0.09
	0.5	0.09
York	0.02	0.02
	0.05	0.03
	0.07	0.05
	0.09	0.06
	0.12	0.08
	0.14	0.09
	0.16	0.1
	0.19	0.12
	0.21	0.13
	0.23	0.15
Leeds	0.11	0.04
	0.22	0.07
	0.34	0.1

PPP = Purchase Power Parity

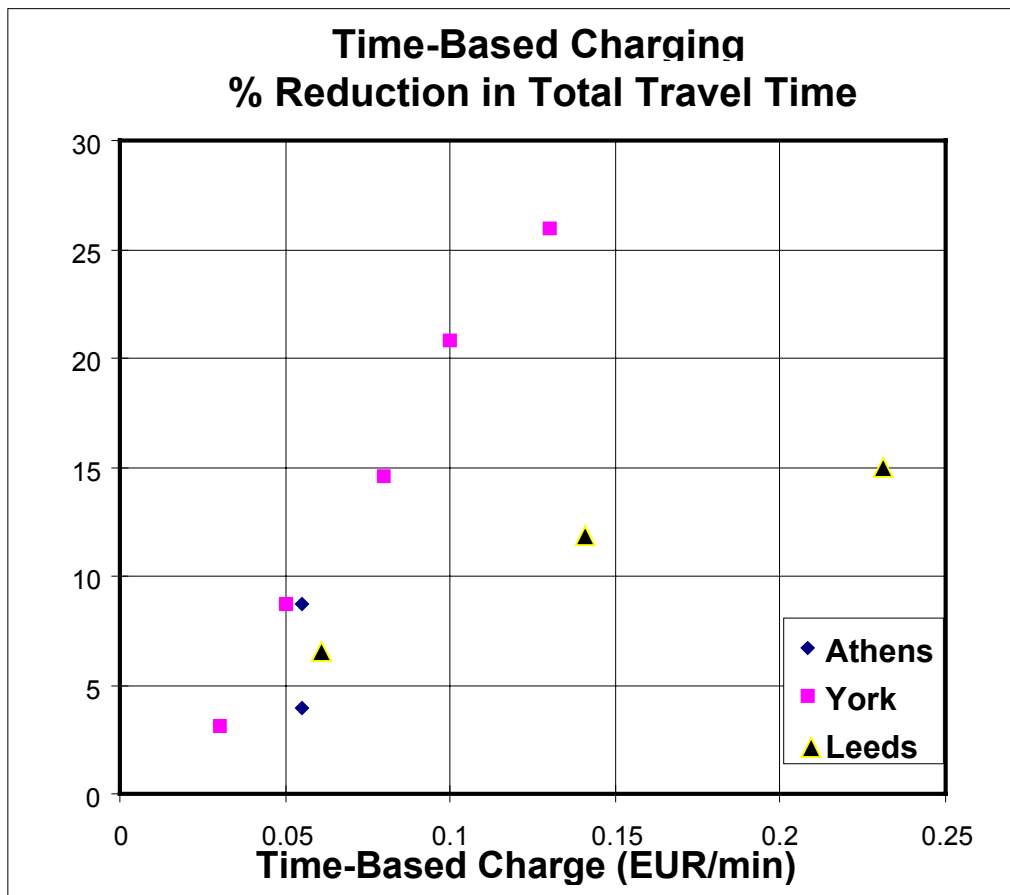


Figure 3.7 % Reduction in Total Travel Time for Time-Based Charging

Table 3.8: % Reduction in Total Travel Time for Time-Based Charging

City	Time-Based Charge Rate (EUR/min)	% Reduction in Total Travel Time
Athens	0.055 (No P&R)	3.9
Athens	0.055 (With P&R)	8.7
York	0.03	3.1
York	0.05	8.7
York	0.08	14.6
York	0.10	20.9
York	0.13	25.9
Leeds	0.06	6.7
Leeds	0.14	12.0
Leeds	0.23	15.1

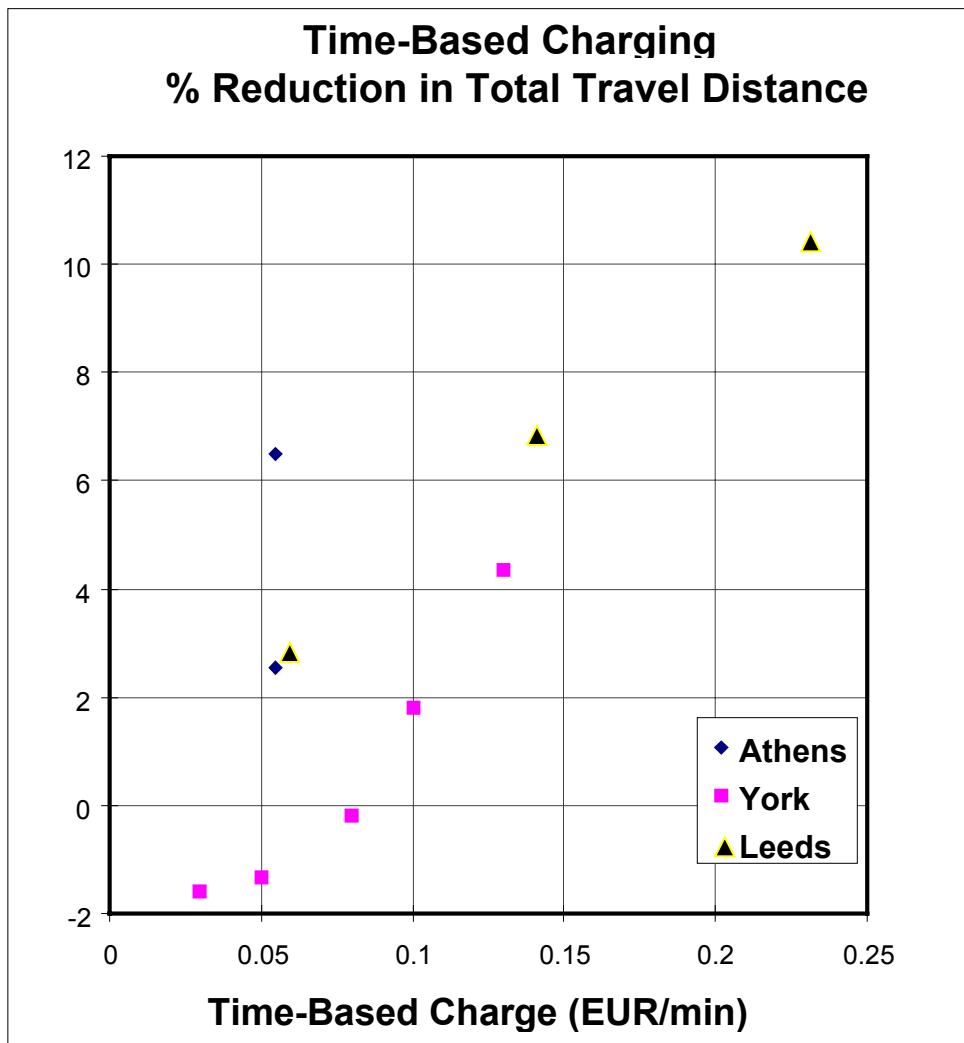


Figure 3.8 % Reduction in Total Travel Distance for Time-Based Charging

Table 3.9: % Reduction in Total Travel Distance for Time-Based Charging

City	Time-Based Charge Rate (EUR/min)	% Reduction in Total Travel Distance
Athens	0.055	2.5
	0.055	6.5
York	0.03	-1.6
	0.05	-1.3
	0.08	-0.2
	0.1	1.8
	0.13	4.4
Leeds	0.06	3.0
	0.14	6.9
	0.23	10.5

PPP = Purchase Power Parity

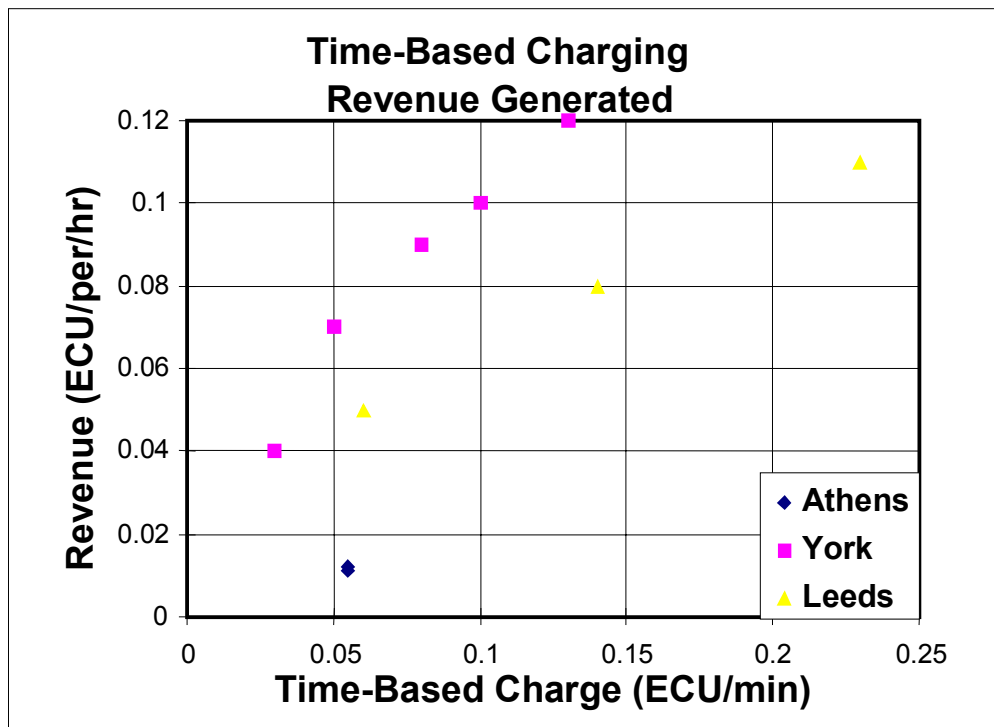


Figure 3.9 Revenue Generated for Time-Based Charging

Table 3.10: Revenue Generated for Time-Based Charging

City	Time-Based Charge Rate (EUR/min)	Revenue Generated (EUR/hr/per)
Athens	0.055	0.01
	0.055	0.01
York	0.03	0.04
	0.05	0.07
	0.08	0.09
	0.10	0.10
Leeds	0.13	0.12
	0.06	0.05
	0.14	0.08
	0.23	0.11

PPP = Purchase Power Parity

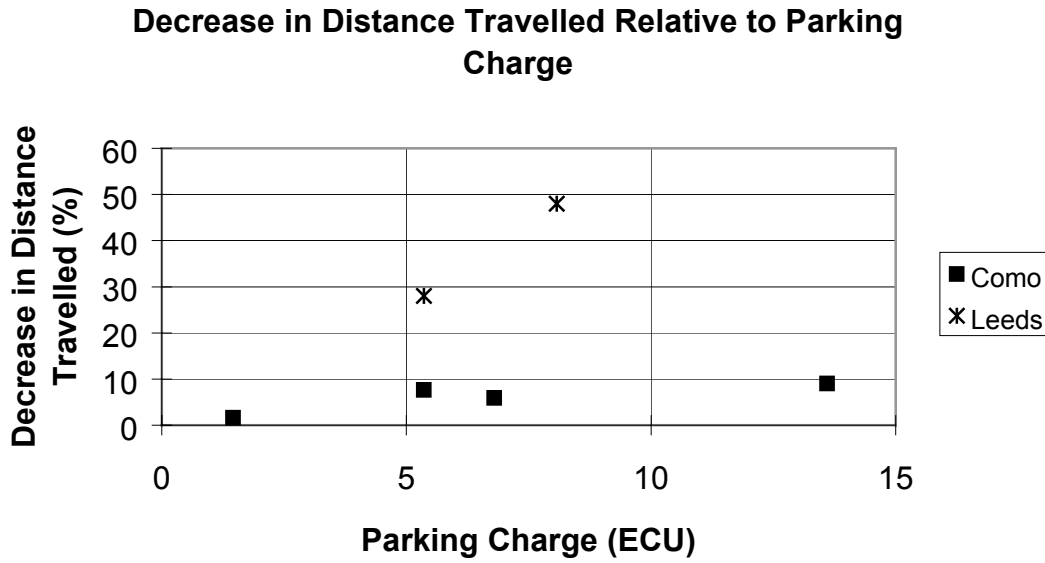


Figure 3.10 Decrease in Distance Travelled Relative to Parking Charge

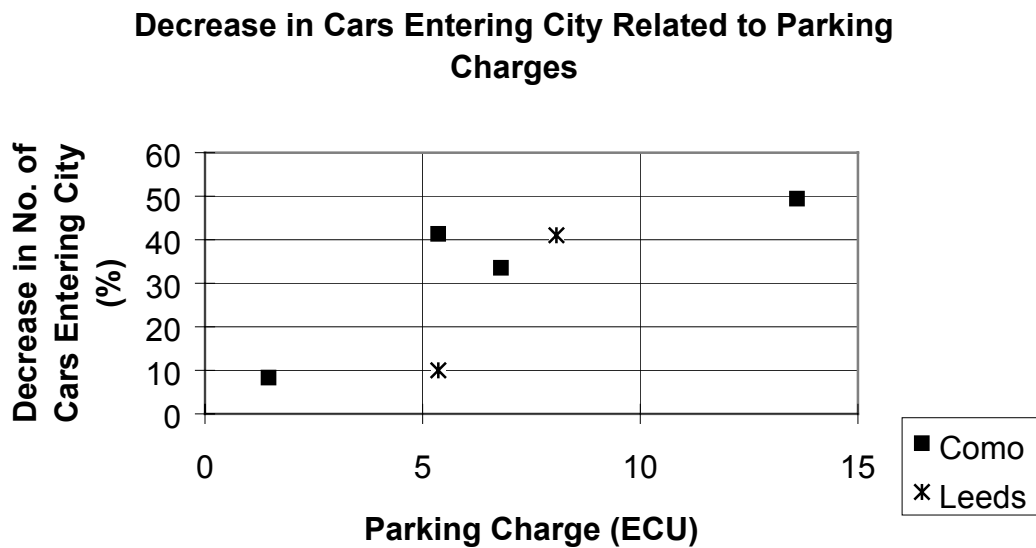


Figure 3.11 Decrease in Number of Cars Entering City Relative to Parking Charge

3.4 Pricing Elasticities Derived from Modelling

Elasticity values of for trips crossing cordons for Athens, Como, Graz, Leeds and Goteborg are shown in Table 3.11. These have been derived using the modelling results provided earlier. As price elasticity is % change in volume divided by % change in price, for each of the above cities we used the first scenario as a reference to calculate the % change in volume.

Table 3.11: Price Elasticity of Trips Crossing Cordon

City	Cordon Fee (EUR, PPP)	Elasticity	City	Cordon Fee (EUR, PPP)	Elasticity
Athens	1.83	-0.04	Leeds	0.66 (Outer)	-0.10
	2.75	-0.14		1.13 (Outer)	-0.17
Como	1.46	-0.11		1.57 (Inner)	-0.03
	2.19	-0.20		3.13 (Inner)	-0.05
	1.46 (Peak)	-0.24		5.48 (Inner)	-0.07
	2.19 (Peak)	-0.42		8.22 (Inner)	-0.08
Graz	3.08 (Peak)	-0.17	Goteborg	18.2	-0.04
	4.62 (Peak)	-0.25		24.4	-0.06

Peak: Peak Period only, Inner: Inner Cordon, Outer: Outer Cordon
PPP = Purchase Power Parity

3.5 Modelling Results by Site

The main conclusions from the modelling results for each site, are as follows:

- **Athens:** in Athens the main interest is to evaluate the impacts and potential benefits from alternative road use pricing schemes in the metropolitan area. Seven different scenarios have been considered, depending on the extent and type of road use pricing scheme and as to whether Park & Ride is included as a complementary measure. The modelling results show that distance based charging with Park & Ride achieve substantial reduction in total distance travelled and total travel time within the cordoned area, while providing significant revenues. A scenario involving two co-centric cordons (outer and inner), with morning peak-hour toll levels of 1 and 2 EUR respectively, produced the most reductions in inner area road traffic levels with associated operational and environmental benefits as well as significant revenues.
- **Madrid:** in Madrid the interest is 1) to model congestion costs for assessing the benefits of subsidy in public transport and of introducing new infrastructure to alleviate congestion problems, and 2) pricing the use of high-occupancy vehicle lanes by solo and two-occupant cars. The main finding of the this analysis in 1) is that total time delay due to congestion is some 37,482 hours per day. Most of this time is allocated during peak periods: morning (24,040 hours = 64%). Any subsidy to public transport and state investment in new infrastructure would need to be assessed against the benefits of reducing congestion. In 2), it was found that strategies that charge only 2-occupants for the use of the HOV lane produce 7.5-12% trip time savings for car users (and 5-7% for bus users), but adversely affects the users of conventional lanes. The results are almost balanced at corridor level resulting in small trip time reduction (3% with a low toll for 2-occupants and no reduction for a high toll). Strategies that charge solo-drivers only to use the HOV lane, do not seem to produce much changes in average HOV lane trip time (0%-

2%), nor do they in the conventional lanes (-2%). Again at corridor level total trip time spent remains almost constant (0% -1%). Strategies that charge both 2-occupants and solo-drivers (although with higher toll levels for solo-drivers) produce different effects. On the one hand, a scenario whereby 2 occupants are charged 0.10 EUR and solo-drivers 0.15 EUR for the use of the HOV lanes, produces a 2.7% increase in HOV lane trip time, a 2% decrease in conventional lanes, and a 2% increase at corridor level. On the other hand, a scenario whereby 2 occupants are charged 0.10 EUR and solo-drivers 0.25 EUR for the use of the HOV lanes, produces significant decreases in HOV lanes trip time (7%), and a slightly smaller trip time increases in conventional lanes (3%). At corridor level, a 3% decrease in average trip time spent is attained.

- **Como:** in Como simulation evaluated the impact on mode choice, change of destination and revenues of introducing parking pricing and cordon-, time- and distance-based pricing. For parking pricing four scenarios related to four different pricing structures were evaluated (*base*, *higher*, *decreasing* with respect to duration of stay, and *constant* with respect to duration of stay). For cordon-based pricing, six scenarios, differing by the toll value and as to whether tolling is time specific or not, were evaluated. For time-based and distance-based pricing, 5 and 6 scenarios, differing by the toll value, were respectively evaluated. The parking pricing results suggest that the scenario with the *higher* fare structure substantially reduces car usage in the pricing area (by approximately 40%), total car trips on the network (by approximately 6%), and congestion by 21%, when considering only the congested length of the network. The cordon pricing results show that the scenario with a fixed toll throughout the day maximises revenues for the peak hour, while reducing car travel the most (4%). The scenario whereby tolling is only applied to the peak period, is more effective in reducing network congestion than the scenario with fixed toll throughout the day by spreading the peak period, while increasing the share of non-car travel modes. With time- and distance-based pricing, the results indicate that total distance travelled, total time, emissions and fuel consumption decrease as the toll increases. For a moderate toll of 0.45 EUR/hr with time-based, a reduction of about 14% in total travel time, and a similar reduction in fuel consumption are expected. With a distance-based toll of 0.09 EUR/km, a reduction of about 8% in total travel time, and a reduction of about 11% in fuel consumption are estimated.
- **Leeds:** in Leeds 1) a ‘parking cordon’ around the city centre, which would charge all motorists accessing the central area as if they were spending time in a public car park or in a private non-residential car park, and 2) four road use charging systems have been assessed. In 1) simulation modelling has been utilised to assess the potential of the parking cordon on trip making. Amongst four different scenarios tested, the scenario whereby current parking charges are all increased by 50% with free Park & Ride (assumed to be subsidised by parking revenue) has been found to achieve the most benefits in terms of total distance travelled, with a reduction of about 7% compared to the base scenario. Time spent in delay in the centre of Leeds is reduced by more than three quarters with this scenario, trip making by car into the centre of Leeds is reduced by 41%, and current unpaid ‘private non-residential’ parking by a notable 56%. In 2), cordon-, distance- and time-based pricing systems were considered. With cordon-based, a reduction of about 10% is expected in total travel time in the whole of Leeds with a moderate charge of 0.63 EUR per crossing. Corresponding revenues is estimated to be 51 MEUR. With distance-based, for a charge rate of 0.21 EUR/km the reduction in total travel time is over 10%, and revenues are about 52.5 MEUR. With time-based, for a charge rate of 0.14 EUR/min,

the reduction in total travel time is over 12%, and revenues are about 57 MEUR.

- **York:** in York the objective of simulation modelling is to evaluate 1) the impact of increasing car parking charges in the city centre and Park & Ride fares on Park & Ride usage, and 2) the impact of road use pricing on network efficiency and mode of travel. The results of car parking and park-and-ride tariff increases indicate that the mode split of P&R is likely to increase by 45% and revenues by 78% if current car parking charges were increased by 50% and tariffs by about 18%. The results of road pricing are in line with current beliefs that substantial reductions in total travel time and delays can be achieved by charging the road use. Three pricing systems were considered: time-, delay- and distance-based. With time- and delay-based significant reductions in total travel time, distance travelled, delays, and fuel consumption are attained network wide; that is within and outside the charging area. With distance-based benefits are achieved generally within the charging area. Distance-based pricing does not bring about reductions in network performance indicators in the whole of York.
- **Helsinki:** in Helsinki, a series of toll points have been proposed, with a view to influencing travel choice in terms of mode and route, and trip distribution. Two options were considered in terms of the location of the toll points: 1) along the Helsinki Ring Road I and on all radials leading to the city centre and 2) around the city centre on all radials leading to the centre. The toll levels envisaged is according to vehicle type and time of day and is the same in both options: EUR 0.7 for private cars at all times, EUR 2.8 for Heavy Goods Vehicles during the peak and EUR 1.4 at other times. The results show that significant benefits in terms of network performance can be achieved; namely that total travel time can be reduced by nearly 8%, total distance travelled by about 9%, and car volume by 6%, whereby car trips are switched to public transport (5.4%), cycling or walking (0.6%).
- **Göteborg:** in Göteborg model based evaluation focused on the overall impacts of introducing 1) a road user cordon toll system surrounding the central area of the city, and 2) area pricing, together with improvements in the road and public transport systems. With the cordon toll system, three different scenarios were investigated corresponding to three different toll charges (SEK 10, SEK 15 and SEK 20). With area pricing, two scenarios were considered, depending on whether the charging area is confined to the city centre or the whole of Göteborg. The main results indicate that implementing a cordon toll system in Göteborg would substantially reduce the traffic volume in the Central City Area. With a toll fee of SEK 10 a reduction of nearly 15% is expected. With a toll of SEK 20 a reduction of 22% is possible. Total revenues are estimated to be between 533 to 821 million SEK per year. With area pricing, a 15 SEK charge within the central area of Göteborg results in a 20% reduction in the traffic volume in the Central City Area, and levies about 607 million SEK per year.
- **Graz:** in Graz modelling comprised investigating the influence of introducing a cordon toll surrounding the central part of Graz together with other complementary measures, such as provision of car parks just outside the toll cordon. For a test corresponding to a toll of EUR 1.1 during the off-peak period and twice that during the peak period, it has been found that the number of trips by car, in and out of the tolled area, is reduced by 17% as compared to the base scenario; the share of public transport increases by 35%.

European level for the implementation of transport pricing measures. In terms of cordon pricing (based on analysis for Athens, Como, Helsinki, Goteborg and Graz), these show that reductions of 5-20% in total distance travelled by private car are possible for cordon toll levels of between 1 and 3 EUR (after allowing for Purchase Power Parity - PPP - differentials between EU member states). In terms of the number of private cars entering inner urban areas, reductions of between 5% (Helsinki) and 40-50% (Como, Athens) can be expected, depending on toll levels (around the 1-3 EUR range) and city characteristics. It is evident that the higher the present level of congestion, the more the scope for road use pricing.

Regarding parking pricing measures, reductions in distance travelled by private car of 8-48% can be expected for a parking charge of 5-10 EUR (based on analysis for Leeds and Como).

4. Specification of Integrated Urban Transport Pricing Measures

The *Specification* phase within the *TransPrice* project relates mostly to the design of the demonstrations and the identification of the pricing scenarios for assessment, on the basis of the outputs from the *Review of Options and Issues*, the *Travel Behaviour Research* and the *Simulation Modelling*, thus providing the inputs for the *Demonstration* and the *Evaluation*.

The main objective was to specify the pricing scenarios and mechanisms to be tested in the demonstration phase and assessed in the evaluation phase, based on the analysis of previous experience, the travel behaviour research (stated preference analysis) and simulation modelling. The demonstrated measures are described in the next Chapter (Chapter 5).

Before considering the site-specific measures, it is important to examine the specification of pricing measures in general terms. This task is the scope of this chapter, under the following headings:

- road use and congestion pricing
- charge collection technology
- parking management and control
- public transport improvements and finance requirements
- intermodal integration
- land use/spatial impacts.

These general specifications of pricing measures are included in the subsequent sections of this chapter, in the above order.

4.1 Road use and congestion pricing

4.1.1 Background and Definitions

Road use pricing and congestion pricing are two terms that are used to describe a system of charging for the use of roads by vehicles at specific times and areas. Congestion pricing implies that charging is only applicable when there is congestion. The idea is that when severe traffic congestion occurs, or is likely to occur, a charge should be levied as a means of controlling traffic demand and thus alleviating congestion. In this respect, congestion pricing may be considered as a form of road use pricing, whereby the charge level and timing is dependent on the congestion level itself. However, a paradox exists in so far as if “congestion pricing” could work well in practice, the congestion would never be allowed to materialise in the first place and therefore there would not be a need for pricing. In an extreme case, those road users that could in principle afford to pay the charge (and could take the risk of being charged) would continue using their cars, forcing the less well off (that could not take the risk of being charged) to other modes of transport. As this could lead to no significant congestion level, the congestion charge will be zero thus resulting in no revenues. Although in such a scenario there would be willingness to pay, no charges will be levied. The allocation of road space will be the result of accepting the risk of being charged, rather than the willingness to pay.

For the above reasons, the term road use pricing is preferred here as a more general term, rather than congestion pricing.

A road use pricing system should be able to divert a proportion of road-based trips to other modes of transport (mainly Public Transport modes, but also Park & Ride), other time periods (from peak to off-peak) including peak spreading, other destinations (less congested areas), or indeed to suppress road-based travel demand altogether. The main impact of a road use pricing scheme is however expected to be that of modal split changes during the congested (peak) periods, through shifts from private car to public transport, Park & Ride and non-motorised modes. By diverting a proportion of the road traffic to other modes through road use pricing, alleviation of peak period congestion levels is expected, which should improve travel conditions for all transport modes.

A road use pricing system should result in significant revenues which should be enough to pay for the installation and operating costs of the system, and provide adequate funding for improvements of alternative modes of transport, particularly for those travellers that have been priced off the roads.

Road use pricing can have direct impacts on mode choice, time of day choice, destination choice, frequency of travel, vehicle occupancy, and in the longer-term indirect impacts on land use patterns.

A critical aspect of any road use pricing system is its public and political acceptability, which is a function of the fairness and efficiency of the system.

4.1.2 Types of Road Use Pricing

Road use pricing may be in several forms, viz:

- **Congestion pricing:** varying charge according to traffic conditions, area and time of day (in principle the higher the congestion the higher the charge).
- **Time-based pricing:** charge being proportional to the time spent travelling within a specified area.
- **Distance-based pricing:** charge is directly related to the distance travelled within a specified area.
- **Cordon pricing:** charges are applied at points crossing a cordon (usually around the city centre); charging could be one-way (eg for inbound traffic only) or two-way (with differential charge levels by direction).
- **Area pricing:** charging is applied to vehicles being in a specified area at specific periods of the day.
- **Combinations of the above.**

Most experts agree that in order for a road use pricing system to be acceptable to the user, the charge level must be clear before travel is undertaken. Congestion pricing and time-based road use pricing may result in a charge much higher than the expected level judged as acceptable by users. If severe congestion occurs, the user not only will suffer in terms of extensive delays but his road use charge will go up as well. It has been found that the willingness to pay a road use charge is dependent on some expected benefits in terms of journey time savings. In other words, road users may be willing to pay a price for using the roads, if they can notice an improved level

of service (ie the lower the congestion, the higher the journey time savings, the higher the willingness to pay, the higher the price). With congestion pricing and time-based pricing there is the inverse effect of charge level going up with journey time and this is most likely to lead to lack of acceptability from road users. These forms of pricing may also encourage speeding or dangerous driving. Congestion pricing and time-based pricing cannot be considered as fair and efficient instruments on the above grounds.

Distance-based pricing, cordon pricing and area pricing offer, however, easy and clearly understood bases for charging road users. In these cases, the exact charge level can be known (or can be easily calculated by the user) before the trips is made. Distance-based pricing however, may lead to users selecting the minimum distance route to minimise the charge and this may lead to additional congestion. The benefits of diverting some trips to other modes may be eroded or lost due to this additional congestion.

Cordon pricing is considered to be the most efficient form of road use pricing. The charges can be clearly identified by the user yet differential charging may be applied by time of day and direction of travel. Cordon pricing could be implemented by several cordons (eg central, inner and outer) and be extended to include screenlines (depending on city structure). The automatic debiting and electronic tolling technology already available makes cordon pricing technically viable (see Section 2.5).

Area pricing is easy to understand and can be implemented without sophisticated technology. However, it has to use a flat rate which is not related to the amount of travel. Therefore, no differentiation can be applied other than the hours of operation of the area pricing during the day. The latter could cause additional congestion around the particular time of change.

There are a number of issues involved in selecting a road use pricing system, viz:

- The cost of the system
- The ease of implementation
- The ability to apply differential charges by time of day, vehicle type, direction of travel, etc
- The ability to give incentives or privilege to users.

With regard to the latter, an obvious incentive (or privilege) is to charge a lower tariff (or no charge at all) for cars with high occupancy (say with 3 or 4 people in the car). This way acceptability of the system by High Occupancy Vehicle (HOV) users is secured from the outset.

4.1.3 Example of a Fair and Efficient Road Use Pricing System

Given the above considerations, a specification for a **fair** and **efficient** road use pricing system has been made in the ***TransPrice*** project, as follows:

Every car owner registered within an urban area affected by a road use pricing scheme gets an allocation of units adequate for car travel on (say) 10 working days per month or equivalent. Each car owners has then the following choices:

- Use all of the allocated car units and use public transport for the rest of the time (at normal fare levels).

- Use public transport and redeem the allocated units at the current rate (or use them to pay for public transport fares).
- Buy more units at standard rates and use the car all the time.

This way:

- Every car owner gets a “basic needs” allowance (for say half of the monthly travel needs by car).
- Every car owner has a choice between:
 - * 50% Car free of charge & 50% Public Transport at normal fares
 - * 100% Public Transport, at least 50% of which free (using the allocated units)
 - * 50% Car free of charge and 50% Car and pay charge.
- Acceptability increases.
- Public Transport gets part of the road pricing revenue automatically, by using road pricing revenue to compensate the operator for the additional public transport demand through the allocated car units.

Such a system may be considered as **fair**, given that all car owners will be given a minimum basic needs allowance and those that want to do so may buy more road space at standard prices. This system may also be considered as **efficient**, in so far as a proportion of car travellers will be given incentives to switch to public transport with associated decongestion benefits and it is expected that there will be adequate road pricing revenue generated to pay for the required additional public transport capacity.

Equivalent examples of similar systems exist in other fields of socio-economic activity such as:

- National health provision for all and optional private treatment for those that want to pay for it.
- State national insurance and optional private pensions schemes.
- Minimum paid annual leave and optional unpaid leave.
- Parking control and charges (eg maximum 2 hours free for shoppers, etc, and then escalating charges to avoid use of spaces by commuters).

A timing problem may occur, however, in terms of the “funding gap”. The road pricing revenue will not accrue until a later stage (and the first stream will most likely be required to cover system operating costs), whereas the extra funding for public transport will be required immediately following introduction of road use pricing in order to provide the necessary additional capacity. This funding gap can nevertheless be closed with loans raised against the expected revenue stream, or by private capital and the development of Public Private Partnerships (PPPs). The financial success of the system will depend on the public acceptability and willingness to pay which in turn depends on the expected and perceived **fairness** and **efficiency** of the system.

4.2 Charge collection technology

4.2.1 General

The purpose of this Section is to consider the generic specification of charge collection technology from the point of view of the user, towards enhancing acceptability of road use pricing and the potential for changing modal split from

private car to public transport (and/or Park & Ride). It is not within the scope of this Section (not within the scope of the **TransPrice** project), to develop technical specifications for road use charge equipment and integrated payment systems. This issue has been covered or is being covered in depth in the Transport Telematics Programme of the European Commission DG XIII (CARDME Concerted Action, Projects PAMELA, GAUDI, ADS, CASH, ADEPT, ADEPT II, CONCERT, ICARE, MOVEIT, VASCO, etc).

Technology for road use charging and toll collection should ensure:

- Anonymity and privacy for those that want it
- Very high enforcement level
- Ability to vary tariffs by time of day
- Interoperability and combined use with other electronic payment systems (eg national tolls, on-street and off-street parking charges, public transport fares, telephones and electronic purse applications)
- Possibilities for incentives, privileges and concessions.

The characteristics of a charge collection system should:

- Allow for combined road use and parking charges
- Include provisions for day visitors
- Facilitate reallocation of revenues (eg from Road User Charges to Public Transport revenue support)

The available systems for road use charging and toll collection comprises the following broad types:

- Conventional Toll Booth
- Supplementary Licence or “Vignette”
- Electronic Tag (Read-only or Read-and-Write)
- Automatic Debiting Transponder with Smartcard
- In-vehicle Meter.

Due to the practical problems with conventional toll booths in dense urban area road networks, this method is not considered generally appropriate for urban road pricing. The other four methods offer viable alternatives. The specification of each method is considered in turn below.

4.2.2 Supplementary Licences

Supplementary licences are stickers or “vignettes”, placed normally on the windscreen of the vehicle and could be of three main types:

- Entry permit
- Area permit for moving vehicles
- Area permit for all vehicles (moving and stationery).

Entry permits need a very high level of enforcement at the cordon (or screenline) locations. Vehicles travelling wholly within the cordon area are not charged. This could cause enforcement problems.

Area permits would apply to all moving vehicles in the charge area. This would have a more substantial effect than entry permits and improve enforcement conditions as all moving vehicles would be required to show the licence. Enforcement could therefore take place at any point of the road network within the charge area. However, enforcement may have difficulties if the permit is required only for moving vehicles (drivers may just park in anticipation of a road check). Enforcement is improved if the permit would apply to all vehicles, moving and stationary (on public roads). This could ensure that road use charging is combined with parking charging (ie the area permit could also cover on-street parking charges), thus increasing public acceptability. Conversely, the area licence could be presented to the public as a parking permit with charges levied not at the point of use. This will also have a positive side-effect of charging for Private Non-Residential (PNR) parking spaces (eg in Leeds 45% of city centre parking spaces are PNR).

Presenting the area licence as a parking charge is likely to increase acceptability and ensure that city centre PNR parking spaces are also charged. It is expected that a system of area licensing for all vehicles will induce modal shifts from private car to public transport.

The main disadvantage of supplementary licensing is that it is not possible to vary the charge by time of day. It is only possible to restrict the charge to specific hours during the day.

In terms of revenue allocation to public transport a paper-based licence does not provide any automatic transfer between modes. However, there maybe a simple way of achieving this: making the supplementary licence interchangeable with a public transport monthly (or other period) pass (as it has been proposed for Stockholm). In this way all revenues are directed to the public transport operator (or co-ordinating agency) who has to also bear the costs of issuing, distributing and operating the supplementary licences as with the monthly pass. This gives the choice to the users between the private car and public transport and make it easier to change mode, although it is not be possible to differentiate the relative charges between the two modes.

It is concluded therefore that the most appropriate supplementary licence system is area licensing for all vehicles moving or stationary within a certain charge area. The implementation cost of such system is very low but operating costs could be relatively high and enforcement may be difficult. Area licensing however provides a viable entry-level system for urban road pricing which is simple enough to be understood by the public, could allow for revenue allocation to public transport and can be integrated with parking charges (including charging for PNR parking spaces).

4.2.3 Electronic Tags

Electronic tags can be read-only or read-and-write. Read-only tags are the simplest form of an In-Vehicle Unit (IVU) and requires an account held centrally. Information is passed from the vehicle to the central account but not the other way round which means that no charge details can be transmitted to the user. Although read-only tags have widespread applications in road tolling, they are not considered suitable for urban road use pricing where the charge and account information to the user may be a key requirement, due to their inability to provide information to the user.

Read-and-write tags have a two-way link and therefore the IVU can display the charge and account details to the user. Read-and-write tags can allow both pre-payment and post-payment account and anonymity of the user can be ensured. Information about the last few transactions can be displayed through an LDC display. Read-and-write tags can meet the user requirements for urban road pricing, but there is a need for high security encryption of the transaction details.

4.2.4 Automatic Debiting Transponders with Smartcards

Transponders are basically two-way communication devices with additional data processing and storage capabilities. In most cases transponders have a smartcard interface. Smartcards incorporate an Integrated Circuit (IC) or chip which holds information that can be read and written. Smartcards can hold information on the last 10 transactions with more capacity becoming available. A smartcard-based system for urban road use pricing may use a smartcard already on the market, or an electronic purse system (eg VisaCash, Mondex smartcards). Smartcard systems can combine road use charging with parking charges and public transport fares (together with other small value transactions such as telephones) and can be also be used for other municipal uses such as libraries and leisure facilities. In this respect they provide an ideal payment medium from both the user requirements and the operator needs.

With the growth in smartcard applications for general electronic cash purposes, it is evident that any road use pricing system will greatly benefit in terms of user acceptability if it is combined with a smartcard electronic purse system. The ability to trade the stored value on the smartcard for road use charges, parking charges and public transport fares (plus other municipal uses) is a big advantage. Smartcards can also offer a lot of potential for privileges and incentives, differential charging by time period and accountability. Anonymity is fully ensured.

A key advantage of a smartcard transponder system is that all the transaction details are held on the IC and therefore are completely secure. This, however, needs more time per transaction and may pose an operational problem for high speed toll points. In terms of urban road use pricing, nevertheless it may not be an issue since charged vehicles will move at speeds of under 80 km/h.

4.2.5 In-Vehicle Meters

In-Vehicle Meters (IVM) record the travel characteristics of the vehicle and can be used for congestion-based, time-based or distance-based charging. An IVM-based system can offer simplicity as it does not necessarily require roadside communication equipment. The IVM needs however to be connected to the odometer of the vehicle from where the travel characteristics of average speed, time and distance can be obtained. Charging can be set as a function of:

- the average speed (ie congestion pricing: the lower the speed the higher the price),
- the journey time (time-based pricing)
- the journey distance (distance-based pricing).

For the reasons explained in Section 2.1.2, congestion pricing and time-based pricing are not preferred forms and therefore an IVM can only offer a viable possibility for

distance-based pricing. In order to introduce some kind of disincentive to using the car during hours of expected congestion, the distance-based charge can be varied by time of day and/or combined with a time-based charge (at a low rate in order to avoid the negative effects of time-based charging). The combination of distance-based and time-based charging (although weighted heavily by distance) would provide an easy to understand charging concept, similar to the familiar taxi meter. However, differentiation by area is not easy as it has to rely on visual inspection. An IVM system can be appropriate for a wide urban region and can be combined with a smartcard electronic purse application. The user can have real-time information on the charge rate and balance at any time through an LCD display.

Use of IVM for point-based or cordon-based charging has been proposed based on driver activation on entry of the restricted area and an external display for enforcement purposes. Such a system is not considered as adequate, since it may prove extremely difficult to monitor and enforce. Alternatively, an external display of an IVM can be combined with one-way communication to activate the charge once the vehicle enters the restricted area through roadside communication equipment. Such a system combined with a smartcard account will approximate all the features of an automatic debiting transponder, but it has not been tested in practice. Its advantage over a smartcard two-way transponder can only be in terms of cost but given the likely economies of scale with future mass production of automatic debiting transponders with smartcard electronic cash systems, IVM-based transponders may not prove a substantially cheaper option.

4.2.6 Conclusion

The specifications of the various types of charge collection technology indicated that:

- **Supplementary Licences** for Area Pricing provide a viable, entry-level system, but has limitations in terms of differentiation of charges by time of day. Its advantage is the low cost and ease of implementation.
- **Electronic Tags** have reached their limit and their capability has been exceeded by Automatic Debiting Transponders. Their main disadvantage is that although they require roadside communication equipment, they cannot offer an integrated payment medium.
- **Automatic Debiting Transponders with Smartcard** and electronic cash offer the best system for urban road use pricing, allowing for fully integrated payment for parking charges and public transport fares, revenue allocation between modes, information to the user, anonymity and security. The disadvantages are the higher cost and the higher transaction times.
- **In-Vehicle Meters** offering a combination of distance-based and time-based pricing (weighted heavily by distance and having differential charges by time of day) can provide a reasonably low cost automatic charging system, combined with smartcard and parking charges, but is not likely to offer cordon pricing capabilities at a competitive cost compared to automatic debiting transponders.

4.3 Parking Management and Control

4.3.1 Parking policies

Parking management and control in an urban area has different but also contradictory purposes. On one hand it aims to:

- Give access and parking service for car users at their destination points through supply of parking facilities.
- Promote use of parking facilities by several users, through pricing and regulation.

On the other hand it aims to:

- Restrict car traffic through limitation of access to an area
- Reduce the number of parking facilities in combination with pricing and regulation, and also promote Par & Ride services where available.

Policies of parking management have therefore to be integrated with policies of urban planning, as well as traffic and environment issues. Parking policies include:

- Providing guidelines and norms for supply of parking facilities in an area, related to the number of floor space, number of residents or employees;
- Setting prices for the use of parking space;
- Organising parking supervision and also parking service and information;
- Setting prices for parking fines.

Municipalities are responsible only for parking on public spaces, including on-street. That means that parking fees and control do not affect private car parks. Parking fees as a control instrument for an area can therefore be pointless if there is high degree of private parking (in the central business district of Stockholm, for example, 90% of the parking facilities are private). If car traffic has to be restricted, mostly for environmental reasons, it is not enough to only reduce number of public parking facilities or increase rising parking charges. The most effective way will be to implement an area license system with payment for each entry of a vehicle, combined with the parking charge (ie parking charges not at the point of use). Improvement of the public transport system, including Park & Ride, and of the walking and cycling network and facilities will also be needed. Given that Private Non-Residential (PNR) parking facilities are usually provided by employers as a benefit in kind to employees (thus encouraging commuting by car), PNR parking spaces could be taxed.

Charging principles for parking space

Charging of the use of parking space is set as a function of:

- Type of area, ie higher prices for more attractive areas like city centres, lower prices for residential areas;
- Type of vehicle, ie normally only cars are charged;
- Type of user, ie there are different fees for residents and visitors respectively;
- Time of day, ie there are different fees for daytime parking and night-time parking;
- Duration, ie there are different parking fees depending on the elapsed time of occupying a parking space.

Payment systems

Payment of parking fees can be made through:

- Entrance/exit control
- Parking meters or ticket machines;
- Smart cards, including possibilities to integrate payment for other types of service, eg for public transport.

Control

Parking violations are controlled by parking guards or by the police. The parking enforcement is normally organised by a special control office accountable to the local government. Strategies are set up for the enforcement in order to increase the probability to detect violations. On the other side, parking guards also have to be seen as a traffic service and help for car drivers. In some cases the parking guards work for a private company that has a concession by the Municipality.

Parking fines

Parking fines can be issues for:

- Parking within designated parking space without any or insufficient payment;
- Parking violation outside a designated parking space.

The fine can be 20-100 times higher than the hour-based parking fees and depends on the severity of the violation, eg on pedestrian crossings, blocking entrances and bus lanes. In some cases illegally parked vehicles are removed or clamped (sometimes by private contractors under an agreement with the police).

Information

It is important that the user is given full information on parking facilities and charging, on routes, occupancy and Park & Ride possibilities where applicable.

Money circulation

The parking fees go normally back to the municipal parking control authority or organisation. Parking fines in Sweden are collected by the National Police Department which then pays back a percentage of the fines to the controller. In Graz, revenue from parking charges is used to support public transport and cycling facilities.

4.4 Public Transport Improvements and Finance Requirements

The following issues and specifications have been based on the experience of two important urban public transport authorities in Europe (**TransPrice** project partners):

- CTM – Consorcio Transportes de Madrid (Madrid Transport Consortium)
- OASA - Athens Area Urban Transport Organisation.

Improvements in Public Transport that can lead to a modal switch can be seen in different ways, each one dealing with the different elements of Public Transport. In each case, some elements can have more importance than others, and therefore there is not a unique policy or scheme that can solve all Public Transport problems.

Those Public Transport improvements related directly with pricing can be classified into three main groups:

- Fare levels (also related with finance requirements).
- Fare integration and information.

- Payment technologies.

Each group deals with a specific aspect of pricing and can be described as follows.

4.4.1 Fare levels

Regarding fare levels, a common topic of discussion in recent years is: how much does the fare paid by the user cover the system costs? This question is not, unfortunately, so simple. First of all, it is necessary to separate operating costs from capital costs. Fare structures can be designed to cover either one or another or even both. In most cases, there is a fare level that assures a minimum level of public and political acceptance, but which does not cover costs. In this case there must be a scheme of identifying finance requirements and securing revenue support (or subsidies), that must be clear and stable through time.

One other related aspect is the extra revenues that can be obtained from other activities, which help to balance the costs, as in the following examples:

- Quantification to the Public Transport Operator of the benefits provided by the existence of Public Transport, not solely from the local authority budget but also from other sources benefiting directly or indirectly by the provision of public transport (employers, enterprises etc.)
- Financial contribution by bodies (such as school administrations, Universities, benefits providers, etc) offering reduced fares or free usage of Public Transport to specific groups of passengers.
- Increase in revenue through other sources such as advertisements, renting-out of spaces, joint development of stations, interchanges, etc.

4.4.2 Fare integration

There is extensive experience of fare integration and the resulting improvements in Public Transport use are well known. Multimodal, multitrip passes and tickets are some of the more used schemes, in which zone or distance based systems define ticket validity. Other aspects related to fare integration are easiness of payment (related to payment technologies), types of tickets targeted to main segments of demand (tourist passes, weekend passes, etc). In this case, revenue allocation between different operators is also an important issue.

Other issues of fare integration are related to fares corresponding to services apart from Public Transport itself. Park & Ride ticketing, in which there is a single fare paid for Public Transport and parking, is an example.

The following principles and measures are required for effective fare integration:

- Existence of an integrated urban transport body guaranteeing the redistribution of revenues among existing modes (eg allocation of proportion of road user or parking charges to Public Transport, or relating congestion costs to Public Transport subsidies), with the aim of providing a level of transport services specified by the central, regional or local government.

- Development by the Public Transport Operator of an improved sales and promotion policy by provision of special-price services. This could be achieved by promotion of yearly travel cards (already successfully applied for personnel of the Health and Welfare Ministry in Greece), in the public as well as the private sector. Provision of discounted travel cards could be included in salary packages in the future (eg in employer/trade union pay agreements)
- Linking operational budgets to current pricing policy and placing responsibility on the part of the operator management for adherence to those budgets, whereby any shortfalls will be documented and be carried over to the next budget.

4.4.3 Payment technologies

Payment methods are an important issue which can act as a deterrent to Public Transport use, particularly for non-regular users. The possibility of reducing the numbers of tickets needed to only one, as well as reducing payment operations, is linked to new technologies, that can involve the use of multimodal and multitrip tickets, smart cards, etc.

In relation to financial requirements the following are important:

- Separation between operating costs and capital costs (infrastructure and rolling stock).
- Establishment of agreement between operating companies, public authorities, etc. to finance some or all of the costs, in order to provide a stable background.
- Financing scheme for the whole system, with clear indication of financing flows, amounts provided by each organisation, etc.

4.5 Intermodal Integration

4.5.1 Introduction

A main aim of pricing policies is to improve urban traffic and environmental conditions by reducing car use in favour of more sustainable modes. This must bear in mind the quality of the transport alternative given to car, mainly public transport. Several EU reports, in particular the *Citizen's Network* paper and the Communication "Developing the Citizen's Network", highlight the importance of quality public transport alternatives to the car and the ultimate aim of the "seamless" journey, whereby no disruption points are perceived by the travellers.

Mobility in urban areas is becoming more and more complex: trips are longer and they include an increasing number of transfers from mode to mode. It is not sufficient to analyse the efficiency of each mode alone but to analyse in connection with other modes.

Within this framework, and in order to be able to compete with private car, the public transport system has to make the most of each of its elements: bus, underground Metro, suburban (commuter) railways. Every element has a different capacity to transport passengers and different level of economic, technical and space limitations. It is therefore important that each mode is used for the right function and that an

adequate integration is established between modes.

Private car is, not taking into account potential parking or congestion problems, the most flexible and door-to-door service. Public transport has its own limitations in this aspect but it can be improved so as to increase its flexibility, efficiency, comfort and coverage, in order to compete with private car. One of the major areas of improvement towards achieving flexibility is to develop a connected and integrated public transport system that functions as a single system not as three or four different and separate sub-systems.

One of the best quality indicators of a public transport system is its ability to combine all modes of transport, including the private car as an element in Park & Ride schemes.

This system integration can be achieved through three different lines of actions:

- *Administrative integration*: such as the creation of Single Transport Authorities that co-ordinate the public transport system planning and operations.
- *Fare integration*: through the establishment of multi-trip, multi-mode transport tickets such as the Madrid's Monthly Pass, Metro card in Leeds, the Carte Orange in Paris, etc.
- *Physic integration*: public transport interchanges as places where a quick, comfortable, reliable and safe transfer between modes can take place.

4.5.2 Nature of Relations

As far as the **TransPrice** demonstrations are concerned, several aspects have to be taken into account in terms of intermodal integration.

Firstly, there can be elements that may have a negative effect on a certain measure. For example, it is difficult to co-ordinate a Park & Ride policy implemented in a transport environment where parking in the suburbs and parking in the city centre are the responsibility of different authorities, thus losing any opportunity for synergies.

In the same area, any road use charging policy aimed at increasing the modal transfer from private car to public transport has to be done in a situation where high quality public transport, and especially transport intermodality is in existence. If not, it will be very difficult to achieve an increase in public transport demand due to its deficiencies in achieving a quick and cheap transfer between two modes.

Having in place a system of a fare integration for all public transport modes and operators will greatly help to implement a new smartcard-based integrated payment system.

The existence of a single transport authority that is in charge of the planning and management of all modes (including road traffic and the design of bus priority schemes) and operators, discussions and arrangements between operators and modes will greatly facilitate the intermodal integration.

4.5.3 Approach

As every pricing policy has as one of its objectives to look for a transfer from private car to more environmentally friendly modes, this approach should be common to all pricing options addressed in **TransPrice**. In the light of the above it is necessary to consider the following factors in assessing the nature of intermodal integration in *trans modal pricing*:

Physical integration

General

There must be an interchange system in the city, with interconnection and hierarchical distribution of functions between them; not just an addition of different interchange points. They have to make the most of every mode of transport in terms of capacity, speed, reliability and external effects.

Transport interchanges influencing pricing actions

The quality of the interchange has to be suitable in terms of transfer time, distances to be walked, number of stairs in the way, elevators to facilitate vertical movements, etc.

There must be adequate complementary systems such as information, signalling, illumination systems that help passengers to use the interchange safely and efficiently.

The existing ticketing systems have a key role to play and their number and technology must be so as not to produce bottlenecks, they must be able to cope with daily demand. In this sense, contactless and high-tech validating systems will greatly improve interchange efficiency.

The inclusion of other activities that enhance the attractiveness of the transport interchange such as commercial activities, security systems, cleanness of its elements, will greatly improve the image of the interchange .

Administrative structure of public transport system

General

The distribution of functions for public transport, road network and parking supply relating to infrastructure planning, management and fare policy definition must not be a barrier to the implementation of pricing policies and of intermodal integration measures.

In this sense, relations between different transport modes and operators, institutional arrangements between local, regional, national and supra-national administrations must help to integrate all transport modes at the interchange points.

The existence of a single transport authority, a single public transport authority, or a co-ordination body that is in charge of planning priorities, construction and operational procedures of intermodal interchanges will greatly facilitate intermodal integration.

Possible influences on pricing actions

Complementary institutional bodies could be involved in the implementation of integrated pricing. Potential conflicts of interest should be identified and minimised.

Fare integration

General

Existing fare structures will greatly influence the applicability of pricing policies. In fact, the existence of an integrated payment system that is valid for all public and private transport modes in the city will be a major advantage.

Another aspect that must be taken into account is the fare policy in the city: the existence of any subsidy to public transport, to what extent, and what is the level of coverage. They may influence in the design and public acceptability of pricing options.

Possible influences on pricing actions

Limitations and opportunities of the ticketing system and validation technologies may hinder or support the designed pricing action. Therefore, they must be carefully analysed before deciding which pricing options is selected, which paying technology is chosen and which time-table for the implementation is foreseen.

The possibility of synergies towards the defined objectives when applying a new pricing measure with a new fare integration actions must not be forgotten. When a new integrated fares system is implemented is also a good opportunity to implement an integrated pricing strategy. This parallel application of two different actions may include the need of clearly defined money circuits, for example the allocation of new revenues from pricing policy to subsidise the monthly pass. The institutional, legal, social, political, economic, and/or technical limitations of such parallel actions must be carefully identified well in advance of plans for implementation.

4.6 Land use / Spatial Impacts of Pricing Measures

Should the integrated *trans* modal *pricing* measures put forward in **TransPrice** prove successful in changing modal split and traffic operations in the urban areas under consideration, it is possible that economic and social conditions will be affected as manifested through land use changes. This is primarily due to the close relationship between transport and land use which together influence the distribution, scale and nature of economic and social activities in urban areas. Very little research has been carried out to assess land use impacts from the transport pricing measures, partly because of their innovative nature and the lack of time to gauge long term land use effects. The **TransPrice** project however recognises the importance of land use changes resulting from new transport pricing measures in urban areas, both in the short and long term, and therefore considers the likely impacts of the proposed *trans* modal *pricing* measures on land use in each of the cities under consideration in the comprehensive evaluation framework (see Chapter 7).

A common denominator concerning the integrated pricing measures is that they intend to reduce traffic congestion in specific areas of the city, most often the city centre, and that any direct land use impact is likely to be experienced in such areas. These land use impacts are discussed below.

Nature of Impacts

Positive impacts on land use resulting from the integrated pricing measures include the following:

- regeneration/promotion of tourist/cultural/recreational opportunities due to environmental improvements in the affected areas;
- restructuring of land uses in affected areas such as introduction of specialist economic activities (retail/commercial) which benefit from improved environmental conditions and/or changes in accessibility;
- reduction in development pressures in congested city/town centres relieving threats to infrastructure capacities;
- stimulation of economic activity in central areas due to improved access conditions for commuting (by improved public transport or Park & Ride).

Negative impacts may be manifested as:

- relocation of businesses away from town centres due to increased costs by car travel or perceived restrictions on accessibility, leading to decline in town centre activities, employment etc.;
- preference for residents to relocate away from inner city areas should new employment areas emerge in suburban locations;
- increased development pressures in non-affected areas (such as suburban or out of town locations) leading to environmental threats to urban fringe areas, diseconomies of scale through urban sprawl and eventual shifting of traffic congestion from central to suburban locations.

It will be seen that the nature of impacts will depend on the success of the measures in achieving not only transport objectives, but in responding to wider social, economic and planning goals for the city as a whole. For example, better access to city centres may stimulate further investment as city centres become more efficient, cost effective and desirable places to work (a positive impact). On the other hand, too restrictive or costly access to city centres, with inadequate trans modal supporting infrastructure and policies, may have the opposite effect and cause a decline in economic activities in the city centre. Equally important to note is that changes in land uses will ultimately affect future transport conditions in the city, leading either to a shift of traffic congestion to other areas or improving existing transport conditions vis a vis available capacities.

Planning Context of Impacts

In determining whether impacts are negative or positive, it is important to consider the whole urban area and the particular characteristics of the city in question as well as the overall land use and planning policies applied to that city. For example the generation of additional employment-related land uses in suburban locations (should the restriction of car travel in central locations discourage certain businesses to remain or expand in city centres) could, in particular circumstances, be regarded as a positive development.

This is in evidence in several north American cities where down town locations assume a specialist function, with suburban areas playing a more pronounced social and economic role than many European cities. Indeed land use policies here complement

transport policies in allowing and encouraging a dispersed land use pattern throughout the city.

In the European context, such decentralisation of cities may also be considered acceptable where environmental, land use, transport and utility infrastructure conditions permit. On the other hand, cities ringed by green belts or other sensitive environmental areas, or where the nature of road and utility infrastructure provision does not allow sustainable urban growth to take place, decentralised development would be inappropriate. Current planning research in Europe tends to favour more nucleated forms of urban expansion as these allow more sustainable urban growth.

Distribution of Impacts

Direct impacts can be anticipated in those areas where improvements in traffic conditions are sought (the targeted areas), mostly the city centres but also along major transport corridors. Improved traffic flows, better environmental conditions and changes in travel mode can be expected to favour certain land uses whilst discouraging other types of activities which may consider alternative locations in the urban area more appropriate.

A second category of impacts can be expected in those areas outside the zones where transport measures are targeted (peripheral areas). Such areas could attract certain land use activities wishing to relocate from the targeted areas. New strategic nodal locations may also emerge in peripheral areas as a result of new public transport infrastructure (Park & Ride facilities, transport interchange facilities etc) around which development may be further attracted.

Important in both aspects will be the impact that the proposals have on land prices in both targeted and peripheral areas. These will be a major determinant in attracting or alienating land use activities within the certain areas of the city under the new transport conditions. Complementary incentive schemes conducted by city authorities accompanying the transport improvements (such as rent subsidies, environmental improvements etc) also have an important part to play in the future land use changes.

Timing of Impacts

The impacts on land uses are likely to occur at different time horizons (ie short, medium or long term). This will depend in part on the land use policies applied in the whole of the city, the presence of Government incentives or support policies for housing and businesses, and the nature of land uses in areas directly affected by the new transport measures. Also of importance will be the timing and availability of land and infrastructure support for alternative development areas outside the subject areas (such as business parks and low cost housing on green-field sites) which can make the urban environment more dynamic in facilitating land use changes.

Development Control

Equally important is the nature of development control measures which are applicable to the urban area. Irrespective of potential land use trends to emerge from the influence of *trans* modal transport *pricing* policies, the extent, nature and location of land use changes will ultimately depend on the type of land use controls applied and enforced in and around the urban area. These in turn should reflect the strategic planning policies

applied to the city. For example, particularly stringent land use controls can exclude all development in certain areas designated as conservation or green belt (for example on the periphery of cities), whereas building density controls can influence the degree and location of building intensification allowed.

Assessment of Impacts

Key questions in addressing land use impacts include the following:

- What is the anticipated scale and nature of land use impacts likely to be in the targeted areas?
- Would any change in land use be at intra-urban or inter-regional level? (ie is there a risk that certain land uses would relocate outside the city or region?)
- Do anticipated land use changes adhere to strategic planning policies of the city?
- Are anticipated land use changes positive or negative to the development of the targeted areas and the overall development of the city?

Approach

In the light of the above, it is necessary to consider the following factors in assessing the nature of land use impacts from *trans* modal integrated *pricing*:

- the land use context of the city
- land use structure of targeted areas
- the function of the targeted areas in the city
- relevant broad planning policies applied to the city
- the propensity for future land use changes in the city
- the spatial boundaries where transport measures will impact (ie whether they apply to a limited area or form part of a city-wide policy of transport improvements)
- identification of possible conflicts between the transport pricing measures and other policies (as related to economic development, planning policies, etc).

It is also appropriate to consider probable impacts from development trends recognised to have occurred as a result of other (non-transport pricing) influences. These include the decentralisation of land uses away from city centres, partly due to increasing road traffic congestion and high land values in such areas. The land use and spatial impacts of integrated transport pricing policies and measures can contribute towards redressing the balance between the prevailing property values and traffic congestion levels over urban space (eg city centres Vs suburban centres). In this sense, *trans* modal integrated urban transport *pricing* can be an instrument of land use spatial urban planning.

5. Demonstration of Pricing Measures and Integrated Payment Systems

5.1 General

One of the objectives of the *TransPrice* project was to carry out demonstrations of *trans* modal *pricing* measures and integrated payment systems (including road use charging and integrated payment/automatic debiting systems for parking, public transport, Park & Ride) in selected European cities and examine effects on modal split, traffic operation, environment, land use and public and political acceptability. The demonstrations that were defined by the relevant urban authorities were either experiments with limited sample of users or real-life applications involving the general public. The demonstrations took place in five cities as summarised below:

- Athens: road use pricing with park & ride and integrated payment, and (re)introduction of monthly pass for all public transport modes
- Como: automatic access control for residents and time-based parking pricing for visitors in a tourist area
- Madrid: park & ride with integrated ticketing, and tariff integration by monthly pass for all public transport modes (10 years ex-post assessment)
- Leeds: multi-service smartcard pilot application for parking and public transport
- York: changes to central car park and park & ride tariffs, introduction of multi-use smartcards, and generalised cost changes through bus priorities.

The purpose of the demonstrations were to gauge potential user response to the measures considered and where applicable draw conclusions through evaluation of the demonstration results. The results of the demonstrations are given in this Chapter. The results of the public acceptability are given in Chapter 6 and the multi-criteria evaluation results are given in Chapter 7.

5.2 Athens

5.2.1 Background

The Athens conurbation consists of about 80 Municipalities and communes, including the city of Athens and the port city of Piraeus. The old limits of the “Capital Region” or “Athens Basin” (area of 433 sq km), have long been exceeded by spreading development and most of the Attica Region (total area of 2900 sq km, subdivided into four Prefectures) is now urban or suburban. Athens is a city with a population of 3.3 million inhabitants (metropolitan area), tending to stabilise around the current levels but also to redistribute among the various parts of the city (Municipalities). Its public transport system consists of a 26-km-long metro line, diesel buses, electrically powered “trolley” buses, and a very limited suburban-rail service. The Greater Athens area is characterised by chronic air pollution (photo-chemical smog), the worst in Europe.

In the city centre, covering a large part of the Municipality of Athens, a system of traffic restraint (known as the “Daktylios” or Ring) has been operated since 1982. The scheme allows access within a cordon covering the historical and commercial centre for any private car on alternate working days, by odd-even last digit of the number plate. Traffic growth, increased double-car ownership, induced car use on allowed days, exemptions, some violations, and increased use of taxis (unofficially shared) and motorcycles are some well-established facts and developments of the past fifteen years, and are believed to amount to a severe reduction of the effectiveness of the Daktylios regarding city-centre car traffic.

In a way, the Daktylios scheme could be considered as a form of road pricing, although a lumpy one: those that can afford a second car may overcome the alternate day traffic restrictions by purchasing another car with the relevant number plate so that they can drive every day. In this respect, the Daktylios scheme has the same impact as any road pricing scheme: where there is willingness to pay, the user can continue to drive whereas other users that are not prepared to pay extra (in this case for a second car, in the case of road pricing the charge), have to shift to other modes of transport, destination, time of day, etc. However, the Daktylios scheme is not efficient as a pricing measure as the lumpy price for a second car is not at all related to the marginal costs (on the contrary, once a second car is purchased it will be used for additional trips) and the scheme does not result in any revenues to the public authorities.

The Daktylios scheme may have been reasonably effective in reducing traffic congestion in the early years of its operation, but as car ownership and use in Athens has more than doubled in the past 15 years, the effectiveness of the Daktylios scheme has been exhausted and cannot be extended (other than by restricting all traffic by more drastic measures such as access control). Given the lack of efficiency and effectiveness of the Daktylios scheme, the use of pricing options has been discussed as a potentially efficient and effective option, worth testing as a possible alternative to the existing alternate day traffic restrictions.

5.2.2 Purpose and Definition of the Athens Demonstration

The objectives of the Athens demonstration were to:

- Demonstrate how a road use charging system could work in practice
- Gauge user response to road use charging by monitoring
- Examine travel behaviour and analyse mode choice based on revealed preferences
- Investigate choice characteristics and elasticities regarding alternative fee levels and structures
- Examine the acceptability of road use charging by members of the public and decision makers
- Analyse the effects of the (re)introduction of a monthly pass (travelcard) for all public transport modes.

The **TransPrice** Athens demonstration consisted of two activities: main and secondary.

The **main** activity examined a possible scenario for introduction of road use charging.

It involves a field trial of a road use charging system with two waves of 50 selected users each. These users are current car users who commute to central Athens from northern Athens suburbs. The users are presented, for the field trial, with a choice between:

- Driving to central Athens in their car, as before, but having to pay a charge for crossing a road-use charge "cordon" corresponding to the *Daktylios* traffic restriction ring.
- Using a P&R service at the *Irini* station of the existing metro line, at the Olympic Stadium area.

Payment of the price for crossing the "cordon" was made using a vignette-based ("pay-and-display") system. The vignette corresponded to a daily licence for entering central Athens by car. Information on participants' daily travel choices was obtained through use of specially designed travel diaries, as well as daily monitoring of P&R usage.

The **secondary** activity concerned the reintroduction by OASA of integrated payment on the public transport system of Athens. From January 1998, public transport users have the option of using a multi-modal travelcard, valid on all modes serving the Greater Athens area, i.e. metro and all buses. Until that time, the travelcard did not cover the metro service. The old travelcard (bus-only) is still in use alongside the new one (all-modes). This activity monitored the usage of the new travelcard, based on data collected by OASA during the first half of 1998. Evaluation of these results by OASA led, in August 1998, to a readjustment of the travelcard to single-fare price ratio.

The Athens demonstration corresponds closely to the emerging policy orientations regarding transport pricing in Athens. Project partner OASA, who are responsible for public transport planning and operation in the Athens area, published a consultative "Green Paper" on Urban Transport in 1998, which includes a dedicated section on the proposal for funding public transport through charging of the use of private cars. Moreover, recent pricing policy decisions by OASA were based on the monitoring of travelcard usage, carried out for the secondary demo action. Thus a vital link is provided between European research and formulation of local-level policy options.

5.2.3 Road Pricing and Park & Ride with Integrated Payment

i) Demonstration Design

The duration of the demonstration was during June 1998 and July 1998 (two months). During this time, two waves of the field trial were carried out, involving 50 users each. The users had a mode choice between (1) car and (2) P&R.

Users were given an initial budget of 15,000 DRA / 43 EUR for the first wave (June) and 20,000 DRA / 57 EUR ¹ for the second wave (July). Choice of the car on a given day corresponded to purchase of a daily licence for entering central Athens. This daily licence cost 500 DRA / 1.43 EUR for the first wave, and 750 DRA / 2.14 EUR for the

¹ All prices are converted from drachma (DRA) to EUR using the approximate rate of 350:1.

second wave. Using P&R involved a reduction of 100 DRA / 0.29 EUR (in both waves) from the users' budget. At the end of the experiment, users were paid an amount equal to what was left in their budgets after the two waves. For the second wave only, public transport passes valid for all modes were given to the users.

Participants in the field trial had to fulfil the following requirements:

- Workplace in central Athens, preferably within the restricted-traffic cordon (Daktylios) and at convenient walking distances from downtown metro stations
- Home / trip origin in the northern suburbs
- Availability of a car
- Usage of car for the work trip, at least on the days when allowed to enter the restricted area.

Figure 5.1 shows the pay-and-display vignette (corresponding to the daily road use charge)



Figure 5.1: The Athens Pay & Display Vignette

ii) Results

Table 5.1 shows overall results concerning modal choice for the home-to-work trip, for the full sample and both waves.

Table 5.1 Overall Modal Choice (Both Waves)

Percentage of participants using:	car all the time	25%
	park-&-ride (P&R) all the time	21%
	public transport (PT) all the time	4%
	more than one mode	50%
Percentage of participants that never used:	car	29%
	P&R	29%
	PT	79%
Percentage of total trips made by:	car	40%
	P&R	48%
	PT	11%
	other modes	1%

The data refers to all working days in June and July 1998, regardless of whether the driver was allowed to enter the *Daktylios* or not. It can be justifiably argued that, on days when drivers are not allowed to enter central Athens, their choice is constrained. Indeed, a significant number of current car users *already* (i.e. in the current situation of no road use charges) commute by PT, P&R, taxi or other modes on those days. Therefore, it is worth examining separately the choices made by drivers on days when they had a “real” (non-constrained) choice, i.e. on days when they were allowed to drive to the centre.

It is noted that the percentage of participants’ cars with number plates ending in an odd-number digit was 56%, and that the demo period (1 June to 31 July) included 23 odd dates and 21 even ones (Monday 8 June was a holiday). Therefore, the percentage of “allowed” days was 58%. On those “allowed” days (non-constrained choices), the estimated percentage of total trips is presented in Table 5.2

Table 5.2: Estimated Modal Split For Non-Constrained Choices

Estimated percentage of trips made by:	Car	69.0%
	P&R	25.0%
	PT	5.5%
	other modes	0.5%

The results shown in Table 5.2 represent an approximation of the “true” modal shift from car to other modes, especially public transport, resulting from the demo action (road use charge plus P&R). It is interesting to note that, according to the modelling results:

- Diversion from car to PT would be approximately 5% if a central cordon road use charge of 620 DRA (without P&R) were to be applied.
- Diversion from car to PT / P&R would be in the order of 20% to 30% if more sophisticated road use charge systems, in combination with P&R, were to be

applied.

Therefore, even keeping in mind the differences between the modelled and demonstrated conditions, it appears that the two sets of results are compatible regarding modal split changes.

iii) Discussion

The main activity of the Athens demonstration served to demonstrate how a real road use charging system would work in practice. The cost of producing pay-and-display stickers as supplementary area licences (functioning as daily, weekly, monthly or even annual passes for entering the centre of Athens) is expected to be considerably lower than the cost of preparing and installing a reliable electronic tollpoint cordon. Moreover, the technological performance of a large-scale electronic system is still to be proven. Finally, a system of area licences would be an extension of already operating measures: pay-and-display licence is used for the annual car tax payment, and enforcement of such a measure would not require much beyond the current enforcement (in terms of method and police force employed). Thus, acceptability of an area licensing system might be higher than that of a sophisticated electronic system (considering that the latter could also raise concerns about violation of privacy etc.), at least as a first-step application (entry system).

The percentage of road users that would shift to P&R, if the latter measure was to be introduced in combination with road use charging, is in the order of 25%, with a further 5.5% shifting to public transport and 0.5% to other modes (mainly taxi). These percentages correspond to the totality of the demonstration and are estimated by taking into account only non-constrained mode choices - that is, considering only the days when participants were allowed to drive into central Athens.

A more detailed analysis, taking into account the variation of travel characteristics between the two waves of the demonstration, reveals that the share of car trips (as a percentage of the sum of car and P&R trips) would fall by 6.8% if the average cost difference between car and P&R were to be increased by 34.8%². This corresponds to a "price elasticity" estimate of approximately -0.195 (= -6.8 / 34.8).

By applying the estimated elasticity (bearing in mind the limited data available), and assuming that it holds for the whole range of prices, it would follow that the share of car usage would drop (for our sample) by approximately 15% compared to its current value, if a package of road use charging (at 500 DRA / 1.43 EUR) plus P&R (at 100 DRA / 0.29 EUR) were to be applied³.

²In the first wave, the difference in cost between car and P&R is 1606 - 544 = 1062 DRA / 3.03 EUR. In the second wave, the difference is increased to 1923 - 491 = 1432 DRA / 4.09 EUR.

³The current cost difference between car and P&R is 162 DRA / 0.46 EUR, i.e. 85% less than the base case (first wave), which was 1062 DRA / 3.03 EUR. If 85% is multiplied by the elasticity of -0.195 it means that the current share of car use represents an estimated 17% increase compared to the base case (first wave). Conversely, it means that the first wave would bring about a drop in the share car use of $[100 - 100 \cdot (100/117)]\% = [100 - 85]\% = 15\%$.

It must be stressed that these elasticities are calculated from a relatively small sample of trips.

iv) Conclusions

The above results represent approximations as to the percentage of car trips that would be diverted to P&R if the demonstrated measures were to be applied. The order of these diversion percentages (15% to 25% from car to P&R and 5% to public transport, for central cordon charges around 1.5 to 2.2 EUR) is compatible with the findings of the modelling results reported in Chapter 3.

5.2.4 Reintroduction of the All Public Transport Modes Travel Card

i) General Information

The reintroduction of a travelcard valid for all public transport modes (bus, trolley bus and Metro) became effective in January 1998. Prior to that date, the bus-only travelcard used to cost 5000 DRA / 14.3 EUR. The new prices were: 6000 DRA / 17.1 EUR (bus-only) and 8000 DRA / 22.9 EUR (all-modes). The single fare level was kept at 100 DRA / 0.29 EUR.

It is noted that, in July 1997, there had been a previous price increase. The single fare had changed from 75 DRA / 0.21 EUR to 100 DRA / 0.29 EUR, and the bus-only travelcard from 3750 DRA / 10.7 EUR to 5000 DRA / 14.3 EUR.

In addition, in August 1998 there was a new development worth monitoring. Namely, the single fare rose from 100 DRA / 0.29 EUR to 120 DRA / 0.34 EUR, whereas the bus-only travelcard price was restored from 6000 DRA / 17.1 EUR to 5000 DRA / 14.3 EUR. The all-modes travelcard price was kept at 8000 DRA / 22.9 EUR.

ii) Results

The changes in single-fare and travelcard prices are summarised in Table 5.3. It can be seen that the ratio of travelcard to single-fare prices was significantly raised as a result of the January 1998 increase.

Table 5.3 Changes in Single Fare and Travel Card Prices

Time	Single fare	Bus-only travelcard	All Public Transport modes travelcard
Before July 1997	75 DRA	3750 DRA (50:1)	-
July - December 1997	100 DRA	5000 DRA (50:1)	-
January - August 1998	100 DRA	6000 DRA (60:1)	8000 DRA (80:1)
August 1998 -	120 DRA	5000 DRA (42:1)	8000 DRA (67:1)

1 EUR = 325 DRA (July 1999)

Figures 5.2 and 5.3 show the evolution of ticket validations and travelcard sales, respectively Figure 5.4 shows the change in travelcard sales and Figure 5.5 shows that share of the All-modes travelcard on total travelcard sales.

Figure 5.2: Change in Ticket Validation

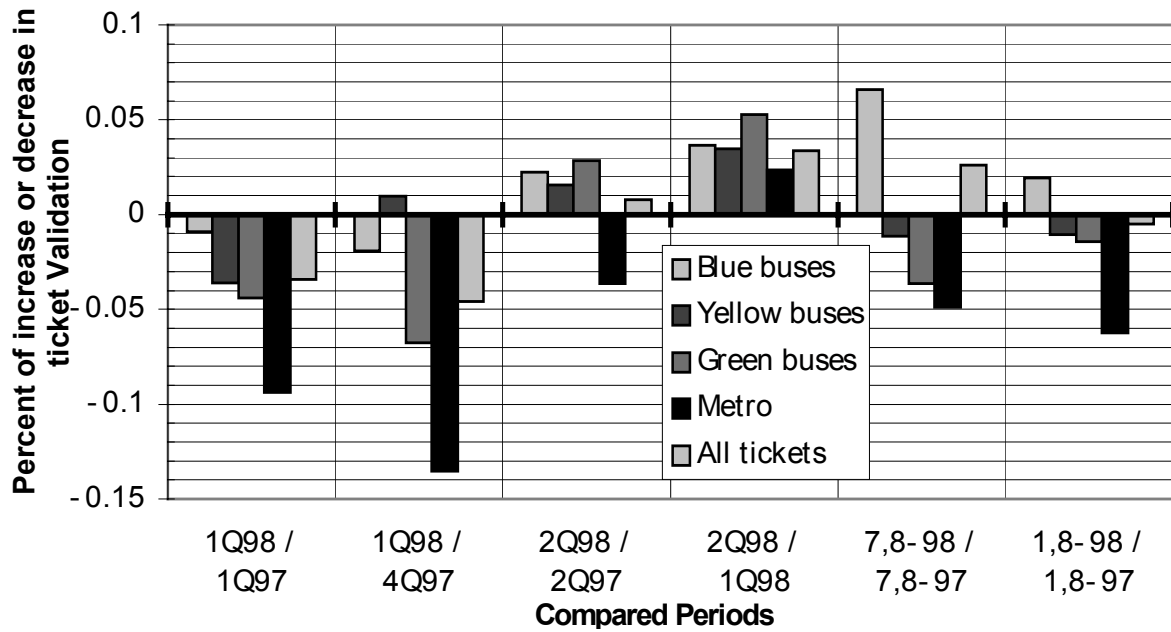


Figure 5.3: Total Travelcard Sales

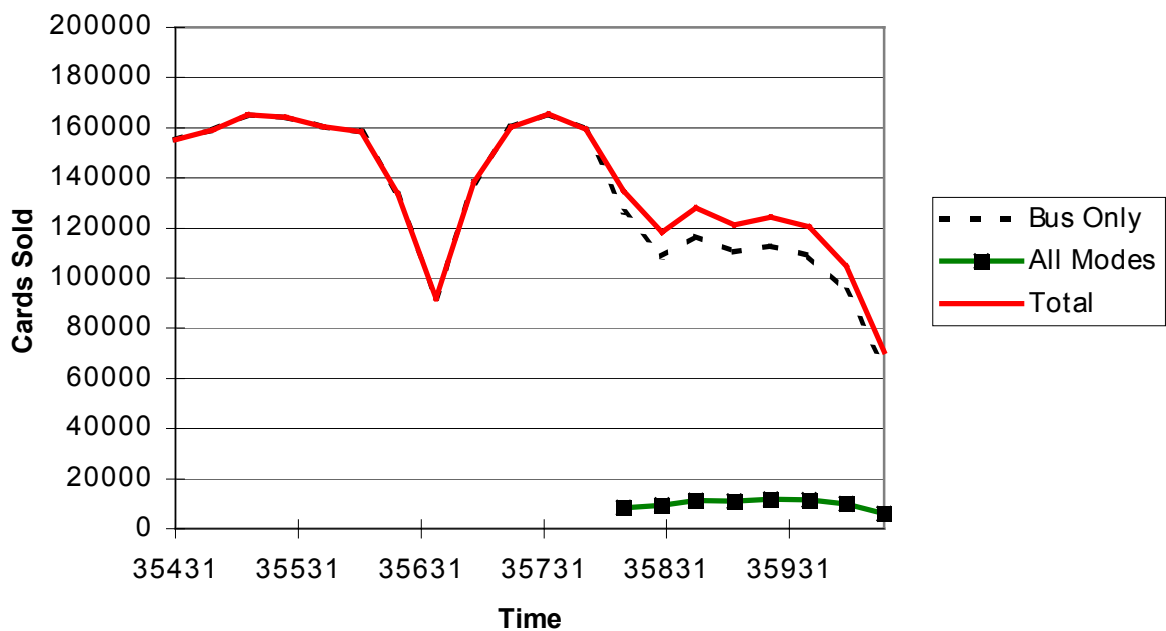


Figure 5.4:

Change in Travelcard Sales

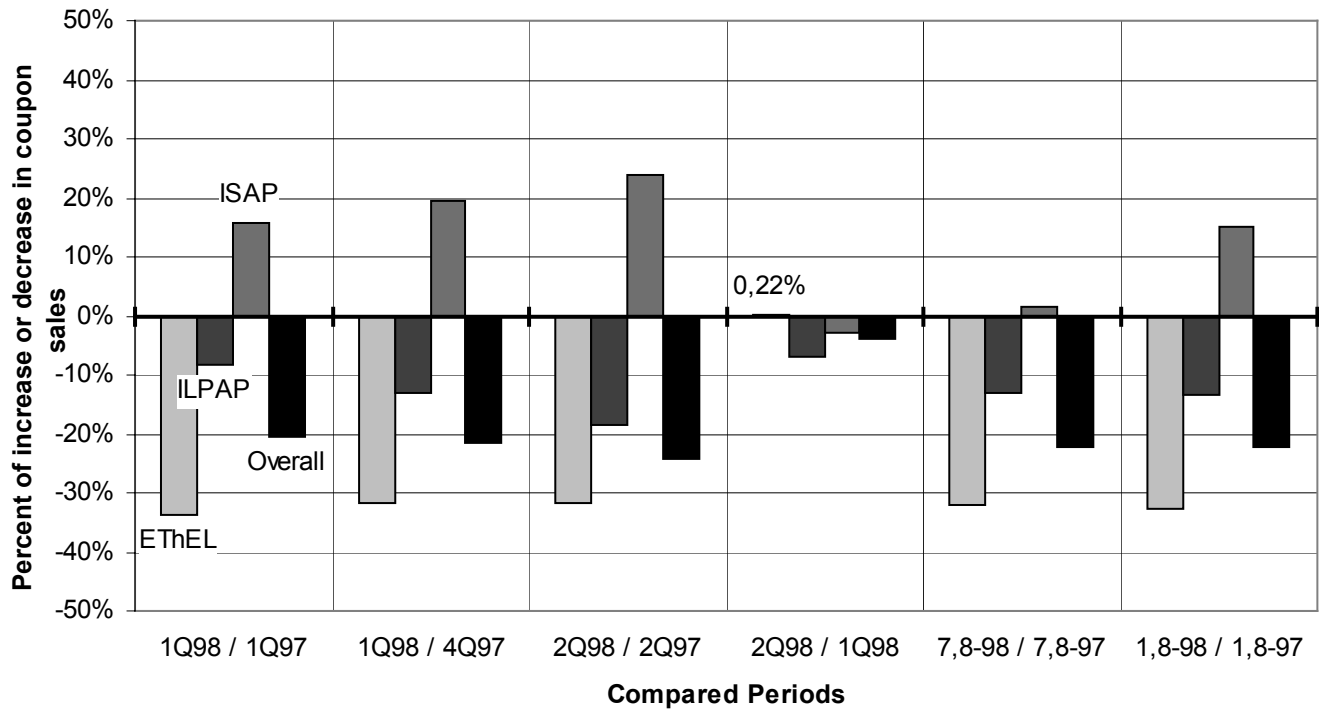
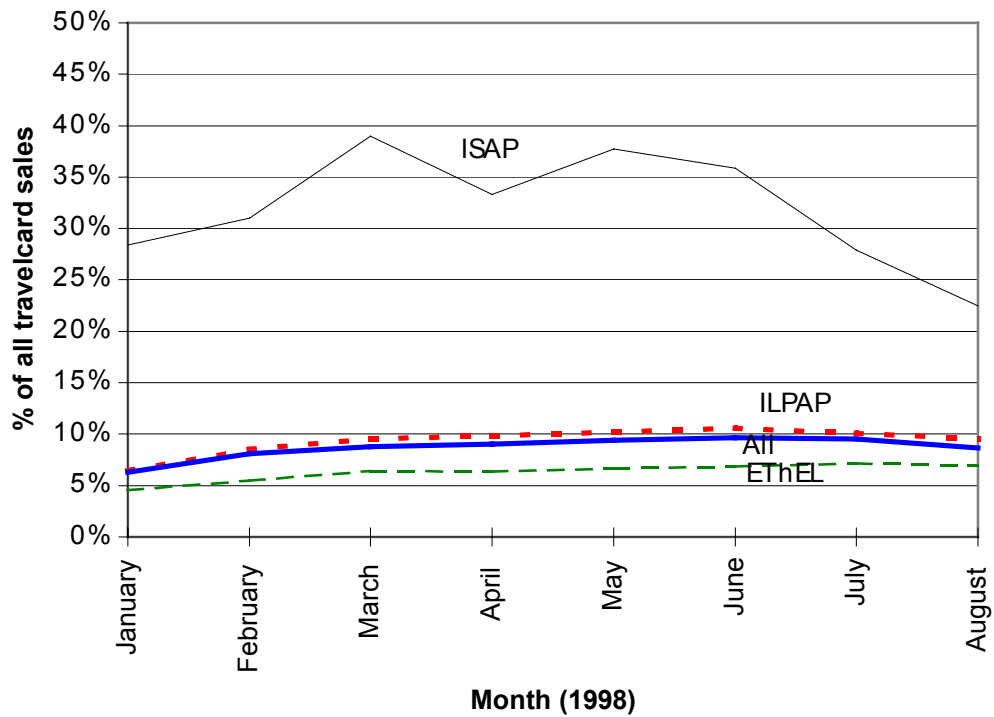


Figure 5.5: Share of new travelcard



iii) Discussion

The introduction of the all-modes (old) travelcard, and the increase in the price of the bus-only (new) travelcard, brought about the following shifts:

- About 10% of metro users (including a portion of old travelcard users) shifted to the new travelcard.
- A significant proportion of old travelcard users (approximately 20%) shifted to plain tickets, as the ratio of travelcard to single-fare prices rose from 50:1 to 60:1.

iv) Conclusions

The analysis of the data points to the following conclusions:

- The new travelcard (all-modes) appears to have found a niche among metro users, in particular longer-distance commuters.
- The old travelcard has an apparent price elasticity of approximately -1.0 (20% reduction in sales after a 20% price increase).

These conclusions have led OASA to introduce new changes in the fare structure since mid August 1998. Initially, only an increase of 20% in the single fare was envisaged, as part of the overall strategy to gradually bring fares to a more realistic level. However, the drop in the sales of the old (bus-only) travelcard has led OASA to reduce the price of the bus-only travelcard by 17% to the previous level of 5000 Drachmas (instead of 6000). The price of the all public transport modes travelcard was retained at 8000. The adopted pricing strategy is presented in Table 5.3.

Thus, the ratio of the old-travelcard to single-fare prices is restored to levels applicable until the early 1990's. OASA continues to monitor ticket validations and travelcard sales.

The results of the monitoring of ticket and travelcard sales over the period of the changes indicate that the effect of the action concerned primarily those already using public transport, causing a redistribution among ticket types and did not bring about any measurable change in modal split as a result of the price changes.

5.3 Como

5.3.1 Background

Como is situated beside the lake of the same name, in the Lombardy Region (Northern Italy). With a population of 84,000 (1996), it is the sixth largest city in Lombardy. The surrounding topography constrains the urban mobility system, and this, together with the high rate of car ownership (676 per 1000 inhabitants) and the large number of commuters (about 35900 at 1991 census), results in severe traffic congestion. The situation is worsened at weekends and during the tourist season, due to insufficient parking spaces being available.

The **TransPrice** demonstration deals with a specific tourist area near the lake (the *Villa Geno* promenade). The objective of the demonstration is to produce a compromise between reducing the vehicle entries into the area and allowing the access to "authorised" people. The authorisations would be ruled by an access control

system, the entries reduction will be ensured by a pricing policy. The Como demonstration involved real users (citizens of Como and tourists), paying real money for parking in the selected area.

5.3.2 Description of the Demonstration

The location of the Villa Geno promenade within the municipal territory of Como is shown in Figure 5.6 and is composed of a cul-de-sac avenue beside the lakeshore, backed by characteristic narrow streets. In this area there are many restaurants and tourist attractions. During the tourist season parking demand exceeds supply, causing a waste of time in searching for unavailable parking places and creating negative environmental effects on a beautiful promenade. The Villa Geno area is shown in detail in Figure 5.7.

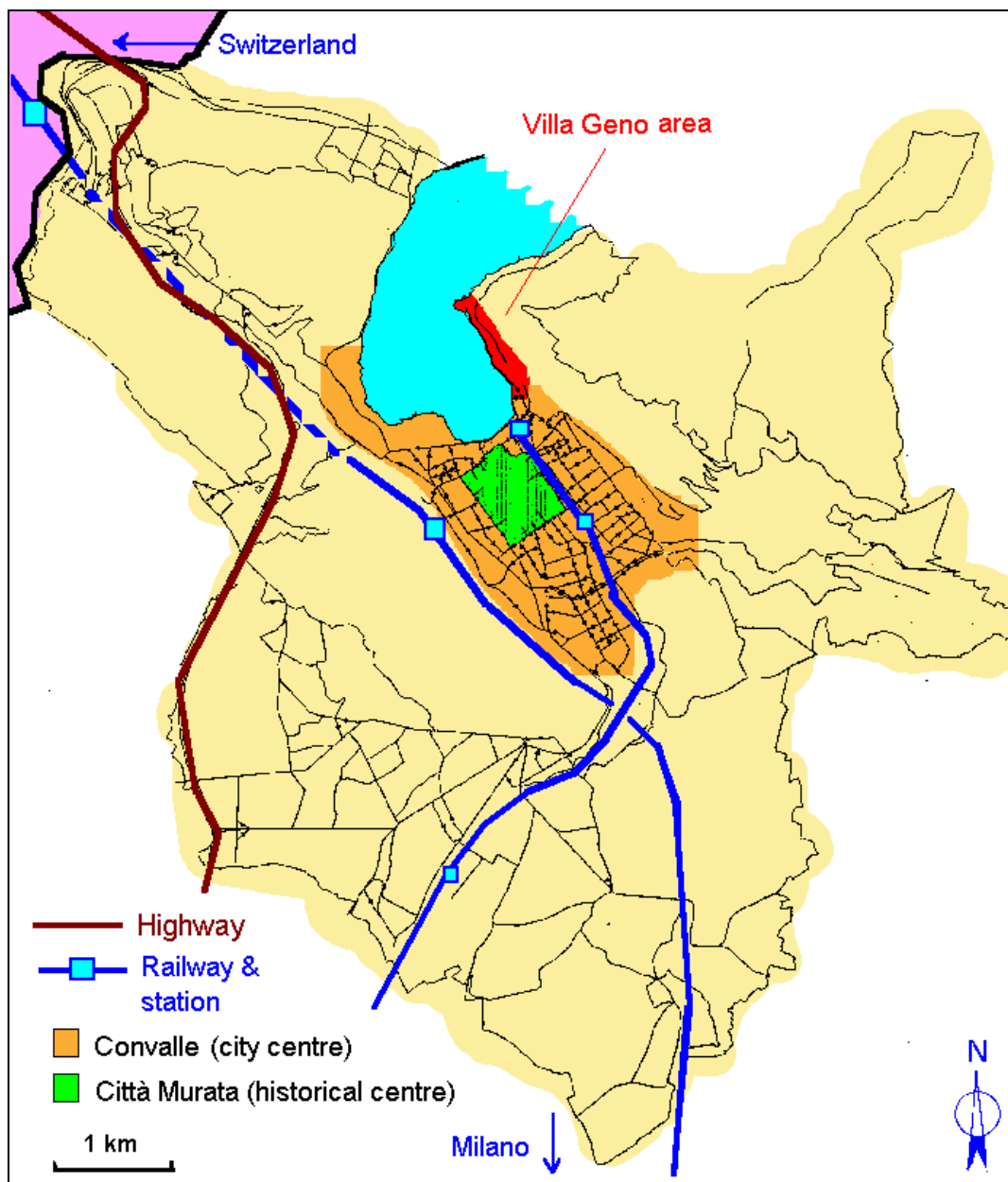


Figure 5.6: Overview of the city of Como

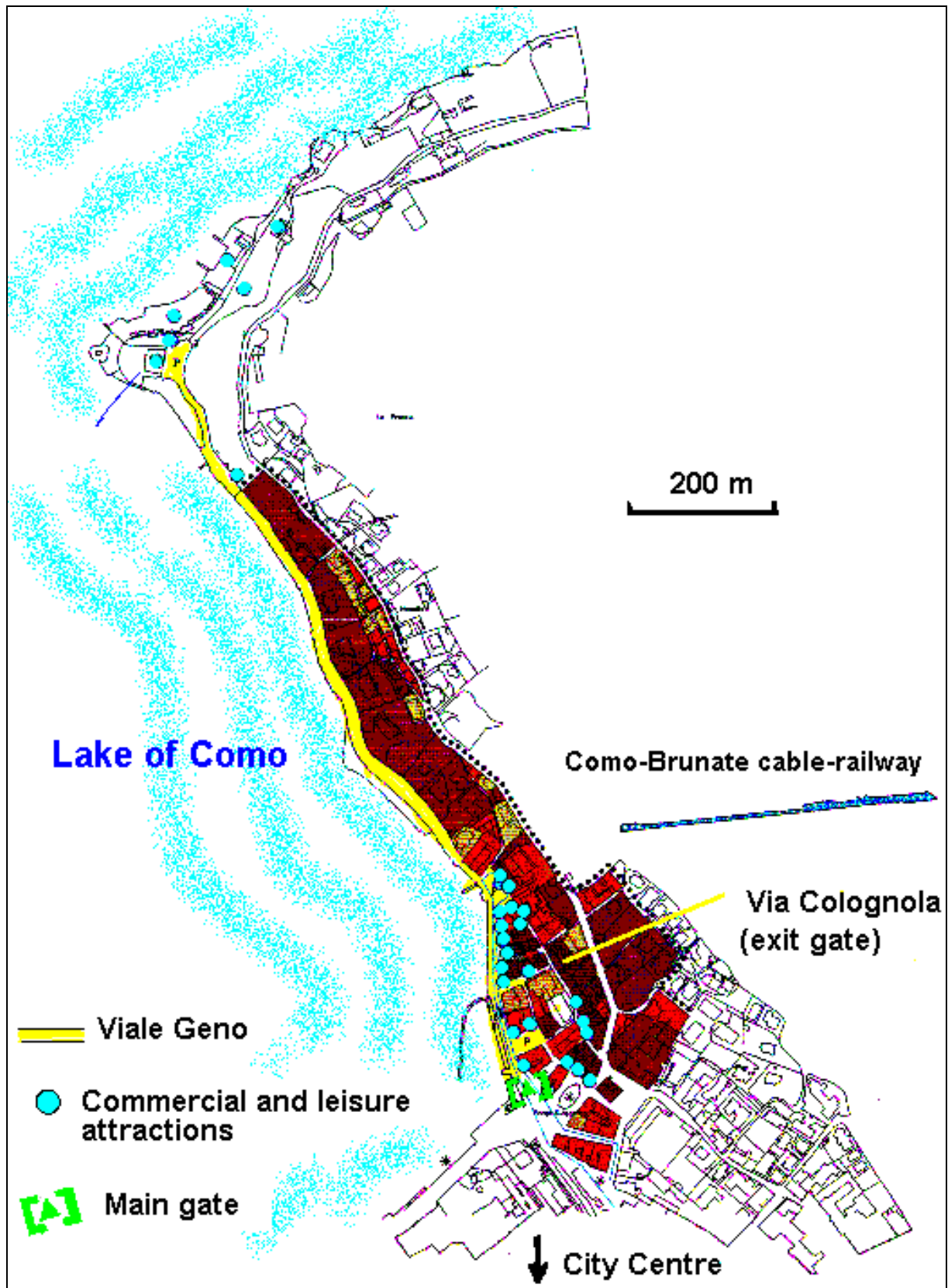


Figure 5.7: Como - Villa Geno tourist area

5.3.3 Demonstration results

Following the start of the demonstration, data was collected on three Sundays. Previous data was available for 25th April 1997 (a bank holiday in Italy), when the pricing was not yet applied, so that a comparison can be made between the “before”

and the “after” situation. Note that the Bank Holiday is considered completely comparable with the other three days as the demonstration was specifically designed to operate during the tourist season, holidays and weekends.

The following trip modes have been taken into consideration:

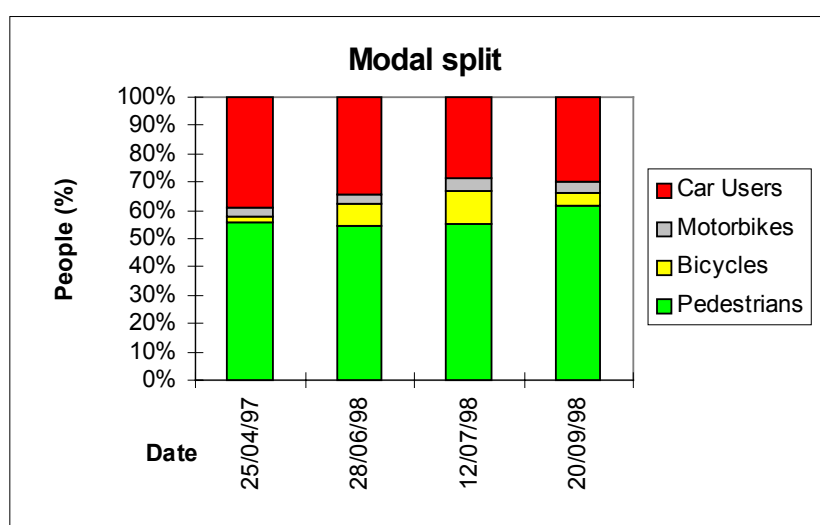
- Pedestrians,
- Cars,
- Bicycles,
- Motorbikes.

Only cars are affected by pricing.

A complete detail on the recorded modal split is shown in Table 5.4 and Figure 5.8. In this case, the number of cars has been replaced with the number of car users, by means of an average car occupancy coefficient of 2.33⁴. The trend of the modal split is characterised by an 8-9% reduction of the car share. The reduction is in favour of the bicycles and motorbikes in the days of June and July. During the last day the percentage of pedestrians increases of about 5-6%, with a small reduction in the bicycle share.

Table 5.4: Modal Split for Each Survey Day

		Pedestrians	Car Users	Bicycles	Motorbikes
Entering	25/04/97	56%	39%	2%	3%
	28/06/98	54%	35%	8%	3%
	12/07/98	55%	28%	11%	5%
	20/09/98	62%	30%	4%	4%
Exiting	25/04/97	58%	36%	2%	3%
	28/06/98	62%	29%	6%	4%
	12/07/98	59%	28%	8%	5%
	20/09/98	66%	27%	4%	4%



⁴ This coefficient has been estimated using a sample of 200 cars entering the Villa Geno area on 25/4/97. Its value is greater than the average value for ordinary trips in Como (about 1.3). The higher value is justified by the different trip purpose (mainly leisure trips in Villa Geno compared to commuting or business trip purposes on average for the whole town).

Figure 5.8: Modal Split for Each Survey Day

The last set of results (Table 5.4 and Figure 5.8) investigates the behaviour of the single 15 minutes intervals that have been used as the basis time span for the survey. The minimum, maximum and average value are reported in Table 5.4 for the four modes.

The chart shows the car data, disaggregated for each entrance/exit gate. In this case the following facts can be highlighted:

- the average value has decreased from non-pricing to pricing situation;
- also the maximum value is lower for the pricing situation: a lower maximum generally reduces the probability of incurring congestion problems even more than the simple reduction of the average value; a reduction in the maximum value (especially significant in July and September) can be considered as an important result of the demonstration;
- the positive values for exiting Lungo Lario (the one way entrance) in the priced days correspond to special circumstances, reported by the charge collectors.

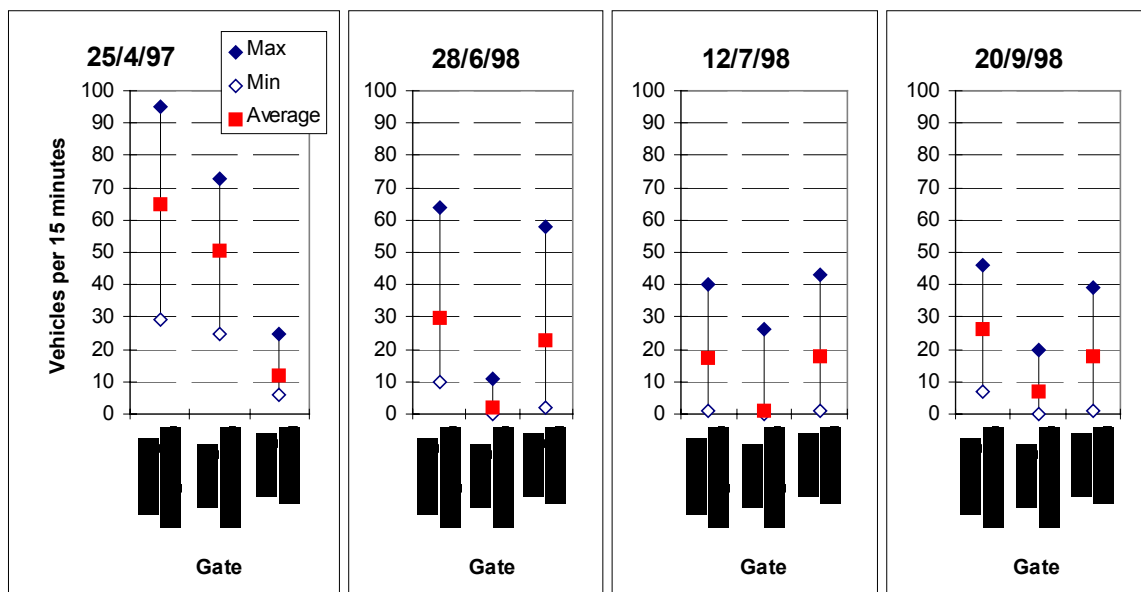


Figure 5.9: Average, Minimum and Maximum Numbers of Cars Passing Each Gate by Day

5.3.4 Future developments from the Como Demonstration

The Como demonstration in the *TransPrice* project did not stop with the end of the demonstration phase. An automatic access control system was built for the main entrance of Villa Geno area (Lungo Lario gate) and it is expected to be introduced experimentally during holidays by Summer 1999, following the success of the *TransPrice* demonstration.

The access to the area will be controlled by a three-lane entry gate. (see Figure 5.10). The objective of the system is to provide as automatically as possible the recognition of authorised vehicles (householders, hotels clients, emergency vehicles, public cars, goods vehicles). The system is composed of two parts: the Central Room (which is a control room located inside the Como Municipality building) and the entry point (which is located at the beginning of Villa Geno promenade).

Figure 5.11 shows the automatic access control gate. The gate is represented by the red pole, supporting the optical tools for number-plate recognition. The infrared camera can be seen in the centre. The two items on the right and on the left are infrared lights, which illuminate the license plate of a vehicle when the camera is active. The posts create an artificial lane for vehicles (the vehicle lane must be not wider than 3.5 meters: if not, the license plate recognition would be difficult). The booth in the background is used by the attendants to collect parking charges from paying visitors.

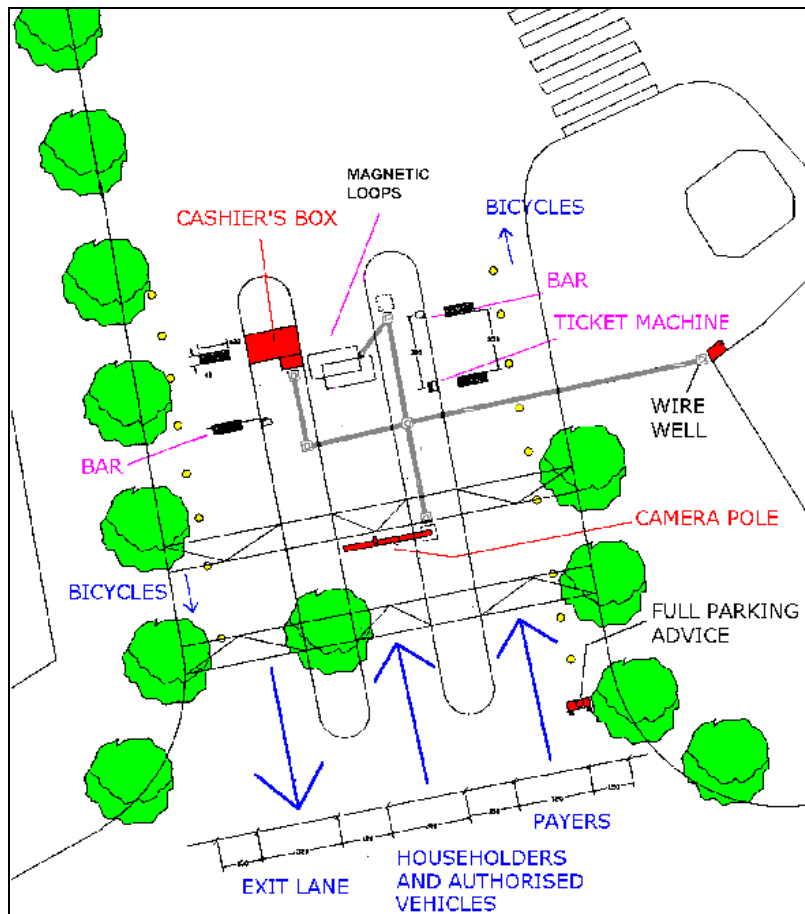


Figure 5.10: Proposed Automatic Entry Point Layout
 Bicycle entries and exits are allowed through dedicated lanes

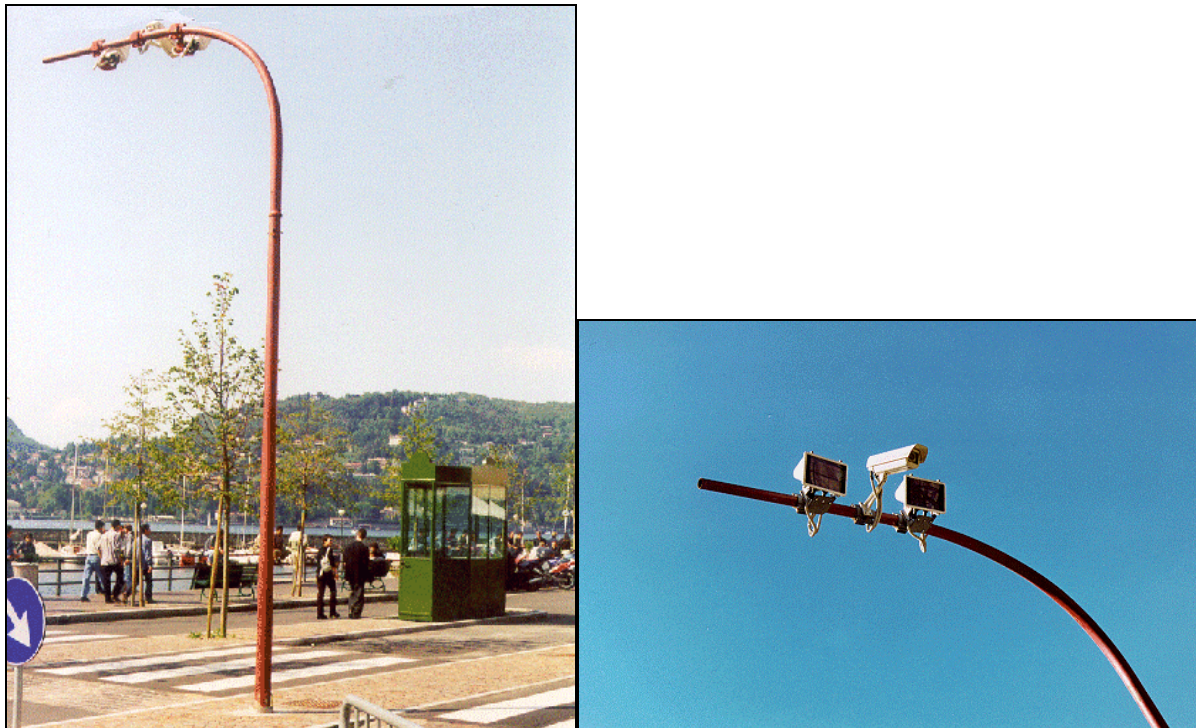


Figure 5.11: The Access Control Gate

5.3.5 Conclusions

After a set of difficulties, related to the political willingness in implementing a pricing scheme, as well as to some Italian national legal problems regarding automatic access control⁵, the Villa Geno experiment started on the last Sunday of May 1998, and was completed in Autumn 1998.

The main measure demonstrated was parking pricing. Due to the pricing a tangible reduction in the number of cars and a positive change in modal split towards pedestrians and bicycles was observed on the three survey days.

The demonstration also included an access control system: thanks to access control the gate can be closed when all parking spaces are occupied. This prevents congestion due to people searching for an unavailable parking space, as occurred in mid afternoon on the survey days. Furthermore access control allows authorised vehicles (householders) to have easy access to the area.

Both the reduction of car usage due to pricing and the reduction of congestion due to access control have contributed positively to reducing the peak values of entering and exiting cars.

The following three indicators can be considered, for an assessment of the effectiveness of the experiment (values for the priced situation represent an average

⁵ At the time of the demonstration, the use of *automatic* access control systems in access-controlled areas had a main drawback, due to the Italian Highway Code. According to the law, the violation control can be done only by a policeman present in the site where the infringement happens. It means that, *from a strictly legal point of view*, it would be impossible to give a penalty using the automatic camera. Some proposals were presented in the Italian Parliament during the last years with the aim at allowing the usage of an automatic control system, due to the increasing number of cases involved in this problem (among others, the cities of Bologna and Roma). This issue has determined the decision of starting the experiment in its manual form. The legal problem has been solved by a new regulation in 1999 (Ref 38/400/31).

among the three priced days, both entering and exiting vehicles):

- reduction of the average number of cars per hour from 254 to 94 (63% decrease);
- reduction of the modal share of cars from 37.6% to 29.4% (parallel to an increase of pedestrians from 57.1% to 59.7%, up to 66% in the last day, and of bicycles from 1.9% to 6.8%);
- reduction of the maximum value of vehicles crossing the gate in 15 minutes from 84 to 48 (43% decrease).

This experiment of access control and park pricing represents only a first step within a larger project of re-organisation of the pricing system, planned by the Municipal Council of the city of Como. In 1999 the pricing scheme will be re-proposed, with the introduction of the automatic access control system, together with the other gates protecting the historical centre.

5.4 Madrid

5.4.1 Background

The Region of Madrid has a total population of more than 5 million inhabitants distributed as follows:

- 0.91 millions in Madrid *inner core*
- 1.94 millions in the rest of Madrid Municipality
- 1.92 millions
- 240,000 inhabitants in the rest of the Region.

Nevertheless, population and employment are not homogeneously distributed over the Region of Madrid. In fact there is a high concentration of employment in Madrid city centre:

- the ratio of workplaces per active inhabitant in Madrid *inner core* is 1.96
- this ratio decreases to 0.68 workplaces per active inhabitant in the rest of the Metropolitan Area.

This urban structure causes a strongly radial mobility pattern directed towards the Madrid centre, especially for journeys to work and, therefore, in peak hours. Of a total of 6,464,582 mechanised trips (ie all trips except cycling and walking) -for all purposes- generated in weekdays over the whole Metropolitan Area of Madrid:

- 45.5% of total mechanised trips (2.9 million) are radially oriented
- 33.3% of total trips have the *inner core* as their destination.

One of the main problems in Madrid is the commuting movements from the outer areas towards the city centre. Radial mobility patterns are usually more oriented towards public transport. However, car patronage is still very high even in these radial relations (percentage over total mechanised trips):

All the data considered, there are around 1 million daily car trips streaming from the outer areas into the city's *inner core*. Despite the efforts made in road infrastructure investments in Madrid (and in some degree due to them), these car flows are

responsible for heavy congestion in all radial roads during peak hours.

Two actions have been analysed and evaluated in Madrid. One of them, Madrid's Public Transport Pass, has already been operating for 10 years. The second, the integrated payment system for a new Park & Ride, was implemented in 1997.

5.4.2 Public Transport Multi-Pass (Abono Transportes)

A 10-year evaluation of Madrid's Public Transport Pass, a multi-trip, multi-day, multi-mode transport ticket, has been undertaken. This analysis would permit to gauge the impact of a major action in urban public transport after 10 years of operation.

The main objectives were to investigate:

- the effect of the introduction of the Pass in public transport demand
- the characteristics of the PT Pass demand and an analysis of user perception
- the impact of pricing structure of the PT pass.

i) Public Transport Organisation in Madrid

The institutional framework of public transport in the Region of Madrid is centred in the *Consortio de Transportes de Madrid* (CTM). CTM was created in 1986 as a public institution where the competencies in public transport in the Region of Madrid were concentrated. CTM was created to co-ordinate the different modes and transport operators that constitute the public transport system in Madrid. It implied an administrative and technical re-organisation that, from a global conception of the system, would improve the level of service and optimise the use of the existing resources. A scheme of the institutional framework is presented in Figure 5.12. Its main competencies are:

- Global planning of passengers transport infrastructures
- Definition of co-ordinated exploitation programmes for all modes, except for commuter rail
- Establishment of an integrated fare structure for the whole system creating transport tickets valid for all operators
- Creation of a global image of the transport system, being the interlocutor with the public transport users.

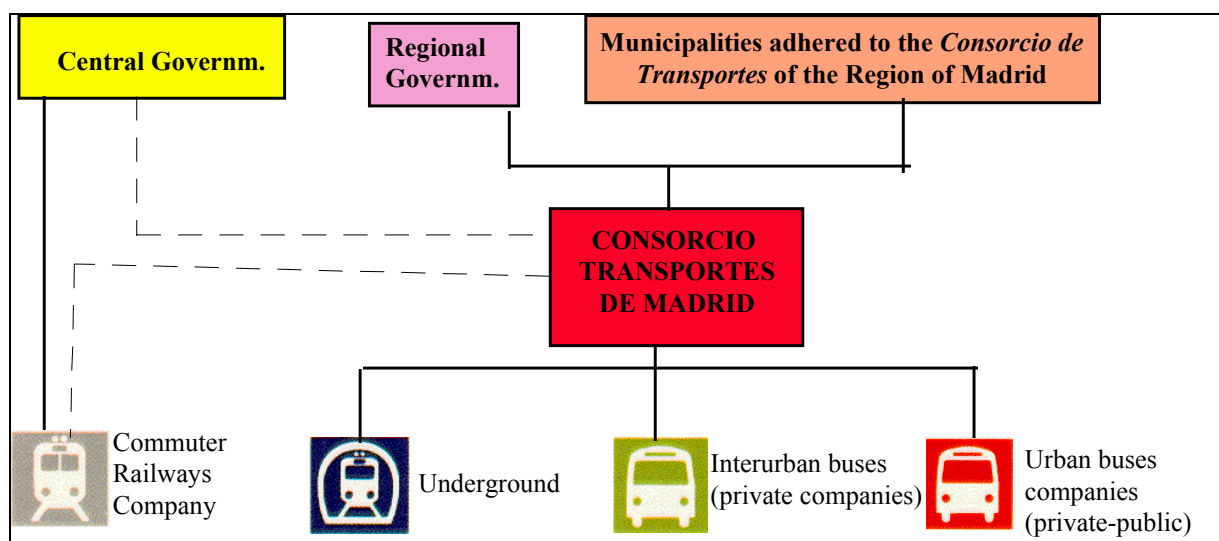


Figure 5.12: Institutional framework for the Public Transport in the Region of Madrid

One of its major achievements was the creation of an integrated fare system in particular the creation of the Monthly Pass that will be later analysed in detail.

Total public transport demand has been steadily increasing since the creation of the *Consortio de Transportes de Madrid* and especially since the creation of the new Monthly Pass (Figure 5.13). In 1997, public transport total demand reached 1,327 million passengers, a 3,7% increase in relation to 1996. (The decreasing value in 1992 was due to two months of strikes in several transport modes).

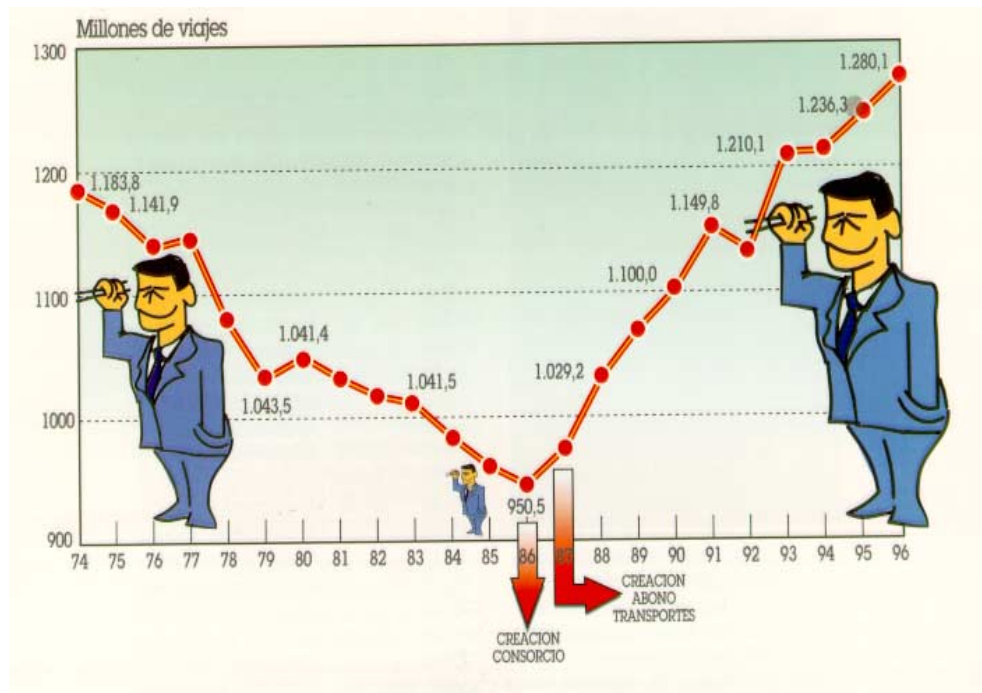


Figure 5.13: Evolution of public transport demand in the last 20 years

ii) Concept and characteristics of the Public Transport Pass

The PT-Pass was conceived as a personal non-transferable ticket, valid for a month (from the 1st to the last day of a nominal month), that permits to do an unlimited number of trips on all lines and regular services -and all modes and transport operators- inside the area of validity. Six concentric areas were defined (Figure 5.14); each of them includes the smaller ones inside. There are three different types of Pass:

- GP: General Pass, monthly and annual
- YP: Young persons (under 21 years), which is only monthly
- EP: Elder Pass (over 65 years), monthly and annual

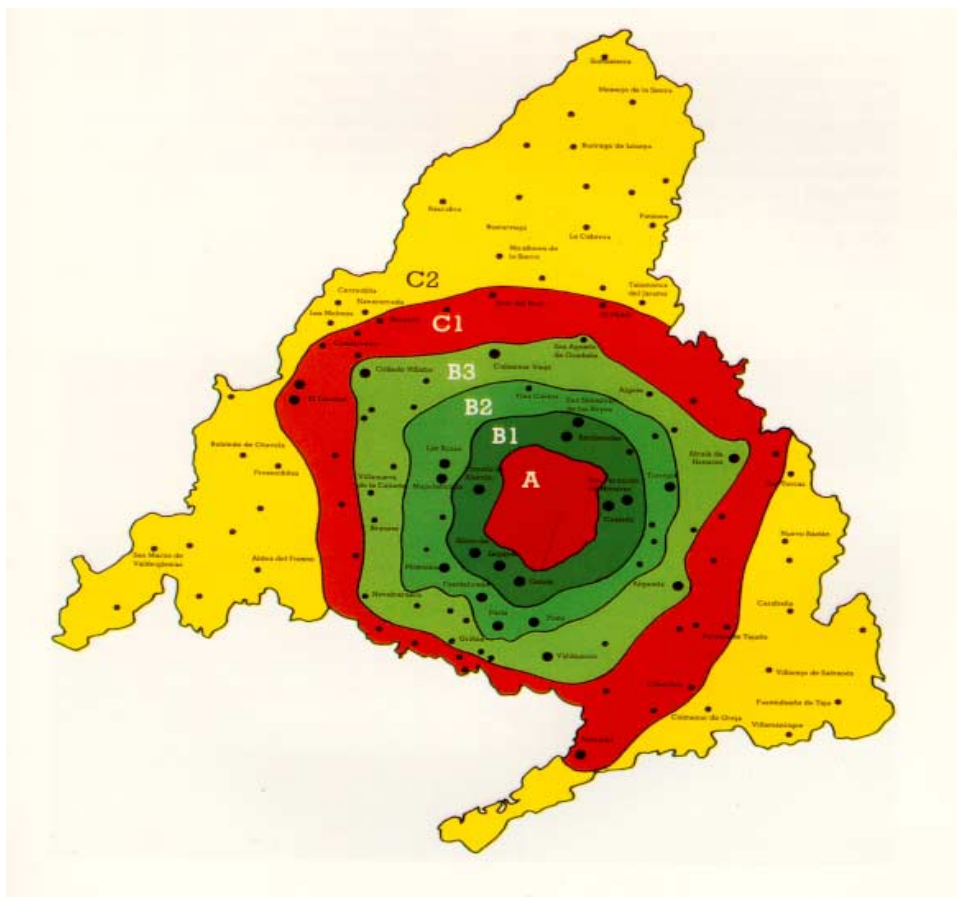


Figure 5.14: Spatial distribution of fare structure in Madrid

The monthly pass was introduced in 1987, one year after the creation of the CTM. It was intended to be one of the main actions in order to have an integrated and interconnected global public transport system. Before it, there were many different transport operators each of them with different fares structures. Modal transfer was therefore not only penalised in terms of time but also in terms of money.

Present fare structure is presented in Table 5.5. In order to get an idea of the relation of this fare with other transport tickets we can say that the price for a single ticket in zone A is 1 EUR and 0.4 EUR when buying a 10-trips ticket.

**Table 5.5: Fare structure of the PT Pass in EUR
(approx. Average radius of the fare crown)**

	A (7 km.)	B1	B2 (20 km.)	B1-B2	B3 (40 km.)	C1	C2 (70 km)
G P-month	27	31	35	23	40	44	49
G P-year	294	340	390	-	438	485	536
Young P	19	21	24	16	27	30	33
Elderly P.	8						
Elderly P-year	85						

iii) Demand for Madrid's PT Pass

In 1997, 52,1% of PT Passes was of the GP type, 21,5% was YP and 18,7% is EP. Only 6,7% were annual passes. The percentage of public transport trips using any of these Passes is presented in Table 5.6. It can be seen its growing importance since its creation in 1987, especially for Commuter Railway trips where 66,6% of the trips in 1996 were done by Monthly Pass users.

Table 5.6: Evolution of Monthly Pass patronage over total public transport trips					
Year	Underground	Urban buses	Commuter railway	Interurban buses	Total
1987	15.5	12.6	14.5	12.4	13.7
1990	38.6	41.7	36.1	37.9	39.5
1993	50.4	54.9	53.4	54.2	53.2
1995	54.2	59.8	64.0	59.4	58.3
1996	56,1	61.7	68.4	60.9	60.5
1997	57.3	63,2	66.6	60.9	61.5

Urban buses are the most used mode of transport within zone A, underground being the second most used mode. There is a small difference between GP users and YP users, the latter use more urban buses. When we analyse modal characteristics for zone B users, we see a more balanced distribution between modes: although there is a tendency to use more the underground system (due to the fact that connection commuter railway-underground are very good thanks to the good transport interchange system). When focusing on zone C users, we see similar trends both for GP and YP users; nevertheless there is a bigger tendency among young people to use interurban buses more than commuter railways. EP users travel more in urban buses -understandable if we think in the greater difficulties for elder people to travel in the underground network (stairs, personal security, etc.). This information is summarised in Table 5.7.

Table 5.7: Modal split of stages made by Monthly Pass users (Type of Pass-Zone of Validity)							
	GP-A	GP-B	GP-C	YP-A	YP-B	YP-C	EP
Urban bus	56.1	21.3	23.7	60.2	23.8	19.5	62.2
Underground	40.4	32.8	24.9	36.9	29.1	24.3	25.0
Commuter Railways	3.6	20.0	21.0	2.8	21.5	16.1	4.0
Interurban buses	0.0	25.7	28.3	0.0	25.5	40.2	8.7

iv) User opinion and fare structures impacts

After 10 years of *Abono de Transportes* (PT Pass) in operation, the Consorcio de Transportes carried out several opinion surveys to test the impact of this integrated payment system and fare structure.

The main reason for using public transport is different according to zones (A through C). In the inner zone (A) most users are captive (no alternative), while in Zones B and C PT Pass is used mainly due to economy and money savings. The users perception of money savings is summarised in Table 5.8. It can be seen that there are big differences among zones. The *Abono de Transportes* is more profitable in outer zones of Madrid Region, which are more subsidised than inner ones.

Table 5.8: Opinion of PT Pass users on monthly money saving (EUR in year 1989)				
	Zone A	Zone B1	Zone B2/B3	Zone C
1-6.3 EUR	55%	50%	38%	23%
6.3-12.5 EUR	15%	27%	30%	29%
12.5-18.8 EUR		9%	9%	20%

Table 5.9 presents the results to the following questions: Do you use PT now more than before having the Abono (Pass)? and Do you use PT when you do not buy the Abono (Pass) in one specific month? It should be noted that some 25-75% people do not buy PT Pass every single month (e.g. students or workers during holiday periods); then they can use the more expensive single or 10-trip ticket, or use private cars.

Table 5.9: Opinion of use of PT when not PT pass (% of PT pass users)							
Type of PT pass	GP			YP			EP
Zone	A	B	C	A	B	C	A
Use PT more than before pass?	45	35	50	47	59	45	31
Use PT when do not buy PT pass?	48	54	52	50	49	38	36

According to this opinion survey results, having the PT Pass makes travellers use public transport more often. In the case of young people, they use more PT in 45-60% of the cases. There are also some results that indicate that once having the PT pass people tend to make more trips than when they have not a PT pass. Elders are the group of people that change less their current use of PT, mainly because they are captive in many cases and less able to use private cars.

The second question highlights the importance of PT pass on modal split. For all types of pass holders PT use represents less than 50% (on average) of all trips in months when they do not purchase a pass. This is particularly evident for young and elder people. It also reflects the impact of the integrated ticketing system, which avoids the need to buy a different ticket for each mode of public transport.

v) Impact of the Abono on PT demand

If we analyse the percentage of population that currently use the Abono (PT pass) we find that they are 20 percent of the inhabitants. Table 5.10 indicates which is the evolution of this percentage and the differences among different groups of population.

Table 5.10: Percentage of population (over 6 years) using PT pass in Madrid Region						
	1987 (1 st year)	1991	1996			
			< 21 years	21-64 years	>64 years	Total
Inhabitants	4,445,932	4,601,227	912,115	3,069,796	688,820	4,670,731
Abono users	617,062	890,521	205,150	554,835	186,308	946,293
% users	14%	19%	22%	18%	27%	20%

This analysis shows clearly that the number of Abono users is a high percentage of the population. Some 20% of the Madrid population make their trips usually using PT modes. The Abono penetration rate has developed from 14% in 1987 (first year of introduction) to 20% in 1996. Within the Abono users, the higher penetration rate correspond to elders and -in the second place- to young people; this is because EP and YP are relatively cheaper than the GP pass and secondly because those groups of population have less availability of private car.

5.4.3 Park and Ride With Integrated Ticketing

i) Introduction

Madrid has major traffic congestion problems on its radial roads, especially during peak hours. One of the most congested corridors is the N-VI, in the Western part of Madrid. This corridor is served by two commuter railway lines, C-8 and C-10, which connect the area with the centre of Madrid. The railway company RENFE has the policy of building Park & Ride facilities by the railway stations. There is one such Park & Ride facility at the Pinar rail station.

The objectives of this demonstration were:

- to analyse the influence of the improvement of a Park & Ride infrastructure on travel demand
- to analyse public acceptability and its influence on user demand of a charge for the Park & Ride infrastructure
- to test functional validity and user's acceptability of integrated ticketing systems.

ii) Parking at Pinar Station

The station of *Pinar* is situated in an industrial (non-urban) zone, close to a commercial centre. From 1988 a free parking lot was in operation with around 400 places. This parking lot had poor conditions and was always full. The rail company decided to build a better and larger one to improve services and to attract more Park & Ride trips. In 1997 a three storey parking facility was inaugurated with 1266 places in total. However, in order to cover maintenance costs the enlarged parking facility was charged. The tariff structure is dependent on the type of PT-ticket used. Table 5.11 shows for each type of trip ticket the possible parking tickets allowed and the cheapest among them.

Table 5.11: Pinar: Relationship between trip and parking ticket

Travel Ticket	Allowed Parking Tickets	Cheapest Parking Ticket Cost (EUR)
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PT-pass (monthly)	<ul style="list-style-type: none"> • Monthly ticket • 5 parking ticket • single ticket 	monthly ticket (12 EUR)
commuter railway's pass (monthly)	<ul style="list-style-type: none"> • monthly ticket • 5 parking ticket • single ticket 	monthly ticket (12 EUR)
10 trips ticket (5 days=1week)	<ul style="list-style-type: none"> • 5 parking ticket • single ticket 	5 parking ticket (3 EUR)
return ticket	<ul style="list-style-type: none"> • single ticket 	single ticket (0,6 EUR/day)
single ticket	<ul style="list-style-type: none"> • hourly ticket 	hourly ticket (1.1 EUR/hour)

iii) Data collection and survey results

To test the impact of the improved but charged parking facility a survey was carried out in 1998 in the framework of **TransPrice** project. The survey was oriented towards the type of users and their opinion. The interviews asked users about their travel behaviour before and after the new Park & Ride, their opinion about the integrated fare and ticketing and their evaluation of the facilities.

In total 175 valid interviews were conducted. 52% of the respondents came to the station by car, 83.5% of people who drove to the station used the station parking and 16.5% parked outside in the vicinity to avoid payment. The main reason for not using the station parking was: 73.3% because it is not free (72.2% of them were users of the old free parking) and of the rest because it is easier and quicker to park outside the station parking facilities. Of the non-users, 20% never used the station parking, 53.3% used it occasionally and 26.6% used it frequently. 67.1% were users of the old free parking, the majority of the rest (21.1%) did not make this trip before (they had changed their residence or destination), only 2.65% made the same trip as before and had changed the transport mode because of the parking improvements.

The frequency of use was: 85.5% daily, 10.5% frequently and 3.9% occasionally.

Purpose of the trip was: 94.7% work 1.3% study and 4% others. Trip destination was in most cases the city of Madrid, mainly the “Castellana” zone (CBD) with prevalence of white-collar jobs. 36.9% used the *monthly parking ticket* associated with the *monthly Commuter railway pass* or *Public Transport Pass* and 63.1% the *single parking ticket*.

The distribution of trip tickets was: 55.3% *monthly Public Transport Pass*, 13.2% *commuter railway monthly pass*, 26.3% *10 trips ticket* and 5.2% *return ticket*.

The use of the *monthly parking ticket* is lower than expected, considering that people would use the “cheapest parking ticket”. The reason could be that there are not any savings in buying the parking ticket by month rather than daily and the convenience factor of a unique ticket is not enough for people to prefer buying it.

Table 5.12: Users of the parking tickets in Pinar

	% expected users	% real users
Monthly parking ticket associated with monthly PT-pass	55.3	21.1
Monthly parking ticket associated with monthly Commuter rail pass	39.5	15.8

Single parking ticket	5.2	63.1
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It appears that public awareness of the integrated ticket is low and this is confirmed by the questionnaire: 45.3% declared they did not know about it. At the same time 81.6% considered that the integrated ticket could be useful or very useful.

The cost of the parking is 100 pesetas/day (approx. 0.6 EUR/day,); 23.7% considered it cheap, 52.6% correct and 22.4% expensive. 26.3% would not pay more, 39.5% would pay 25% more, 11.8% up to 50% more, 15.8% would pay double than now; only 7.1% would pay more than 200 pesetas daily.

The area attracted by the station has a radius of 5 km on average. Among car users 65.4% drove less than 5 km, 12% between 5 km and 10 km, 17.3% between 10 km and 20 km and 5.2% more than 20 km; the maximum distance was 50 km.

Travel time distribution was as follows: 38.6% declared to spend less than 5 minutes in their travel from home, 49.4% between 5 and 15 minutes and 12% more than 15 minutes with a maximum of 30 minutes.

The alternative mode for the reference trip is the car for 69.7%, car as accompanying person for 3.95%, bus for 21.1% and “Kiss & Ride” for 1.3%.

iv) Conclusions

There has been an increase in parking users, before there were about 400 cars in the Park & Ride site and after the introduction of integrated ticket around 700 cars daily. This indicates that there is been an important effect on the demand and mode choice. However it is not possible to attribute this increase either to the quality of the new parking facilities or to the integrated ticket, because the users of the Commuter railway network in the Region of Madrid have increased 8.7% in the previous year. The survey detected that only 2.65% of parking users had changed their trip mode because of the improvements of the park and ride. Around 300 new cars use the park and ride travel mode instead of commuting by car to Madrid.

Public opinion about the utility of an integrated ticket is very positive, but its use and awareness is rather low. Therefore it would be very convenient to make publicity and information campaigns among potential users. The reason for the low use could be also that there is no saving between buying the parking ticket monthly rather than daily.

People are ready to pay for Park & Ride, if the price remains low. Security is the most important concern of the Park & Ride site, especially when it is not free.

5.5 Leeds

5.5.1 Background

The city of Leeds is the centre of the second largest metropolitan authority area in England and has a population of approximately 750,000 and a surface area of 549 square kilometres. Leeds is experiencing continuing and sustained growth in personal mobility, most clearly demonstrated by the rising number of cars on it’s roads (20% increase between 1987 and 1997) and the increased number of journeys made in those cars.

Currently over 66% of motorised journeys to work in central Leeds are made by car and the continuing growth of Leeds as a regional centre for retail and business activities has led to rapid interpeak growth and increasing off peak as well as peak period congestion.

One of the main themes of the City Councils transport strategy is to encourage the use of alternatives to the car, particularly for journeys to work and in order to achieve this and other aims a package of measures has been developed with five key elements:

- Better public transport
- Traffic Management, including bus priority
- Selective Road Proposals, to encourage orbital movements
- City Centre initiatives and
- Financial measures, including the use of parking charges to influence demand, introducing a smart card based integrated payment system for public transport and parking charges and to consider the potential for a future development of a parking cordon enabling charges to be levied on the 45% of drivers who currently park free of charge.

5.5.2 Description of the Demonstration

There are three elements to the Leeds TransPrice demonstration, summarised below:

- To evaluate the use of smart cards in the transport sector, in particular for the payment of parking charges.
- To assess the public and political acceptability of multi use smart card applications
- To evaluate the potential for modal shift from private car to Park & Ride through the use of multimodal smart card based ticketing systems.

Visa International selected Leeds as the UK pilot city for its Visa Cash smart card payment system. The VisaCash card is a stored value electronic purse specifically designed for low value purchases up to £5 (7 EUR). Various types of card are being trailed by the six financial institutions involved ranging from a true electronic purse to a VisaCash addition to a credit or debit card which results in monthly bills if the card is overspent and not reloaded. At the end of the trial one type of card will be selected for universal use.

Over 1250 outlets citywide are currently able to accept VisaCash for payment in three main service sectors:

- Transport - Car park payments, pre paid public transport tickets. It was initially hoped to include taxi fares in the pilot but technical difficulties prevented this.
- Vending Machines and Pay phones.
- Retail and leisure outlets, including sports centres, fast food restaurants, newsagents, licensed premises etc.

The card can be reloaded when required with a maximum stored value of £50 (75 EUR) at over 30 special locations throughout the city centre and at specially adapted automatic cash dispensers in participating banks.

The VisaCash pilot started in autumn 1997 and over 50,000 VisaCash cards have been issued till 1998, (the target set by Visa International was for 70,000 cards to be made available free of charge to selected clients of participating financial institutions) but there is no information on how many are in regular use and how many have been obtained for novelty value.



Figure 5.15 VISACash Operations in central Leeds: Loading Points



Figure 5.16: Car Park Payment by VisaCash

Public and Political Acceptability

Following a pilot survey in June 1997 a full-scale survey of potential smart card users was conducted in October 1997 prior to the start of the VisaCash pilot. Both car drivers and public transport users were interviewed.

Following the introduction of multiuse smart cards in Leeds a repeat of the above survey was undertaken to assess whether any changes in attitude had taken place. Again both public transport and private transport (car parkers) were interviewed. This time the sample was further subdivided into smart card or “cash” users. The survey aimed for a total of 100 valid responses in each category but the small number of user in the public transport field reduced this to 100 in total, i.e. 80 “cash” and 20 smart card users.

Political acceptability of smart cards was assessed by a series of informal, but structured interviews with senior officers and politicians. These interviews were conducted in early 1998 after the VisaCash pilot had started and after bus operator First Group had introduced their own “Smart Traveller” card on selected buses in another city in the region.

Potential Transfer to Park & Ride.

The potential transfer to Park & Ride and conventional public transport was assessed using the results from the local questions included as part of the common Stated Preference Survey.

5.5.4 Results

Smart Card usage

Table 5.13 shows the continuing growth in the use of smartcards for payment of parking charges in Central Leeds. The use of smart cards for parking payment increased steadily since its introduction and has currently levelled off at just less than 1.5% of all payments. Although lower than the level of usage of single function cards (2) this is seen as a highly satisfactory level of usage and is above pre-introduction predictions.

Table 5.13 Use of Smart Cards for Parking Payment

Month	Total Transactions	Smart Card	% Smart Card
November 1997	34,000	114	0.34
December 1997	33,917	327	0.96
January 1998	58,898	871	1.48
February 1998	77,407	1,189	1.54
March 1998	96,930	1,383	1.42
April 1998	145,906	2,769	1.89

May 1998	98,767	1,169	1.18
June 1998	103,301	1,509	1.46

Note: System became operational late November 1997
 Number of payment machines capable of accepting VisaCash
 Increased monthly until March 1998

A detailed examination of the data indicates most smart card payments in long stay car parks with payments occurring before 0930 suggesting the majority of users are commuters. Figure 5.17 illustrates the weekday/ Saturday split for smart card usage - central area parking is free on Sundays.

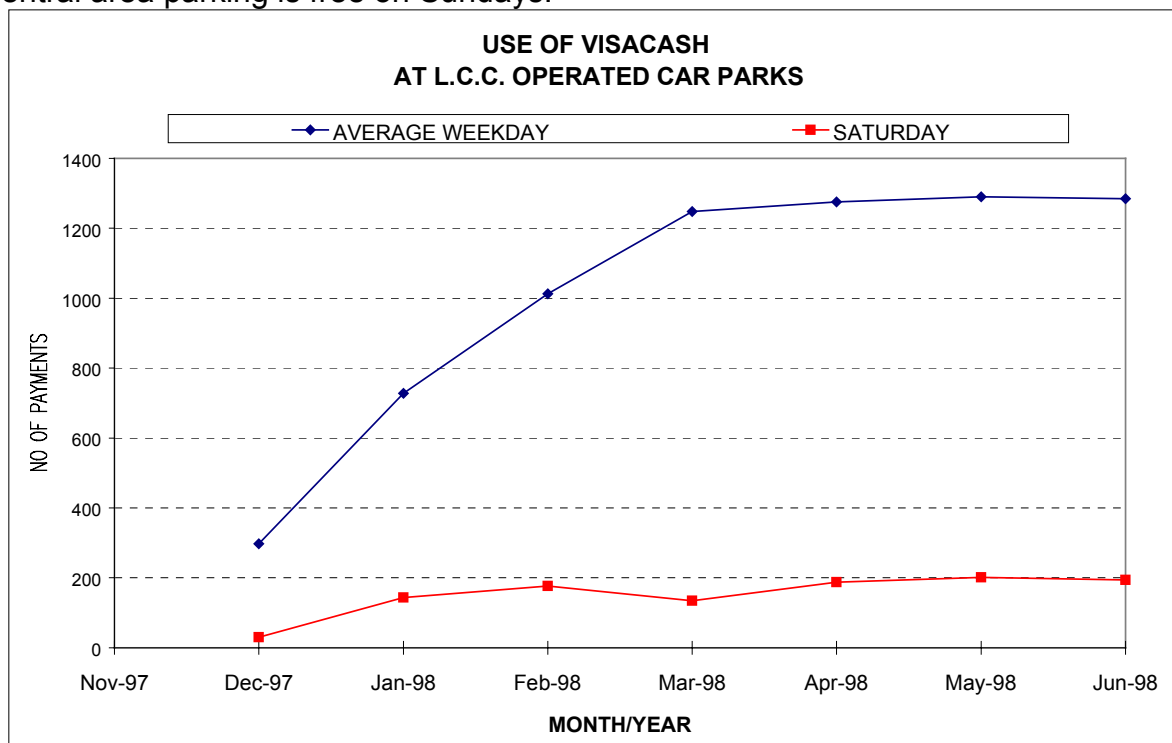


Figure 5.17 Smartcard usage for parking - Weekday/Saturday split

Public and Political Acceptability

The results of the surveys conducted before the introduction of the VisaCash trials are summarised below.

Of *Car Park Users* 59% of respondents were female, 41% were on shopping trips and over 54% said they never used public transport.

There was great potential interest shown for the use of smartcards - 58.8% of respondents would have liked a parking card, 90% of these indicated they would prefer to use car parks offering only card payment (they were felt to be more secure due to lack of cash on site).

In terms of the type of card preferred 32% would prefer a monthly-itemised bill, 21.5% a prepaid decrementing card but there was a zero response to the idea of a rechargeable card.

Of *Public Transport Users*, 67% of respondents to the survey were female with 19% on work trips and 43% on shopping trips. 29% of those surveyed had access to a car

for the journey they were undertaking. 77% were paying cash for their ticket, 18% used a monthly ticket with the remainder using various other passes and permits. 72% of respondents would have liked the option of a smart card mainly due to the convenience of not having to carry loose change for tickets.

25% would prefer a system that sent monthly bill, 24% would like a prepaid decrementing card and 15% would prefer a rechargeable card. The remainder showed no preference.

The results of the survey undertaken after the introduction of the VisaCash pilot (February 1998) indicated little change of attitude. Again most respondents welcomed the idea of a smartcard (Car Parkers 63%, Public Transport Users 76%) although less than 20% had, or had considered, getting a VisaCash card. This reluctance appeared to be mainly due to the perceived temporary nature of the pilot, uncertainty of the future use of the system and the fact that not all types of bank account were included in the experiment.

Those respondents who had VisaCash cards used them mainly for day-to-day small purchases - newspapers, confectionery, fast food- or leisure activities. Parking and public transport payment was not regarded as a prime reason for having a VisaCash card.

Again a card with a monthly-itemised bill was most popular (47%) although a higher proportion (29%) indicated a preference for a rechargeable card (or electronic purse). The main problem associated with the rechargeable card was a fear of losing a fully charged card.

Amongst public transport users there was little use of VisaCash as it offered no advantages to purchasers of pre-paid tickets over existing card purchases (credit or debit card). There was however a significant, and increased, potential demand for the use of smart cards for individual ticket purchase (83% of VisaCash users and 73.5% of cash users).

Few respondents considered that the use of a smartcard which could be used for public transport and private transport would be a prime reason for changing mode, although 65% of current car parkers welcomed the idea of Park & Ride.

Discussions with the Public Transport Authority and main Bus operator in Leeds indicated that there were many advantages associated with smartcard payments - security, reduction in fraud etc. but both stressed that in order to be useful the system would have to be contactless. Discussions are underway with systems manufacturers to investigate the possibility of an add on "wallet" to convert the contact VisaCash card to a contactless system for public transport users similar to that used in Paris.

Within the City Authority the increased use of "plastic" for small value purchases was seen as important for fraud reduction and security. In the long term the use of multi-modal ticketing using smartcards was seen as an important element in the cities transport strategy. Depending on the outcome the VisaCash trial the original idea of a rechargeable Leeds Card may be resurrected either as a replacement for VisaCash or in competition with it.

Potential transfer to Park & Ride.

The results of the analysis of the additional Stated Preference data showed that, in order to achieve a maximum transfer (37.8%) to Park & Ride, parking charges would have to increase by 100% to £7.00 (11.7 EUR), journey times for both car and conventional public transport increase by 20% and Park & Ride fares and journey times would have to be 20% lower than conventional public transport. However a 50% increase in parking charges combined with Park & Ride fares 20% lower than conventional public transport would result in a 22.8% shift to Park & Ride even allowing for better private transport journey times.

Any significant increase in parking charges (over 50%) coupled with a cut in public transport fares will result in significant transfer, over 50%.

5.5.5 Conclusions

Following the introduction of the VisaCash multifunctional smart card in November 1997 its use in the transport sector has been monitored and although its use for parking payment transactions (the main transport application) is at first sight low, at 1.5% of all transactions, this is above pre launch expectations and is sufficient for the project to be extended to other parts of the city and additional functions particularly in public transport.

The low usage can possibly be explained by the experimental nature of the scheme - several different cards were being trialled and by the general reluctance of people to accept new forms of payment - initially the use of credit and debit card payment systems was below expectations in this part of the UK

However, the public attitude surveys conducted indicated that there is a demand for smart card payment systems for both parking and public transport payments, and whilst the availability of a card would not directly influence mode choice its convenience would be important for non regular public transport users.

5.6. York

5.6.1 Background

York is a regional centre in the North East of England with a population of 175,000 within its administrative boundary. It is an historic City and attracts around 4 Million visitors annually which combined with the narrow streets, makes it relatively congested compared with other cities of a similar size.

For almost a decade the City Council has developed a transport strategy that aims to promote methods of transport, which are more efficient than the car in using the limited road and parking spaces available. The Council has sought to encourage the use of walking, cycling and public transport as realistic options to the private car in an attempt to hold rush hour car use at 1992 levels.

Around a quarter of journeys to work within the main urban area are made on foot. This is almost twice the national average. A further 20% of journeys to work within the main urban area are made by cycle.

Park & Ride is the corner stone of the Council's Transport Strategy. There are now three full time Park & Ride services operating that carry over 1,000,000 passengers a

year and keep over 500,000 cars out of the City Centre. The Council hopes to provide a total of five Park & Ride services around the edge of the City by 2006.

The Council is also actively seeking to enhance the environment in which public transport operates. A very successful bus priority scheme has been introduced on one of the main radial roads into the City Centre. This route is also used by one of the Park & Ride services. The Council has recently implemented a second major bus priority scheme. It is this scheme, described in detail later, which forms a part of the **TransPrice** demonstration. Other radial roads and important bus corridors will be investigated and facilities introduced as finance becomes available.

The Council continues to use parking policy as a method of traffic control through the price and availability of spaces. The number of publicly controlled long stay spaces in the city centre has been reduced and the number of short and medium stay spaces has increased. The cost of long stays in Council Car Parks has been increased above the rate of inflation for several years whilst short stay prices have seen a more modest rise.

Price rises are made each year on both parking and Park & Ride. These are being monitored as part of the **TransPrice** demonstration. The Council has introduced new ticket machines on three car parks and at three on street locations. These machines accept Smartcards. It is intended to use the same cards on the Park & Ride service. An experimental system has been introduced to allow this Smartcard payment system to take place as part of the **TransPrice** demonstration.

There are three main objectives to the **TransPrice** demonstration in York:

- To investigate whether the introduction of the same Smartcard based payment system for city centre parking and Park & Ride encourages modal change
- To assess the influence on modal split of the differential price rises for all day parking vis-à-vis Park & Ride
- To assess the effects on modal transfer of a reduction in Park & Ride generalised costs.

5.6.2 Description of the Demonstration

Background

The **TransPrice** demonstration in York has three main elements.

1. Changes to car park and Park & Ride tariffs
2. Introduction of multiuse Parking smartcards
3. Changes in the generalised cost of using Park & Ride and driving to City Centre car parks

In all cases extensive monitoring is being carried out to determine the level of modal shift resulting from the measures.

Parking and Park & Ride Tariffs

A differential pricing strategy is being used with regard to the City Council's City Centre car parks and Park & Ride. All day parking in the City Centre is being discouraged, with Park & Ride encouraged. The aim is to influence modal split through a differential parking charge strategy, which favours Park & Ride.

The Council increased the parking tariffs in April 1997 by 15-25% and did so again in April 1998 (taking into account the modelling results). The Park & Ride charges went up in July 1997 by 9% and again in May 1998.

Multimodal Smartcard Demonstration

A multimodal Smartcard demonstration, involving Park & Ride, Council owned City Centre car parks and selected on street locations has been introduced in York. This enables payment to be made for City Centre car parking and Park & Ride using the same Smartcard. The overall aim is to demonstrate whether such a system will encourage motorists who regularly park in the City Centre to consider using Park & Ride more than they do at present.

Smartcards were introduced on the Park & Ride service in 1992. These consisted of two different types. The first is a period card. This stores a time period (week or month) and allows unlimited use of the Park & Ride during that period. This card is aimed at passengers who regularly travel 4-5 times per week (typically commuters) and offers a considerable discount over paying for individual journeys. When the card expires it can be recharged with another time period. The other type of card is a stored value card that is like an electronic purse. Every time a ticket is bought the fare is taken of the balance on the card. This card is aimed at passengers who travel less frequently i.e. shoppers. A discount fare (almost 20% off) is offered to users of this type of card to encourage use. This scheme has been in operation for 5 years and accounts for over 20% of all journeys on Park & Ride (62% in the peak hour). It was indicated by several manufacturers initially that the card used for Park & Ride could be adapted for the new car park ticket machines. However, this has not proved possible.

Smartcard payment for City Centre parking has never been available in York prior to this demonstration. The City Council was, however, starting a ticket machine replacement programme in 1997. This offered the opportunity to trial a Smartcard scheme. New car park ticket machines were installed in two long stay car parks one short stay car park and one on street location have been adapted to accept smartcards.

To overcome Smartcard system mismatch between the Park & Ride system and the car parks, machines have also been installed at two of the Park & Ride sites. These issue tickets off the bus, which are then valid for a return journey on the Park & Ride service.

Figure 5.19 illustrate the Smartcard and ticketing machines at both car park and Park & Ride locations.

A sample of 79 car users was selected and was sent a Smartcard pre loaded with £20.00 (30 EUR) that could be used in any of the six Smartcard machines. Each card was accompanied with a diary survey so that some information related to each

journey when the card was used could be recorded. The demonstration started on 5 January 1998 and ran for a period of 3 months until early April 1998.

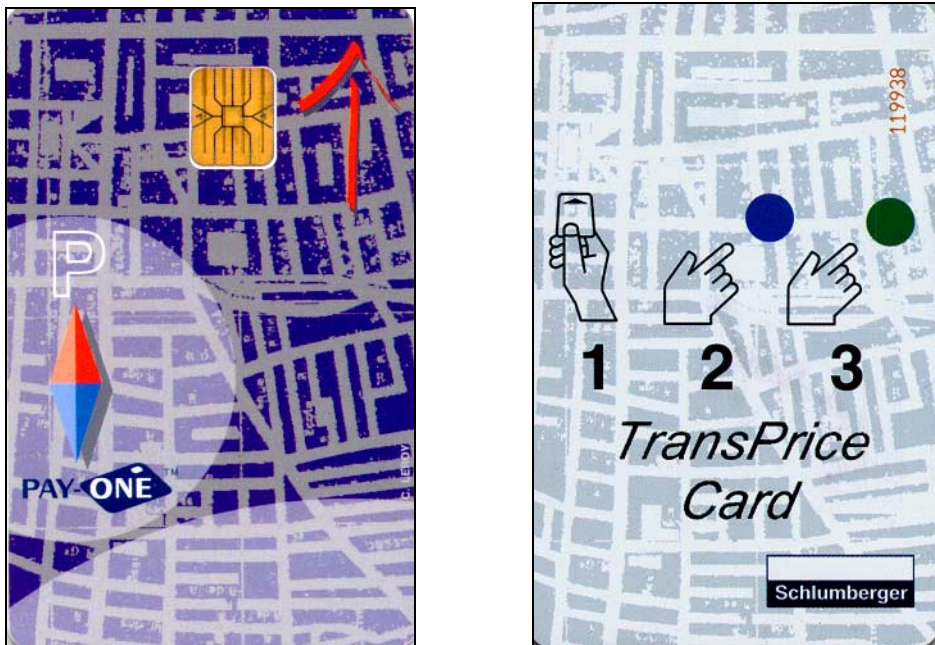


Figure 5.18 The TransPrice Smartcard



Figure 5.19 The TransPrice Ticket Machine with Smartcard Reader

Generalised Cost Changes

Two bus priority measures, which have been implemented on the Grimston Bar Park & Ride corridor, provide an ideal opportunity to alter the generalised costs for both the Park & Ride and car trips to the City Centre.

This is a supporting measure to the other demonstration elements (changes to tariffs and the introductions of multiuse smartcards). The overall aim is to encourage a modal shift to Park & Ride from private vehicles, by reducing the time element of generalised cost for travelling by Park & Ride.

5.6.3 Monitoring and Results

Parking and Park & Ride Tariffs

City Centre car parks are being continuously monitored using ticket machine data. This gives the total number of tickets by length of stay and by date. The overall drop in tickets sold between April 1997 and March 1998 was 145,951 (6.3%).

The annual increase in Park & Ride patronage over the same period was 110,900 or 12.0%. Overall the drop in usage in City Centre car parks has been partly replaced by increased usage of Park & Ride. (Care needs to be taken when comparing these figures, as the car park data is vehicles whereas the Park & Ride numbers are passengers).

Multimodal Smartcard Demonstration

All those involved were initially interviewed in City Centre car parks although 9% had used Grimston Bar Park & Ride at some time in the past but had a particular reason for choosing to park in the City Centre on the day of the survey.

Only 2 of the 79 were travelling to work or on employers business, 72 were on a shopping trip and the remaining 5 were attending to personal business. Given the high proportion of shopping trips it is not surprising that 87% of trips stayed less than 3 hours in the car parks and 81% came to York less than twice a week.

Only 54 of the 79 (68%) had responded to the stated preference and public acceptability survey. The preferred payment methods for a road congestion charge of those who did respond are set out in Table 5.14. It has been assumed that a rating of three or less to the payment method question indicates a reasonable willingness to use that method.

Table 5.14 Preferred Payment Systems

Method of paying for a road congestion charge	% Preferring this method of payment
Cash	65%
1 Day Unlimited Entry Prepaid card	19%
1 Month Unlimited Entry Prepaid card	2%
Electronic Credit Card	63%
Prepaid "Cashcard" For Congestion Charge only	83%
Prepaid "Cashcard" - Multi application.	59%
Monthly Transport Card.	6%

As parking charges are similar in nature to congestion charging it can be assumed

that these results are broadly transferable. Of those involved in the demonstration there is a clear willingness to use a dedicated cashcard as a payment method. There is also strong support to continue paying cash although this may assume that change will not be a problem. Credit cards and multi application cash cards are also popular payment methods. It is the latter of these that has been implemented in the York demonstration.

Nearly 90% would like to see a Smartcard scheme introduced although some would only use it if some form of discount were given. Their main reason for wanting a Smartcard was the convenience of not needing to carry change for the ticket machines. This of course is not a problem on the Park & Ride where the bus driver gives change.

Table 5.15 Analysis of trips made by Smartcard

Parking place with Smartcard	What they would have done without card	Number of Trips	% of Trips
City Centre	Parked in City Centre	423	80.4%
City Centre	Used Park & Ride	8	1.5%
City Centre	Travelled to another location	6	1.1%
City Centre	Travelled by another mode	2	0.4%
City Centre	Not travelled at all	2	0.4%
Park & Ride	Parked in City Centre	26	5.0%
Park & Ride	Used Park & Ride	55	10.5%
Park & Ride	Travelled to another location	3	0.6%
Park & Ride	Travelled by another mode	1	0.2%
Park & Ride	Not travelled at all	0	0.0%
		526	

The 55 cards returned have been used to make a total of 526 journeys. Of these, 16% were by Park & Ride and the remaining 84% parked in the City Centre. The Smartcard influenced 6.5% of all trips made. 5% of all trips made used Park & Ride when they would otherwise have used a City Centre car park.

If we look at the trips made by Park & Ride, 30.6% of these trips would otherwise have used a City Centre car park. This is not too surprising since the people involved in the trial had been contacted via surveys at City Centre car parks. It is difficult to be certain if the Smartcard was the primary reason for using Park & Ride. It may have been the case that the drivers weren't previously aware of Park & Ride, or thought it was too expensive or inconvenient, with the Smartcard simply giving them an extra incentive to try the Park & Ride. Closer analysis of these trips shows that 75% of those trips that have switched were made by 3 regular travellers (5% of those taking part in the trial), living within 8 kilometres of the Askham Bar Park & Ride site. Their trips were predominantly regular, short-medium stay, for shopping and personal business. The remaining trips that switched were less frequent, short- to medium-stay trips on the Grimston Bar service. All those that switched stated their reason for not using the Park & Ride service previously, as being that the site was not convenient. Of the remaining Park & Ride trips, 64.7% would have used Park & Ride

anyway.

1.5% of total trips involved parked in the City Centre when they would otherwise have used Park & Ride. This could be a result of the participants in the demonstration receiving £20 of free parking / Park & Ride use. Some would not have come to York often enough to have spent all the money therefore they may have decided to “treat” themselves to the relatively expensive City Centre parking. However, the majority of trips (80.4% of the total) would have parked in the City Centre anyway. If we consider the 441 trips to City Centre car parks alone, the percentage that would have parked there anyway rises to nearly 96%.

Generalised Cost Changes

Usage of Park & Ride and City Centre car parks is continuously monitored through bus and car park ticket machines. Journey times of private cars have been measured along the part of the Park & Ride route where priority measures have been implemented. Surveys have been made of both the before and after situations. The after situation is still being adjusted to give greater priority to buses and therefore the after results are yet to be finalised. These surveys have been undertaken using video recorders at either end of the route to record the registration plate and time of each vehicle as they pass. The registration plates are then matched and the difference in time calculated. Around 350 journey times on each of six days have been collected. Car journey times along the part of the corridor with bus priority have reduced by around 8% mainly due to traffic rerouting onto adjacent roads.

Park & Ride bus journey times are continuously monitored by an electronic tag and beacon system. Information from an electronic tag on each Park & Ride bus is recorded in a roadside beacon at either end of the route as the bus passes. This is then downloaded to a central computer and either end of the route is matched to provide journey time information. It is important to note here that the journey times have different start and end points. The car journey time recorded is only over part of the Park & Ride route.

The results collected show that the average inbound Park & Ride bus journey time over the whole route in the AM Peak Hour (0800-0900) has been reduced by about 12% from the before situation.

Actual usage of Park & Ride did not increase significantly in the first month or two after the introduction of the inbound bus priority measures. During March 1998 however there has been a rise of 8% in the number of morning commuters compared with the same period last year and a 1% fall during April 1997 and February 1998. It is likely that the modal transfer will take a longer period to have an impact, particularly as the measures have been introduced gradually.

6. Public and Political Acceptability

6.1 Approach to Acceptability Research

The potential acceptability of urban transport pricing schemes is a very important issue regarding the implementation of such schemes, particularly when involving some kind of road use pricing. The perceived public acceptability levels tend to govern the potential political acceptability. Acceptability research to date has been reviewed in this project and the results are summarised in Section 2.7. Following that review, a specific programme of public acceptability surveys was carried out in 1997 and 1998, viz:

- “Before” survey, as part of the Stated Preference survey (Spring 1997) in all eight **TransPrice** cities.
- “After” survey, following the demonstrations in the five demonstration sites of Athens, Como, Madrid, Leeds and York, as well as in the city of Graz.

The results of the above public acceptability surveys are given in Section 6.2.

Political acceptability has been examined on a city by city basis according to local policy issues, current initiatives, previous proposals, and the results of the demonstrations where applicable. The results of the political acceptability research are given in Section 6.4

6.2 Public Acceptability

6.2.1 Results from “Before” Survey

An attitudinal survey with current car users was carried out in all eight **TransPrice** cities during Spring of 1997 (as part of the common Stated Preference survey). This “Before” survey included three questions related to the justification for road pricing, the preferred use of expected revenues and the preferred method of payment.

The first question assumed that the authorities decided to impose a cordon or area pricing scheme for private cars entering the city centre area. The question assumed that the scheme would reduce car traffic and improve traffic conditions. Respondents were asked to indicate the extent to which the measure were justified by the following criteria:

1. *Reduce air pollution*
2. *Save energy (reduce fuel consumption)*
3. *Improve private car traffic conditions for those who pay*
4. *Improve conditions for pedestrians in the city centre*
5. *Improve public transport conditions.*

The second question was formulated to study to what extent respondents agree with different ways of spending revenues collected by the road use pricing scheme. The different ways to spend the revenues were:

1. *Revenues support state/municipal budget in general*

2. Revenues are used for traffic flow improvements (new roads, signalling, etc.)
3. Revenues are used for reducing public transport subsidy financed by general taxes
4. Revenues are used for reducing public transport fares
5. Revenues are used for public transport infrastructure improvements
6. Revenues are used for environmental improvement schemes.

The third question was used to set seven ways of collecting the charges in order of preference. The options were:

1. You pay a toll of 1 EUR in cash each time you enter the area/city centre/ etc. There is a certain delay at the entrance point (as in National Toll Roads).
2. A prepaid card valid for one day costs 2 EUR and gives you unlimited number of entries.
3. A prepaid card valid for on month costs 40 EUR and gives you unlimited number of entries.
4. A kind of credit card (electronic) where charges will depend on the number of times you enter the area/city centre/ etc. (unit cost is 1 EUR). You will receive the bill at home every month (like a telephone bill).
5. A prepaid electronic card where each time you enter the area/ city centre/ etc. its value will be automatically decreased by 1 EUR.
6. A prepaid electronic card as above. The card can also be used to pay for parking charges, public transport fares as well as other municipal uses (such as swimming pools, libraries etc.) and other general uses (telephones etc.) (electronic purse).
7. A monthly Transport Card costs 50 EUR. You will be able to use the card for unlimited travel by public transport and to enter the area/ city centre/ etc by private car.

In total 2155 valid responses were obtained from current car users in the eight cities. Table 6.1 summaries the information about the data collected.

Table 6.1 Information about the “Before” survey data

	Athens	Madrid	Como	Leeds	York	Helsinki	Göteborg	Graz	Total
Sample size	304	234	279	399	363	278	184	114	2155
Trip length Mean (km)	10	25	10	20	22	12	18	11	
Time min	8	8	2	10	20	16	2	3	
Time max (minutes)	288	131	355	140	48	175	252	156	

The results of the “before” survey are given here for the total sample of 2155 car user respondents in all eight **TransPrice** cities.

The results on the justification for road use pricing are given in Figure 6.1. They indicate that the respondents in general considered road use pricing to be justified according to all criteria presented. The highest justification (66%) is due to reduction of air pollution, followed by improvement road traffic conditions (64%), public transport improvements (63%), better conditions for pedestrians (60%) and energy saving (50%). The case against is supported by a minority of 25-32% with road use pricing being unjustified for energy savings (32%) followed by conditions for pedestrians

(29%), improvement in road traffic conditions (28%), reduction of air pollution (27%) and public transport improvements (25%). A proportion of 8-19% of the respondents did not express an opinion.

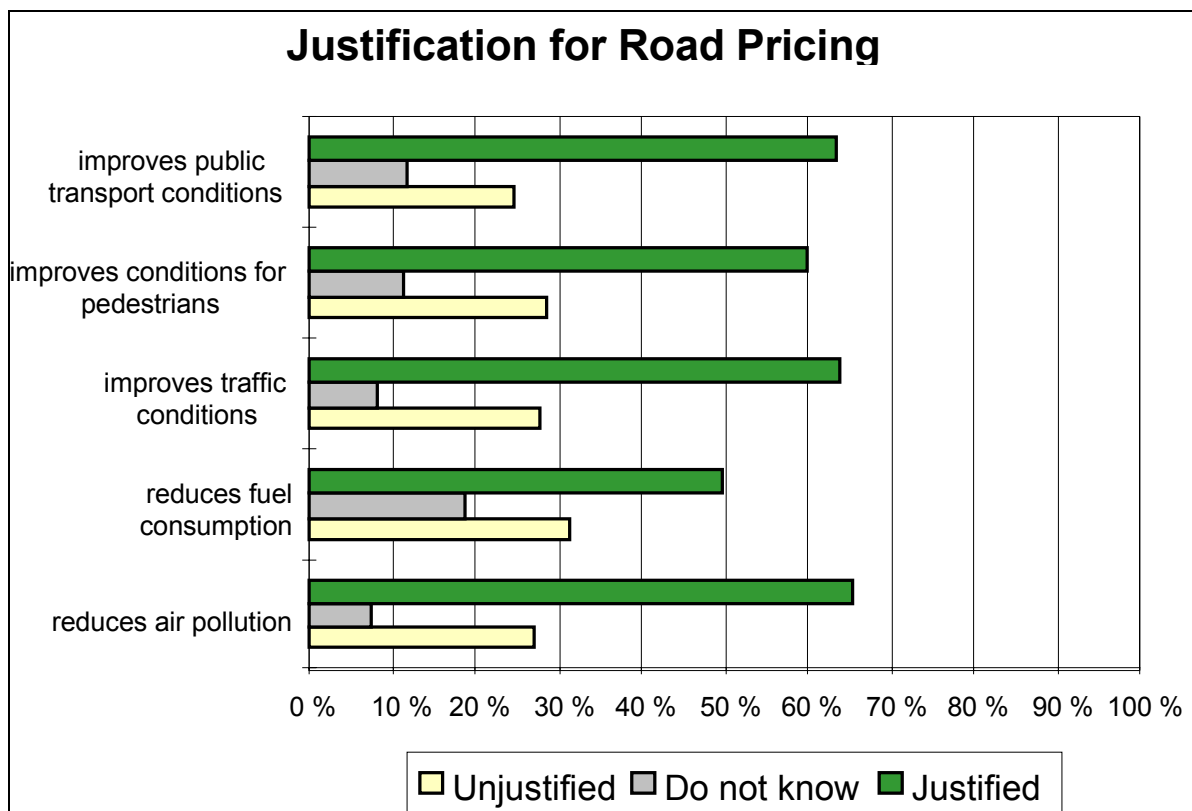


Figure 6.1: Justification for Road Use Pricing

Regarding the opinions on the allocation of road pricing revenues, the results are given in Figure 6.2. The vast majority of respondents considered investment in public transport systems as a top priority (79%), followed by investment in facilities to improve road traffic conditions (76%), environmental improvements (73%), reducing public transport fares (65%), reducing public transport subsidies (49%) and least agreed to support the state or municipal budget (20%). The latter was also the most unjustified use of revenues (65% against), followed by public transport subsidies (31%), lower public transport fares (22%), improvement in traffic conditions (16%), environmental improvements (15%) and public transport investments (13%). It is clear from these results that public acceptability of urban road pricing is found to be much higher when the resulting revenues are allocated to public transport, road traffic facilities (remembering that the respondents are car drivers) and environmental improvements.

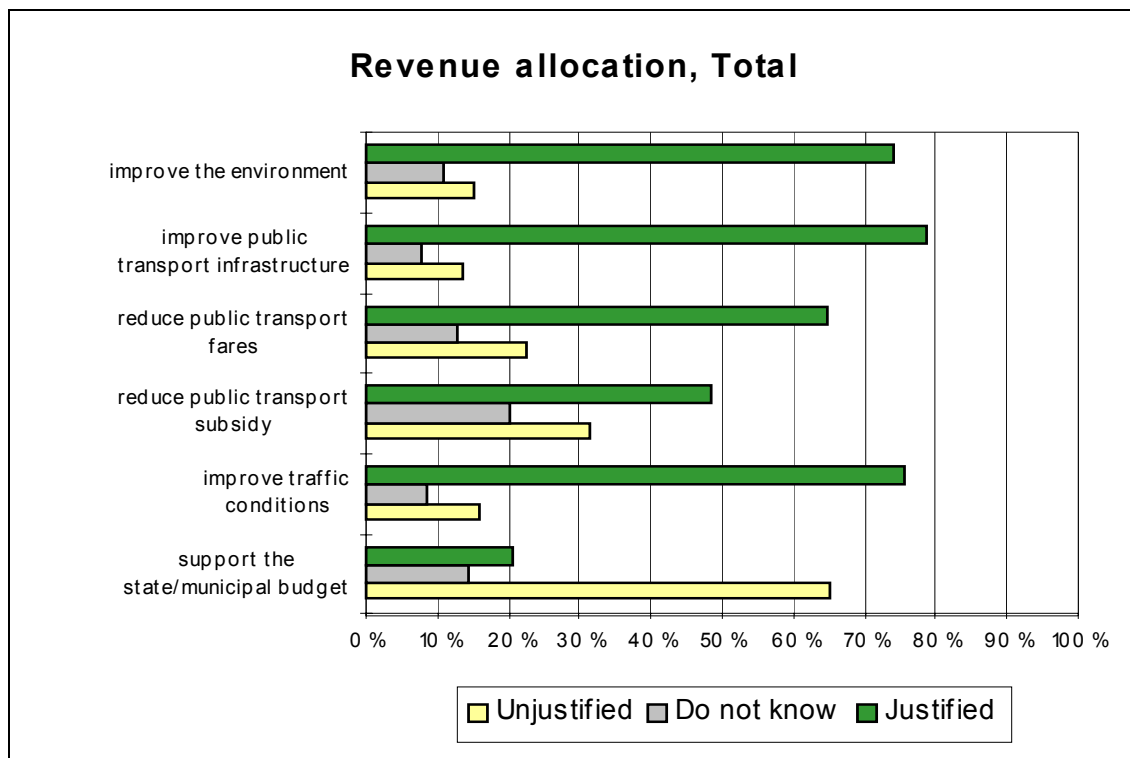


Figure 6.2: Preferred Revenue Allocation

The most popular method of payment for road user charges was a prepaid electronic card which can be used for other purposes as well. The least popular method of paying a toll was by paying in cash (Figure 6.3).

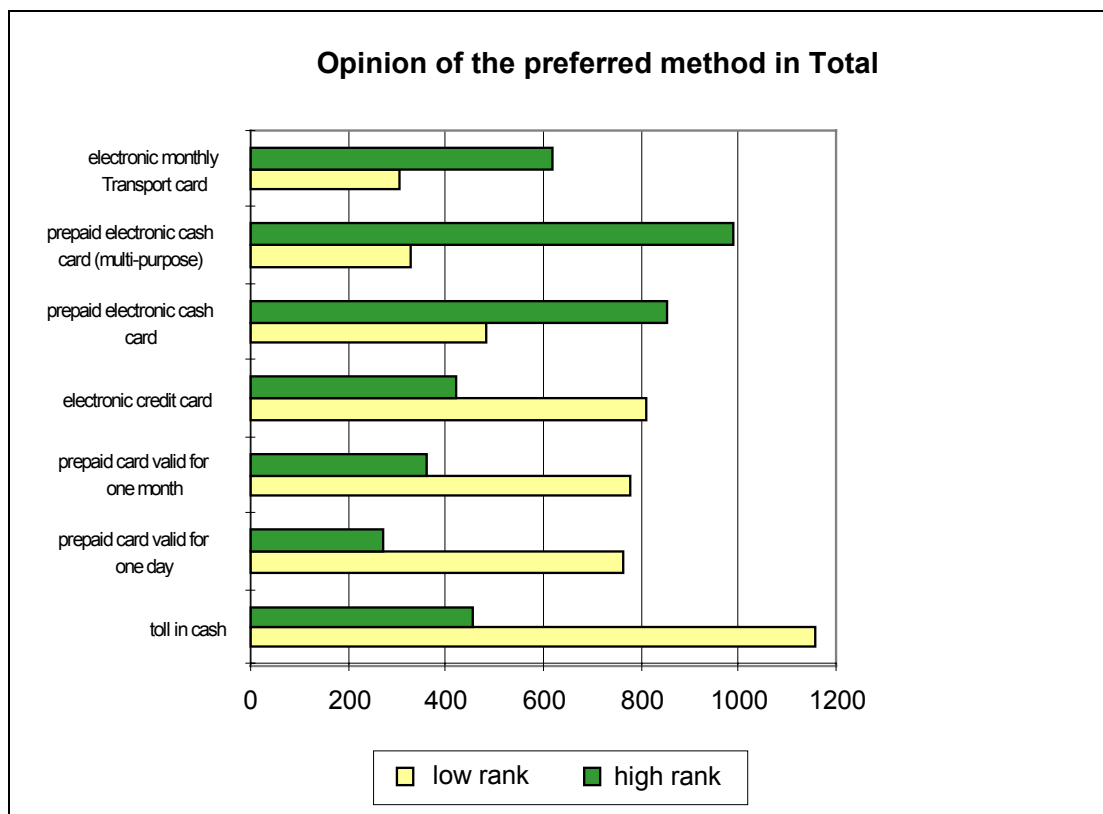


Figure 6.3: Opinion of the preferred method of collecting the charges, all respondents total

6.2.2 Results from the “After” Surveys

This survey was carried out after the demonstrations in 1998. It involved the following issues:

- **Problem perception:** Peoples perception of traffic related problems like e.g. congestion, air pollution, parking problems and safety;
- **Information** about pricing and Travel Demand Management (TDM) options;
- **Acceptability** of pricing and TDM options;
- **Equity:** respondents' perceived costs and benefits expectations;
- **Intentions:** respondents' intentions if the use of urban roads will be charged.

The survey questionnaire had two different parts:

- a) a common part with common questions; and
- b) supplementary city-specific questions which could be customised to take account of the particular needs of specific cities.

The following pricing and TDM measures had to be evaluated by the respondents:

- reducing parking space,
- increasing parking cost,
- cordon pricing ("Making drivers pay to use the roads if they enter e.g. the inner city")
- distance based pricing ("Making drivers pay dependent on the distance travelled by car")
- congestion pricing ("Making drivers pay only when on congested roads (a variable amount depending on the level of congestion"),
- improving public transport,
- park & ride,
- access restriction ("Restricting driving in various areas of the city (except residents and delivery vehicles"), and
- transport package ("Package approach) which considers revenue allocation.

Furthermore in some cities a specific measure was considered, viz:

- **Como:** automatic access control for residents and parking pricing for visitors,
- **Madrid:** HOV lane pricing option (ie HOT lane)
- **York:** travel card for parking and all bus services including Park & Ride .

In total 1459 valid responses were obtained from six cities (the five demonstration sites plus Graz). The whole *TransPrice* sample contains the following number of respondents and division according to gender:

Table 6.2 “After” Survey Sample Sizes

	Total	Athens	Madrid	Como	Leeds	York	Graz
Sample size	1459	116	239	177	300	91	536
female	629 (43.1%)	47 (40.5%)	78 (32.6%)	70 (39.3)	110 (36.7%)	48 (52.9%)	276 (51.3%)
male	830 (56,9%)	69 (59.5%)	161 (67.4)	107 (60.7%)	190 (63.3%)	43 (47.1%)	260 (48.5%)

The most pressing problems in the six European cities were traffic congestion and a lack of parking spaces. On average roughly 80% of all respondents perceived these as being problematic. The respondents were also aware of environmentally related problems. In particular air pollution was seen as a problem. The problem perception is higher in large cities and also in southern cities. Unsafe roads was found a specific problem in large cities.

From different pricing and TDM measures the highest acceptability was given to improvements in public transport, park & ride and access restrictions. Road pricing methods, restricting parking space were generally poorly accepted. It has to be noted that people generally have too little information of price-based measures, as Table 6.3 shows.

Table 6.3 Information about demand management options (in per cent)

Pricing and TDM measure	know a lot about this scheme	know somewhat	know nothing at all
reducing parking space	15,6	34,7	49,7
increasing parking cost	17,6	41,4	41,0
cordon pricing	11,6	44,9	43,4
distance based pricing	6,5	21,7	71,7
congestion pricing	7,4	17,3	75,1
improve public transport	31,5	50,7	17,8
park & ride	31,2	43,7	25,0
access restriction	27,5	49,9	22,6

Table 6.4 Acceptability of demand management options (in per cent)

Pricing and TDM measures	absolutely not acceptable	not acceptable	acceptable	absolutely acceptable
• Reducing parking space	43,4	37,4	12,4	6,8
• Increasing parking cost	50,4	34,0	11,3	4,3
• Cordon pricing	51,5	32,0	12,0	4,4
• Congestion pricing	53,5	32,2	11,1	3,1
• Distance based pricing	58,2	32,4	6,6	2,8
• Improve public transport	2,0	2,1	30,1	65,8
• Park & ride	2,3	5,7	36,9	55,1
• Access restriction	22,6	18,3	40,3	18,8
• Package approach	32,2	24,1	26,7	17,0

Respondents were asked whether, on balance, they would support the following package:

“Charge motorists a fee for driving in the inner city.” and use this money to provide: much better quality and cheaper public transport, plus measures to improve the urban living conditions, plus better facilities for pedestrians and cyclists.”

The results are shown in Table 6.5

Table 6.5 Acceptability of a Package Approach

Traffic demand management measure	Support (in per cent)						
	total	Athens	York	Como	Leeds	Graz	Madrid
<i>Package approach</i> (cordon pricing plus revenue allocation)	45%	64%	53%	53%	44%	41%	36%
<i>Cordon pricing</i>	19%	16%	20%	24%	16%	16%	20%

Compared to the level of acceptability of an isolated (e.g.) cordon pricing measure there was a considerable increase in support for a transport pricing package. In Athens, York and Como the majority of respondents supported a pricing package. An increase in support was also significant in other cities. The next figure shows how the supporters of the package reacted to road use pricing as an isolated measure. A transport package was totally supported by 45% of all respondents whereas 19 % of respondents supported cordon pricing as a single measure.

In this survey it can be seen that support for road use pricing more than doubled when it was presented as the cornerstone of a package of measures that improves alternative modes of transport and provides a safer and more pleasant environment.

6.3 Political Acceptability

Political acceptance of trans-modal urban transport pricing measures has not been high, and in the case of road use pricing very low. The lack of political willingness to implement pricing measures stems from a perceived low acceptance of such measures by the electorate. In some cases public acceptability appears to be almost adequate, but still there is no political willingness to implement a trans-modal pricing scheme, particularly involving a form of road use pricing. However, there are currently several slow but consistent and promising changes taking place in several EU member states and in the *TransPrice* cities in particular, that indicate an increasing political acceptance of pricing measures, some of which are given below.

- The publication of a Green Paper by the Athens Urban Transport Organisation which includes a proposal for funding public transport improvements through charging private car use.
- The publication of a White Paper in Britain that proposed powers for local authorities to introduce congestion charging and workplace parking charges, also accepting hypothecation of revenues for local transport investment. Leeds City Council has given political approval for a trial of workplace parking payment system based on electronic fee collection.
- Acceptance by a committee appointed by City of York Council for all measures demonstrated in York during the *TransPrice* project (change to city centre parking and Park & Ride tariffs, introduction of multi-service smartcards, changes to generalised costs in favour of public transport).

Following the publication of the OASA Green Paper and the ensuing debate, latest legislation introduced in December 1998 includes a provision for allocation of part of the revenues derived from bus lane violation fines to public transport, thus establishing the principle of hypothecation of revenues from car user charges to public transport improvements. This has been accepted politically. However, any form of road use charging in Athens will have to wait until after the completion of EMU and the opening of the new Metro lines around 2001. There is another major target year for Athens: the Olympic Games of 2004. Given:

- the high expectations and pride of the Greek public for the second Olympiad of the modern era in Athens and the necessary environmental improvements not just during the Games but during the period leading to 2004
- the operation of the two new Metro lines from 2000-2001 and the resulting freed road capacity
- the introduction of the Euro (EUR) as single currency in 2002
- the need for further transport and environmental investments in connection with the 2004 Olympics,

the time to strike with the implementation of a road use pricing scheme in order to secure maximum political acceptability will be between 2002 (EMU completion) and 2004 (Olympics). An "Olympics" road user charge could be introduced in Euros (EUR) by 2003 (at least one year before the actual Games) and then retained thereafter, if found effective as a demand management and revenue raising trans modal pricing measure.

TransPrice

This kind of packaging and promoting road user charging as a necessity due to exogenous reasons and/or a wider strategy may be followed in other cases to increase acceptability. The issue of completion of EMU applies to most EU countries, as it is unlikely that a new road user charge will be implemented before Euro becomes the single currency in 2002 for both operational and fiscal reasons.

Parking charges, Park & Ride, integrated public transport ticketing and smartcard payment systems have a substantially higher political acceptability than road use pricing. The hypothecation of revenues from road user charges, a key requirement for the trans modal pricing and financing concept of ***TransPrice***, is now more politically acceptable in several EU member states. The ***TransPrice*** user surveys have provided guidance on how public acceptance can be increased through a trans modal, package approach and this could in turn increase political acceptability of trans modal, integrated transport pricing measures in European cities.

7. Evaluation

7.1 Evaluation Methodology

The common evaluation framework adopted involved **Functional Evaluation** at local level, and **Multi-Criteria Analysis (MCA)** at “global”, pan-European level.

The **functional evaluation** was aimed at analysing to what extent **TransPrice** measures serve the specific objectives of the transport policies at a local level. Factors such as mobility characteristics, population segment affected by the measure, quality of the transport offer, and more particularly, congestion levels have been considered. This evaluation also made it possible to compare the different transport measures or options within the same area. In some cases, the functional evaluation dealt with only one measure that has been applied for different pricing levels. The results from this analysis revealed which measure turns out to be the most effective one at a local level. However, this approach does not lend itself to contrasting different cities, since the characteristics observed in any of them appear to be considerably distinct.

The comparative analysis between sites and pricing measures was conducted at pan-European, or “global” level following a **multi-criteria methodology**. Moreover, results obtained from the MCA evaluation helped to assess the effectiveness of **TransPrice** measures and options in different cities, both globally (social utility value function), and individually for the different evaluation criteria.

At both evaluation levels, it was essential to adopt an approach that should allow homogenising results for later comparison. The approach adopted can be outlined as follows:

- Short-term evaluation at common level for all sites (appraisal of the various impacts of the measures examined, if these measures were implemented at present).
- Impacts on the target area (the study area, ie the urban area where the measures were considered to apply).
- Decision Value functions were positive: range from 0 to +1 (all indicators related to the selected criteria were normalised to a value between 0=worse performance and +1=best performance, for the purposes of the multi-criteria analysis).
- Only direct effects of **TransPrice** measures were taken into account (ie indirect effects were excluded, eg employment opportunities, shopping turnover).

Multicriteria analysis was applied in order to rank the scenarios proposed for each test-site that has been included in the **TransPrice** project by means of a weighted sum. This analysis dealt both with the modelling simulations and with the demonstrations.

The first step in the evaluation framework was to draw up a criteria set with related indicators as show in Table 7.1.

Table 7.1 Criteria and Indicators Set				
	Level 1	Level 2	Specific indicator	Units
Root	1. Economic indicators	1.1. Costs and benefits	-	EUR
		1.2. Time savings	Total travelling time	veh*h
		1.3. Safety	Accidents	EUR
	2. Financial profitability	Financial profitability	-	EUR
	3. Energy efficiency	Energy efficiency	Fuel consumption	Litres of fuel
	4. Environmental impact	4.1. Air pollution	Emissions of pollutants	kg CO, NOx, ...
		4.2. Noise	Variation in affected people	(veh*km)
	5. Accessibility and land use	5.1. Accessibility	Relationship jobs-inhabitants	inhabit.*jobs
		5.2. Land use	Trend in land use	-
	6. Equity & acceptability	Acceptability survey	-	-

Each indicator used in the evaluation matrix has to be converted into a value between 0 and 1. The multicriteria analysis framework affords the use of a “value function” to be defined for each indicator. The value function is intended to provide a measure of the degree of satisfaction produced by the indicator: maximum satisfaction gives a 1 value, while minimum satisfaction yields a 0 value. In order to simplify this step, all value functions are linear having two straight-lines that correspond to the negative and positive values of the indicator respectively.

A new matrix, $\mathbf{U} = [u_{ij}]$, is obtained (“normalised matrix”) after the application of the value function. The element u_{ij} represents the “value” produced by scenario j with respect to indicator i , and it is contained in the range 0–1.

The value function matrix \mathbf{U} is to be multiplied by a vector matrix \mathbf{W} , which includes the relative value of each indicator within the global MCA analysis of each measure.

A two-round Delphi procedure was designed to determine, among **TransPrice** partners, which weights should be applied. After the first round of results, each partner received as input for the second round the average of all partners weights, and their corresponding variation range. Then, they assigned a second value that might or might not correct the first score. Finally, a global value was determined to calculate the average of all second round weights.

The procedure is iterative until an acceptable convergence range is reached. The results of the two steps are shown in Table 7.2

Table 7.2. Delphi Weighting Table

Concerns & indicators		1 st step		2 nd step	
		Average	range	average	Range
1. Economic	Cost and benefits	14	6-25	13.5	10-20
	Time savings	11.5	5-20	11.5	8-18
	Safety	10	4.5-20	11	5-20
2. Financial Profitability		10	5-17	10	5-13
3. Energy efficiency		5.5	0-15	6.5	4-20
4. Environmental Impact	Air Pollution	10.5	5-25	10	3-20
	Noise	6.5	2-10	6	3-10
5.1. Accessibility		11.5	5-20	11	5-15
5.2. Land Use		7	2.5-14	7	5-10
6. Social Equity and Public Acceptance		13.5	6-27	13.5	6-26
Total		100		100	

7.2 Multi-Criteria Evaluation Results

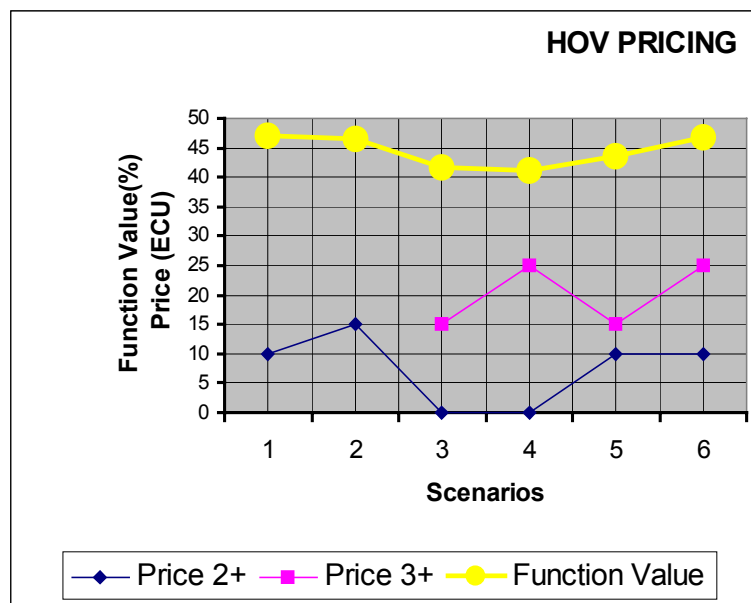
The results from the multi-criteria evaluation are given in Table 7.3 for various pricing measures and are discussed below.

Table 7.3 Value Function (social utility results)		
Value function results (%)		
	Average	Range
HOV pricing	44	41-47
Parking pricing	58	50-65
ROAD PRICING	A) Cordon Pricing	59
	B) Area Pricing	58
	C) Other measures	64
	Distance based	55
	Delay based	65
	Time based	71

- **HOV pricing**

HOV pricing implies the existence of an HOV lane operating for cars with at least 2 occupants, which can be made available to solo drivers at a price (ie turning the HOV lane into a HOT: High Occupancy Toll lane). If the HOV lanes operates for multi-occupancy cars, the HOT option could be available for cars with a lower occupancy (ie if the HOV is for 4+ persons/car, the HOT option could be there for cars with 3, 2 or 1 occupants).

This type of measure seems to be less effective when trying to achieve *social utility goals*. It is responsible for negative values in some indicators (socio-economic, financial, energy efficiency), and liable for poor results in others. The range observed in the *value function* entails that, if viewed from a broad social perspective, the measure has not positive effects. The best results can be obtained when pricing levels are higher. However, some very good results are also obtained when the access to 3+ cars is forbidden. It should thus be highlighted that is essential to carefully establish different pricing options in order to get good results. In this particular case, variation in value functions is not really significant. This is in part a consequence of the experiment having been conducted exclusively in Madrid; thus, the circumstances of the Study Area stand out as identical. On the other hand, the different pricing and management schemes are responsible for just a slight variation in the evaluation global results, even though their effects on some indicators do have a significant impact. This guarantees that the introduction of HOT schemes brings about approximately the same social effects in any of the possible strategies.



- **Parking Pricing**

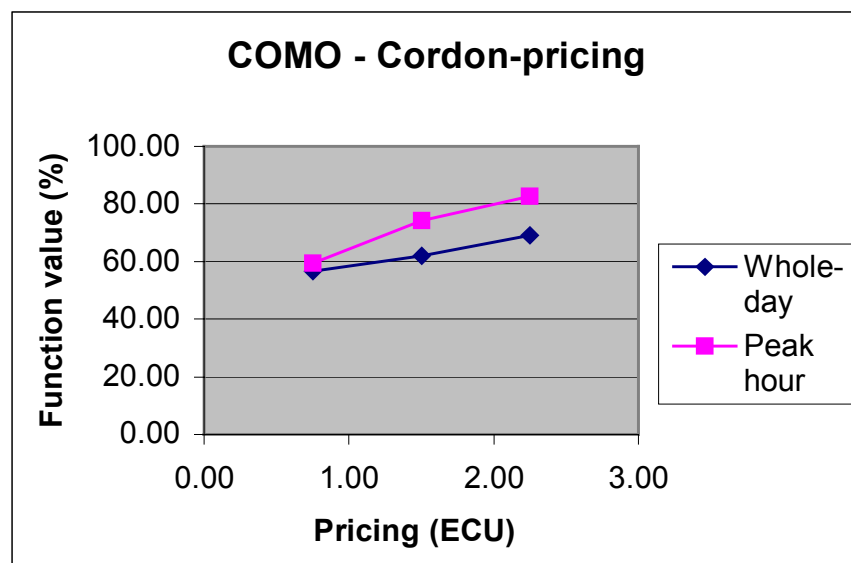
Parking pricing proves considerably effective in all the cases, and produces medium to high results. Furthermore, differences in tariffs seem to have low impact, which suggests that the implementation of pricing measures in any given city always has an effect that can be regarded as positive and with roughly similar range. However, it seems more sensible to consider parking pricing along with other associated measures. The case of Como further reveals that a variable pricing scheme is always preferable to a constant one. We can therefore assert that parking pricing measures should be considered in the first place as a useful tool of traffic demand management than can be enforced in any city or circumstance.

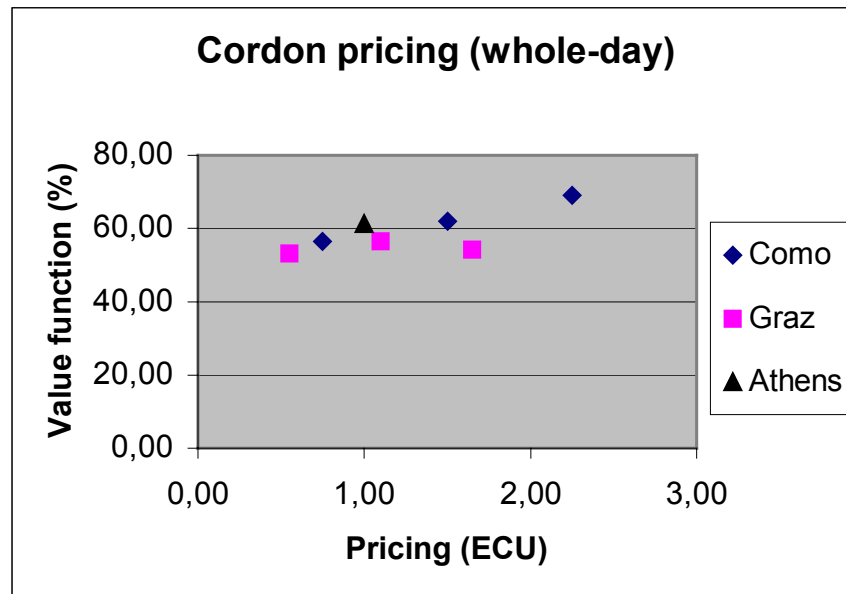
- Road Use Pricing

A) Cordon pricing

Cordon pricing yields rather homogeneous results, always over the threshold of positive *social utility values*. On a general basis, it can be affirmed that the higher the charge level, the higher the social effectiveness. However, it is clear that different pricing policies can alter the effectiveness of this measure. In Como, for instance, a rise in prices is linked to better results. Additionally, peak hour pricing produces better results than all-day pricing. In the case of Graz, the most effective scheme is registered with lower prices, although it proves less effective with the application of medium or high level prices. In Athens, the effectiveness level remains virtually the same for the inner cordon pricing scheme, and for both the internal and the external cordons considered jointly. This fact suggests that the key point is to control access to the inner area, always suffering from the most serious congestion problems.

In the light of the prior points, it can be affirmed that cordon pricing measures are generally liable for positive effects. However, it takes a careful and thorough design process to choose the most appropriate fare level together with its variation for the different time-slices.





B) Area Pricing

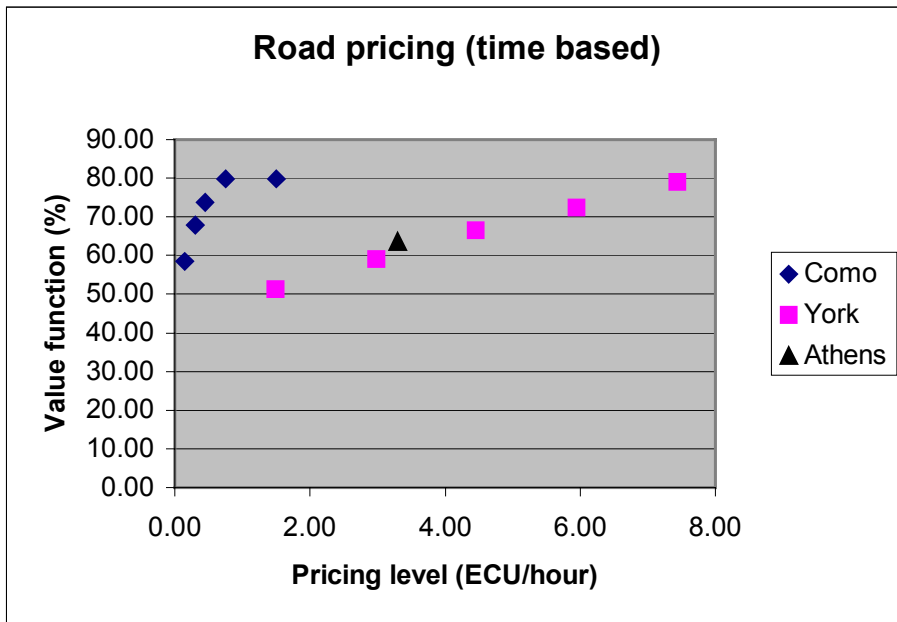
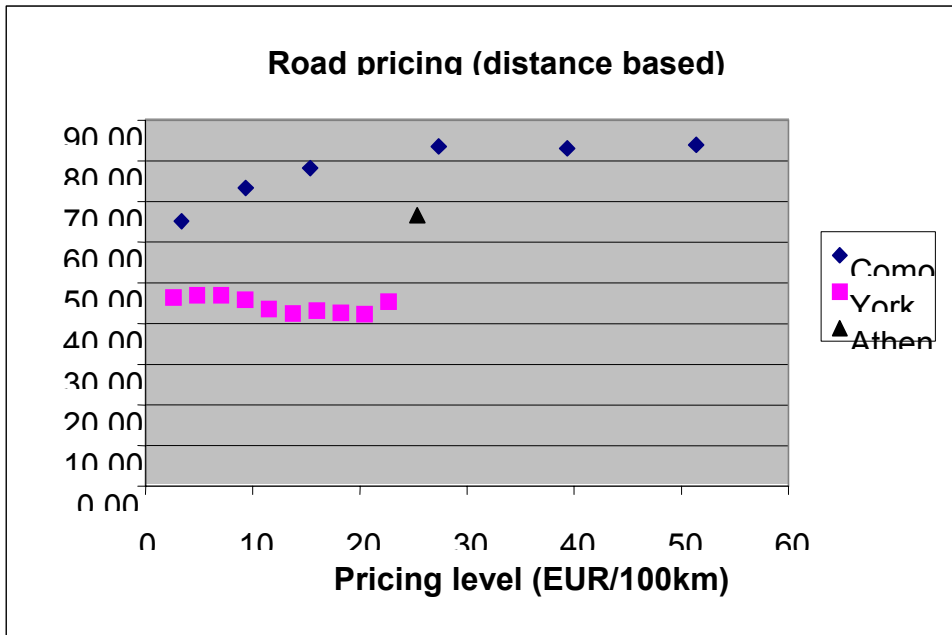
Area Pricing has been properly tested only in Leeds (combined entry and parking charges). The social utility of the measure is rather the same in all scenarios. This means that the main impact is caused by the pricing measure itself and it is quite independent of the accompanied measures.

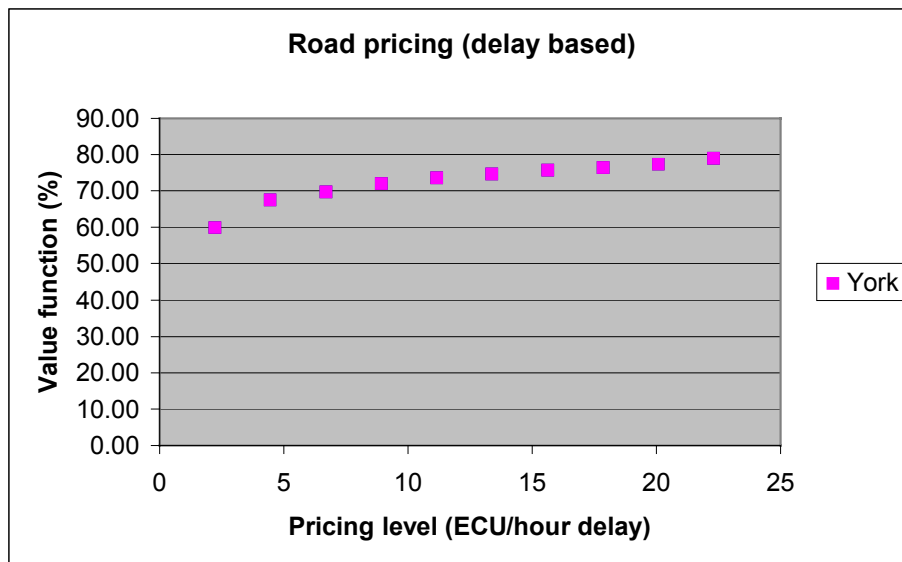
C) Other road use pricing measures

With the only exception of the York distance-based scheme, all scenarios produce very good results. Thus, evidence points out to *road use pricing* as the most effective pricing measure. Among the various types of *road use pricing* already tested, it seems obvious that those based on travel time, either global time or delay-based, yield the most satisfactory results. These types score an average 71 to 65% respectively, and a maximum value of 80%.

Nevertheless, there are big differences among measures depending both on price levels and on the pricing scheme. Those differences (shown in the following figures) reveal that the higher the price the more effective the measure. In the case of Como, the threshold is 20 EUR/100 km for distance-based, up to which effectiveness grows very rapidly and beyond that only marginally. The equivalent threshold is 1.5 EUR/hour for time-based charging in Como.

Therefore, it can be affirmed that these measures may be highly effective, provided that great attention is paid to the implementation scheme and to the general circumstances of the Study Area, as much as to the right toll level for each different case.





In Athens, the effectiveness of the central cordon proves higher than that of its outer counterpart, and appears to be almost equal to both of them considered jointly. As for the other road pricing measures, their effectiveness runs analogous to the outcome obtained with cordon pricing.

In the case of Como, cordon pricing during peak hour time yields better results than the implementation of the same measure during all-day period. These results are similar to those fixed for the other road pricing measures, specially with higher fares. On the other hand, parking measures prove considerably positive, but less effective. It can then be affirmed that, if we are considering a relatively small city with a reduced Target Area and with seasonal demand (tourists), we could reasonably expect to get consistently better results by applying tailor-made measures of road pricing than by implementing traditional parking pricing measures.

Modelling of the different scenarios in Graz evinces that the effectiveness of access control to central areas of medium-size cities is to be studiously designed. An optimal cordon tolls level can be observed (scenario A1), with less effectiveness either by increasing or reducing it. Moreover, modelling highlights the fact that, by favouring users who are oriented towards the main commercial activity in the area (scenario B), we can obtain better results than by taking generic measures (scenario C).

Results collected in Leeds reveal that those pricing measures endowed with the appropriate fee level to be applied in big cities show constant average effectiveness, even if conditions for their implementation are slightly modified.

In Madrid, both two tested measures appear to be rather different. In the case of HOT, quality of results drops as the number of HOV increases. This measure is intended to control demand, and yields economic benefits fundamentally. Owing to this fact, the most convenient scenarios are those with the lowest vehicle flows and the highest fees. On the other hand, the parking pricing experiment affects a much more limited Study Area, generating thus reasonably good results, if viewed from a social standpoint.

The same can be said of the York parking pricing test, since it generates good results in all cases, being even better those corresponding to the highest fares. The modelling of a comprehensive number of road use pricing scenarios (time based, delay based and distance based) reveals once again the vital role of adopting both the correct strategy and the appropriate level of fares. The several “distance-based” alternatives turn out less effective and oblivious to the type of fare imposed. This could be explained by the fact that in small cities distance is normally a rather homogeneous variable for all trips -mean distance remains homogenous by and large-. However, pricing strategies that fluctuate with congestion or trip times prove much more effective and dependent on fare levels.

Summing up, we can conclude that the impact of pricing measures plays a variable part depending on the urban area. More particularly, in smaller cities the design of pricing measures appears to be more relevant, whereas in bigger cities the results obtained follow a rather homogenous pattern. Finally, as they can be oriented to target groups, accompanied/additional measures have a considerable impact on results in small cities. A converse trend can be observed in big cities, where these measures have little impact on the results of *global social utility*.

7.3 Sensitivity Analysis

In order to test the reliability of the MCA methodology, the influence of some possible variations on the weights given to the different criteria has been tested. We have decided to test two different extreme changes in the weights of the indicators.

• ***Test 1: higher Financial Profitability and lower Social Equity and Public Acceptability***

Firstly, we have checked the possibility of evaluating the pricing measures oriented to get revenues. Then the weight of *Financial* Indicator (P) was raised from 9.824 to 19.824. By contrast the *Social Equity and Public Acceptability* Indicator (EA) was reduced from 13.647 to 3.647. The new value function results are summarised in Table 7.4. The results indicate that *value function* results remain at similar levels; there are some lower values for HOV pricing, and road pricing (time based), some higher for road pricing (delay based) and parking pricing, and the rest remain at the same level.

Table 7.4 Sensitivity Test 1 Value Function	
Value function results (%)	
Average	Range

HOV pricing		42	38-45
Parking pricing		60	52-67
ROAD PRICING	A) Cordon Pricing	58	46-83
	B) Area Pricing	57	54-58
	C) Other measures	63	44-81
	Distance based	57	44-81
	Delay based	72	59-79
	Time based	66	50-80

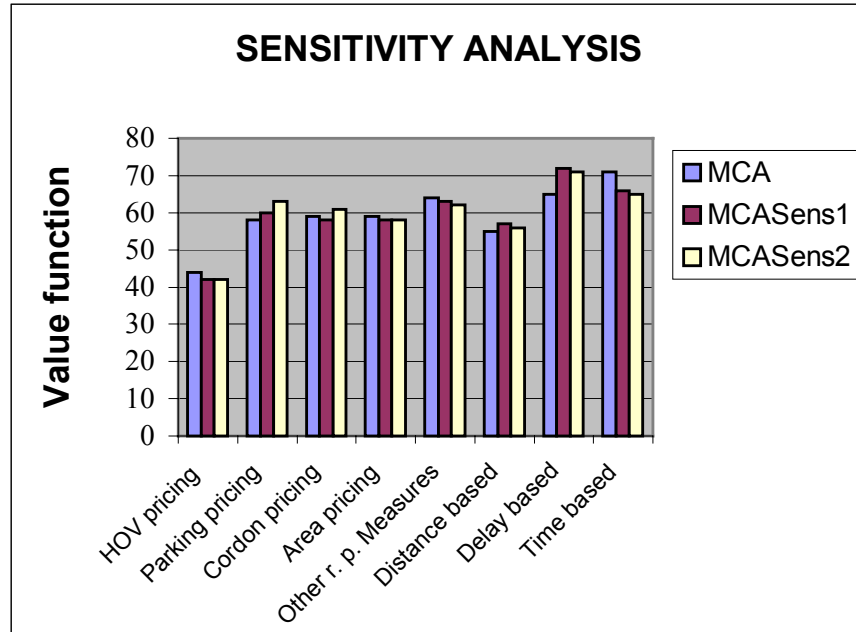
• **Test 2: higher Environmental Impact and lower Socio-Economic**

The second test has been focused on attaching more importance to environmental issues while reducing the weight of time saving within the Socio-Economic set of indicators. Therefore, we have increased the API indicator (Air Pollution Index) from 10.069 to 17.069 and the N indicator (Noise) from 6.294 to 9.294. Consequently, we have reduced the weight of TS indicator (Time Saving) from 11.647 to 1.647. The results are summarised in table 7.5. As in test 1, there are some changes in *value function* scores. The results have the following trends: lower values for HOV pricing and road pricing (time based), higher for parking pricing, area pricing and road pricing (delay based) and similar values for the other measures: cordon pricing and road pricing (distance based).

Table 7.5 Sensitivity Test 2 Value Function			
		Value function results (%)	
		Average	Range
HOV pricing		42	39-47
Parking pricing		63	50-69
ROAD PRICING	A) Cordon Pricing	61	51-82
	B) Area Pricing	67	65-69
	C) Other measures	62	41-79
	Distance based	56	41-79
	Delay based	71	57-79
	Time based	65	49-78

It can thus be said that the impact of the measures correspond to the values given in the central case, which are little influenced by variations in the weights of the

indicators. As a consequence the analysis of pricing measures through the designed value functions is consistent and the results correspond to the level of their impact from the point of view of *global social utility*. The results of the two sensitivity tests are compared to the central case in the Figure below.



8. Conclusions and Recommendations for Trans Modal Integrated Urban Transport Pricing Actions and Policies

8.1 General

The evaluation process in the *TransPrice* project aimed to bring together the results from the modelling tests and the demonstrations and comprised two parts:

- Functional evaluation of the pricing measures tested by modelling techniques and demonstrated through either real life applications or experiments, and
- Multi-criteria evaluation.

From the evaluation results, conclusions and general recommendations at pan-European level may be drawn, on the basis of consistent and comparable information.

8.2 Site-specific Evaluation Conclusions

The **Athens** experience (demonstration and modelling) indicate that *road use pricing* measures could be very effective when they are applied in really congested areas in combination with intermodality facilities such as P&R connected with public transport and combined integrated payment. The diversion rate could reach 15-25% modal change to P&R and 5% to Public Transport for charge levels of 1-3 EUR (1.5-2.2 EUR used in the demonstration). The demonstration results compared favourably with the diversion rates output by the mode choice model.

The *Villa Geno* real life test in **Como** shows that a parking pricing policy in a small access-controlled area can reduce car share in favour of pedestrians and bicycles (8% reduction in car trips). Parking pricing or road use pricing measures applied consistently throughout the city could reduce car trips by up to 22% (corresponding to a shift from car mode for some 75% of the priced trips).

The demonstration of Park & Ride with integrated payment in *Las Rozas*, in the western corridor of **Madrid**, indicated that it is possible to divert car trips to public transport but in a small way. In the same corridor several *HOV pricing schemes* were modelled based on a big survey among current HOV users. The results highlight that HOV pricing options can help to introduce demand management policies and reduce solo drivers by 5-20% depending of price level and its application. Willingness to pay a toll in order to use the HOV lane was however found to be low and the impact on modal split was also low.

Two activities have been evaluated in **Leeds**, second largest metropolitan area in England. The introduction of different combinations of *area & parking pricing* schemes has been modelled. They clearly improve public transport use and reduce car trips, saving up to 9% in overall travel time. Test showed some 7408 car trips could change to public transport resulting in a total of 10,874 cordon crossings in the peak compared to 23,228 in the base case, a reduction of 32%. On the other hand, area charges increase flows and congestion along diversion routes outside the cordon.

The real life demonstration in Leeds consisted in the trial introduction of a smart card, multi-service integrated payment system, which was used in 1.1% of parking payments during the test period. Although at first sight this seems a low figure, it is above pre-trial commercial expectations and the system has been judged a success and will be more widely implemented. Of particular relevance are planned public transport applications and the possibility of introducing discounts for smartcard payments and variable parking charges by time of day which modelling results indicate will have a positive effect on modal choice (ie shift of private car trips to public transport).

The introduction of *multi-use smartcards* in combination with changes in Park & Ride and inner city parking tariffs was the real life demonstration in **York**. The aim was to influence modal split through a differential parking charge and to facilitate their use by means of smart cards. City centre parking tariffs increased by 15-25% while Park & Ride charges increased by only 9% in both 1997 and 1998. The impact of the combined measure has been a reduction of inner city parking users of 6,6% and increase of P+R ones of about 12%. The three months smart card experiment indicates good acceptability and better use of parking facilities. The modelling activity carried out in **York** was the introduction of different *road use pricing* strategies. The results indicate the potential of this policy, which could produce up to 25% trip time reductions.

In **Helsinki** and **Goteborg** the measures evaluated were various road use pricing schemes to control access to city centre. In **Helsinki**, for charge levels of 0.7 EUR for cars, overall modal shift of 2.6%-3% from car to public transport is estimated; this means that car trips are estimated to reduce in the whole metropolitan area by around 6%; the share of public transport to the city centre increases by 7.7-9.3%. Cordon pricing and area pricing schemes were tested in **Goteborg** with the additional aim of collecting money to finance improvements in road and public transport systems. In this case a reduction of road traffic volume in the city centre of 5%-22 % is predicted for charge levels of 1.1-2.3 EUR.

The *cordon pricing* tested in **Graz** was combined with improvements in public transport and cycling facilities. Charge levels of 0.6-3.3 EUR were tested. The model results forecast a reduction of 8-26% in car trips when public transport increases by up to 33%. Besides, about 4% of trips are suppressed. These results underline the *package approach* efficiency.

8.3 General Functional Evaluation Conclusions

The main general conclusions from the functional evaluation results can be summarised as follows:

- Road use pricing is an effective way of changing modal split from private car to public transport and park & ride. The Athens road use pricing demonstration indicated diversion rates of 15-25% from car to park & ride and 5% to public transport. Modelling tests for five cities produced city centre traffic reduction of 5-20%, with associated environmental benefits. In the case of Athens where both demonstration and modelling was carried out, a reasonably close result between the two sources was found.

- The effectiveness of the type of road use pricing depends on the city characteristics: distance-based road pricing was found more effective than time-based for Athens but for York and Como the finding was the other way round.
- Significant revenues can result from road use pricing.
- Parking pricing provides an effective way for restraining car trips (assuming that enforcement can be maximised; however, enforcement of road use pricing options is usually expected to be higher than past experience with enforcement of parking control, which is affected by free workplace parking facilities and significant violation rates).
- High Occupancy Vehicle (HOV) lane pricing options, ie High Occupancy Toll (HOT) lanes, have marginal impacts on modal split in a European setting (based on the analysis for Madrid).
- Modal split impacts from introducing integrated ticketing are small, but could be significant over time.
- Smartcard integrated payment systems can support trans modal pricing measures and can have small but significant modal split impacts on their own (especially for Park & Ride).
- Park & Ride facilities and Intermodality improvements can have a positive impact on the performance of pricing measures.

The above conclusions are based on both real life or experimental demonstrations and modelling activities in the **TransPrice** cities. Demonstrations provided actual, observed results of *trans* modal *pricing* impacts in user behaviour due to different pricing schemes, fee structures and payment methods. Modelling activities have provided the possibility of studying more scenarios, different pricing strategies, methods of charging, fee structures, etc.

8.4 Multi-Criteria Evaluation Conclusions

The results from the Multi-Criteria Evaluation show that in **absolute** terms:

- **HOV lane pricing** is effective for some indicators but acceptable social utility is only achieved when congestion level is very high.
- **Parking pricing** is always effective but it must not be an isolated measure; it is rather an accompanying measure.
- **Cordon pricing** is clearly effective when they are applied to congested central areas. To enlarge the cordon pricing scheme to a broader area or to a whole day does not provide much supplementary social benefits.
- **Other forms of Road use pricing (eg distance-based, time-based, delay-based)** are very beneficial for most of the multicriteria indicators.

In a **comparative** way, the results from the Multi-Criteria evaluation show that:

- The highest level of the value function is achieved through cordon pricing (high end of the range).
- In terms of type of road use pricing, on average time-based road use pricing gives the highest level of the value function, followed by delay-based and cordon pricing.
- Parking pricing on average is found to have similar performance to cordon pricing and area pricing.
- Parking pricing is less effective than road use pricing by 17 percentage points when the maximum end of the range is considered; however, for the minimum end of the range the results show that parking pricing could achieve about the same level of effectiveness as cordon pricing and in some cases surpass the performance of other road use pricing options.
- HOV lane pricing options give the lowest range and therefore they are applicable in special cases only.

The main conclusion from these comparative analysis findings is that road use pricing options should be implemented when parking pricing measures have been proven to have exhausted their effectiveness. The selection of the method of road use pricing is dependent on city characteristics.

The main findings from the Functional Evaluation and the Multicriteria Analysis indicate that urban transport pricing measures have a very different effectiveness. The results also depend on the size of the target area, the price structure and the way of its implementation. The acceptability research reported in Chapter 6 indicated that pricing policies must be part of a package of traffic control and travel demand management/mobility management measures to improve modal shift in favour of public transport and Park & Ride.

8.5 Recommendations

The following recommendations can be made on the basis of the evaluation results:

- Transport pricing measures offer several possibilities of changing modal split in urban areas in favour of public transport, Park & Ride, and non-motorised modes; they can also provide significant revenues for financing appropriate transport systems and environmental improvements.
- Road use pricing should be considered when parking pricing measures have been found to have exhausted their effectiveness.
- Road use pricing should be considered as a part of a package of demand management measures, in order to increase its effectiveness and acceptability.
- Integrated payment systems should be implemented to support the implementation of transport pricing measures; they can have small but significant impacts on their own.
- Intermodality improvements, such as Park & Ride and integrated ticketing should be implemented together with transport pricing measures in order to enhance the impact of pricing measures.

- An effective *trans* modal integrated urban transport *pricing* strategy should combine packages of pricing measures, payment systems, intermodality and public transport improvements, in a comprehensive transport planning and management framework towards sustainable mobility.

8.6 Concluding Remarks

The **TransPrice** project has attempted to shed light on the impacts of *trans* modal integrated urban transport *pricing* measures, including various forms of urban road use pricing, parking charges, public transport fares and ticketing, as well as supplementary measures such as park & ride, generalised cost changes through public transport priority, smartcard integrated payment systems. The project coincided with major policy initiatives at EU Level (Green Paper on Fair and Efficient Pricing, White Paper on Fair Payment for Infrastructure Use, Developing the Citizen's Network) as well as at national level (eg British White Paper on Integrated Transport, Greek Green Paper on Urban Transport for Athens). The **TransPrice** consortium feels that it has made a significant contribution to a field of knowledge that is rapidly developing and that it will have serious policy implications for European cities in the early 21st century. Some relevant issues have been resolved in this project, while others need further research.

We would suggest that following issues have been reasonably resolved:

- Demonstrations with limited sample have given generally positive results
- Public and political acceptability can be enhanced through appropriate use of road pricing revenues
- A Combination of measures (pricing and other demand management) is desirable.

Based on the review of previous and current research, the authors consider that further research is needed on the following topics:

- Large scale demonstrations with real payment
- Demonstration of revenue allocation (from road use pricing to public transport or environmental improvements)
- Comparable evaluation of various forms of road use pricing (cordon, corridor, distance-based, time-based, delay-based congestion charging, etc)
- Land use impacts assessment (longer-term issue)
- Balancing of revenues with additional public transport capacity costs
- Economic, social and environmental impacts assessment.

The **TransPrice** project has benefited through interaction with other EU 4th Framework projects, in the Joint Scientific Committee on transport pricing (joined in April 1997) with representatives from the projects PETS, QUITTS, EUROTOLL and TRENEN and in the CAPRI concerted action (from 1998). Other relevant projects have also been involved in the TransPrice Workshops and in exchange of material (eg OPTIMA, FATIMA, AFFORD, FISCUS, DANTE). A consensus appears to

emerging that urban transport prices need a transformation which will also transform transport system and urban finances.

Finally, if sustainable mobility is the target for the 21st century, somebody should pay the price: the user. "Paying the price" for sustainable mobility is used with all three possible meanings, ie:

- handing over the correct price (through appropriate payment systems)
- bearing the (real) cost of transport
- suffer or be punished (through congestion and environmental damage, if the real costs are not borne by the user).

Transport prices may be paid at present but not necessarily by the right actors and not at the correct level. "Paying the price" could be through proper, integrated and *trans modal pricing* measures and payment systems, as the **TransPrice** project suggests, or through more congestion and environmental damage (as the past trend has been). The choice of appropriate pricing measures exists, and it is a matter of adopting them into policies towards sustainability. It is hoped that the **TransPrice** project results will be further applied and exploited in wider, integrated demonstrations and policy development at local, national and pan-European levels.

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