DIFFERENT

User Reaction and Efficient Differentiation of Charges and Tolls

DELIVERABLE D10.2

POTENTIAL EFFECTS OF DIFFERENTIATED USER CHARGES ON INTERMODAL CHAINS AND MODAL CHANGE

Due Date:	April 2008
Submitted:	30 April 2008
Main Author:	ILiM
Dissemination:	Public Report

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006), Priority 6.2 Sustainable Surface Transport

Contract number 019746

Project Start Date: 1 May 2006, Project Duration: 26 months

Document Control Sheet

Project Number:	019746		
Project Acronym:	DIFFERENT		
Workpackage:	WP 10 Intermodal chains and modal change aspects for freight an passenger transport		
Version:	Final V1		
Document History:	Version	Issue Date	Distribution
	Draft 1.0	05.02.2008	Peer review and Task partners
	Draft 2.0	08.04.2008	Task partners
	Draft 2.1	24.04.2008	Co-ordinator
	Final V1	30.04.2008	Consortium / Project Officer / Advisory Board
	Final V1.2	03.06.2008	Distributed to EC and partners, published on DIFFERENT website

Classification

This report is:

Draft	
Final	X
Confidential	
Restricted	
Public	X

Partners Owning:	All
Main Editor:	Freight part: Włodzimierz Rydzkowski (ILiM), Marcin Hajdul (ILiM), Passenger part: Peter Bonsall (ITS)
Partners Contributed:	Freight part: Angelo Martino, Cosimo Chiffi (TRT), Riccardo Enei (ISIS), Gordon Wilmsmeier (Tri) Passenger part: Peter Bonsall, Dorota Ksiazkiewicz, Gordon Wilmsmeier, Bill Lythgoe and Dan Johnson
Made Available To:	All DIFFERENT Partners / Project Officer / Advisory Board / Public

DIFFERENT Project Office

Transport Research Institute
Napier University
Edinburgh, UK
Tel: + 44 131 455 3202
e-mail: H.Condie@napier.ac.uk
Web: www.different-project.eu

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Deliverable 10.2 summarises work carried out within WP10 - Intermodal chains and modal change aspects for freight and passenger transport. The aim of WP10 was to estimate the effect that differentiation of transport infrastructure user charges might have on modal split for transport of goods and people.

Analysis of the potential for changes through price differentiation in intermodal chains, modal split and city logistics was carried out via:

- intermodal cost comparisons
- analysis and cross-comparison of costs and cost elasticities found in WP5 to WP8,
- case studies and interviews with stakeholders,
- theoretical discussion based on the hypotheses created in D10.1.

Figure 0-1 summarises the methodology of work.

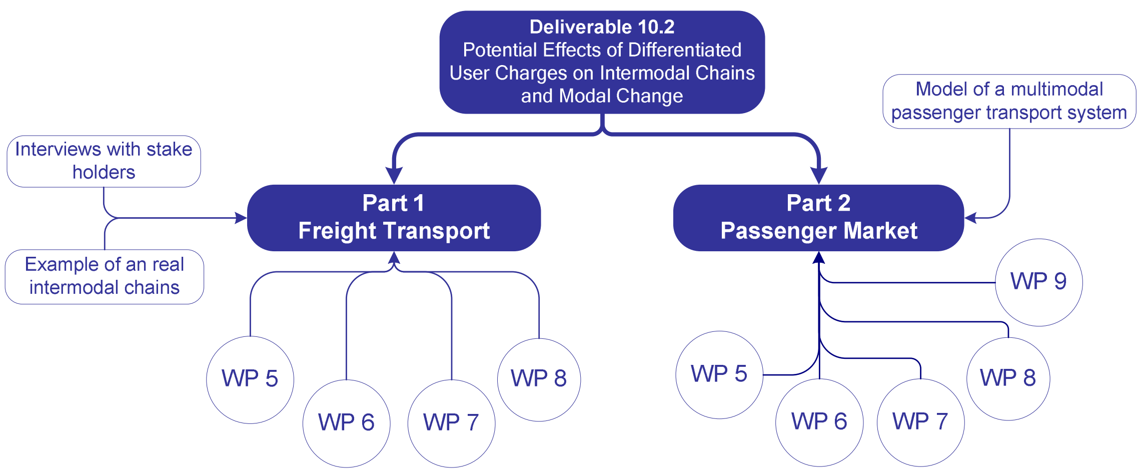


Figure 0-1 Methodology of Work

Eight hypotheses on the effect of price differentiation on mode use were set out in Deliverable 10.1, namely:

Hypothesis 1. “*Greater differentiation of infrastructure charges (in the ways, and to the extents, currently being contemplated) will have no significant impact on overall mode splits*”

Hypothesis 2. Greater differentiation of infrastructure charges (in the ways, and to the extents, currently being contemplated) will have no significant impact on the usage of intermodal chains”

Hypothesis 3. “*Greater differentiation of infrastructure charges (in the ways, and to the extents, currently being contemplated) will tend to increase the average end user prices for the affected modes and any change in overall mode shares will be attributable to this alone*”).

Hypothesis 4. “*Greater differentiation of infrastructure charges (in the ways, and to the extents, currently being contemplated) will increase the perceived complexity of end user prices and this will result in reductions in the market share achieved by the affected modes (after allowance is made for any change in average end user prices)*”.

Hypothesis 5. “*Greater differentiation of infrastructure charges (in the ways, and to the extents, currently being contemplated) will tend to encourage the use of intermodal chains and* *will achieve a modal split which is more economically sustainable than the status quo ante*".

Hypothesis 6. "*Greater differentiation of infrastructure charges (in the ways, and to the extents, currently being contemplated) will tend to encourage the use of intermodal chains and will achieve a modal split which is more environmentally sustainable than the status quo ante*".

Hypothesis 7. "*The use of environmentally desirable modes can be encouraged by means of commercially sustainable pricing regimes which discriminate in favour of users of those modes*".

Hypothesis 8. "*The use of intermodal chains can be encouraged by means of commercially sustainable pricing regimes which discriminate in favour of users of intermodal chains*".

These hypotheses are explored in Deliverable 10.2 using a combination of evidence from previous studies, new modelling work, and logical deduction.

Part 1 of the deliverable, devoted to freight transport, includes analyses of four real transport processes. The analyses show calculation of real cost and time of transportation on four routes for road and intermodal transport. Then, the comparison was done, which shows that in some parts of the Europe intermodal solution is cheaper than road haulages. Hence, transport costs of intermodal haulages cannot be perceived as the crucial restriction in better utilization of this transport mode. The authors also present other barriers constraining the dynamic development of intermodal transport, especially rail-road.

The next chapter of freight part of D10.2 shows analysis of the potential for changes through price differentiation. This chapter includes results of interviews with stake-holders and representatives of companies which can potentially be beneficiaries of intermodal transport of freight. Analyses confirms that there is a belief that intermodal transport is much more expensive and less efficient than road. However, the simulation done in cooperation with railways operators (presented in the previous chapter) show that, on the four analysed routes, road transport was more expensive that intermodal. Only total intermodal transport time was longer than road.

The hypotheses identified in Deliverable 10.1 were assessed using the simulation results together with the results of the interviews in Poland and Italy and other evidence. It was concluded that, on balance, hypothesis 6 should be rejected but that hypotheses 1, 2, 3, 4, 5, 7 and 8 could not be rejected.

Finally, based on evidence presented, recommendations are made for more dynamic development of intermodal haulage.

Part 2 of the deliverable is devoted to passenger transport. The hypotheses, created in D10.1 are examined using a combination of evidence from previous studies, new modelling work, and logical deduction. The new model is a simple elasticity-driven spreadsheet which predicts the usage of individual modes and combination modes by a representative population of travellers under different pricing scenarios.

The scenarios explore the impact of charges which were differentiated in terms of mode, time period and trip length. The analysis begins by examining the effect of charges based on marginal social costs but is extended to explore the effect of:

- Revising the charges to allow for changed conditions caused by introduction of charges based on base year conditions;
- Investing the revenues pro rata to demand or exclusively to favour environmentally sustainable modes;
- Exempting environmentally sustainable modes from all charges
- Abolishing all pre-existing taxes and subsidies, and

- Allowing for any revision to prices associated with changes in the per-unit costs of providing transport services.

The case studies and evidence referred to in this deliverable include:

- River and coastal ferry services in Hamburg, London, The Three-cities conurbation and in Scotland
- The London , Stockholm and Singapore road user charging schemes,
- The abortive attempts at pricing reform by Deutsche Bahn and SNCF
- Pricing Policy in the UK Bus industry and the low cost airline industry
- The UK's National Road Pricing Feasibility Study, and
- New evidence on travellers' response to complex pricing structures.

Evidence relevant to each of the hypotheses identified in Deliverable 10.1 was discussed and it was concluded that, on balance, hypotheses 1, 2, 3, and 5 should be rejected but that hypotheses 4, 6, 7 and 8 could not be rejected. A number of additional conclusions were also drawn:

- With respect to the use of differentiated pricing to influence modal splits:
    - The introduction of infrastructure charges based on marginal social costs differentiated by mode, trip length and time of day, could have a significant impact on modal shares – particularly if the revenues are invested appropriately.
    - The net impact of differentiated pricing on modal shares is reduced by the consequential reduction in congestion but may be magnified by the consequential changes in per-unit costs of service provision.
    - The introduction of differentiated pricing would affect some aspects of the overall modal share more than others and the full effect might take some years to emerge.
- With respect to user's perception:
    - Differential pricing can influence the perception of modes and, most particularly, of intermodal chains.
    - The degree of differentiation can have an effect on modal shares over and above that of the intended price signal.
- With respect to encouraging the use of environmentally sustainable modes:
    - A shift to environmentally sustainable modes could be achieved by imposing larger charges on the least environmentally sustainable modes and by investing the revenue to the advantage of the sustainable modes while retaining the existing subsidies to public transport; the resulting mode shares would be more environmentally sustainable but the charge structure would represent a departure from the economic optimum and the result is unlikely to be economically efficient.
    - Differential pricing of vehicles according to their emissions can be expected to favour the purchase and use of low emission vehicles and thus improve the environmental sustainability of the fleet but may reduce the effect that a charging scheme has on mode shares.
    - Differentiated pricing of infrastructure can produce a more environmentally sustainable mode split but that some of the types of differentiation currently being used or advocated are unlikely to have a significant effect - particularly if accompanied by abolition of existing subsidies as part of wholesale reform of infrastructure pricing.
    - Road pricing or congestion charging can discriminate in favour of environmentally desirable modes whilst remaining commercially sustainable (in that the revenues exceed the cost of collecting them).
- With respect to encouraging the economic activity:

- The overall level of economic activity (as measured by the total number of trips) may increase if charges are introduced and the revenues are invested appropriately, however city managers continue to be concerned about the damage that the introduction of road user charges might do to their local economy.
- Differentiated charging could be designed to discriminate in favour of the most economically important trips.

➢ With respect to encouraging the use of multimodal trips:

- Pricing scenarios designed to favour public transport trips will not necessarily result in increased use of multimodal chains (and vice versa), a pricing structure designed to favour multimodal chains would attract some demand from "pure" public transport trips and could result in a net reduction in sustainability.
- There is considerable scope for introducing pricing regimes which favour multimodal chains, but the commercial sustainability of such regimes will depend on local circumstances.
- Very significant increase in use of multimodal chains could be stimulated by appropriate pricing structures but such discrimination would not be consistent with the principles of marginal social cost pricing, pure MSC would not increase the use of intermodal chains to such a level that they take a significant share of the overall market.
- The main barriers to the introduction of pricing regimes which promote inter-modality are institutional rather than financial, and the use of multi-modal chains can be encouraged by appropriate presentation and packaging of prices.

➢ And not forgetting the wider picture:

- The removal of modal distinctions within a pricing structure reduces the suppliers' ability to manage demand to suit capacity and to maximise income, but the resulting simplification of price structures is appreciated by users and may itself lead to an increase in demand.
- Abolition of existing taxes and subsidies could have a much greater effect than that produced by the introduction of marginal social cost pricing.

Finally, five recommendations were made:

➢ Although we believe that they may be appropriate in some circumstances, we do not recommend a general presumption that the use of multimodal chains should be encouraged (we find that they can sometimes detract from the use of modes which are more economically, environmentally or commercially sustainable).

➢ As a consequence of this, we do not recommend that action should be taken at the European level to promote the use of multimodal chains irrespective of local circumstances.

➢ In the light of these conclusions we recommend that, where local circumstances are appropriate, the local authorities should include price differentiation among the measures used to promote the use of multimodal chains.

➢ We recommend that very careful thought be given to the consequences of any requirement on governments to remove (or desist from introducing) subsidies to public transport (although such subsidies may, in a strict sense, be economically distortionary, their removal can have serious consequences for environmental sustainability).

➢ We recommend that the relevant authorities should be encouraged to use price differentiation to influence the pattern of mode use but that there should be no general supposition that price differentiation should always be applied (some of its effects are not benign).

1 INTRODUCTION

The European Market is growing with new member states' economies growing particularly fast. Changes in the internal market, with mergers and competition between companies, and growing customer expectations mean that efficient logistics management is crucial for companies to function and return profits. As was noted in Deliverable 10.1, this situation is also causing an increase in the volume of cargo and passenger transport, especially by road. This is reflected in increased traffic congestion on roads. Therefore, the European Commission has been promoting use of alternative modes of transport, such as rail, sea, inland waterborne transport and more efficient use of roads in combination with other modes (co-modality). Nevertheless, the potential of other modes of transport, especially railway freight transport, has not been fully utilized by the market. It often happens that companies have neither the time nor expertise to optimize their distribution networks and analyze the possibility of using alternative transport solutions in their businesses.

To estimate the reaction of intermodal chains on the differentiation of user charges of transport infrastructure, which should be understand as a impact on modal split in transport of goods and people eight hypotheses were set out in D10.1, namely:

- Greater differentiation of infrastructure charges (in the ways, and to the extents, currently being contemplated) will have no significant impact on overall mode splits.
- Greater differentiation of infrastructure charges (in the ways, and to the extents, currently being contemplated) will have no significant impact on the usage of intermodal chains.
- Greater differentiation of infrastructure charges (in the ways, and to the extents, currently being contemplated) will tend to increase the average end user prices for the affected modes and any change in overall mode shares will be attributable to this alone.
- Greater differentiation of infrastructure charges (in the ways, and to the extents, currently being contemplated) will increase the perceived complexity of end user prices and this will result in reductions in the market share achieved by the affected modes (after allowance is made for any change in average end user prices).
- Greater differentiation of infrastructure charges (in the ways, and to the extents, currently being contemplated) will tend to encourage the use of intermodal chains and will achieve a modal split which is more economically sustainable than the status quo ante.
- Greater differentiation of infrastructure charges (in the ways, and to the extents, currently being contemplated) will tend to encourage the use of intermodal chains and will achieve a modal split which is more environmentally sustainable than the status quo ante.
- The use of environmentally desirable modes can be encouraged by means of commercially sustainable pricing regimes which discriminate in favour of users of those modes.
- The use of intermodal chains can be encouraged by means of commercially sustainable pricing regimes which discriminate in favour of users of intermodal chains.

The aim of this deliverable (D10.2) is to explore these eight hypotheses using a combination of evidence from previous studies, case studies and stakeholder interviews, new modelling work, and logical deduction.

In the freight part, four case studies were examined and interviews were conducted with stake-holders in Poland and Italy prior to an analysis of the potential for changes through price differentiation. The analysis of the four case studies was conducted using a simulation model. Based on this evidence, each of the hypotheses identified in Deliverable 10.1 was discussed and conclusions were drawn.

In the passenger part, new modelling work was conducted using a simple elasticity-driven spreadsheet which predicted the usage of individual modes and combination modes by a representative population of travellers under different pricing scenarios. The majority of the hypotheses could be explored using this spreadsheet in conjunction with evidence from case studies. However, hypotheses 3 and 4, required us to call on behavioural evidence presented in Deliverables 4.1 and 4.2 and elsewhere.

2 FREIGHT TRANSPORT

2.1 MODEL OF AN INTERMODALTRANSPORT SYSTEM

2.1.1 Models as a Reflection of Real Situations

Before taking any strategic decision on changing the transport system, all possible situations that may take place should be considered. It is important to be precise since the failure may have severe implications for financial results and may threaten the viability of the transport system itself. It is therefore appropriate to conduct cost analyses using simulation models which compare the present situation with the variants possible after differentiation of road infrastructure access fees.

The literature provides many definitions of a model. One of first general definitions described a model as a reflection of reality, an object to be copied whose properties are similar to the model object [0; 0; 0, s. 8]. As work on models developed, the definition of modelling developed either. Therefore, it may be finally stated that a model is an external and clear presentation of a part of reality, developed by people who need the model to understand the changes inside the model, manage and control the modelled part of reality [0, s. 15].

The figure below shows interactions between object, task and model.

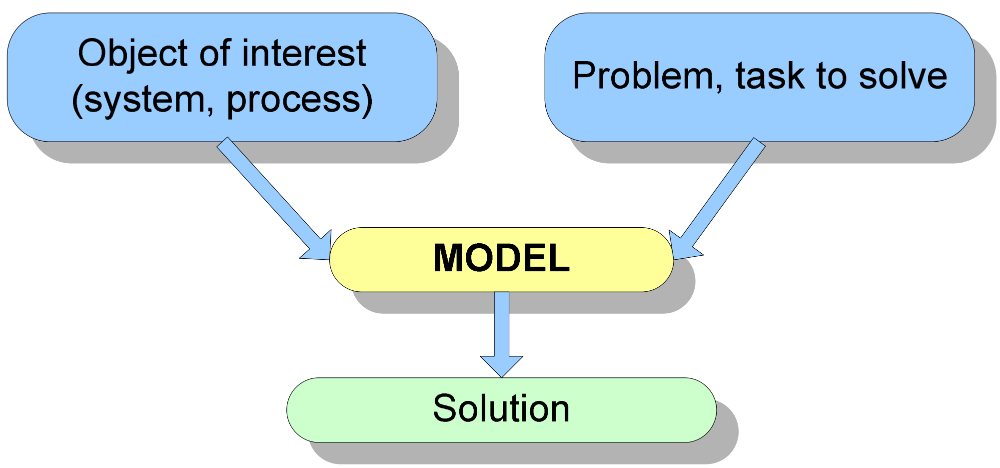


Figure 2-1 Idea of Modelling

The models may be physical objects, mathematical equations, or graphical studies [0, s. 8]. Due to specificity of tasks realized within the research work, mathematical equations will be used to build a model. They will be used in analyses and optimisation of cost, time and information aspects

2.1.2 Methodology of Construction of Cost Model

Desk research done within work on D10.1 proved that price is a major determinant of mode choice decisions within the freight sector, particularly in a competitive market. Thus, it is needed to analyse in details real transport cost on different European routes for selected transport modes. It is essential to compare road transport, as the most frequently used, and intermodal haulages, as widely promoted by the European Commission. We have defined intermodal transport as a road-rail scenario because most European countries have a well developed railway infrastructure (inland waterways are not so ubiquitous, sea transport is not relevant to land-locked countries). There is also another aspect in favour of detailed analyses of intermodal transport using mainly railways, which is the fact that in most European countries railway infrastructure is very well developed and easy accessible for majority

European regions. Furthermore, many big companies have their seats inside the continent, where only railway and air transport may be an alternative to road transport. Although potentially relevant, air transport was not taken into account in the simulations due to the high costs that would have been incurred.

Therefore, to calculate real transport cost and compare prices of road and intermodal haulages simulation model was created. The general idea of the simulation model is presented in the figure below.

The model, summarised in Figure 2.2 and detailed in the following sections, assumes that, on the main part of the route, the loads are transported by rail or/and sea to assigned consolidation/deconsolidation points. The trains shuttle between points of origin and destination. The points may be used by any company. Road vehicles are used to transport goods to the consolidation points and for the final distribution of loads.

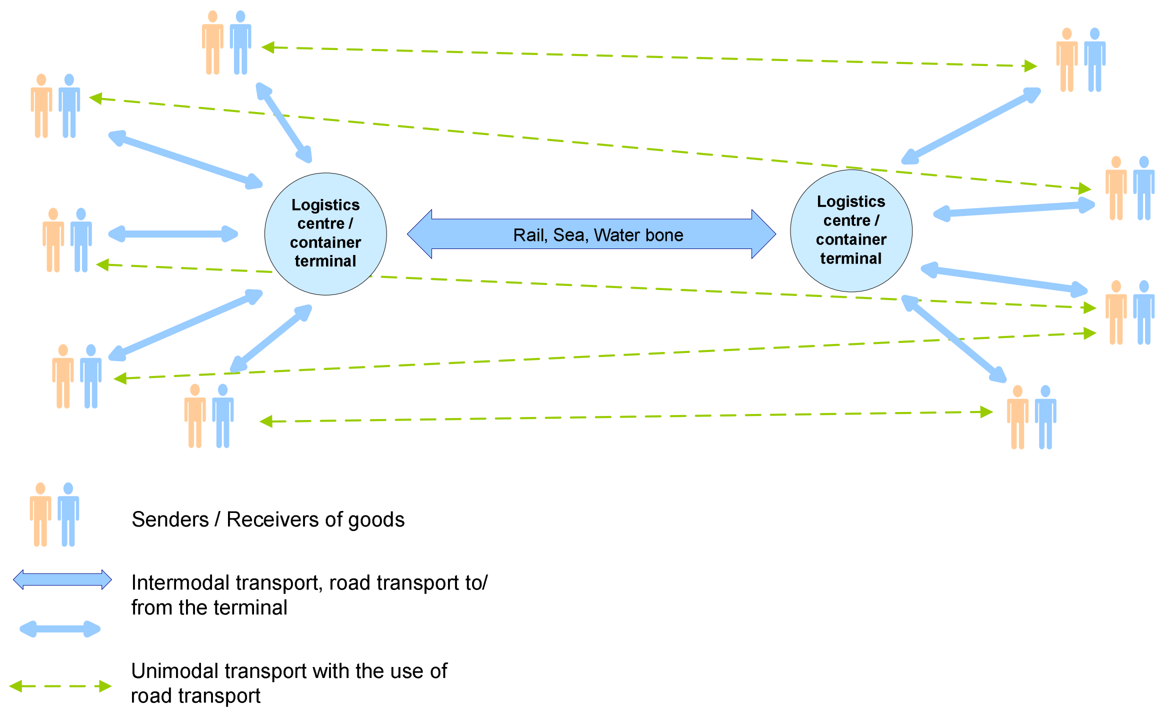


Figure 2-2 Analysed Model of Intermodal Haulages

After analysing available tools for cost simulations of created transport models, it was decided to use *eMapa proffesional+* software for the road transport part of the model and *ERIC Desktop* with *RailMap* module for the railway transport part of the model. The simulations were carried out in *MS Excel*.

In order to model transport systems in distribution network optimisation projects a methodology was created for the acquisition and preparation of data for the computer simulations. The methodology consists of the five main stages presented in Figure 2-3.

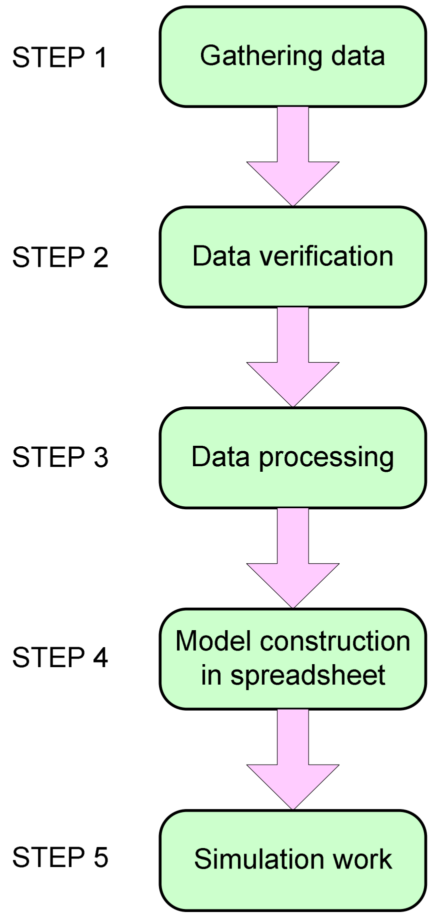


Figure 2-3 Stages of Creating Transport Models Scenarios

Proper acquisition and verification of data for analysis was seen as essential. The choice of time horizon for the data is a significant issue here as is the accurate identification of relevant costs. Figure 2-4 details the data acquisition process.

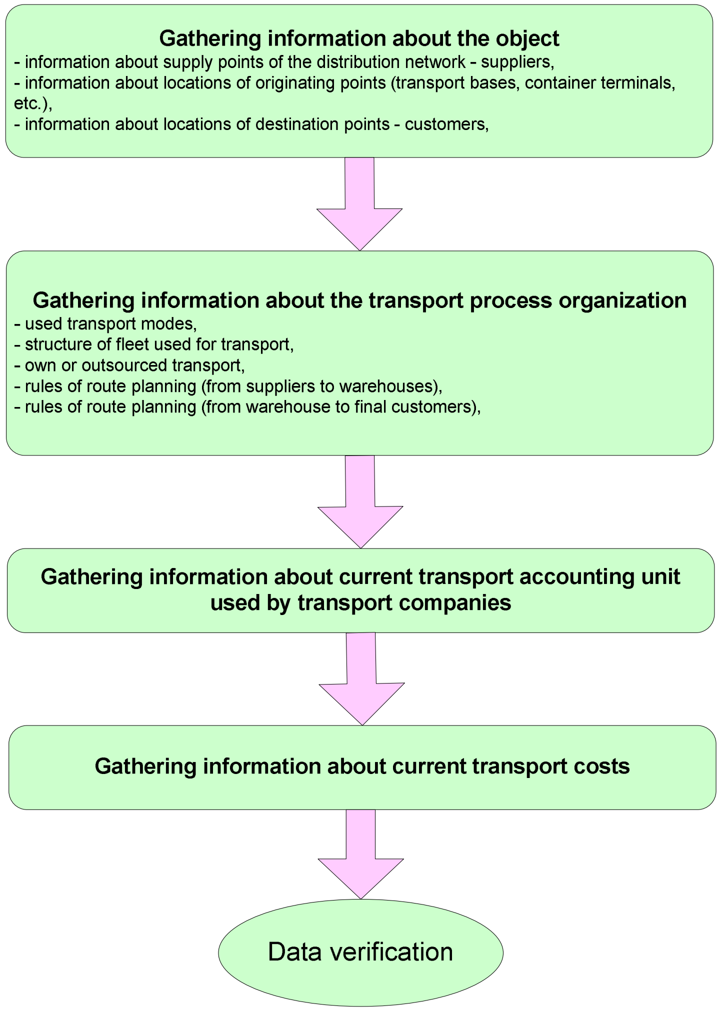


Figure 2-4 Data Required for Further Project Work

Data verification is necessary before further handling of data and creating transport system variants. The verification procedure is detailed in Figure 2-5.

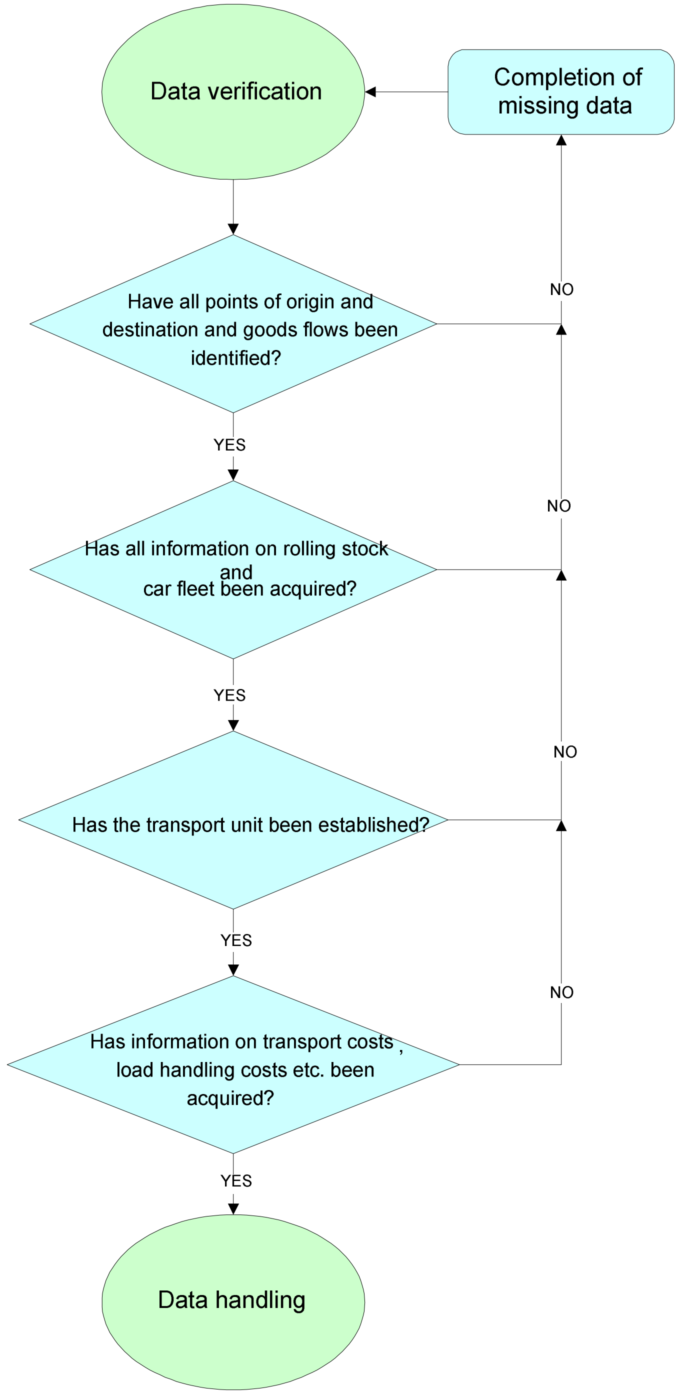


Figure 2-5 Data Verification Procedure in Stage 1

Further stages of work apply to construction of the model in spreadsheet and simulations, showing changes in costs and time parameters. Due to the fact that the price and transport time are two of the most important elements of railway transport systems competitiveness, the mathematical model of multimodal transport will be described by functions of cost and time. A simplified mathematical model of the cost function in the model was used:

$$TC = \sum^{m} \sum c_{ij} x_{ij} ,$$

where:

c_{ij} – unit transport cost on route from the i-point of origin to the *j*-point of destination, *i*=1, 2, ..., m; *j*=1, 2, ..., n,

x_{ij} – transported quantity on route from the i-point of origin to the *j*-point of destination,

m – set of points of origin,

n – set of points of destination.

The created tool can simulate changes in transport prices and in average speed in road and railway transport.

2.1.3 Model Assumptions

The following assumptions worked out by railway and intermodal operators from Poland and Germany were considered in cost calculations: Data on other countries were delivered by project partners.

- Length of train set; according to the assumption that maximum length of station tracks is 600 m, it was assumed that the freight train may consist of 28 cars.
- Train set gross weight; the allowed gross weight of the train (without the engine) is 2200 tons. Net weight is 1600 tons.
- Average exploitation speed; average speed on new motorways is 64 km/h, on other roads is 45 km/h, and of freight trains is 17 km/h.
- Road transport costs; Cost of transport to and from terminal within 100 km was assumed: 130 – 150,- EUR/UTI. The costs within other distances are calculated as: 0,9 EUR per each km.
- Load (UTI) handling costs; a reloading cost of 1 UTI was assumed: 20 – 40,- EUR – includes 2 reloading operations + Interchange.
- Load handling times; a loading/unloading time of UTI of about 10 minutes was assumed.

2.1.4 Mathematical Model of Total Cost of Intermodal Transportation

A linear mathematical model of the total cost of intermodal transport was defined as follows:

In m points of origin resources (supply) of homogeneous product are located (in UTI). Their quantities are: $a_1, a_2, a_3, \ldots, a_m$, respectively. The load is to be delivered to n customers whose demands are $b_1, b_2, b_3, \ldots, b_n$, respectively. Consignors send the homogeneous loads to consolidation points (logistics centre, container terminal), where transport mode is changed. On main part of the route railway transport is used. Next, the load goes to a deconsolidation point, transport mode is changed. The homogeneous load is delivered to customer by road. A mathematical model showing transport costs is as follows:

$$C_{Inter\,\mathrm{mod}\,al} = C_{Road}^{first\ leg} + C_{Rail}^{main\ leg} + C_{Road}^{final\ leg} + \sum m_{ij} ,$$

where:

$C_{Road}^{first\ leg}$ (total costs of road transport to logistics centre / railway terminal) is:

$C_{Road}^{first\ leg} = \sum_{i=1}^{m}\sum_{j=1}^{n} c_{ij} \cdot x_{ij}$, where c_{ij} is unit transport cost, x_{ij} is load quantity.

$C_{Rail}^{main\ leg}$ (total cost of railway transport from one logistics centre to another logistics centre/railway terminal) is:

$C_{Rail}^{main\ section} = \sum_{i=1}^{m}\sum_{j=1}^{n} c_{ij} \cdot x_{ij}$, where c_{ij} is unit transport cost, x_{ij} is load quantity.

$C_{Road}^{final\ leg}$ (total cost of road transport from logistics centre/railway terminal to the n-customer) is:

$C_{Road}^{final\ leg} = \sum_{i=1}^{m}\sum_{j=1}^{n} c_{ij} \cdot x_{ij}$, where c_{ij} is unit transport cost, x_{ij} is load quantity, m_{ij} is load handling cost.

Mathematical model constraints were assumed to be:

$$\sum_{i=1}^{n} x_{ij} = a_i \quad \text{(i=1, 2, 3,…,m)}$$

$$\sum_{j=1}^{m} x_{ij} = b_i \quad \text{(j=1, 2, 3,…,n)}$$

A mathematical model of total transport time (taking into account the time of road transport to logistics centre, load handling, railway transport and transport to customer) was defined as follows:

$$T_{Inter\,\mathrm{mod}\,al} = T_{ic}^{first\ leg} + T_{cd}^{main\ leg} + T_{dj}^{final\ leg} + \sum t_{ij}^{loading} \cdot x_{ij} + \sum t_{ij}^{unloading} \cdot x_{ij} ,$$

where:

x_{ij} is transported load quantity.

Road transport was modelled as having *m* points of origin resources (supply) of homogeneous product (located in UTI). Their quantities are: $a_1, a_2, a_3,…,a_m$, respectively. The load will be transported by road directly to n-customers whose, demands are $b_1, b_2, b_3,…,b_n$. respectively. The model describes unit transport cost c_{ij} from each point of origin $i=1, 2, 3,…,m$ to each point of destination $j=1, 2, 3,…,n$. A mathematical model of transport cost is as follows:

$$C_{Road} = \sum_{i=1}^{m}\sum_{j=1}^{n} c_{ij} \cdot x_{ij} + \sum m_{ij} ,$$

where:

c_{ij} is unit transport cost,

x_{ij} is transported load quantity,

m_{ij} is the load handling cost.

Mathematical model constraints were again assumed to be:

$$\sum_{i=1}^{n} x_{ij} = a_i \quad (i=1, 2, 3,…,m)$$

$$\sum_{j=1}^{m} x_{ij} = b_i \quad \text{(j=1, 2, 3,…,n)}$$

The mathematical model of road transport time takes into account the time for loading, transport time and the time for unloading transported UTIs. It is as follows:

$$T_{Road} = \sum t_{ij}^{loading} \cdot x_{ij} + t_{ij}^{driving} + \sum t_{ij}^{unloading} \cdot x_{ij} \,,$$

where:

x_{ij} is transported load quantity.

2.1.5 Execution of Simulation Work

Simulations of one 40’ container transport cost were carried out in *MS Excel* with the use of real data acquired from road and railway operators. Figure 2-6 presents the created tool for cost simulations. Additional inputs to the simulations are presented below.

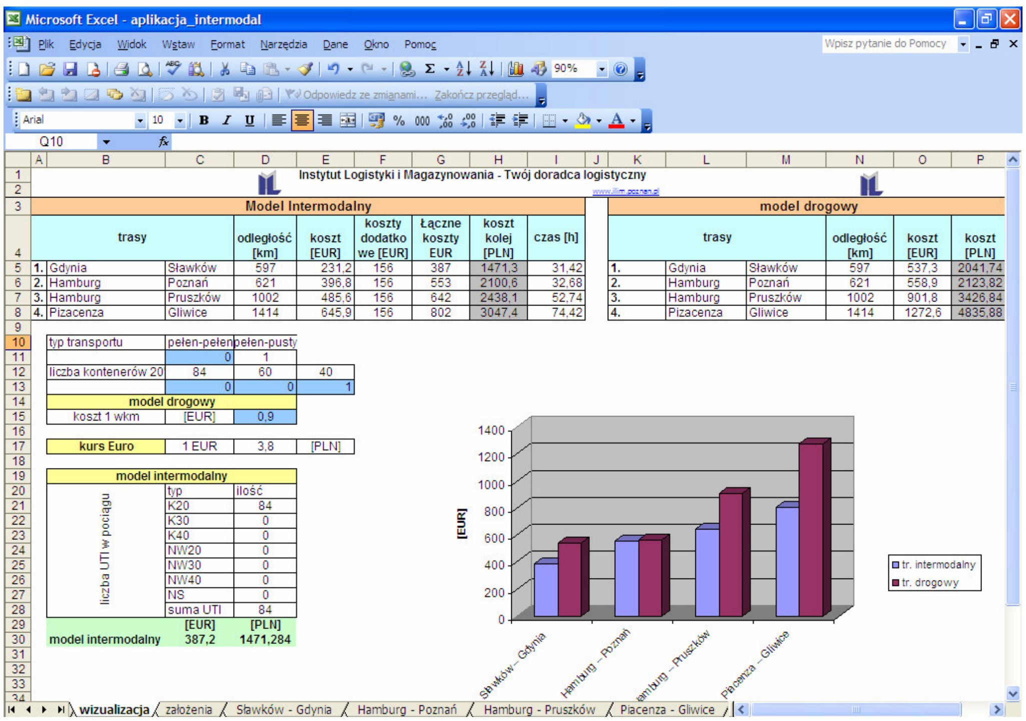


Figure 2-6 Tool for Cost Simulations

Details of the Analysed Connections

Table 2-1 Description of Analysed Routes

Relation	Proposed transport route	Route length [km]
Sławków - Gdynia	Zawiercie – Częstochowa – Zduńska Wola – Inowrocław – Bydgoszcz – Gdańsk	553
Hamburg - Poznań	Berlin – Frankfurt/Odrą (DB) – Rzepin (PL)	559
Hamburg - Pruszków	Berlin – Frankfurt/Odrą (DB) – Rzepin (PL) – Poznań – Kutno – Łowicz – Skierniewice	840
Piacenza - Gliwice	Cremona – Padova – Verona – przeł. Brenner (FS) – Innsbruck (OBB) – Salzburg – Linz (OBB) – Ceske Budejovice (CD) – Jihlava – Brno – Olomuniec – Ostrawa – Bohumin (CD) – Chałupki (PKP) – Wodzisław Śl. – Rybnik	1320

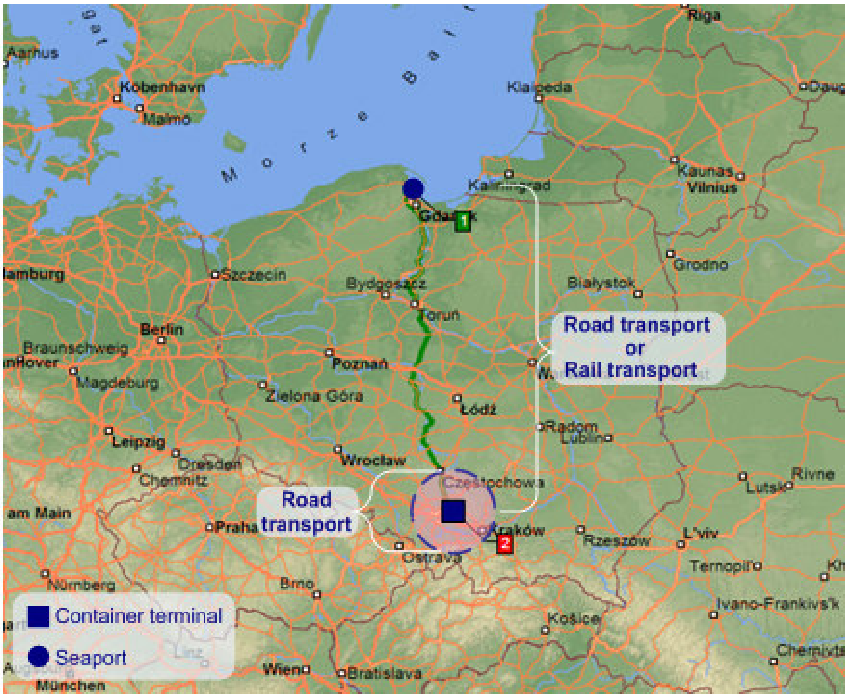


Figure 2-7 Route Gdansk (Sea Port) – Slawkow (Logistic Centre)

Figure 2-8 Route Hamburg (Sea Port) – Poznań (Logistic Centre)

Figure 2-9 Route Hamburg (Sea Port) – Pruszkow (Logistic Centre)

Figure 2-10 Route Piacenza (Logistic Centre) – Gliwice (Logistic Centre)

Assumptions on Labour Costs, Rolling Stock Acquisition Cost, Fuel Costs

Table 2-2 Simulation Assumptions on Labour, Rolling Stock and Fuel Costs

Type of Cost	Value [EUR/h]	Status
Labour cost of Rail Traction [EUR/driver hours	PKP: 12 CD: 4,7 OBB: 22,5 FS: 14 DB: 37	Real Real Real Real Real
Rolling stock rent cost	Traction vehicle: PKP: 500 Eur/24h DB: 500 Eur/24h CD, OBB, FS – as above Container platforms: PKP, DB: 22 Eur/24h/car CD, OBB, FS: 22 Eur/24h/car Pocket cars: PKP, DB, OBB, CD, FS: 32 Eur/24h/car	Real Real Real Real Probable Probable
Fuel cost	1 litre of diesel oil: PKP: 0,87 Eur CD: 0,27 Eur OBB: 0,36 Eur FS: 0,36 Eur DB: 0,9 Eur	Real Real Real Real Real

Assumptions on Train Characteristics, Type of Loading Units

Table 2-3 Simulation Assumptions to the Train Set

Parameter	Assumptions
Train set	Length: 600 running metres (28 cars);gross weight: 2240 tons
UTI units	All UTIs may be transported

Assumptions on Loading Time and Transport Time

Table 2-4 Simulation Assumptions to Loading

Parameter	Assumptions
Loading time of UTI	10 min: handling operations, loading/unloading, seal check, transport documents preparation and check
Transport time	Average intermodal train speeds were assumed: 40 km/h independently from railway infrastructure manager; transport time was increased by presumable time of waiting at the border connected with customs clearance

Assumptions Used in the Calculation Model

The assumptions are:

- free hand in entering data on type and quantity of transported UTI, loading time of UTI, average weight UTI
- restrictions: train length; train weight
- results: transport cost of 1 ton of load and 1 UTI divided by various transport combinations: loaded transport THERE –loaded RETURN; loaded THERE –empty BACK

2.1.6 Assessment of Transportation Costs for Different Variants of Executed Model

First, simulations of transport cost of one 20-foot and 40-foot containers on 4 selected routes were carried out. Next, intermodal and road transport costs were compared. In the case of intermodal transport it was assumed that the main route in Europe will be by rail, whereas, transport to and from the place will be by road. For simulations in was assumed that average distance between container terminal/logistics centre and point of destination is 50km.

The results of the simulations for the 4 selected routes are presented in Tables 2-5 to 2-14.

Table 2-5 20-foot Container Transport Cost Simulation Results on Route Sławków - Gdynia

Transport Price of 20-foot Containers in Both Directions [EUR]							
Type of UTI →		20-foot container					
Train's load assumptions on a round trip →		loaded - loaded			loaded - empty		
Number of UTIs →		84	60	40	84	60	40
Transport operator's margin	30%	86.71	96.87	114.89	132.77	151.9	183.98
	20%	80.04	89.42	106.05	122.56	140.22	169.83
	10%	73.37	81.97	97.21	112.34	128.53	155.69

Table 2-6 40-foot Container Transport Cost Simulation Results on Route Sławków - Gdynia

Transport Price of 40-foot Containers in Both Directions [EUR]							
Type of UTI →		40-foot container					
Train's load assumptions on a round trip →		loaded - loaded			loaded - empty		
Number of UTIs		28	20	15	28	20	15
Transport operator's margin	30%	105.83	122.69	138.58	174.94	205.23	231.18
	20%	97.69	113.25	127.92	161.46	189.45	213.4
	10%	89.55	103.81	117.26	148.01	173.66	195.61

Table 2-7 20-foot Container Transport Cost Simulation Results on Route Hamburg - Poznań

Transport Price of 20-foot Containers in Both Directions [EUR]							
Type of UTI →		20-foot container					
Train's load assumptions on a round trip →		loaded - loaded			loaded - empty		
Number of UTIs		84	60	40	84	60	40
Transport operator's margin	30%	123.26	141.79	169.4	209.1	242.77	306.44
	20%	113.77	130.88	156.37	193.01	224.1	282.87
	10%	104.29	119.98	143.34	176.23	205.42	259.3

Table 2-8 40-foot Container Transport Cost Simulation Results on Route Hamburg - Poznań

Transport Price of 40-foot Containers in Both Directions [EUR]							
Type of UTI →		40-foot container					
Train's load assumptions on a round trip →		loaded - loaded			loaded - empty		
Number of UTIs		28	20	15	28	20	15
Transport operator's margin	30%	160.09	183.63	212.17	288.85	325.11	396.8
	20%	147.78	169.51	195.85	266.63	309.33	366.28
	10%	135.46	155.38	179.53	244.41	283.55	335.75

Table 2-9 20-foot Container Transport Cost Simulation Results on Route Hamburg – Pruszków

Transport Price of 20-foot Containers in Both Directions [EUR]							
Type of UTI →		20-foot container					
Train's load assumptions on a round trip →		loaded - loaded			loaded - empty		
Number of UTIs		84	60	40	84	60	40
Transport operator's margin	30%	162.05	184.89	222.59	265.05	306.03	384.36
	20%	149.58	170.58	205.46	244.66	282.49	354.79
	10%	137.12	156.36	188.34	224.27	258.95	325.22

Table 2-10 40-foot Container Transport Cost Simulation Results on Route Hamburg – Pruszków

Transport Price of 40-foot Containers in Both Directions [EUR]							
Type of UTI →		40-foot container					
Train's load assumptions on a round trip →		loaded - loaded			loaded - empty		
Number of UTIs		28	20	15	28	20	15
Transport operator's margin	30%	206.16	231.17	268.01	360.66	413.02	485.61
	20%	190.3	213.38	247.39	332.92	381.25	448.25
	10%	174.44	195.6	226.78	305.18	349.48	410.9

Table 2-11 20-foot Container Transport Cost Simulation Results on Route Piacenza - Gliwice

Transport Price of 20-foot Containers in Both Directions [EUR]							
Type of UTI →		20-foot container					
Train's load assumptions on a round trip →		loaded - loaded			loaded - empty		
Number of UTIs		84	60	40	84	60	40
Transport operator's margin	30%	171.16	202.28	265.2	310.38	372.71	490.82
	20%	157.99	186.72	244.8	286.51	344.04	453.06
	10%	144.83	171.16	224.4	262.63	315.37	415.31

Table 2-12 40-foot Container Transport Cost Simulation Results on Route Piazenza – Gliwice

Transport Price of 40-foot Containers in Both Directions [EUR]							
Type of UTI →		40-foot container					
Train's load assumptions on a round trip →		loaded - loaded			loaded - empty		
Number of UTIs		28	20	15	28	20	15
Transport operator's margin	30%	233.07	282.36	332.72	441.9	538.01	645.94
	20%	215.14	260.64	307.13	407.91	496.62	596.26
	10%	197.21	238.92	281.53	373.92	455.24	546.67

Next, 1 UTI's road transport cost and total intermodal transport cost was determined.

Table 2-13 Simulation Results of 1 UTI's Road Transport Cost on Selected Routes

Road Model					
Routes			Distance [km]	Cost [EUR]	Time [h]
1.	Gdynia	Sławków	597	537.3	14.9
2.	Hamburg	Poznań	621	558.9	15.5
3.	Hamburg	Pruszków	1002	901.8	25.1
4.	Piacenza	Gliwice	1414	1272.6	35.4

Table 2-14 Simulation Results of 1 UTI's Intermodal Transport Cost on Selected Routes

Intermodal model							
Routes			Distance [km]	Railway transport cost [EUR]	Additional expenses [EUR]	Total costs EUR	Time [h]
1.	Gdynia	Sławków	597	231.2	156	387	31.42
2.	Hamburg	Poznań	621	396.8	156	553	32.68
3.	Hamburg	Pruszków	1002	485.6	156	642	52.74
4.	Piacenza	Gliwice	1414	645.9	156	802	74.42

Figure 2-11 compares 40-foot container road and intermodal transport (road-rail) cost on 4 routes.

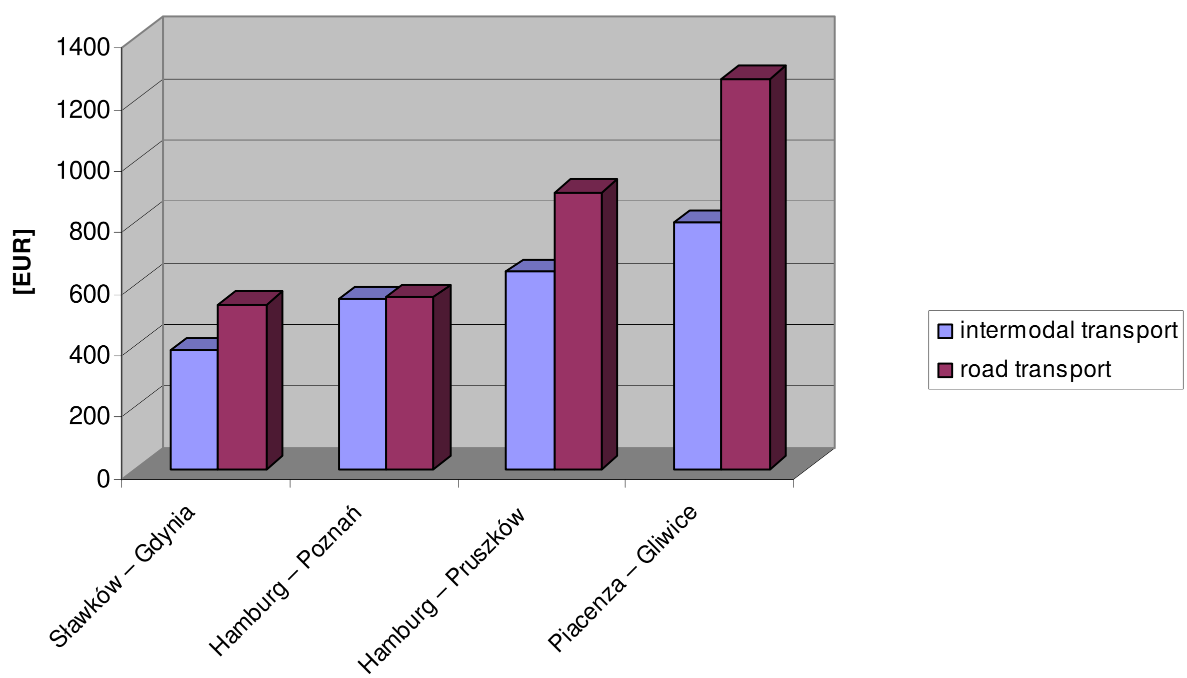


Figure 2-11 Comparison of 40-foot Container Transport Costs on Selected Routes

The comparison shows that in some parts of the Europe an intermodal solution is cheaper than road haulage. According to executed simulation, intermodal haulages are attractive for companies on medium and long routes (e.g. from 500 km). Moreover, calculations assumed 30% transport operator's margin. Therefore, the price of intermodal haulages might be even cheaper, if all actors involved in transport processes agreed on new terms. However, this statement depends on many local constraints, cannot be generalized and should be verified in different EU regions.

Based on the simulation results, transport costs of intermodal haulages cannot be perceived as the crucial restriction in better utilization of this transport mode. It is worth adding that the cost calculations were carried out in cooperation with railway and road operators. The conclusion may be that dynamic development of intermodal transport, especially rail-road one is constrained by many other barriers. The barriers were examined by the Institute of Logistics and Warehousing within the *Corelog* project (Interreg IIIB Cadses) and verified in the *DIFFERENT* project. Some of them are:

- Transport time of intermodal solutions is longer.
- Intermodal transport costs are similar to road transport costs, however they are much more complex.
- Private railway operators do not have easy access to the existing container terminals which are the property of national railway companies (situation in new EU-members states such as Poland)
- Lack of clear policy on freight transport development in many European regions.
- Road administrators do not take under consideration the need of linking container terminals with the road network included in construction and modernization plans. Lack of coordination.
- Lack of a concept of constructing free-accessible container terminals for private and national rail transport companies.
- Lack of fast international intermodal services operated by one operator.
- There is no possibility of railway private carriers becoming independent from national rail transport company due to lack of rolling stock (locomotives and special cars).
- Long time of waiting for information from the railway infrastructure management on the possibility of activation of a private train.
- Different types of rail gauges in Europe.
- Another barrier is slow liberalization of the railway market in Europe. Nowadays, it takes months to fulfil, by e.g. a Polish company, all the administrative requirements for operating in Germany.

2.2 ANALYSIS OF THE POTENTIAL FOR CHANGES THROUGH PRICE DIFFERENTIATION

2.2.1 Introduction

The following section presents an analysis of the potential for changes through price differentiation. It includes results of the interviews with the stake-holders and representatives of companies which can potentially be beneficiaries of intermodal transport. One of the main aims of this analysis is to examine the commonly–held belief that intermodal transport is much more expensive and less efficient than road. The simulations presented in section 2.1 suggest that, on four analysed routes, road transport was more expensive that intermodal transport – although total intermodal transport time was longer than road.

Analysis was based on the direct interviews with stakeholders in Poland and in Italy. In each of the interviewed companies 10 questions were asked . (see Appendix 1 for template used). The first three questions concerned company's general description and the other seven concerned their transport preferences. Interviews were carried out in small, medium and big companies, in the production, distribution, trade, and services sectors.

Firstly, the role of intermodal transport in organizing of transport processes by different companies was analysed. The results, shown in Figure 2-12, suggest that road transport is the most frequently used transport mode.

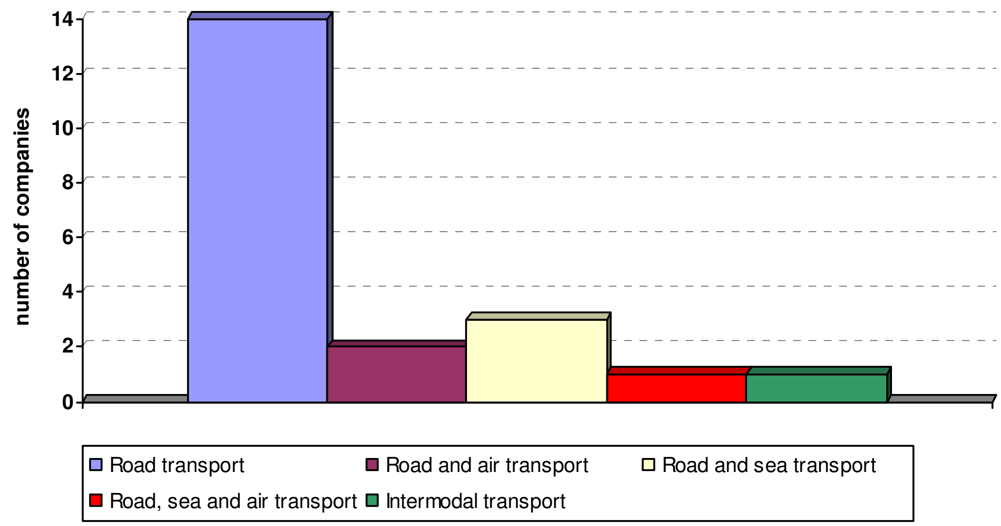


Figure 2-12 Preferable Means of Transport of Analysed Companies

More than a half of analysed companies use road transport only. Other companies combine this mode with other ones. The survey showed basic determinants of such a big use of road transport. It also shows company's readiness and circumstances for changing previously used transport mode.

Further results of the interviews are presented in sections 2.2.1 to 2.2.3. under the headings:

- Key factors determining enterprises' choice of mode.
- Possibilities of using intermodal transport by the enterprises.
- Assessment of possibility of using modern logistics products in city logistics.

2.2.2 Identification of Key Factors Determining Enterprises' Choice of Mode

Road transport is most popular among analysed companies, independently from the line of business. The survey showed main factors that decide about the popularity of road transport among trade and production companies and determinants considered when creating logistics strategy.

The most important determinants of using road transport for distribution (see Figure 2-13) are service price (28%) and delivery time (26%) offered by transport operators. More than a half of companies pointed these two determinants as the main selection criterion. The next most often pointed determinant was service quality, flexibility of offer, service complexity, being accustomed to used solutions and other including specificity of the line of business. On the basis of the results, it may be presumed that companies' logistics strategy depends only on price (the market is vulnerable to price most), however, it turned out that it is one of many elements deciding about the final choice of transport mode.

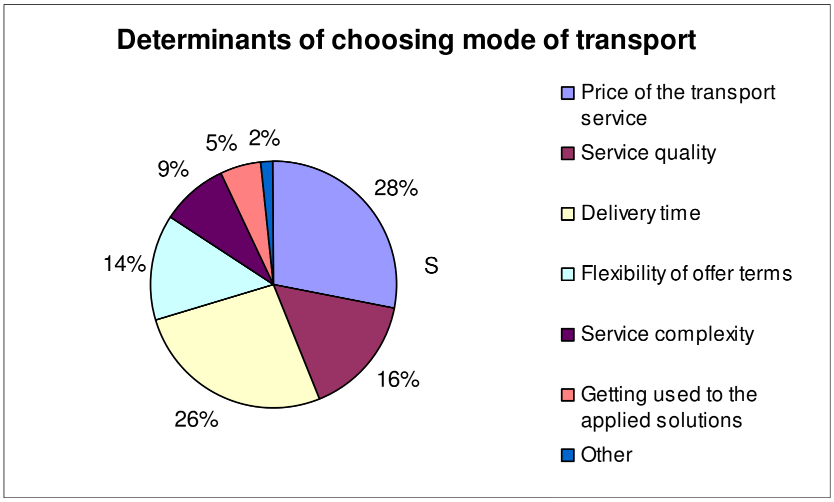


Figure 2-13 Determinants of Choosing Mode of Transport

The choice of transport mode depends on logistics policy and strategy of the company. Factors considered when defining logistics strategy influence the choice of transport operator. As can be seen in Figure 2-14, customer requirements is the most significant factor when creating logistics strategy. The vast majority of companies respect their customers and do everything to provide service of highest quality. They search for ways of minimizing costs in order to be able to compete on the market at the same time. Regional infrastructure is another issue deciding about the shape of logistics strategy. Whereas, ecological and regional strategy-related factors are insignificant for companies and so social costs are not taken into account when creating a logistics strategy.

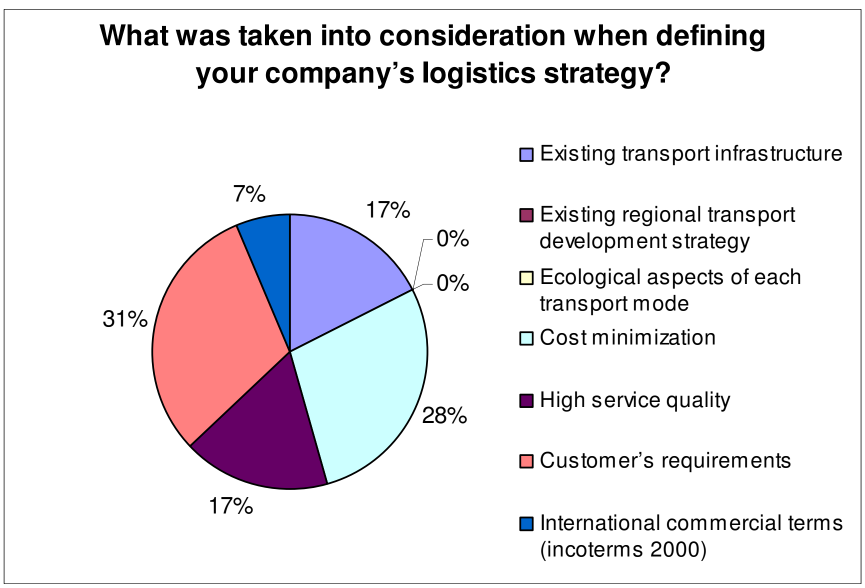


Figure 2-14 Factors Considered when Choosing Logistics Strategy

The idea that the choice of transport mode is simply price-dependent and based on a desire to minimise costs, is not supported by the evidence, As can be seen from Figure 2-15, a majority of respondents said that changes in transport infrastructure charges would not influence their choice of transport mode.

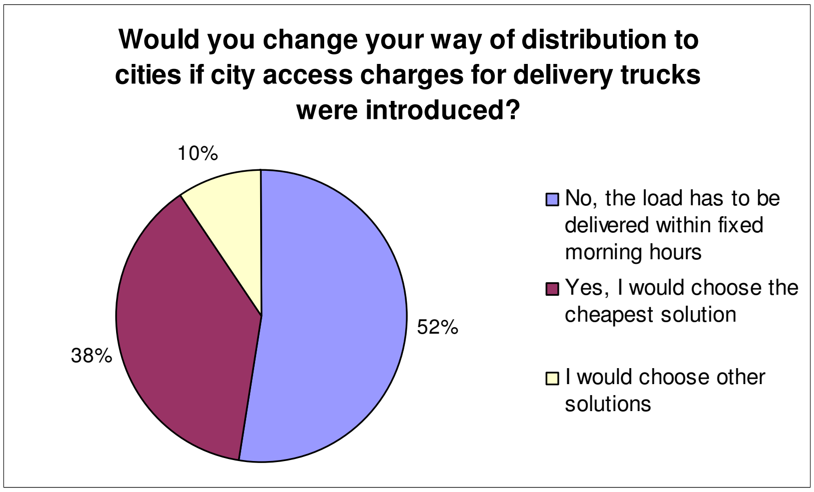


Figure 2-15   Possibilities of Changing Transport Processes

The survey showed that, for a majority of companies, changes in infrastructure charges will not contribute to the change of transport processes organization. They will only cause increases in prices of goods. Consequently, for these companies, all costs connected with higher infrastructure charges will be incurred by the final user. Only 33% of surveyed enterprises indicated that they would select the cheapest solution. However, it was proved that it is not only price that decides about transport mode. Making customers more and more satisfied and providing high-quality services favours solutions that are reliable – even if more expensive.

2.2.3 Possibilities of using Intermodal Transport by the Enterprises

In the survey the respondents asked about intermodal transport. Previously acquired information indicated that it was a marginally used mode. Only one company declared using this mode. Figure 2-16 shows the main barriers to greater use of intermodal transport. It seems that the main perceived barriers are that it is not suitable for goods carried in small batches (rather than containers) and that delivery times are longer (which would constrain on-time service). Interestingly, price is only considered a barrier by 5% of surveyed firms.

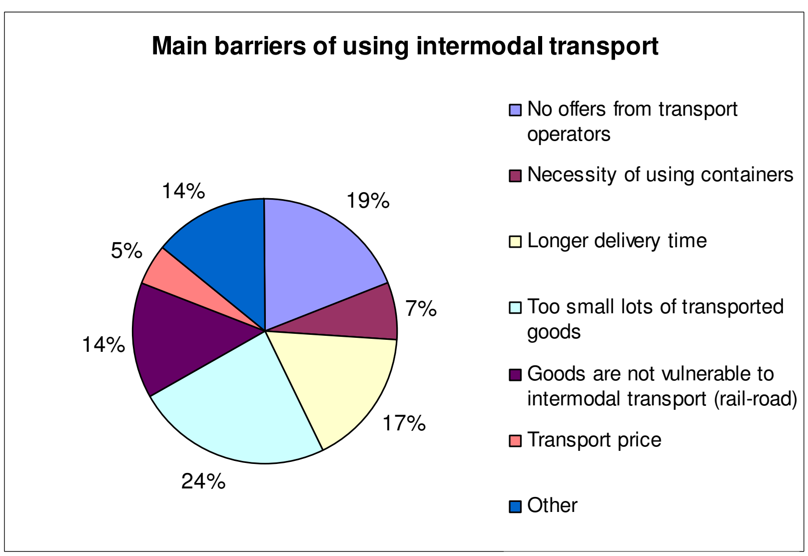


Figure 2-16   Barriers of using Intermodal Transport

Figure 2-17 presents the inclination to wider use of intermodal transport resulting from lower prices of using the mode. Although, according to Figure 2-16, price is only considered a barrier by 5% of surveyed firms, in response to the question: "would lower price incline wider use of intermodal transport?", more than a half of respondents said they would choose the cheaper solution. The results, however, cannot be analysed separately from other conditions. Lack of proper intermodal transport infrastructure is the reason why so few companies use this mode and why there are no offers for intermodal transport on the market.

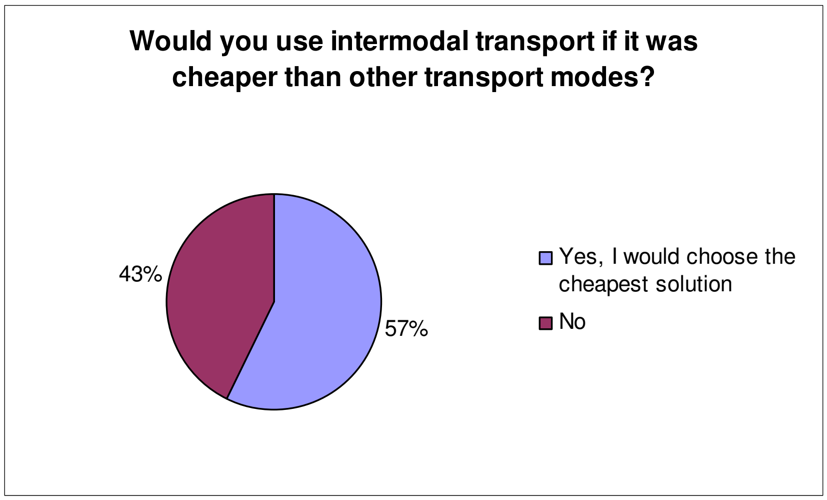


Figure 2-17 Possibilities of using Intermodal Transport By Companies

2.2.4 Assessment of Possibility of using Modern Logistics Products in City Logistics

Due to high frequency of using road transport for distribution of goods, companies' flexibility to changes in transport rates was examined. Most of the interviewed companies (52%) stated that due to liabilities to customers and the character of the business they would not change the way of distributing goods. 33% of companies would choose a cheaper solution and only 2 companies would search for other alternative solutions. The results presented in Figure 2-18 thus confirm those from Figure 2-16 in indicating that price is not the main issue. Customer requirements are most frequently selected, which is why goods must be delivered on time

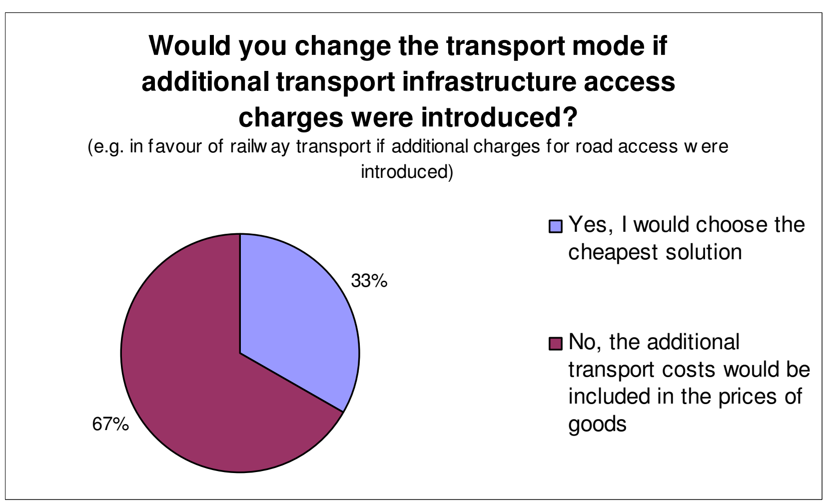


Figure 2-18 Possibilities of Changes in Distribution in Cities

Another important factor that was most frequently selected was cost minimization which will make companies use cheaper solutions as a result of increases in road transport rates. Within the confines of cost minimization the companies were offered a possibility of cooperation with other companies from the same line of business (figure 2-19) Just over half (52%) of the companies stated that such cooperation is impossible. The reason is usually too big competition between companies, company's specificity and full track or off-gauge load batches.

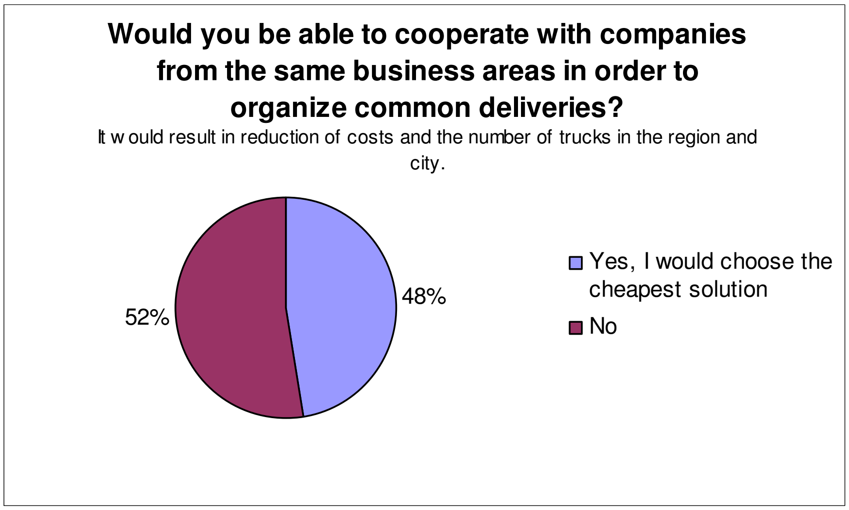


Figure 2-19 Assessment of Possibilities of Cooperation with Competitive Companies in order to Minimize Costs

2.3 THEORETICAL DISCUSSION

This section discusses the hypotheses created in deliverable 10.1. Analysis of the hypotheses is based mainly on the results of the interviews with the stakeholders operating in Europe described in section 2.2 although the simulation work presented in section 2.1, and work carried out in other *DIFFERENT* work packages (notably WP5, WP6, WP7 and WP8) was also taken into consideration.

We will address each of the hypotheses in turn.

Hypothesis 1: Greater differentiation of infrastructure charges (in the ways, and to the extents, currently being contemplated) will have no significant impact on overall mode splits.

The interviews showed that road transport is the most frequently used mode. The factors that are decisive when choosing a transport mode are transport service price and delivery time, independently from the line of business (Figure 2-13). Other factors, by frequency of choosing, are service quality, offer flexibility, service complexity, habits and others, including specificity of the line of business. Choosing a transport mode is also influenced by issues considered when choosing logistics strategy. Here, the most frequently chosen criteria were customer requirements, cost minimization, high service quality and existing transport infrastructure. However, although price was selected very often, the interviews show that 67% of companies (Figure 2-18) would not change current transport organization if additional infrastructure charges were introduced, which would cause increases in goods prices. Close to 40% of companies (Figure 2-17) declare that they would not change their way of distribution even if infrastructure charges were differentiated and caused that intermodal solution would be cheaper that road transportation. Summing up, the interviews proved that bigger differentiation of infrastructure charges will not have a significant influence on the general modal split.

Hypothesis 2: Greater differentiation of infrastructure charges (in the ways, and to the extents, currently being contemplated) will have no significant impact on the usage of intermodal chains.

According to the survey, close to 57% of interviewed companies (Figure 2-17) declare that they would incline to choosing a cheaper solution. However, differentiation of rates will not increase the use of intermodal chains. The survey suggests that (Figure 2-16) price is the main barrier to using intermodal transport for a wider scale for only a small proportion of companies (5%). Rather, the main constraints are: too small load batches, no intermodal transport offers and relatively longer driving time. Another barrier is necessity of using containers and other factors (including more frequent use of courier services and customer requirements). It may be assumed that differentiation of infrastructure charges will not influence the use of intermodal chains.

Hypothesis 3: Greater differentiation of infrastructure charges (in the ways, and to the extents, currently being contemplated) will tend to increase the average end user prices for the affected modes and any change in overall mode shares will be attributable to this alone.

Any changes in infrastructure charges will be transferred to final customers. The necessity of using a particular transport mode with an increase of infrastructure charges will cause an increase of prices of goods. 67% of interviewed companies (Figure 2-18) declare that they would increase of prices while only 33% would apparently search for cheaper solutions. The interviewed companies aim at maximum satisfaction of their customers through meeting their delivery time expectations by using the highest standards of transport services. Being accustomed to road transport services, being convinced about their punctuality, quality and flexibility (Figure 2-13) make production and trade companies choose this mode. A desire to meet customer expectations makes production and trade companies reluctant to change the used mode but rather to increase their prices as a result of the differentiation of infrastructure charges. Increase of prices will be transferred to final customers. In this case, the survey proves the thesis that differentiation of infrastructure charges would (if it resulted in an increase in road costs) increase prices for final customers.

Hypothesis 4: Greater differentiation of infrastructure charges (in the ways, and to the extents, currently being contemplated) will increase the perceived complexity of end user prices and this will result in reductions in the market share achieved by the affected modes (after allowance is made for any change in average end user prices).

The survey did not prove that greater differentiation of prices will increase complexity of final user prices and this will result in changes in the modal split. Transparency and fairness of infrastructure charges have a meaning to transport operators but not for shippers.

Hypothesis 5: Greater differentiation of infrastructure charges (in the ways, and to the extents, currently being contemplated) will tend to encourage the use of intermodal chains and will achieve a modal split which is more <u>economically</u> sustainable than the status quo ante.

The survey showed that companies would use intermodal transport more frequently if it was cheaper. It should be remembered, however, that in companies' opinion small use of intermodal transport results mainly from non-price reasons.

Hypothesis 6: Greater differentiation of infrastructure charges (in the ways, and to the extents, currently being contemplated) will tend to encourage the use of intermodal chains and will achieve a modal split which is more <u>environmentally</u> sustainable than the status quo ante.

The survey did not prove the abovementioned thesis since bigger differentiation of charges which results in increases in road charges will not discourage from using that mode. In the respondents' opinion all changes in charges will be included in product prices and transferred to final customers. Differentiation of infrastructure charges is not enough to change the mode of transport.

Hypothesis 7: The use of environmentally desirable modes can be encouraged by means of commercially sustainable pricing regimes which discriminate in favour of users of those modes.

The survey suggests that 57% of companies (Figure 2-17) would search for cheaper transport solutions and might use intermodal transport if its price was lower than in case of other solutions. Cost minimization is one of main premises of logistics strategies that are prepared by companies. Therefore, sustainable pricing regimes are one of not many ways of acquiring environmentally desirable modes users. Out of the interviewed companies (Figure 2-14) none of them said they consider ecological aspects or any regional transport development strategy when creating their logistics strategy. That is the reason why external tools are necessary to encourage use of environmentally desirable modes.

Hypothesis 8: The use of intermodal chains can be encouraged by means of commercially sustainable pricing regimes which discriminate in favour of users of intermodal chains.

The survey indicated that most of the companies (57%, Figure 2-17) search for the cheapest solution of goods distribution. Introduction of the sustainable pricing regime supporting the use of intermodal chain will be an encouragement for them to use this solution. At the same time, the issues of no intermodal transport offers (Figure 3-4), guaranteeing access to this type of transport services and consolidating small load batches into bigger units (containers) should be considered. The only barrier may be the fact that more than 50% of companies do not approve of common deliveries with competition (Figure 2-19).

2.4 CONCLUSIONS AND RECOMMENDATIONS

2.4.1 Conclusions

On the basis of transport cost analyses fin Section 2.2 it may be concluded that multimodal solutions may be cheaper on selected sections even by about 30%. It is worth remembering that this solution assumes activation of a regular connection on analysed routes. However, to make the connection effective there must be a number of interested companies that will regularly ship so as to load the train maximally (e.g. 60 20' containers). Thus, a problem with coordination appears. Therefore, the concept of the EU's Transport Commission concerning establishment of a new profession – freight integrator – whose task would be to coordinate the intermodal chain seems to be justified. Obviously, a possibility of giving financial support to railway carriers in case of not having sufficient weekly loads to transport must be considered.

When deciding to implement the proposed intermodal transport model it is important to remember that the conditions on the European transport market are changing dynamically. A railway operator (carrier) performs in an environment which comprises: the customer (either a forwarder or logistics service provider) demanding transport services; profit-motivated co-operators providing services (e.g. rolling stock production, rolling stock maintenance and repair), an infrastructure administrator (making railway network available through establishment and realization of the time-table); energy suppliers (e.g. oil fuel suppliers); and human resources suppliers (in new EU member states there are now more and more companies providing qualified engine drivers or rolling stock controllers, dispatchers etc.). Because the customers' demands for low price may be in conflict with the expectations of the railway operators and their profit-motivated co-operators, the final offer will be a compromise for all parties: a customer (ordering transport service), the carrier, and the external companies (necessary for the service to be provided).

The policy of railway infrastructure access fees is also an important issue all over the Europe. As an example, in Poland the access fees are now established on a yearly basis (usually in December together with the change of the railway time-table) by infrastructure administrators on the basis of clearly defined procedures. This situation is the same in many European countries. The procedures allow establishment of a rate which takes account of forecasts of transport demand, planned investments, investment financing sources and current activity e.g. European funds, state budget[1]. Due to the fact that most of railway network in Poland belongs to PKP PLK (Polish Railway Lines S.A.), carriers have no influence on the network access fees; if they do not accept the fees they cannot use the infrastructure. The effect of scale may be used here – the more you run the lower unit costs you have. However, in Poland and other countries, where national railway haulier has still a very strong position, there are two stages of the rule, i.e. there are average rates for carriers that in certain time operate minimum 75% of the network and other rates are higher by about 30-40% and they are for other users. It means that only PKP Cargo S.A., which is a member of PKP S.A Group, uses average rates (because of the biggest rolling stock in the country). Representatives of institutions and companies from this line of business suspect that it is a way of "special treatment" of the group member which

1 If state funding is not forthcoming for railway infrastructure maintenance, the users must pay for it. Lack of state financing and poor quality railway infrastructure make Polish railways among the most expensive in Europe

is negative to competition. Similar examples may be identified in other countries. Thus, it is essential to work on the policy of railway infrastructure access fees at European level.

The survey carried out in chapter 3 suggested that differentiation of infrastructure charges would have a very small impact on demand for each transport mode. The survey suggested that price is not the main barrier to using intermodal transport on a larger scale. The main barriers are: too small load batches, no intermodal transport offers and relatively longer driving time. Another barrier is necessity of using containers and other factors (including more frequent use of courier services and customer requirements).

From the shippers' point of view the price is an important but not the only criterion of transport mode selection. Differentiation of transport infrastructure charges, as other surveys in the *DIFFERENT* project have shown (WP8 Effects of Differentiated Road Charges on Road Haulage), mean more to transport operators than to shippers. In road transport, due to strong internal competition, an increase of infrastructure charges will not always be transferred to shippers. Small road transport operators will not be able to compensate the increase of costs with an increase of productivity. As a result, their competitive position on the market may weaken. However, it does not mean that an increase of transport rates caused by an increase of infrastructure charges will make companies change transport mode. Shippers will rather change the transport operator for the one that will compensate the increase. It should be remembered, however, that tolls account for less than 10% of transport operators' total production costs. The meaning of infrastructure charges from the logistics' point of view is even smaller. It means that an increase of infrastructure charges will not cause proportional increase of prices for shippers. Another survey (carried out within WP8) proved that the goal of differentiation of infrastructure charges which was modal shift was not achieved.

The survey summarised in Section 2.1 showed that the interviewed companies could use intermodal transport more frequently if it was cheaper. However, it should be remembered that the companies thought that the current low level of use of intermodal transport results mainly from non-price reasons.

Summing up, as it was mentioned in chapter 2.3, bigger differentiation of infrastructure charges will not have a significant influence on the general modal split and usage of intermodal chains.

2.4.2 Recommendations

Authors do not recommend a general presumption that the use of multimodal chains should be encouraged (we find that they can sometimes detract from the use of modes which are more economically, environmentally or commercially sustainable). It is also worth remembering that any pricing regimes, aiming at intermodal transport promotion and environmentally desirable modes may be considered as subsidization and intervention into a market driven sector.

As a consequence of this, we do not recommend that action should be taken at the European level to promote the use of multimodal chains irrespective of local circumstances.

In the light of these conclusions we recommend that, where local circumstances are appropriate, the local authorities should include price differentiation among the measures used to promote the use of multimodal chains.

Better utilization of intermodal haulages may be increased by changes in policy of railway infrastructure access fees at European level and working out a model, which will be fair for national and private railway operators.

Finally, one of the aims of intermodal haulages is to reduce congestion. However, some of the goods (e.g. FMCG, drugs) have to be distributed mainly by road. Thus, it is essential to organize such a processes as efficient as it is possible with utilization of one or more transport modes. In this connection, it would be more effective for the European transport system to promote co-modality, as a wider concept of intermodality.

3 PASSENGER TRANSPORT

3.1 INTRODUCTION

This section of the deliverable explores the eight hypotheses set out in Deliverable 10.1 in the context of passenger transport.

The hypotheses have been examined using a combination of evidence from previous studies, new modelling work, and logical deduction. The new model was a simple elasticity-driven spreadsheet which predicted the usage of individual modes and combination modes by a representative population of travellers under different pricing scenarios. The model is more fully described in Section 3.2 below.

The majority of the hypotheses could be explored using the spreadsheet (though hypotheses 5 and 8 required some additional assumptions to be made about what constitutes economic and commercial sustainability respectively). Hypotheses 3 and 4, however, could not readily be addressed via the spreadsheet and required us to call on behavioural evidence represented in Deliverables 4.1 and 4.2 and supplemented by more detailed research reported elsewhere.[2]

3.2 MODEL OF A MULTIMODAL PASSENGER TRANSPORT SYSTEM

3.2.1 Outline of the Model

The model used in this work is an elasticity-driven spreadsheet which predicts the usage of individual modes and combination modes by a representative population of travellers under different pricing scenarios. The model is summarised in Figure 3-1.

At the heart of the spreadsheet is an elasticity/diversion model and a secondary effects model which iterate to calculate a new pattern of mode usage.

The elasticity/diversion model reflects the direct effect that introduction of user charges and, under some scenarios, the abolition of pre-existing taxes and subsidies, has on generalised cost. The secondary effects model mitigates the direct effect of the introduction of the charges and any adjustment in taxes or subsidies by allowing demand to adjust to changes in the generalised cost of each mode caused by:

- changes in the amount of congestion reflecting changes in demand following introduction of the charges;
- (under some scenarios) changes in the prices charged by infrastructure suppliers reflecting changes in their unit costs caused by changes in levels of demand[3], and
- (under some scenarios) improvements in performance brought about by investment of revenues from the charges.

The iteration between the elasticity/ model and the secondary effects model is controlled by a convergence test (labelled as #1).

For some scenarios, we assume that the road user charges might be defined to reflect current (rather than initial) externalities. Where this is the case, the model is extended to include a further iterative loop which continues until the pattern of demand creates externalities (and hence charges) which engender that same level of demand. This iteration is controlled by a convergence test (labelled as #2).

2 For example Bonsall et al 2006, 2007a, and 2007b

3 If increases in demand require investment in additional infrastructure which cannot be paid for simply by the pro-rata increase in income from fares or other charges (e.g. parking charges), these charges will need to be increased. However, if supplier costs increase less than pro-rata with demand increases then competition is assumed to cause a reduction in prices charged to users. A reduction in demand will cause an increase in prices if costs fall less than pro-rata with decreased demand.

Once a satisfactory convergence is achieved[4], the spreadsheet calculates revenues and other key indicators which are then used to assess the impact of the charges.

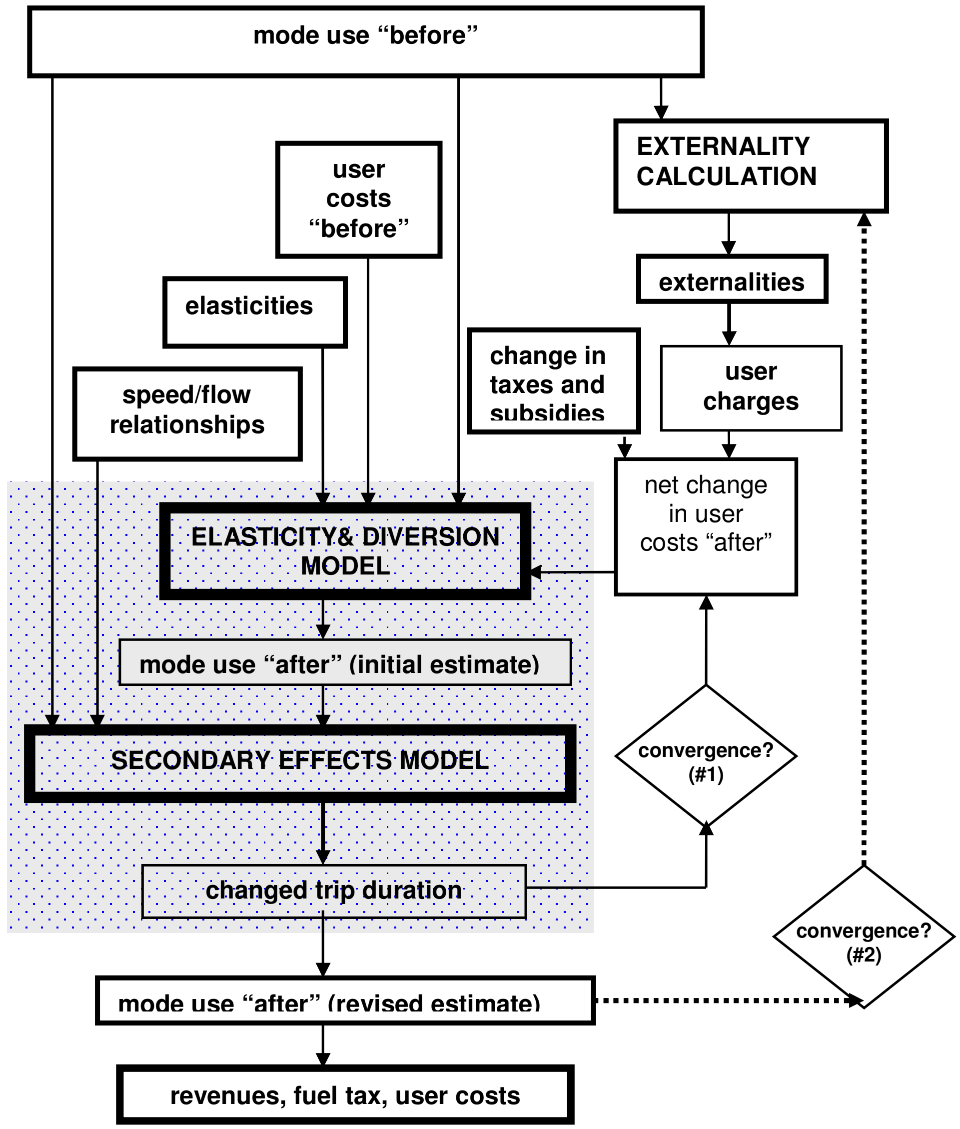


Figure 3-1 Model Structure

The pattern of demand (before and after) is expressed in terms of fifteen modes (seven of which represent unique modes and eight of which represent multimodal combinations). The full list being:

- car or van (sole occupancy)
- car or van (multi-occupancy)
- bus or coach passenger

4 Due to the relative shapes of the two fundamental curves (the cost→demand curve and the demand→elasticity curve), full convergence cannot be guaranteed

- rail
- taxi passenger
- plane[5]
- walk or cycle
- bus plus train (3&4)
- taxi plus bus or train (5&3 or 5&4)
- car/van (accompanied) plus bus or train (2&3 or 2&4)
- car/van (solo) plus bus or train (1&3 or 1&4)
- bus or train plus plane (3&6 or 4&6)
- taxi plus plane (5&6)
- car/van (accompanied) plus plane (2&6)
- car/van (solo) plus plane (1&6)

The users of each of these fifteen modes are disaggregated according to their trip purpose, the length of the journey and whether or not it occurred in a weekday morning peak period.

Four journey purposes are identified:

- commuting (or access to education);
- business;
- personal business (e.g. shopping, escorting to school); and
- leisure/other.

Five trip length categories are identified:

- under 3.0 km
- 3.0- 9.99 km
- 10.0 - 19.99 km
- 20.0 - 99.99 km
- 100 or more km.

Trips in length categories 1-3 are designated as "short" and those in categories 4 and 5 are designated "long". The "short" trips are predominantly urban, while the "long" ones may or may not include an urban element.

The two time periods (based on journey start time) are:

- Weekday peaks (0700-0900 and 1630-1830)
- other

The disaggregation of fifteen modes by four purposes, five trip length categories and two time periods yields six hundred trip types.

3.2.2 Data Inputs

This spreadsheet has ambitious data requirements and considerable effort was required to gather it.

5 Note that, although plane (mode 6) was defined as a unique mode, no trips use plane other than as part of a multimodal chain. It is retained in the list simply to facilitate later description.

Trip Characteristics

Data was sought on the number, length and cost of trips in each of the six hundred categories on a typical day in a medium sized metropolitan area. Data from the UK National Travel Survey[6] for the years 2002-2005 was processed to show the number of trips starting or ending in London or a metropolitan area falling into each of these six hundred categories and, for each category, to show the mean duration, length and out-of pocket costs experienced[7]. This data may be considered as being broadly representative of the trips in a medium sized metropolitan area and is used to represent mode usage patterns and user costs before the introduction of new charges. The data from NTS contained information for just over 425,000 one-way trips. This number was multiplied up to give a total which would be appropriate for the number of trips in a medium sized metropolitan area.
The mean duration and mean out of pocket costs for each category of trip were combined, using a notional mean value of time (0.15€ per minute) to give a mean generalised cost per trip in each category.

Appendix 2 indicates the proportion of trips, and the relevant mean generalised trip cost for each category of trip.

Assumptions about Externality Costs

A key input to the spreadsheet is the total externality cost (per trip) attributable to each category of trip. The total externality cost being here defined as the sum of the costs which a trip (of a given length, by a given mode in given conditions) imposes on other travellers, society or the environment. It thus includes the incremental costs of delay, greenhouse gas emissions, local air pollution, noise, and accidents.

The spreadsheet requires an externality cost per trip for each of our seven main modes for peak and off peak periods for short and long trips. Since delay costs, in particular, differ according to the assumed level of demand, estimates are required for a range of different demand levels.
Although estimates of some of these costs were found in the literature for car, bus, train and air modes, it was not possible to find a single set of mutually consistent estimates covering all seven modes for both time periods and area types for the required range of demand levels. Assumptions had therefore to be made on the basis of the wider literature on externalities. Appendix 3 contains tables detailing the externality cost values used in the spreadsheet. Figures for a specific level of demand are estimated by the spreadsheet by interpolation between, or extrapolation from, the values shown. It should be noted that, although estimates have been provided, in this and equivalent appendices, for a wide range of demand levels, we do not expect the extreme values to be called on and so most attention was placed on making good estimates of those in the central range (50% to 150% of current demand).

Figures for each of our eight multimodal combinations are estimated by the spreadsheet as a weighted average of the costs of the relevant constituent modes – the weighting being based on their assumed relative shares of the trip distance as shown in Appendix 4.

Assumptions about Levels of Taxation or Subsidy

Under certain scenarios, it is assumed that charges might be introduced as part of a package within which pre-existing taxes and subsidies might be abolished. The spreadsheet assumes that, if this were the case, the price of each mode would be adjusted to reflect the abolition of pre-existing taxes and subsidies. It therefore requires an estimate of the net tax (or subsidy) per trip for each of the six hundred trip categories.

Information about existing taxes and subsidies for the different modes were sought in the literature and, mindful that different levels of taxes and subsidies are to be found in different countries and even

6 See www.statistics.gov.uk/ssd/surveys/national_travel_survey.asp

7 The average out of pocket costs recorded in NTS for 2002 to 2005 were increased by a factor of 1.1 to bring the costs up to a 2006 base. The out of pocket costs recorded in NTS do not include fuel costs so, for car trips, the trip distance together with a notional fuel cost per kilometre (0.1 €) was used to estimate the fuel cost and added this to such out of pocket costs as had been recorded.

in different metropolitan areas within the same country, assumptions were made about typical levels. These assumptions are recorded in Appendix 5. Note that, under these assumptions, our base year city is assumed to provide a net annual subsidy of 109 million Euros to transport.

Assumptions about Elasticities and Diversion Factors

The elasticities and diversion factors used in the spreadsheet are defined below and indicate the change in demand (d) expected in a given mode (k) following a specified change in the generalised cost (GC) of that mode or of competing modes.

$$d_k^{NEW} = \sum_m \delta_{mk} d_m^{OLD} \left\{ \left(\frac{GC_m^{NEW}}{GC_m^{OLD}} \right)^{\eta_{mm}} - 1 \right\}$$

where:

η_{mm} are the own elasticities of demand for mode m with respect to generalised cost, and

δ_{mk} are diversion factors.

The original intention had been to find or estimate cross-elasticities (η_{km}) but this proved unachievable and so the effect of a change in the cost of one mode (m) on the demand for another (k) was represented via diversion factors (δ_{mk}) defining the proportions of any lost demand for mode m which are assumed to be diverted to mode k (and, for simplicity, the proportions of any additional demand for mode m which are assumed to originate from mode k). Note that $\sum_m \delta_{mk}$ does not sum to 1.0 because some of the “lost” demand is assumed to be suppressed entirely (and similarly some of the additional demand is assumed to be pure generation).

Evidence on elasticities was sought in the literature. Little evidence was found on generalised-cost elasticities or on elasticities for composite modes. Available estimates on price elasticities for the main modes[8] were transformed into generalised-cost elasticities using ratios of price to generalised cost based on journey times and costs shown in Appendix 6a (for walk and cycle there were, of course, no price elasticities because - these modes generally being free - and so an appropriate generalised-cost elasticity, designed to be compatible with the generalised-cost elasticities estimated for the other modes, had to be assumed).

Elasticities for composite modes were estimated as the cost-weighted harmonic mean of those of their constituent modes.

Little evidence was found on the relative elasticities for different purposes and so assumptions had to be made. We assumed that employer’s business trips, commuting (and access to education) would be the least elastic, and that personal business and leisure would be most elastic. For any given time period, journey length and mode, the relative elasticity ratios for commuting, business, personal business and leisure are, respectively, 1.00, 0.75, 1.80 and 2.00. Appendix 6b shows the own generalised cost elasticities we have used for peak journeys between 3km and 10km.

Mode-to-mode diversion factors (δ_{mk}) were generated for each trip purpose, time period and trip length category based on available evidence combined with intuition. The overall assumption was that diversion factors should reflect the perceived substitutability between pairs of modes in a given context. Thus, for example, it was assumed that:

- diversion to/from walk or cycle would be significant for trips of less than 3kms, less marked for trips of 3-10 kms, less still for trips of 10-20 kms and non-existent for trips of more than 20kms;

8 The main sources used were: Vicario (1999) and Button (1982)

- diversion to/from plane would not occur for trips of less than 100km;
- diversion to/from train would be insignificant for trips of less than 3kms and would become increasingly important as trip length increased;
- diversion to/from bus would be greatest for trips of less than 10kms and become less important as trip length increased above that; and
- other things being equal, one might expect more diversion to a commonly-used mode than to one which serves a small market (e.g. former rail users were thought more likely to choose bus than the combined mode bus & train).

Diversion between adjacent trip lengths was assumed to occur to a marginal degree (at 2% of the level assumed within a given trip length). Diversion between time periods was assumed to occur at 2% of the level assumed within a given period.

No diversion was assumed to occur between:

- trips with different purposes
- trips of very different lengths (cross-elasticities are only assumed to exist between adjacent length categories)
- trips which differ in terms of trip length and time period (e.g. 9 km peak trips are not affected by the cost of 11 km off-peak trips)[9]

It was thought important to constrain the operation of the diversion factors such that the demand for a given mode was not allowed to go negative (as might have happened if high volume competitor modes - or even one very high volume competitor mode – became much more attractive and subtracted demand from a relatively low volume mode). However, when the own elasticities and diversion factors were applied, there was little evidence of negative demands.

The full matrix of diversion factors contains 600 x 600 cells and is too unwieldy to include in this report. Appendix 6c is therefore restricted to showing only two "blocks" of our diversion factors.

Assumptions about Secondary Effects

The Secondary Effects model seeks to reflect the effect on demand of changes in modal costs due to:

- changes (usually reductions) in congestion following introduction of charges
- and, under certain scenarios:
  - changes in the prices charged by infrastructure suppliers reflecting changes in their unit costs caused by changes in levels of demand, and
  - improvements assumed to be achieved by investment of revenues from charges.

We will deal with each of these in turn.

Assumptions about the cost of congestion. Changes in demand for travel by a particular mode at a given time of day in a given type of area will, unless there is ample spare capacity, affect travel times for that mode at that time and place because they will affect the degree of congestion and crowding. This effect can even apply for pedestrian and cycle trips. For air and rail trips the effect is created by queuing and delays at terminals rather than through reduced speed on the journey itself. For road-mode trips (car, taxi and bus or coach), the delay created by trips on one of these modes is suffered by users of that mode and by users of the other road modes (though taxi and bus /coach users will also experience an element of delay due to queuing or vehicle shortage which is not felt by car users).

Estimates of the level of these delays were sought in the literature but, as with the externality costs, it was difficult to find fully consistent estimates for all modes. A degree of judgement, based on the

9 These assumptions were prompted by the lack of information about such relationships and may be excused by the low number of such trips.

principles set out in the literature was therefore required. Appendix 7 shows the values which we have used for the seven main modes for different demand levels (estimates for the mixed modes are derived by the spreadsheet as a distance-weighted average of figures for the constituent modes). Values for a given level of demand are interpolated or extrapolated as necessary.

Assumptions about the costs infrastructure provision and operation. As noted in Section 3.2.1, the spreadsheet allows for the possibility that infrastructure suppliers would alter their prices to reflect changes in the unit costs of service provision following a change in demand. This necessitates estimates of the unit costs (i.e. per passenger trip or per passenger journey) of service provision at different levels of demand. The costs of service provision are here defined as including infrastructure provision, operation and wear and tear, thus including, *inter alia*, the costs of traffic policing and control, taxi dispatching, airport operations, track maintenance and so on.

Estimates for these items were sought in the literature and, where appropriate figures could not readily be found, assumptions were made as necessary. Appendix 8 shows the values which we have used for our seven main modes (values for cycling and walking are included for completeness even though we do not test any scenarios under which users of these modes would be required to contribute directly to the costs).

Assumptions about the benefits of investment. As noted in Section 3.2.1, the spreadsheet allows for the possibility that net revenues raised from new infrastructure charges might be invested in improvement of the transport system. The extent of improvement assumed to be achieved for each mode was determined in the light of: the net revenue available (we assume that five[10] years' revenue is available but that implementation and administration would devour 40% of total revenues – leaving 60% for investment); the allocation of that revenue between modes (this can vary in different scenarios – see Section 2.4); and the reductions in user cost for each mode per unit investment in that mode.

Estimation of the likely reductions in user cost per unit investment requires a considerable degree of speculation. The values shown in Appendix 9 are based on estimates and commentary provided by prominent experts in the field. They reflect the following assumptions:

- The reductions in user cost are achieved primarily through investment in infrastructure to provide time savings – the use of the revenue simply to subsidise fares is not allowed.
- It is generally easier to reduce road journey times during the peak than off peak (traffic management can produce greater gains during congested periods than during uncongested periods). However, for bus/coach and train, off-peak time savings can be produced by increasing the level of service (bringing under-utilised capacity into operation).
- Proportionate reductions in the generalised cost are more easily obtained for short trips than for long ones (significant improvement in the speed or comfort of the line-hail element is particularly expensive).
- There is little scope to reduce journey times for pedestrians or cyclists (improved crossing facilities and the provision of cycle routes will generally have a marginal impact on city-wide journey times).
- Significant time savings can be achieved for plane users by increasing the capacity of check-in and security facilities.
- For mixed modes, improvements in interchange facilities and service integration offer scope for generalised cost reductions over and above those achievable within the constituent modes.

3.2.3 Caveats

The spreadsheet used in this analysis is clearly a very simplified version of reality. We would not presume to suggest that results obtained using it are wholly representative of any specific location (or even an average of UK metropolitan areas). Simplifications and short cuts have been adopted where

10 The spreadsheet predicts the situation after the benefit of any investment has come to fruition. The fact that we are assuming five years' revenue does not mean that we are predicting the situation after five years – the investment might actually be put in place in advance using anticipated revenues.

we thought it impossible to achieve an accurate representation or that the extra effort required to improve the representation would not have a commensurate impact on our conclusions. As a result of this, it is important to recognise the following limitations on any predictions from the spreadsheet (arranged in probable decreasing order of importance):

- The own elasticities are based on a variety of sources rather than one a single incontrovertible source. Although we believe them to be realistic and mutually compatible, we cannot claim that they are all definitively correct. Any error in the elasticity assumptions will of course have a direct effect on the results.
- The diversion factors are based on our own assumptions rather than on a single source of observed evidence. Any error in the diversion factor assumptions will of course have a direct effect on the results.
- We have assumed that the diversion factors used to represent the likely choices of people who divert from a given mode can also be used to indicate the likely original modes of people diverting to that given mode. In scenarios characterised by increasing costs this will tend to predict a net shift from commonly-used modes to those which were initially used only by a minority of people.
- Some of the externality values are controversial and would vary from location to location - we allow them to vary with trip length, type of area and time of day (weekday morning peak/ other) but assume no other variation.
- Our estimates of the extent of congestion relief (and of additional congestion) are based on generalised assumptions about the amount of spare capacity which currently exists for each mode in our hypothesised metropolitan area. The true figures would depend crucially on local circumstances
- Our assumptions about the costs of infrastructure provision and operation are speculative. The true figures would depend crucially on local circumstances
- Our assumptions on the effectiveness of revenue investment are extremely speculative. The true figures for a specific metropolitan area would depend crucially on the status quo ante (amount of spare capacity, quality of existing provision, costs of construction and operation, etc).
- We have assumed all travellers have the same value of time (allowing for variation in value of time would allow a closer adaptation of behaviour to charges).
- Our assumptions about the proportion of charge revenue that would be devoured by administration and implementation costs relate to a generalised scheme. The true figures would depend crucially on the type of charging scheme being implemented.
- Our own elasticities are assumed constant for all levels of demand and will thus not be reliable for very large changes in demand (in fact our work rarely predicted changes outside the "comfort zone" prescribed by constant elasticities).
- Our elasticities and diversion factors do not allow for the possible effect that the complexity of differentiated charges might have on behavioural response (but see Hypothesis 4)
- The spreadsheet treats all trips as unique (whereas, in reality, most are part of a two-way journey) and so does not reflect the fact that most mode choices – and certainly those involving driving a car - have to be based on the conditions for *both* directions of travel.
- Our spreadsheet does not allow for the possibility that car drivers might change routes in order to minimise their exposure to charges. This restricts the range of charge structure that we can investigate.
- We have assumed all car travellers have the same class of vehicle and that they cannot respond to car-use charges by migrating to another type of vehicle.

3.2.4 Scenarios

The hypotheses established in Deliverable 10.1 refer to "…..differentiation of infrastructure charges *in the ways, and to the extents, currently being contemplated*"). This phrase leaves some room for interpretation and so we have constructed several scenarios to allow for some difference in interpretation. The nine scenarios we have explored with the spreadsheet, summarised in Table 3.1, are as follows:

Scenario 1 has charges based on ex-ante externalities and represents a basic policy in which differentiated charges are introduced to reflect different MSC)

Scenario 2 differs from #1 in that it is assumed that it would be politically feasible, as well as economically desirable, to revise the charges in the light of their effect on demand and the new MSCs that then apply.

Scenario 3 differs from #2 in assuming that the economic argument for abolition of distortionary taxes and subsidies is accepted and that all pre-existing taxes and revenues have therefore been abolished.

Scenario 4 differs from #2 in assuming that political realities demand the re-investment of revenues in the transport system.

Scenario 5 differs from #4 in assuming that pro-environmental sentiment is more influential than pro-motorist sentiment and that net revenues have therefore been re-invested solely in environmentally sustainable modes.

Scenario 6 differs from #5 in that, because pro-environmental sentiment is in the ascendancy, the “sustainable” modes are exempt from the MSC charges..

Scenario 7 differs from #6 in that it is assumed that suppliers adjust their prices to reflect the changes in per-unit costs caused by changes in demand (as would be expected in a competitive market).

Scenario 8 differs from #7 in assuming that the economic argument for abolition of distortionary taxes and subsidies is accepted.

Scenario 9 differs from #8 in assuming that, despite the economic argument for abolition of distortionary taxes, pro-environmental pressures succeed in diverting resulting “spare” money to the sustainable modes.

Table 3-1 Scenarios Tested using the Spreadsheet Model

	Scenarios								
	1	2	3	4	5	6	7	8	9
Charges reflect the MSCs in the base year	x								
Charges reflect the MSCs in the current year (i.e. after iteration to reflect changes in demand)		x	x	x	x	x	x	x	x
“Sustainable modes” (public transport, walk and cycle) are exempt from charges						x	x	x	x
Previous taxes and subsidies rare abolished			x					x	x
Net revenue[1] from abolition of previous taxes and subsidies is re-invested in sustainable modes									x
Net Revenue[1] from charges is re-invested pro-rata to base year demand (measured in passenger kms)				x					
Net revenue[1] from charges is re-invested in environmentally sustainable modes (split pro rata to demand)					x	x	x	x	x
Suppliers adjust their prices to reflect new costs							x	x	x

[1] five years revenue after deduction of costs of implementation and administration

3.2.5 Results

Table 3-2 shows the results of our spreadsheet analyses. We note that, except in respect of minority modes, none of the scenarios show changes in demand outside the expected range (thus vindicating our decision to concentrate our attention on input data applicable to the range 50% to 150% of current demand and limiting the error introduced by our assumption of constant elasticities).

Per Scenario

Comparison of Scenario 1 with the Base suggests that, in the context of a simple charge (without any change to pre-existing taxes or prices or any re-investment of revenues), the introduction of MSC-like charges to all modes of transport reduces the total number of trips in the system by about 1% (leaving mandatory trips as a marginally higher share of total demand) and reduces environmental externalities by about 8%. It achieves this via some notable changes in modal shares – with significant reductions in use of car modes (particularly solo driving) and significant increases in the use of rail, walk and cycle and rail-with-car. Generally speaking, the changes are most marked among short trips. The net revenue from the new charges (after deducting the costs of collection) is 103.1 m€ p.a. – which, interestingly, is somewhat larger than the net 93 m€ p.a. subsidy inherent in the existing taxes and subsidies.

Comparison of Scenarios 1 and 2 suggests that, in the context of a simple charge (without any change to pre-existing taxes or prices or any re-investment of revenues), the revision of charges to reflect the new pattern of demand slightly reduces the scale of effects caused by the initial introduction of charges which reflected the original pattern of demand. This is due primarily to the fact that, since the initial charges caused some trip suppression and hence reduced congestion, the revised charges (being based on MSC principles) did not need to be so high.

According to Scenario 3, the abolition of existing taxes and subsidies, which some economists see as a necessary part of any attempt to achieve efficient pricing, results in an increase of over 8% in environmental externalities and a 1.3% reduction in total demand. This reflects significant reductions in the use of bus, short distance rail and of multimodal chains comprising bus and train or car and long-distance train offset by increases in the use of car (particularly multi-occupied) and of walking and cycling. Interestingly, abolition of taxes and subsidies also causes an increase in the net revenue from charges – thus providing a double benefit to the exchequer. Comparison of the results from Scenarios 2 and 3 suggests that the effect that abolition of pre-existing taxes and subsidies has on demand outweighs that of the introduction of MSC-like pricing – leaving usage of rail and bus/coach at significantly lower levels than in the base[11]

[11] It should however be noted that the predicted impact of abolition of subsidies depends on the assumptions made about the efficiency with which it was being used. The spreadsheet assumes that the subsidy to bus and rail was being used to reduce fares (and thus that abolition of subsidy leads directly to an increase in fares), but if part of the subsidy was being used to invest in infrastructure then the impact of abolition on generalised cost would be lower than predicted in the short term but higher than predicted in the long term.

Table 3-2 Results from Spreadsheet

	Base	*Scenario 1*		*Scenario 2*		*Scenario 3*		*Scenario 4*		*Scenario 5*		*Scenario 6*		*Scenario 7*		*Scenario 8*		*Scenario 9*	
			Δ%		*Δ %*		*Δ %*		*Δ %*		*Δ %*		*Δ %*		*Δ %*		*Δ %*		*Δ%*
Total Trips (000s) per day	1277.0	1260.7	*-1.3*	1261.7	*-1.2*	1256.8	*-1.6*	1273.0	*-0.3*	1263.8	*-1.0*	1266.4	*-0.8*	1266.6	*-0.8*	1258.7	*-1.4*	1259.6	*-1.4*
Annual revenue (Euro M) net of costs		103.1		104.0		117.1		108.6		104.3		93.1		92.6		109.3		109.0	
Annual cost of externalities (Euro M)	179.1	164.2	*-8.3*	166.3	*-7.2*	194.3	*8.5*	176.5	*-1.4*	166.7	*-6.9*	148.9	*-16.8*	147.5	*-17.6*	181.5	*1.3*	181.1	*1.1*
Average trip length (km)	12.8	12.9	*0.7*	12.9	*0.6*	12.9	*1.0*	12.8	*0.0*	12.9	*0.5*	12.8	*0.4*	12.8	*0.4*	12.9	*0.9*	12.9	*0.9*
Average Generalised Cost (cents per trip)	475.6	552.6	*16.2*	547.2	*15.0*	551.9	*16.0*	515.6	*8.4*	541.9	*13.9*	536.1	*12.7*	535.9	*12.7*	545.5	*14.7*	542.0	*14.0*
% commuting or employers business	30.4	30.5		30.5		30.4		30.3		30.5		30.5		30.5		30.4		*30.4*	
% in weekday peak periods	29.0	29.0		29.1		29.0		28.8		29.0		29.0		29.0		29.1		*29.0*	
Overall mode shares (%):																			
(1) car or van (solo)	22.5	21.4	*-5.1*	21.5	*-4.7*	23.3	*3.5*	21.4	*-4.9*	21.2	*-5.7*	20.9	*-7.2*	20.9	*-7.2*	23.0	*2.4*	22.9	*1.9*
(2) car or van (multi)	35.5	33.7	*-5.0*	33.9	*-4.6*	37.1	*4.4*	35.6	*0.2*	33.4	*-5.8*	32.9	*-7.4*	32.8	*-7.5*	36.6	*3.3*	36.4	*2.7*
(3) bus or coach passenger	9.8	10.1	*3.1*	10.1	*2.3*	6.6	*-32.9*	10.1	*2.4*	11.1	*12.9*	12.5	*26.7*	12.4	*25.7*	7.6	*-22.8*	8.1	*-18.1*
(4) rail	3.5	4.6	*30.7*	4.5	*28.6*	2.9	*-17.9*	3.8	*9.8*	4.4	*24.6*	4.2	*19.0*	4.3	*23.3*	2.7	*-22.4*	2.6	*-24.4*
(5) taxi passenger	1.4	1.4	*-1.8*	1.4	*-1.5*	1.7	*25.9*	1.4	*4.7*	1.3	*-5.9*	1.2	*-11.2*	1.2	*-11.5*	1.7	*21.8*	1.6	*19.7*
(7) walk or cycle	24.5	25.0	*2.3*	25.0	*2.2*	25.4	*3.6*	24.5	*0.2*	24.9	*1.8*	24.8	*1.2*	24.8	*1.2*	25.3	*3.3*	25.2	*3.2*
(8) bus & train	1.1	1.2	*11.2*	1.2	*10.3*	0.8	*-26.9*	1.1	*1.1*	1.2	*8.8*	1.2	*9.8*	1.2	*9.8*	0.8	*-27.8*	0.8	*-28.8*
(9) taxi & bus or train	0.2	0.3	*70.9*	0.3	*66.0*	0.5	*158.7*	0.2	*17.7*	0.3	*53.2*	0.2	*40.3*	0.2	*39.6*	0.4	*149.7*	0.4	*143.8*
(10) car/van multi & bus or train	0.9	1.3	*45.5*	1.2	*42.2*	0.9	*7.6*	1.0	*14.2*	1.2	*41.4*	1.2	*39.3*	1.2	*38.9*	0.9	*6.7*	0.9	*6.4*
(11) car/van solo & bus or train	0.6	1.0	*53.3*	1.0	*49.5*	0.8	*30.4*	0.8	*22.4*	1.0	*47.6*	0.9	*44.9*	0.9	*44.4*	0.8	*28.8*	0.8	*28.1*
(12) bus or train & plane	0.0	0.0	*362.5*	0.0	*343.6*	0.0	*565.6*	0.0	*251.5*	0.0	*315.6*	0.0	*259.8*	0.0	*241.0*	0.0	*534.6*	0.0	*517.5*
(13) taxi & plane	0.0	0.0	*33.9*	0.0	*32.0*	0.0	*49.7*	0.0	*22.7*	0.0	*29.7*	0.0	*36.5*	0.0	*35.3*	0.0	*47.2*	0.0	*45.7*
(14) car/van multi & plane	0.0	0.0	*81.2*	0.0	*76.2*	0.0	*78.8*	0.0	*52.1*	0.0	*73.4*	0.0	*70.8*	0.0	*78.6*	0.0	*75.6*	0.0	*73.7*
(15) car/van solo & plane	0.0	0.0	*38.4*	0.0	*36.1*	0.0	*40.8*	0.0	*25.8*	0.0	*34.3*	0.0	*32.2*	0.0	*32.2*	0.0	*38.8*	0.0	*37.6*
short trips (000s) per day	1108.8	1094.6	*-1.3*	1095.5	*-1.2*	1090.3	*-1.7*	1105.9	*-0.3*	1097.4	*-1.0*	1099.7	*-0.8*	1099.9	*-0.8*	1092.0	*-1.5*	1092.9	*-1.4*
Share of short trips (%) :																			
(1) car or van (solo)	20.9	19.8	*-5.4*	19.9	*-5.0*	21.7	*3.9*	19.8	*-5.4*	19.6	*-6.2*	19.3	*-7.9*	19.2	*-7.9*	21.4	*2.6*	21.3	*2.1*
(2) car or van (multi)	34.6	32.8	*-5.2*	33.0	*-4.7*	36.3	*4.8*	34.8	*0.5*	32.5	*-6.1*	31.9	*-7.9*	31.9	*-8.0*	35.8	*3.5*	35.6	*2.9*
(3) bus or coach passenger	10.9	11.2	*2.8*	11.1	*2.1*	7.3	*-33.2*	11.1	*2.1*	12.3	*12.9*	13.8	*26.5*	13.7	*25.7*	8.4	*-22.8*	9.0	*-17.7*
(4) rail	2.8	3.7	*34.0*	3.7	*31.8*	2.0	*-27.3*	3.0	*8.9*	3.5	*26.0*	3.3	*18.8*	3.4	*22.8*	1.8	*-33.9*	1.7	*-37.1*
(5) taxi passenger	1.5	1.4	*-2.5*	1.4	*-2.2*	1.8	*24.6*	1.5	*4.3*	1.4	*-6.6*	1.3	*-11.9*	1.3	*-12.0*	1.8	*20.6*	1.8	*18.5*
(7 walk or cycle	28.2	28.8	*2.3*	28.8	*2.2*	29.2	*3.7*	28.2	*0.2*	28.7	*1.8*	28.5	*1.2*	28.5	*1.1*	29.1	*3.4*	29.1	*3.3*
(8) bus & train	0.7	0.9	*20.0*	0.8	*18.5*	0.5	*-27.3*	0.7	*3.3*	0.8	*14.6*	0.8	*13.1*	0.8	*13.6*	0.5	*-31.6*	0.5	*-34.1*
(9) taxi & bus or train	0.0	0.2	*509.9*	0.2	*477.0*	0.3	*791.1*	0.1	*176.5*	0.1	*401.5*	0.1	*320.7*	0.1	*315.1*	0.2	*723.9*	0.2	*684.5*
(10) car/van multi & bus or train	0.3	0.7	*144.4*	0.7	*134.0*	0.5	*63.8*	0.4	*44.9*	0.6	*127.7*	0.6	*121.7*	0.6	*121.7*	0.4	*58.1*	0.4	*54.5*
(11) car/van solo & bus or train	0.2	0.5	*211.2*	0.5	*196.4*	0.4	*147.4*	0.3	*88.3*	0.5	*184.7*	0.5	*174.2*	0.5	*173.6*	0.4	*137.6*	0.4	*131.3*

long trips (000s) per day	168.2	166.1		166.2		166.5		167.1		166.4		166.7		166.7		166.7		166.8	*-0.9*
Share of long trips (%):																			
(1) car or van (solo)	33.1	31.9	*-3.9*	31.9	*-3.6*	33.6	*1.5*	32.2	*-2.8*	31.9	*-3.8*	31.7	*-4.4*	31.6	*-4.6*	33.5	*1.2*	33.5	*1.1*
(2) car or van (multi)	41.2	39.6	*-4.0*	39.7	*-3.7*	42.0	*2.0*	40.7	*-1.4*	39.6	*-4.0*	39.3	*-4.7*	39.2	*-4.9*	41.9	*1.7*	41.9	*1.5*
(3) bus or coach passenger	3.0	3.3	*9.6*	3.3	*8.1*	2.3	*-24.2*	3.3	*7.8*	3.4	*12.1*	4.0	*32.2*	3.8	*25.9*	2.3	*-23.7*	2.3	*-24.9*
(4) rail	8.3	10.2	*23.2*	10.1	*21.7*	8.5	*2.5*	9.3	*12.1*	10.1	*21.4*	9.9	*19.6*	10.3	*24.3*	8.5	*2.7*	8.6	*3.2*
(5) taxi passenger	0.7	0.8	*9.2*	0.8	*8.8*	1.0	*45.4*	0.8	*9.6*	0.7	*4.8*	0.7	*-2.1*	0.7	*-3.9*	1.0	*40.1*	1.0	*37.6*
(8) bus & train	3.7	3.7	*0.0*	3.6	*-0.3*	2.7	*-26.8*	3.6	*-1.5*	3.7	*1.4*	3.9	*5.6*	3.8	*5.0*	2.8	*-23.3*	2.8	*-22.3*
(9) taxi & train	1.1	1.1	*-3.8*	1.1	*-4.0*	1.7	*50.4*	1.0	*-9.0*	1.1	*-6.0*	1.1	*-7.4*	1.1	*-7.2*	1.7	*51.4*	1.7	*51.1*
(10) car/van multi & train	4.7	5.0	*6.0*	4.9	*5.6*	4.0	*-15.3*	4.8	*2.3*	5.0	*7.1*	5.0	*6.6*	5.0	*5.9*	4.0	*-14.2*	4.1	*-13.1*
(11) car/van solo & bus or train	3.8	4.1	*7.2*	4.1	*6.7*	3.7	*-4.2*	3.9	*3.5*	4.1	*7.7*	4.1	*7.2*	4.1	*6.9*	3.7	*-3.3*	3.7	*-2.4*
(12) train & plane	0.0	0.0	*362.2*	0.0	*343.4*	0.0	*561.6*	0.0	*252.8*	0.0	*315.7*	0.0	*260.1*	0.0	*241.2*	0.0	*531.2*	0.0	*514.3*
(13) taxi & plane	0.1	0.1	*33.8*	0.1	*31.9*	0.1	*48.8*	0.1	*23.1*	0.1	*29.7*	0.1	*26.5*	0.1	*26.3*	0.1	*46.4*	0.1	*44.9*
(14) car/van multi & plane	0.1	0.1	*81.1*	0.1	*76.1*	0.1	*77.8*	0.1	*52.7*	0.1	*73.4*	0.1	*69.7*	0.1	*69.2*	0.1	*74.7*	0.1	*72.8*
(15) car/van solo & plane	0.1	0.2	*38.3*	0.2	*36.0*	0.2	*39.9*	0.1	*26.2*	0.2	*34.4*	0.2	*32.3*	0.2	*32.3*	0.2	*38.1*	0.2	*36.9*

Comparison of Scenario 4 with Scenario 2 shows that reinvestment of the net revenues from MSC-like charges pro-rata to demand (pass kms) results in an increase in trip numbers and environmental externalities (both of which return to something like the levels experienced in the absence of the charges). The pattern of mode use changes – with a notable increase in the use of multi-occupied cars but decreases in the use of rail, the composite modes and walking and cycling. The increase in multi-occupied car use is interesting because the use of solo car actually decreases somewhat. This probably reflects the fact that, while the per-head expense of the charges is reduced by sharing it among all occupants, each occupant gets the full benefit of any reduction in congestion. It is also interesting to note that bus use does not decline in the same way as rail use. This may be partly because part of the benefit from the investment of car's "share" of the revenue (the in-vehicle journey time increases) is experienced by bus and coach trips and this, taken together with the benefit coming from bus and coach's "own" share, favours bus and coach relative to rail.

Comparison of Scenario 5 with Scenario 2 suggests that investment of revenues raised by MSC-like charges solely in environmentally sustainable modes (bus/coach, rail, walk and cycle) has very little impact on demand or on the levels of environmental externalities. Targeting the investment in this way, rather than allocating it pro-rata to demand (as in Scenario 4), results in lower total trip numbers and a lower level of environmental externalities – the number of car trips is significantly lower and is not fully offset by the higher usage of the sustainable modes (despite the notably higher use of short distance bus and long distance rail). Scenario 5 suggests that targeting the investment to sustainable modes is less economically efficient than allocating it pro-rata to demand. (Part of the loss of efficiency is perhaps attributable to the absence of the double-benefit effect noted in the previous paragraph).

The incremental effect of providing the environmentally sustainable modes (bus/coach, rail, walk and cycle) with an exemption from MSC-like charges (obtained by comparing scenarios 6 and 5) is that the use of such modes increases by less than 3% while that of the non-exempt modes falls by a similar proportion and overall trip numbers decrease somewhat. The reason for the modest boost to the overall "sustainable modes" group is that the exemption results in a significant switch from rail to bus. Although the sustainable modes' share of overall trips does not change significantly, their exemption from charges does result in a much greater reduction in environmental externalities. Interestingly, but entirely co-incidentally, the loss of revenue from charges on sustainable modes brings the net revenue from charges to precisely the same level (93.1 m€ p.a.) as the net subsidy inherent in pre- existing taxes and subsidies.

Comparison of Scenarios 6 and 7 shows that overall demand is not materially affected by whether or not suppliers change their prices in response to changes in unit costs (as they might be expected to do in a competitive market). The only impact of any consequence seems to be a switch from bus to rail – particularly for long distance journeys (presumably reflecting the fact that long distance rail benefits particularly strongly from the classic "public transport virtuous circle" whereby increases in demand lead to reductions in the cost per passenger and, if this reduction is passed on to users, demand increases still further. This effect is present to some extent for bus but the effect is much greater for the rail modes and so the reduced cost for rail attracts passengers from bus despite the marginal reduction in bus costs).

Comparison of Scenario 8 with Scenario 7 shows that, as was noted in the comparison of Scenario 3 with Scenario 2, abolition of previous taxes and subsidies causes an increase in net revenue from charges but a reduction in overall demand – with a very significant fall in the use of bus and rail – and an erosion of the environmental benefits achieved by introducing MSC-like charges . The pattern of demand in Scenario 8 is actually quite similar to that in Scenario 3 – indicating that the deleterious effect that abolition of taxes and subsidies had on public transport modes more than outweighs all the public-transport-friendly elements built into Scenarios 6 and 7 (i.e. exemption of environmentally sustainable modes from MSC charges, diversion of all revenue-based investment to environmentally sustainable modes and reduction in prices to reflect reduced unit costs for public transport suppliers).

Comparison of Scenario 9 with Scenario 8 shows that channelling the money "saved" by abolishing previous taxes and subsidies into the sustainable modes has almost no effect on the pattern of demand or on the level of environmental externalities. This echoes and re-enforces our finding from Scenario 5 – namely that targeted investment in the sustainable modes does not seem to be a very effective policy.

Overall Conclusions from Model Results

Although the results must be treated with some caution, a number of important conclusions can be drawn:

- The introduction of MSC-like charges has a marginal net effect on overall demand but can have a marked effect on modal split – with notable increases in the use of bus and train and reductions in solo car driving.
- Significant reductions in environmental externalities can be achieved by introducing MSC-like charges and further reductions, of equivalent magnitude, can be achieved by exempting the "sustainable" modes from the charges.
- The abolition of all pre-existing taxes and subsidies has an effect which is opposite in direction to that of introducing MSC-like charges (it results in a reduction in the use of bus and train and an increase in the use of car). The abolition of all pre-existing taxes and subsidies more than outweighs the effect of introducing MSC-like charges.
- Re-investment of net revenues from MSC-like charges pro-rata to demand (kms) leads to a shift to multi-occupancy car and away from rail, the composite modes and walk and cycle.
- Re-investment of net revenues from MSC-like charges, and/or of the money "saved" by abolishing previous taxes and subsidies, solely to sustainable modes has little effect on demand or on the level of environmental externalities.
- The effects noted above are not materially affected by whether or not suppliers adjust their costs to reflect changes in their unit costs caused by changes in demand.

3.3 OTHER SOURCES OF EVIDENCE IN THE PASSENGER SECTOR

3.3.1 Studies of User Response to Complex Pricing in the Public Transport Sector

Evidence on travellers' responses to complex price structures was reviewed by Bonsall *et al* (2007a) for the UK Department of Transport. They found many examples of quite complex tariff systems in the public transport sector. Some of these, e.g. in the UK rail sector, are an attempt by the operators to provide niche products for niche markets – business travellers are offered high-priced tickets which can be purchased on board and are fully flexible while leisure travellers are offered low-priced tickets tied to specified off-peak services and obtainable only several weeks in advance. Such differentiation of products and prices can, in theory, allow producers to maximise their return (pricing each product in the light of the price elasticity in that market) while offering the consumer a wide range of choice. However, there is growing evidence to suggest that consumers are put off by an excess of choice and, if faced by too wide a choice, may decide not to purchase anything. In so doing they are responding to the "transaction price" involved in selecting the appropriate product (i.e. the effort required to understand the tariff structure in order to make the appropriate choice).

The recognition that users have a clear preference for simple price structures has caused many commercial operators to simplify their structures wherever possible – even where this reduces their control over the pattern of demand. The increasing use of flat fare systems in the bus industry (see for example Glazer *et al*, 2001) is thought to be a reflection of consumer preference as well as of the fact that such tariffs are cheaper to operate. Contacts within the bus industry suggested that a significant proportion of their customers had experienced difficulty with geographically complex tariffs and that this had been dissuading them from making unfamiliar journeys. It was also suggested that attempts to communicate complex fare structures had got in the way of promoting the industry's products and services (it being difficult to make a product sound attractive if its price is complicated). The UK bus industry claims some evidence of increased patronage following simplification of fare structures but it is difficult to be sure how much of the change in patronage is more properly associated with other changes (re-branding, service alterations etc).

The bus industry apparently recognises two types of potential customer; those who want to know the price in advance and are willing to go to some effort to research the prices in advance, and those who just turn up and pay. The industry capitalise on this by offering discounts and special offers (and consequential complexity) to people who are prepared to take the effort to research them, while allowing the “standard” fare to increase.

In 2002, Deutsche Bahn introduced a new rail tariff structure which prompted six months of bad publicity and falling revenues. The objectives of the reform are discussed in Section 3.3.2. The revised tariff structure replaced the traditional distance-based fare structure combined with a 50% discount for people who had purchased a *Bahncard50* by a regime built around discounts for advance purchase of tickets on trains with spare capacity. The new discounts ranged from 10% to 40% depending on the degree of notice given but were subject to availability of spare seats and other restrictions and there was a penalty for cancellation of pre-purchased tickets. In theory, holders of the (new) *Bahncard25* could combine their initial 25% discount (automatically provided to *Bahncard25* holders) with other service-specific discounts to obtain discounts of up to 75% on the basic fare. However, the availability of large discounts was apparently not fully understood by most people and the withdrawal of the *Bahncard50* was very unpopular. The new tariff structure was widely regarded as too complex and most travellers ended up paying significantly higher fares. The main objections came from long distance commuters and from businesses who said they had no alternative but to pay the increased prices. Their objections were taken up by the media which built a campaign stressing the unfairness of the price increases and the limited possibility of making use of the discounts on offer (Seidl et al, 2004). The criticism broadened into an attack on the supposed bureaucratic insensitivity of DB and their inability to run an efficient service. Government pressure eventually led to resignations from the DB Board and the withdrawal of the least popular aspects of the new tariff system.

SNCF’s attempt to introduce a similar pricing regime also had to be withdrawn in response to public protests (and in the light of some spectacular own goals such as the occasion on which a train was sent out empty because no tickets had been sold due to a glitch in the software). The main public complaint was that uncertainty about the price and availability of tickets made it impossible to plan journeys effectively. The experience of DB and SNCF suggests that, if the public regard price differentiation as unfair they will object very strongly and that, against this background, any perceived complexity will be one of the targets of criticism.

The experience of DB and SNCF may be contrasted with that of Virgin Rail whose introduction of a similar system of discounts has apparently been welcomed by regular customers as part of a revised pricing structure which offers more straightforward opportunities to customers to save money by booking in advance and by using off-peak trains. Virgin Rail’s new tariff structure was based simply on whether the journey(s) were to be made on peak or off-peak services (conventional practice in the UK rail industry had allowed off-peak rates only in connection with two-way journeys). Virgin also offered a range of discounts for tickets purchased in advance (subject to availability), much as was the case in the ill-fated DB scheme. Regular customers have apparently welcomed these initiatives as providing a more logical basis for pricing and, crucially, more opportunities to save money on rail travel.

An exception to the general rule that users are averse to complex price structures is perhaps provided by the low cost (low frills) airline sector which has prospered despite an extremely complex pricing structure that, for the customer, means that they never know the price of the ticket until they come to purchase it; prices can vary even during a booking transaction. The public are apparently willing to accept this uncertainty in the belief that, at whatever level, the prices are probably good value. The public appear to accept that variation in the price of airline tickets is a consequence of supply and demand – with the prices for the most popular dates being higher than those for those with spare capacity.

The fact that attempts by DB and SNCF to introduce yield management pricing was met with such opposition, while the use of similar principles by Virgin and the low cost airlines is accepted as sound commercial practice, may suggest the existence of a double standard whereby public service authorities are not expected to behave in so commercial a manner[12]. However, the comparison is complicated by the fact that the low cost airlines are offering a new product which is widely perceived as being good value for money while DB and SNCF were acting in a market where people have preformed expectations and established patterns of demand. It is difficult to judge whether the criticism would have been more or less vocal if DB had been a genuinely private company but it seems that the

12 although DB is a private company, it is wholly owned by the Government and is generally perceived as be in the “public” sector

critical distinction is whether the consumer has a choice as to whether they consume a product or service not whether the service is provided by the public or private sector.

Bonsall et al (2007a) contained a variety of evidence on public response to complex prices but the general conclusion which is particularly relevant to the subject of this deliverable is that, although it might be desirable to introduce price differentiation in order to influence demand or recover externalities, there is likely to be a limit to the degree of differentiation which can be introduced before consumers (travellers) become confused or unwilling to make the effort to understand the subtleties of the charging structure. Subsequent work for the UK Department of Transport (Bonsall et al, 2006), within the GRACE project (Bonsall et al, 2007b), and in the current project (see Deliverables 4.1 and 4.2) has confirmed that many people are put off by complex price structures and try to avoid exposure to them (unless they have reason to believe that the charge would not exceed a certain amount). This causes them to be reluctant to adopt modes which are characterised by complex charges and may even cause them to withdraw their custom from modes whose charges become too complex.

3.3.2 Deutsche Bahn's use of Fare Differentiation to Manage Demand for Rail Services

DB's initial attempt to revise its fare structure, described in Section 3.3.1, reflected three main aims:

- to reduce the high variance in demand, especially between peak hours and weekends. (by introducing new offers intended to smooth demand curves over time);
- to increase the attractiveness of rail travel and reduce overcrowding (by offering early booking discounts); and
- to respond to the growing competition from low-cost airlines, which had been able to reach market shares of up to ten percent on some of the traditional rail travel relations (by offering more attractive pricing on long-distance routes).

Prior to 2002, prices had been a strictly linear function of the rail-line distance and this resulted in rail fares for long distances being uncompetitive with air fares and in the fares between a given pair of towns being higher on meandering routes than on direct ones. The new price structure was more related to market conditions; it sought to reflect users' willingness to pay and the existence of competing services. Thus, for example, it provided lower prices for the slowest or least comfortable services and lower prices per kilometre for the longest journeys. A key feature of the new structure was the provision of discounts of up to 40% for tickets bought in advance. By providing higher advance-purchase discounts on services with most spare capacity, and by controlling the number of advance-purchase tickets available on each service, DB sought to influence travellers to use the underutilised services rather than those which were likely to be oversubscribed. The *Bahncard50* was replaced by the *Bahncard25* in order to give DB more scope to use the service-specific discounts to influence the pattern of demand.

As was noted in Section 3.3.1, the new tariff structure was initially very unpopular and had to be revised following bad publicity. A revised scheme was introduced in August 2003 which, while retaining the main features of the 2002 scheme, was modified to make it simpler to understand (the main difference being that the popular *Bahncard50* was re-instated, some of the special discounts introduced in 2002 were discontinued and some penalties were reduced). These modifications seem to have been successful and the overall scheme is now regarded as a success.

A major feature of the new regime is the use of railcards (bahncards) to incentivize regular travel. Bahncards were first introduced in 1992 in order to improve customer retention and were immediately popular (one million cards being sold within the first four months). The *Bahncard50* (entitling the holder to a 50% discount on any rail fare) was very popular with users but effectively limited DB's ability to manage demand. DB now offers other variants: notably the *BahnCard25* and the *MobilityBahnCard100*. The *BahnCard25,* introduced in December 2002, entitles the owner to a 25% discount on all rail travel and can be used in combination with special early booking offers thus giving discounts to up to 70% on the regular fare. As of December 2007, the annual price of *Bahncard25* was 55 Euro (second class, 110 Euro first class) and, as of January 2008, 2.23 million *BahnCard25s* were in circulation[13] - each one being used, on average, for 10 rail trips per year[14]. The *MobilityBahnCard100* will be described in more detail in Section 3.3.3.

Ticket and bahncard sales figures suggest that DB's new tariff structure is proving popular and DB is succeeding in its aim of managing the demand for its services away from the most congested ones and on to those which were previously under-utilised – leaving the peak and premium services for commuters and business travellers. The new fare structure also seems to be addressing the issue of competition from airlines; Lufthansa has now withdrawn its Koln-Frankfurt service and instead offers passengers check-in at Koln followed by free use of the express rail connection from Koln to Frankfurt.

3.3.3 Intermodal Transport Chains

In this section we present some case studies of intermodal transport chains. First we present more information about integrated public transport ticketing in Germany. Then we present several examples of attempts to integrate ferry services into wider transport chains.

The German evidence is interesting because it provides an example of the successful use of integrated ticketing and fare structures to promote the use of public transport services provided by separate operators. The ferry examples are particularly interesting because almost all ferry services are, almost by definition, part of intermodal transport chains and can be seen as "moving bridges" Ferries form an integral part of the local and regional public transport system in many city regions. Pricing of ferry services is usually differentiated for passengers and for vehicles. For passengers, pricing schemes often differentiate by age groups (adults, children and infants, with the last group usually being free of charge). Further differentiation of passenger charges is highly dependent of the function of the ferry; where ferries serve a commuter route (e.g. in Hamburg, Germany) frequent traveller tickets in the form of multi-trip tickets are often available. On routes with a highly seasonal demand, fares are often differentiated in low and high season, with high season tickets being priced higher. For vehicles, differentiation is usually related to the type of vehicle and the specific length of the vehicle. Thus the fare is often directly related to the area the vehicle occupies on deck of the ship. Vehicle prices are also usually differentiated according to the height of vehicle because space for high vehicles on ferries is usually restricted - the additional charge for an extra metre of height will often be more than that for an extra metre of length.

Integrated Rail and Bus Ticketing in Germany

DB has, in co-operation with other public transport operators, sought to develop a multimodal mobility card based on the success of the existing Bahncard. They have gone a long way to achieving this by joining with regional and urban transport operators to create the *City-Ticket* and *Mobility BahnCard100* concepts.

The *City-Ticket* was introduced in December 2003. Jointly developed by Deutsche Bahn AG and the Verband Deutscher Verkehrsunternehmen (VDV), it allows travellers with a rail journey of over 100km[15] free use public transport in their destination city on the day of arrival. In the beginning 44 cities participated in the city ticket scheme, 13 more had joined by the end of 2004, another 16 had joined by the end of 2005 and, by December 2007, the city-ticket was valid in 109 cities. By January 2008 100 million tickets had been sold within the scheme. In 2005 DB won an innovation award for their city-ticket at the public transport congress CiTOP. The award was made in recognition of the high and direct benefit to that the city-ticket provides for users and customers.

The *Mobility BahnCard 100 was also introduced in 2003.* It costs 3500 Euro (2nd class) or 5900 Euro (1st class) per year and entitles holders to free, unlimited, use of trains throughout the German rail network and of public transport in 109 cities. It also entitles holders to send their luggage to their destination free of charge, to make free seat reservations and to receive discounts for car-sharing and

13 Bahn verkauft mehr Bahncards. In: Die Welt (Newsticker), 26. Januar 2008

14 Bahncard 50 kostet künftig 220 Euro. In: Westfälische Rundschau vom 25. September 2007

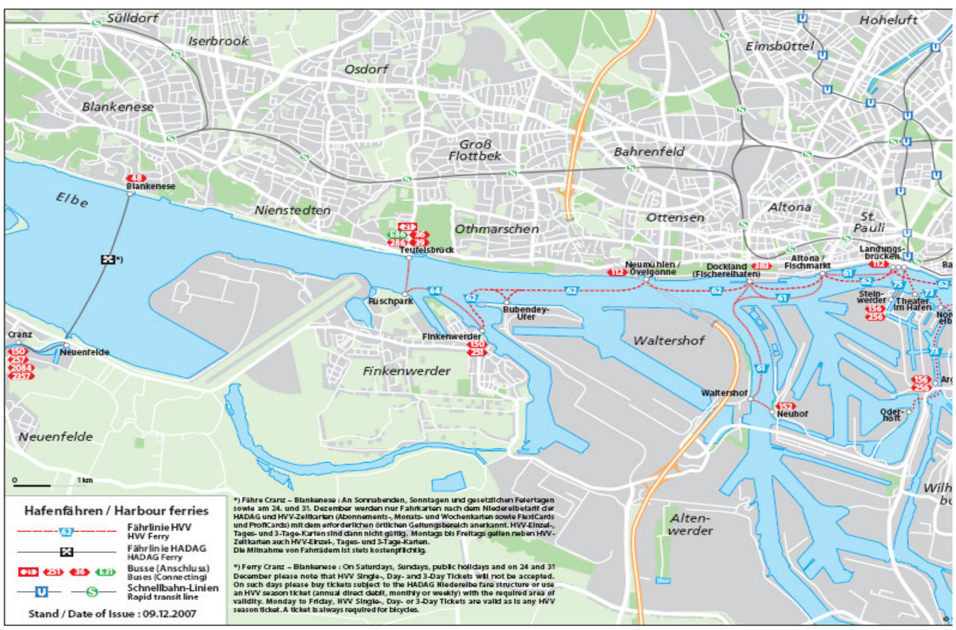
15 There are some restrictions: the rail ticket must have been bought with BahnCard25 or BahnCard50 and part of the travel must have been made using a train in DB's product group A or B.

bike-sharing schemes. One year after introduction of the card, the number of users was around 14000[16], and by the end of 2007, this had reached 29000[17].

In addition to promoting the *City-ticket* and *Mobility BahnCard* concepts, many bus companies, especially the regional companies, grant a 25% discount on the regular fare to *BahnCard* owners. The basic idea being to tap into a new potential market – namely the users of other modes of public transport and, by removing barriers to the use of multimodal chains, to erode one of the perceived advantages of car travel. A specific and innovative example of this co-operation between public transport providers is the *FanBahnCard25.* Originally introduced to promote the use of rail and public transport during the FIFA World Cup 2006, it has been reissued for the European Cup in 2008, and, in order to promote loyalty, the valid period of the *FanBahnCard25* is linked to the success of the German national team. It is thought that this initiative provides a way of reaching an important market of people who, if they can be persuaded to use public transport during this popular sports event, may recognise its qualities and be more likely to use it in future, thus sowing the seeds for increased use of rail and bus.

Hamburg Hafenfähren – Towards Full Integration of Transport Modes

The Hamburg Verkehrs Verbund (HVV) serves an area of 3000km² of which the city area of Hamburg makes up 747km². The region has 3.0 million inhabitants and the city of Hamburg has 1.8 million. The Hamburg Hafenfähren (harbour ferries – see Figure 3.2) are an integral part of HVV's overall public transport strategy (10% of Hamburg has access to the water and so ferries can play an important role in this overall system). The Hafenfähren are operated by HADAG (a 100% subsidiary of the Hamburger Hochbahn AG). HADAG pays the Hamburg Port Authority an annual lump sum (200,000 Euro) for the right to use 20 pontoons in the port and on the Elbe and is responsible for setting up ticket machines, timetables and information boards.



Source: HADAG 2008-02-25

Figure 3-2 Hamburg "Hafenfähren" within the Public Transport System

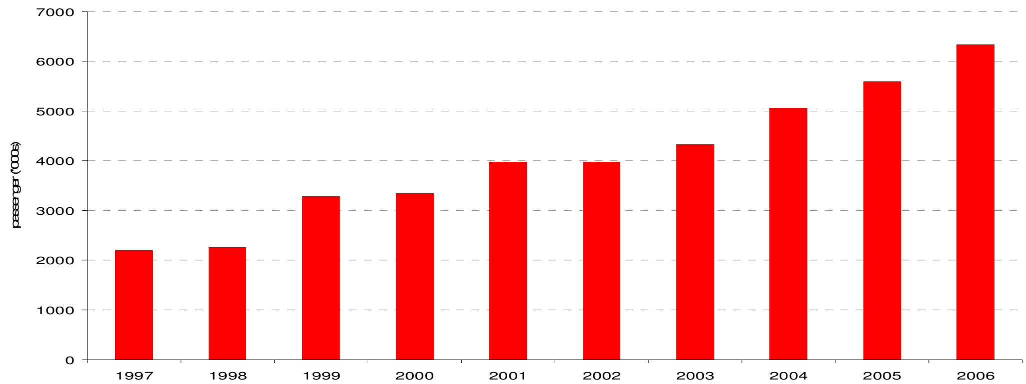
Hamburg has an open public transport system and the Hafenfähren are fully integrated into that system; a person with a general HVV ticket can use the ferries with that same ticket (there is thus no

16 Bahncard 50 kostet künftig 220 Euro. In: Westfälische Rundschau vom 25. September 2007

17 Deutsche Bahn AG: Bahn hebt für 2008 Preise in der 2. Klasse um rund 2,9 Prozent an. Presseinformation vom 25. September 2007

differentiation by the different modes of public transport). The Hafenfähren are integrated at the main stops with the public bus network and at the main interchange (Landungsbrücken) they are located right next to the S-Bahn, bus and subway. Bicycles can be taken for free during all periods.

The HVV public transport plan incorporates a unified fare system for all modes of public transport and seeks to provide seamless transport options in an open transport system. The success of the integration can be seen in the rising number of passengers on public transport (which reached 21% of overall passenger trips in 2006 – see Figure 3.3). The particular success of integrated ticketing can be seen in the steady rise of sales of period tickets (weekly, monthly and season tickets) over the last years - by 2006, 84% of public transport users were using period tickets. The Hafenfähren share this success as their passenger numbers have increased threefold since the integration of the ferries with the public transport system. Since, 2002 annual growth rates have been above 10%.



Source: Wilmsmeier, based on HADAG 2007

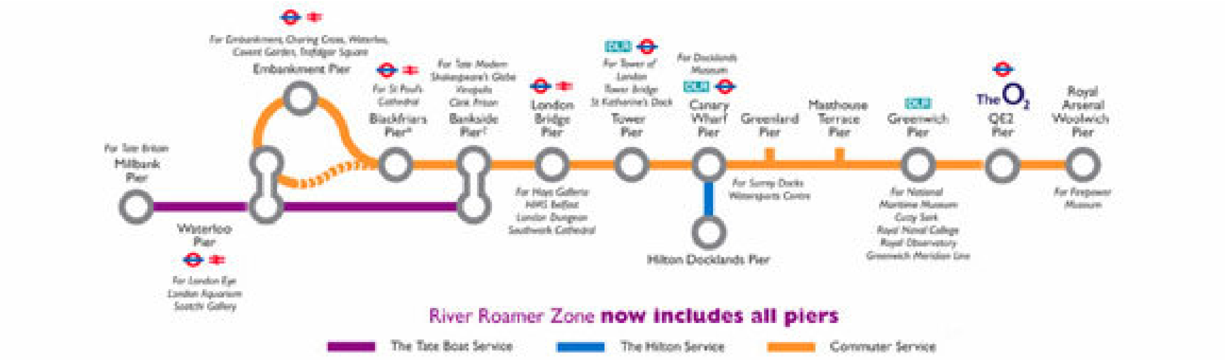
Figure 3-3 Passengers on the Hamburg "Hafenfähren"

The focus on frequent users and on differentiation on specific user groups (commuters, tourists, elderly, students etc.) rather than on individual modes trips and trip length seems to have been a rather successful strategy.

London – The Thames Clipper – An Example of User Group Differentiation and a Lesson Learned

The currently operating London Thames Clipper is the second attempt to provide fast ferry connections along the Thames. It is generally agreed that the first attempt (some ten years earlier) failed due to a lack of integration within the public transport system. This lack of integration was twofold: (a) the pontoons were not conveniently located with respect to the main interchanges of the bus and subway system; and (b) No integrated ticketing was available.

The new Thames clipper ferry service network started to operate in 1999 with 1500 passengers per week and by 2007 was carrying around 20000 passengers a week. The operator (Thames Clippers) has a grant to provide the only commuter service in Central London and operates a fleet of fast high-quality vessels. The service is fully integrated into the TfL (Transport for London) pricing system, so holders of Travelcards are eligible for discounts, and the river has become part of an 'integrated modal transport network' with improved signage on bus and underground maps and at stations, to facilitate onward interconnections. Figure 3.4 shows the service map and interconnections.



Source: Thames Clipper 2008

Figure 3-4 The Thames Clipper Network

The Thames Clipper operator differentiates between key user groups: occasional users; local users with Oyster Cards; tourists; and frequent users (commuters). Although a separate ticket is still needed for the ferries, Oyster card holders are eligible for a significant discount of the regular fare. As such the operator uses the different elasticities of user groups in his differentiation approach, by charging tourists higher prices than regular users and giving regular commuters significant discounts if they opt for seasonal or annual tickets. The main idea behind the approach is that commuters and tourists use the services in different time frames. Thus the operator aims at maximum capacity utilization throughout the daily operating times maximizing incomes by charging related to elasticity of demand. In interviews with the operator it has become clear that the willingness of certain user groups (in this case tourists) gives scope to increase the price differential between commuters and occasional users.

In the case of the commuter user group the operator grants frequent user discounts, because for these users he operates in a competitive environment with the other public transport options (e.g. the subway). The strategy is to capture market share with a product, which offers high quality in terms of service standards, especially reliability and punctuality, in combination with attractive cost.

Scottish Ferries

Various types of ferry exist in Scotland. Ferry services fulfil lifeline, commuter and services for recreational traffic often in one and the same service. Due to Scotland's geographic characteristics ferry services are in many cases an integral part of infrastructure as they provide key accessibility to a wide array of regions. Scottish ferry services show similar price differentiation irrespective of their type of operation (public or private),

The Gourock–Dunoon ferries provide an interesting example. The route, which serves an important commuter market is less than 5 kms long but reduces the distance from Dunoon to Glasgow by about 90km (see Figure 3.5) . A substantial proportion of users use the ferries in conjunction with onward public transport (primarily train) to Glasgow. The route is served by two ferry companies, Western Ferries and Caledonian MacBrayne (CalMac). Both companies have similar differentiation in their pricing schemes and broadly follow the scheme outlined at the start of Section 3.2. But differences do exist; for example, CalMac does not differentiate between passengers on the basis of age groups. Part of the reason for the similar differentiation is that the companies have to pay pier dues for different types of vehicle (CalMac indicate this amount on their tickets). Frequent travellers (typically commuters) receive discounts.

Source: http://www.western-ferries.co.uk

Figure 3-5 Gourock – Dunoon Ferry Route

Typically, for Scottish ferries, the fares are not integrated with other transport modes and neither of the service providers offers any incentives for intermodal passenger transport (although CalMac does publicise onward travel options). The lack of through tickets makes intermodal transport less attractive and raises perceptional barriers. The potential benefit of using intermodal transport chains is not directly evident to users because the pricing is not clear. The current set up of companies and the funding structure from the Scottish government does not allow integrating ticketing and an initiative like the Transport for London (TfL) is absent in the region. No direct evidence can be provided of how big the actual modal shift through integrated ticketing could be. However, results from a ferry user survey conducted in conjunction with the Kirkcaldy–Portobello Hovercraft trial[18] indicate that users saw integrated ticketing (whether ferry+public transport or ferry+parking) as a key factor to attractiveness of a transport service. These findings revealed that parking might as well be an important part of infrastructure charging and that differentiated charging for parking can create significant user responses in terms of attractiveness and thus usage of a transport service.

Study of Water Tram Services in Three-Cities Area of Poland

In Summer 2006, the first water tram routes were introduced in the Three-cities (Gdynia-Gdansk-Sopot) conurbation on the Baltic coast of Poland19. Five routes, providing links between the main built up areas within the conurbation and with the Hel peninsula, are now in operation – see Figure 3-6.

The routes compete with existing public transport (buses, trams and trains) offering comparable journey times for some routes and much superior journey times for the routes across bay (e.g. the water tram takes 60 minutes to travel between Gdynia and Hel, whereas the train would take two hours). Routes operate at frequencies of three or four return trips per day during the summer months and use vessels capable of accommodating up to 450 passengers. The services are timed to suit the tourist market rather than commuters. The services are provided by ZKM Gdynia and ZTM Gdansk and are organized as part of the local public transport systems by the local Transport Authorities. They receive an operating subsidy from the municipal and regional governments. Route characteristics and usage are summarized in Table 3-4.

18 For details see Deliverable 6.1.

19 The Three cities conurbation has a population of nearly one million and is particularly well known as a summer tourist resort.

Figure 3-6 The Three Cities Area – Showing Water Tram Routes

Table 3-4 Water Tram Services in the Three-Cities Area

	Distance (kms)	Duration (mins)	Daily frequency	Ticket price (€ per adult)	Passengers (2007)
Gdańsk- Hel	35	110	3	4.3	62 534
Hel - Gdańsk	35	110	3	4.3	61 446
Sopot – Hel	27	65	3	3.2	25 657
Hel - Sopot	27	65	3	3.2	25 437
Gdańsk - Sopot	28	65	4	2.1	30 534
Sopot - Gdańsk	28	65	4	2.1	25 972
Gdynia - Hel	20	60	4	2.70	95 983
Hel – Gdynia	20	60	4	2.70	92 860
Gdynia – Jastarnia	24	75	3	2.7	50 621
Jastarnia - Gdynia	24	75	3	2.7	52 893
Total					523 937

Water trams are, it is argued, more environmentally sustainable than land based modes of transport. Their attraction to travellers in the Three-cities area is that they offer shorter journey times than the land-based alternatives (due to the fact that they can short-cut across the bay), that the price levels are relatively low (notably lower than that of the equivalent train connection), and that, in summer at any rate, the journey is aesthetically pleasing. Ticket sales have been exceeding forecasts but the revenue from ticket sales covers less than 60% of the operation costs (falling from about 60% in 2006 to about 55% in 2007).

Although the existing services primarily serve the local tourist market (with the scenic quality of the ride being an attraction in its own right), and require a subsidy, it has been suggested that they might be modified to serve the important daily flow of commuters in the conurbation – for example by introducing services at peak commuting times and by providing year round services. It is suggested that the abstraction of road traffic would be a particular benefit on the environmentally sensitive Hel peninsula.

Conclusions on Case Studies of Intermodal Chains

DB's *City-Ticket* and *Mobility Bahncard* concepts are good examples of how integrated ticketing can be used to promote intermodality. It demonstrates the commercial success of a concept which provides users with a simple means of making complicated journeys by public transport. It also demonstrates that independent operators can gain commercial advantage by co-operating with other operators (in this case operators in other locations) to promote a common brand and integrated ticketing.

The integration of ferries into intermodal passenger transport chains is well developed in London and Hamburg but considerable scope for improvement exists elsewhere. In London and Hamburg, integrated ticketing has been recognized as a means of getting the ferries perceived as part of a public transport scheme. In Hamburg, where the overall strategy is to achieve seamless transportation system, the user does not need to consider individual modes of public transport mode, but rather can consider the system as a whole and this seems to be helping to increase public transport's overall share of the market – particularly among regular travellers.

Differentiation in price by user group seems to be helping to maximise ticket revenues in London. The differentiation capitalises on the different elasticities of different groups. The potential success of such strategies was also underlined in the online survey during the Hovercraft trial. In the survey users were looking for highly differentiated charges appropriate to their needs. Interestingly the survey also revealed that there is a willingness to pay more for integrated services that respond to specific needs.

3.3.4 Modelling of National Road Pricing Schemes in the UK

The modelling work conducted in the UK National Road Pricing Feasibility Study (DfT 2004) tested the effect of implementing road charges based on the principles of Marginal Social Cost (MSC) pricing and of combining this with reductions in fuel tax to preserve revenue neutrality. A large number of alternative schemes were tested ranging from distance–based charges which varied according to the marginal externalities produced by a particular type of vehicle on a particular type of road at a particular time of day, through to simple, constant, distance charges and local cordon charges. The most complex of the tested charge structures comprised 75 different charge levels. The models allowed for change in route, mode and time of day but did not allow for trip suppression. The predictions were based on the assumption that road users would be able to understand the charge structures (even the one with 75 different charge levels) and would respond to them in line with established evidence on elasticities.

The results suggest that pricing would lead to only a limited amount of modal shift. Most scheme variants produced limited reductions in road traffic and a modest shift to other modes of travel (up to a 5 per cent increase in bus trips and rail passenger kilometres). Under the revenue neutral pricing scenario there was actually an increase in long distance road use (reflecting the fact that the reduction in fuel tax more than offset the MSC charges). This increase in long distance road use was accompanied by a reduction in rail patronage. The national modelling predicted that, following introduction of MSC charges, car drivers are more likely to become car passengers (i.e. car share) than use alternative modes.

3.4 ANALYSIS OF THE HYPOTHESES

Hypothesis 1: Greater differentiation of infrastructure charges (in the ways, and to the extents, currently being contemplated) will have no significant impact on overall mode splits.

Our spreadsheet analysis suggested that the introduction of infrastructure charges based on marginal social costs differentiated by mode, type of area and time of day, could have a significant impact on modal shares. However, the largest changes (in absolute terms) were the increase in the use of multi-occupancy car and the decreases in use of bus, coach and rail which were seen to occur when existing taxes and subsidies (which favour public transport modes) were abolished. Overt discrimination in favour of public transport by exempting its users from MSC charges does increase use of public transport but this does not outweigh the effect of abolishing existing subsidies. One conclusion from these findings is that marginal social cost pricing, differentiated by mode, time period and area-type have much less impact on mode shares than can be achieved by other pricing instruments.

Evidence from UK road pricing studies similarly suggests that MSC pricing of road use has a limited effect on mode shares.

The literature contains numerous examples where subsidies have been used to support price reductions which have enhanced the demand for particular modes of transport (most examples relate to bus or rail and many refer to the effect of *removing* a subsidy rather than to the effect of introducing one). The evidence from this literature is that removal of such subsidies can have a significant effect on modal shares but that the full effect can take some years to emerge.

On balance it seems that Hypothesis 1 can be rejected (evidence on the effect that differentiation *per se* might have on mode shares is clearly relevant to this hypothesis but is reported in the discussion of Hypothesis 4 below).

Hypothesis 2: Greater differentiation of infrastructure charges (in the ways, and to the extents, currently being contemplated) will have no significant impact on the usage of intermodal[20] chains.

Our spreadsheet analysis suggested that, in the absence of an overt discrimination in favour of multimodal trips, marginal social cost pricing would not increase the use of intermodal chains to such a level that they take a significant share of the overall market. The share of total trips that were made using multimodal chains was 2.8% in the base case and, although higher than this in all our scenarios, it never rose above 3.8% (note that our analysis did not count public transport journeys combined with short walks as multimodal chains). Having said that, the proportionate change in the percentage shares achieved by multimodal chains did change significantly – with some very large changes being recorded for some chains in some scenarios.

Interestingly, our spreadsheet analysis suggested that, where charges were designed to favour bus and rail, multimodal combinations incorporating these modes tended to share the benefit. However, when public transport was disadvantaged by the abolition of previous subsidies (as in scenarios 3, 8 and 9), the consequent decreases in the use of trips solely by bus or rail occurred alongside increases in the number of park and ride trips. It seems that the deleterious effect that abolition of previous subsidies had on public transport was offset by the increased attractiveness of car (previous taxes having been abolished). Although we did not include a specific scenario to test it, we have no doubt that if the charge had been differentiated to favour multimodal chains, a very significant increase in use of such modes could have been achieved. But it should be noted that such discrimination would not be consistent with the principles of Marginal Social Cost pricing.

Evidence summarised in Section 3.2 suggests that the absence of differentiation between modes (i.e. an integrated charge structure which does not discriminate between modes) can be used to encourage use of multi-modal chains. The effect of such price structures is both psychological (reducing the perception of inter-modal barriers) and tangible (e.g. with multimodal tickets reducing effort required to estimate and purchase tickets). The phrase "seamless journey" is very apposite in such cases.

On balance it seems that Hypothesis 2 can be rejected.

Hypothesis 3: Greater differentiation of infrastructure charges (in the ways, and to the extents, currently being contemplated) will tend to increase the average end user prices for the affected modes and any change in overall mode shares will be attributable to this alone.

At one level this hypothesis is a statement of the obvious; price differentiation costs money to implement and, since this cost needs to be recouped, it is likely that average prices will increase. The key question is whether investment of the net revenues would bring benefits sufficient to outweigh the price increases. The evidence from our spreadsheet analysis is that, although some modes would benefit, the all-mode average generalized cost was not significantly reduced by investment of five years' net revenue and indeed was still higher than it had been in the Base (before any charges had been applied) even though we were adopting the most optimistic assumptions about the effectiveness of investment. One reason for this is that, since the average generalized cost of car is lower than that of public transport modes, the migration of trips from car to public transport modes necessarily tends to increase the all-mode average.

20 We take intermodal chains to be synonymous with what we have elsewhere called multimodal chains

Examination of the costs predicted by our spreadsheet indicate that part of the impact that introduction of differentiated pricing had on modal shares is attributable to the indirect effects of reductions in congestion and, although to a much lesser extent, of changes in the per-unit costs of service provision. The congestion relief effect was most evident for short distance peak period trips by road and so tended to reduce the effect of the price changes, while the change in per-unit costs of supply were most marked for the rail mode (because of the high fixed costs) and so tended to magnify the effect of the price changes.

The spreadsheet's predictions were driven solely by changes in price and duration because the spreadsheet was unable to represent any changes in behaviour resulting from any change in the perception of modes or of prices. However, case studies and research presented in Section 3 suggest that such changes could have an important effect on mode choices. The use of differentiated pricing to influence the perception of modes – and most particularly of intermodal chains – is obviously relevant here, but so too is the potential effect of price differentiation on people's willingness and ability to engage with the pricing signal.

On balance it seems that Hypothesis 3 can be rejected.

Hypothesis 4: Greater differentiation of infrastructure charges (in the ways, and to the extents, currently being contemplated) will increase the perceived complexity of end user prices and this will result in reductions in the market share achieved by the affected modes (after allowance is made for any change in average end user prices).

This issue was raised in work conducted for the UK Department for Transport and reported in Section 3.3. Further evidence was sought in Work Package 4 of the current project and is reported in Deliverables 4.1 and 4.2. This new evidence, collected via surveys conducted in the field and under experimental conditions, suggests that excessive differentiation could indeed depress demand for the affected modes. It seems that, when differentiation becomes so complex that users find it difficult to understand the structure or predict the price, a significant proportion of users will be so put off that they will seek to avoid exposing themselves to the unknown price. Interestingly, this effect goes into reverse if the unknown price is expected to be low (in such circumstances people have the tendency to pay up without bothering to calculate the actual price). We can thus conclude that the *degree* of differentiation can have an effect on modal shares over and above that of the intended price signal.

On balance it seems that Hypothesis 4 cannot be rejected.

Hypothesis 5: Greater differentiation of infrastructure charges (in the ways, and to the extents, currently being contemplated) will tend to encourage the use of intermodal chains and will achieve a modal split which is more economically sustainable than the status quo ante.

The use of fully differentiated marginal social cost pricing tends to favour public transport modes over private car modes and to impose the highest charges in the busiest locations at the busiest times of day. The most immediate and direct effect is therefore to increase the price of the journeys which are generally considered most vital to the health of the economy. The second round effects (congestion relief and environmental improvement) serve to mitigate this effect and, taken with the third round effect (benefits achieved through judicious investment of the revenues), might more than compensate for any depressive effect of the original charges. Our Scenario 4 allowed for all three effects and the results suggest that the overall level of economic activity (as measured by the total number of trips) decreased much less than in any other scenario. It should, however, be noted that the decrease was held in check only with our most optimistic assumptions about the impact of investment, and that when investment was targeted at the sustainable modes, the mitigating effect of the investment was much less marked.. One might then conclude that differentiated charges can help the economy but this result is far from guaranteed. However it can be argued that our spreadsheet is likely to have underestimated the economic benefits because it did not differentiate between groups on the basis of their value of time; had it done so, travellers with the highest values of time (those most important to the economy) would have valued the charges less highly but the congestion relief more highly and so would have been better off.

Although we did not test it as a scenario, differentiated charging could clearly be designed to discriminate in favour of the most economically important trips – for example by offering discounted public transport tickets to regular travellers (thus favouring commuters) and by pricing parking spaces to maximise turnover. It therefore seems safe to conclude that differentiated pricing *could* help to achieve a more economically sustainable mode split.

The Hypothesis specifically associates the use of multimodal chains with economic sustainability. We have no new evidence to offer on this particular proposition but note that the economically successful Scenario 4 had no more trips in multimodal chains than was the case in the Base – and indeed the multimodal chains' share of overall trips was actually lower in Scenario 4 than it had been in the Base.

On balance it seems that Hypothesis 5 can be rejected.

Hypothesis 6: Greater differentiation of infrastructure charges (in the ways, and to the extents, currently being contemplated) will tend to encourage the use of intermodal chains and will achieve a modal split which is more environmentally sustainable than the status quo ante.

Our spreadsheet analysis suggested that the use of multimodal chains increased under all our scenarios. Although this result may have been exaggerated[21] we are confident in concluding that the increased use of multimodal chains was not always associated with a reduction in environmental externalities. We should also repeat the observation, noted in our discussion of Hypothesis 2, that increases in multimode trips may occur alongside reductions in the use of "pure" public transport modes. We are confident that the spreadsheet would similarly predict that pricing policies designed specifically to favour multimodal chains (see Section 3.3.3 for examples) would attract some demand from "pure" public transport trips and could thus result in a net reduction in environmental sustainability. We therefore conclude that the hypothesis is wrong to assume that increased use of multimodal chains will necessarily increase overall environmental sustainability.

The use of fully differentiated marginal social cost pricing tends to favour public transport modes over private car modes because of the lower marginal externalities of public transport trips. However, the resulting change in modal shift is not very substantial unless the revenues are invested to benefit the public transport modes and, even then, the beneficial effect can be lost if larger changes in costs occur as a result of abolition of pre-existing subsidies to public transport.

A larger shift to environmentally sustainable modes could doubtless be achieved by imposing a larger charge on the least environmentally sustainable modes and by investing the revenue to the advantage of the sustainable modes while retaining the existing subsidies to public transport. The resulting mode shares would be more environmentally sustainable but the charge structure would represent a departure from the economic optimum and the result is unlikely to be economically efficient.

Differential pricing of vehicles according to their emissions is becoming an established feature of transport pricing. It is, for example, a feature of annual vehicle taxation in Germany and the UK, and has featured in the London Congestion charge in the form of discounts or exemptions for electrically powered or alternatively–fuelled vehicles. Although the effect of such differentiation has been difficult to distinguish from that of other trends affecting people's choice of vehicle type, it can be expected to favour the purchase and use of low emission vehicles and thus improve the environmental sustainability of the fleet. It may not, however, affect modal shares and indeed, where the differentiation is in the form of discounts or exemptions the net effect may be to reduce the effect that a charging scheme has on mode shares.

We must conclude that differentiated pricing of infrastructure can produce a more environmentally sustainable mode split but that some of the types of differentiation currently being used or advocated are unlikely to have a significant effect - particularly if accompanied by abolition of existing subsidies as part of wholesale reform of infrastructure pricing.

On balance it seems that Hypothesis 6 cannot be rejected.

21 One of the caveats listed in Section 3.2 noted that our model may have exaggerated the shift to minority modes.

Hypothesis 7: The use of environmentally desirable modes can be encouraged by means of commercially sustainable pricing regimes which discriminate in favour of users of those modes.

Subsidies to public transport which allow the maintenance of low fares, or otherwise unaffordable support for infrastructure or running costs, undoubtedly promote greater use of public transport. But such subsidies cannot properly be regarded as commercially sustainable. However, the evidence from Singapore, London and Stockholm is that the operation of road pricing or congestion charging can be commercially sustainable (in that the revenues exceed the cost of collecting them) and, since the pricing regimes in those three cities do discriminate in favour of environmentally desirable modes (public transport, walking and cycling)[22], the hypothesis can be said to hold.

Taking a wider view, one should also consider the commercial sustainability of city centres which are subject to road user charges which discriminate in favour of the environmentally desirable modes. Although some contrary evidence has been published on behalf of retailers, the balance of evidence is that the commercial performance of the London economy has not been harmed by the introduction of the congestion charge. The potential damage that the introduction of road user charges might do to the local economy is, however, a continuing concern among the managers of cities whose economies are less evidently robust than that of London and this concern is a major reason for the reluctance of such cities to commit to the introduction of road user charges.

On balance it seems that Hypothesis 7 cannot be rejected.

Hypothesis 8: The use of intermodal chains can be encouraged by means of commercially sustainable pricing regimes which discriminate in favour of users of intermodal chains.

It has been difficult to obtain clear evidence on the commercial sustainability of pricing regimes which discriminate in favour of users of multimodal chains. This is in part because of commercial sensitivities in the industry and in part because, in the context of multimodal operations, the attribution of costs and revenues can be far from straight-forward. However, our consideration of case studies leads us conclude that the main barriers to the introduction of pricing regimes which promote inter-modality (e.g. provision of through tickets for multimodal journeys, and prices which do not differentiate between the different public transport modes) are institutional rather than financial – indeed the costs of operating a pricing regime are likely to be reduced if the differentiation between modes is removed. There is also evidence to suggest that the simplification of price structures which follows the removal of modal differentiation is appreciated by users and itself leads to an increase in the number of passengers.

The removal of modal distinctions within a pricing structure does, of course, remove one of the instruments that can be used to ensure that prices reflect the true costs of operation. It also makes it impossible to capitalise on the fact that users might be willing to pay more for journeys on faster or more comfortable modes and removes the supplier's ability to offer discounts to attract users away from congested modes onto those which have spare capacity. London's approach to this problem has been to introduce a simplified fare structure which, while still discriminating between modes (it has different prices for bus, underground, rail and river ferry), assists intermodality by offering users a universal payment mechanism (the Oystercard) which allows the user to make multimodal journeys without having to make a series of separate cash transactions.

Multi-modal journeys can also be encouraged by appropriate presentation and packaging of prices. The pricing of park and ride services provides many examples; the parking is often described as "free" but if it is reserved for users of the park and ride service then its cost can be incorporated into the ticket for the line-haul service (alternatively, the line haul shuttle can be described as "free" – but reserved for those who have paid to park - thereby making it possible to cover the costs of the line-haul service from the car park revenues). Where it is not feasible to make use of the parking exclusive to users of the line-haul service, or vice versa, another approach is to offer special combined tickets for the two – perhaps at a discount on the cost of two purchased separately.

22 Road pricing based on a per-vehicle charge can also be said to favour high occupancy use of cars – since the charge per occupant is lower the higher the number of people in the vehicle.

The general conclusion would thus seem to be that, while there is considerable scope for introducing pricing regimes which favour multimodal chains, the commercial sustainability of such regimes will depend on local circumstances, and that, even if a price distinction between modes is maintained, intermodality may be promoted by appropriate presentation and packaging of prices for such journeys and the provision of simple methods of paying for them.

On balance it seems that Hypothesis 8 cannot be rejected.

3.5 CONCLUSIONS AND RECOMMENDATIONS (PASSENGER SECTOR)

3.5.1 Conclusions

We conclude that hypotheses 1, 2, 3, and 5 can be rejected but that hypotheses 4, 6, 7 and 8 cannot be rejected. We can also draw some more general conclusions.

With Respect to the Use of Differentiated Pricing to Influence Modal Splits:

- The introduction of infrastructure charges based on marginal social costs differentiated by mode, trip length and time of day, could have a significant impact on modal shares – particularly if the revenues are invested appropriately.
- The net impact of differentiated pricing on modal shares is reduced by the consequential reduction in congestion but may be magnified by the consequential changes in per-unit costs of service provision.
- The introduction of differentiated pricing would affect some aspects of the overall modal share more than others and the full effect might take some years to emerge.

With Respect to User's Perception:

- Differential pricing can influence the perception of modes and, most particularly, of intermodal chains.
- The degree of differentiation can have an effect on modal shares over and above that of the intended price signal.

With Respect to Encouraging the Use of Environmentally Sustainable Modes:

- A shift to environmentally sustainable modes could be achieved by imposing larger charges on the least environmentally sustainable modes and by investing the revenue to the advantage of the sustainable modes while retaining the existing subsidies to public transport; the resulting mode shares would be more environmentally sustainable but the charge structure would represent a departure from the economic optimum and the result is unlikely to be economically efficient.
- Differential pricing of vehicles according to their emissions can be expected to favour the purchase and use of low emission vehicles and thus improve the environmental sustainability of the fleet but may reduce the effect that a charging scheme has on mode shares.
- Differentiated pricing of infrastructure can produce a more environmentally sustainable mode split but that some of the types of differentiation currently being used or advocated are unlikely to have a significant effect - particularly if accompanied by abolition of existing subsidies as part of wholesale reform of infrastructure pricing.
- Road pricing or congestion charging can discriminate in favour of environmentally desirable modes whilst remaining commercially sustainable (in that the revenues exceed the cost of collecting them).

With Respect to Encouraging the Economic Activity:

- The overall level of economic activity (as measured by the total number of trips) may increase if charges are introduced and the revenues are invested appropriately, however city managers continue to be concerned about the damage that the introduction of road user charges might do to their local economy.
- Differentiated charging could be designed to discriminate in favour of the most economically important trips.

With Respect to Encouraging the Use of Multimodal Trips:

- Pricing scenarios designed to favour public transport trips will not necessarily result in increased use of multimodal chains (and vice versa), a pricing structure designed to favour multimodal chains would attract some demand from “pure” public transport trips and could result in a net reduction in sustainability.
- There is considerable scope for introducing pricing regimes which favour multimodal chains, but the commercial sustainability of such regimes will depend on local circumstances.
- Very significant increase in use of multimodal chains could be stimulated by appropriate pricing structures but such discrimination would not be consistent with the principles of marginal social cost pricing, pure MSC would not increase the use of intermodal chains to such a level that they take a significant share of the overall market.
- The main barriers to the introduction of pricing regimes which promote inter-modality are institutional rather than financial, and the use of multi-modal chains can be encouraged by appropriate presentation and packaging of prices.

And Not Forgetting the Wider Picture:

- The removal of modal distinctions within a pricing structure reduces the suppliers’ ability to manage demand to suit capacity and to maximise income, but the resulting simplification of price structures is appreciated by users and may itself lead to an increase in demand.
- Abolition of existing taxes and subsidies could have a much greater effect than that produced by the introduction of marginal social cost pricing.
- Price differentiation costs money to implement and, unless this cost can be recouped by efficiencies elsewhere (e.g. reduced congestion at peak times), an increase in average prices may be necessary.

3.5.2 Recommendations

Although we believe that they may be appropriate in some circumstances, we do not recommend a general presumption that the use of multimodal chains should be encouraged (we find that they can sometimes detract from the use of modes which are more economically, environmentally or commercially sustainable).

As a consequence of this, we do not recommend that action should be taken at the European level to promote the use of multimodal chains irrespective of local circumstances.

In the light of these conclusions we recommend that, where local circumstances are appropriate, the local authorities should include price differentiation among the measures used to promote the use of multimodal chains.

We recommend that very careful thought be given to the consequences of any requirement on governments to remove (or desist from introducing) subsidies to public transport (although such subsidies may, in a strict sense, be economically distortionary, their removal can have serious consequences for environmental sustainability).

We recommend that the relevant authorities should be encouraged to use price differentiation to influence the pattern of mode use but that there should be no general supposition that price differentiation should always be applied (some of its effects are not benign).

4 REFERENCES

Freight Transport

Ackoff R., Sasieni M.: *Fundamentals of operations research*, London: John Willey & Sons, 1968

Adamczewski P.: *Informatyczne wspomaganie łańcucha logistycznego.* Poznań: Wydawnictwo Akademii Ekonomicznej w Poznaniu, 2001.

Anholcer M., Gaspars H., Owczarkowski A.: *Przykłady i zadania z badań operacyjnych i ekonometrii.* Poznań: Wydawnictwo Akademii Ekonomicznej w Poznaniu, 2005.

Barcik. R, *Logistyka dystrybucji*. Bielsko-Biała: Wydawnictwo ATH, 2005.

Encyklopedia popularna PWN, wyd. czternaste, Państwowe Wydawnictwa Naukowe, Warszawa, 1982.

Guzik B., Appenzeller D., Jurek W.: *Prognozowanie i symulacje. Wybrane zagadnienia.* Poznań: Wydawnictwo Akademii Ekonomicznej w Poznaniu, 2005.

Hajdul M., *Rozwój narzędzi informatycznych dla MSP branży transportowej*, Wybrane zagadnienia logistyki stosowanej 2006, nr 3, Kraków: PAN Komitet transportu, 2006.

Ignasiak E. (red.):Badania operacyjne, PWE, Warszawa, 2001

Krawczyk S.: *Metody ilościowe w logistyce (przedsiębiorstwa)*. Warszawa, Wydawnictwo C.H. Beck, 2001

Kubicki J., Kuriata A.: *Problemy logistyczne w modelowaniu systemów transportowych*, Warszawa: Wydawnictwa Komunikacji i Łączności, 2000.

Leszczyński J.: *Modelowanie systemów i procesów transportowych*, Warszawa: Oficyna Wydawnicza Politechniki Warszawskiej, 1994.

Liberadzki B., Mindur L.: *Uwarunkowania rozwoju systemu transportowego Polski*, Warszawa: Wydawnictwo Instytutu Technologii Eksploatacji – PIB, 2006.

Manikowski A, Tarapata Z.: *Prognozowanie i symulacja rozwoju przedsiębiorstw*, Warszawa: Wyższa Szkoła Ekonomiczna, 2002.

Piasecki S.: *Optymalizacja systemów przewozowych,* Warszawa: Wydawnictwo Komunikacji i Łącznosci, 1973.

Pidd M.: *Computer simulation in management science*, Lancaster: University of Lancaster, 1992.

Pidd M.: *Tools for Thinking. Modelling in Management Science*, Chichester: John Willey & Sons, 2003.

Radin R.: *Optimization in Operations Research*, New Jersey: Prentice Hall Inc., 1998.

Steenbrink P.: *Optimization of transport networks*, London: John Willey & Sons, 1974.

Tarnowski W.: *Modele matematyczne,* Warszawa: Państwowe Wydawnictwa Ekonomiczne, 1998.

Wrona A.: *Modelowanie i symulacja procesów transportowych za pomocą pakietu symulacyjnego SLAM II*, Gdańsk: Wydawnictwo Uniwersytetu Gdańskiego, 2000.

Zawadzka L.: *Metody ilościowe w organizacji i zarządzaniu.* Gdańsk: Wydawnictwo Politechniki Gdańskiej, 1996.

Misztal K, Szwankowski S, Wasilewska K, *Problemy kształtowania lądowo – morskiej infrastruktury transportowej w obsłudze polskiego handlu zagranicznego i tranzytu*. Wyd. UG, Gdańsk 1997.

Sienkiewicz P, *Inżynieria systemów, Wybrane zastosowania wojskowe*, Wyd. MON, Warszawa 1983.

Fishman G.S., *Symulacja komputerowa*. Pojęcia i metody, PWE, Warszawa 1981.

Gołembska E., Szymczak M., *Informatyzacja w logistyce przedsiębiorstw*. Wydawnictwo Naukowe PWN, Warszawa, Poznań 1997.

Beer S., *Cybernetyka w zarządzaniu*, PWN, Warszawa 1966.

Porter M., *Porter o konkurencji,* PWE, Warszawa 2001.

Kelly K., *Nowe reguły nowej gospodarki*, WIG – Press, Warszawa 2001.

Jüngemann R., Lublow R., *Basis für einen intelligenten Güterverkehr.* Internationales Verkehrswesen. 46/1994.

Zieliński Z, *Analiza ekonomiczna procesów stochastycznych,* UMK, Toruń 2002.

Passenger Transport

Acutt, M. Z. and Dodgson, J. S. (1996) Cross-elasticities of demand for travel, Transport Policy, Vol 2, No 4 pp. 271-277.

Bonsall, P., Dix, M., Stone, V, and Stewart, J. (2006) "Consumer Behaviour and Pricing Structures: Final Report on Qualitative Research"**,** Report to Department for Transport on Research Project R104, see: http://www.dft.gov.uk/stellent/groups/dft_roads/documents/page/dft_roads_611352-01.hcsp

Bonsall PW, Shires JD, Matthews B, Maule J and Beale J. (2007a) "Responses to Complex Pricing Signals: Theory, Evidence and Implications for Road Pricing", Transportation Research A 41 (A) , 672-683 .

Bonsall P.W., Shires, J., Link, H., Becker, A., Papaioannou, P. and Xanthopoulos, P (2007b) "Complex congestion charging – an assessment of motorists' comprehension and the impact on their driving behaviour", paper presented at the European Transport Conference, Amsterdam, September 2007, PTRC

Button, K. J. (1982) Transport Economics. 2nd Edition Edward Elgar, Cheltenham

CE Delft, "Methodologies for external cost estimates and internalization scenarios. Discussion paper for the workshop on internalisation on March 15, 2007, 2007, Brussels

CE Delft Report on The price of transport in The Netherlands, 2004

Department for Transport (2004) Road Pricing Feasibility Study, DfT, UK http://www.dft.gov.uk/pgr/roads/roadpricing/feasibilitystudy/

Foltynova, H and M.B.Kohlova, "Cost-beneft analysis of cycling infrastructure: a case study of Pilsen", Charles University Environment Centre in Prague, 2003

Glazer, A., Link, H., May, T., Milne, D., Niskanen, E. (2001) "Barriers to Transport Pricing – a Review of research". Paper presented to IMPRINT- EUROPE Seminar, Brussels.

GRACE project, Generalisation of Research on Accounts and Cost Estimation, "Transferability requirements, cost drivers and cost functions for transferability/generalization, 2007, Brussels

Lythgoe, W.F. (2008) Preparation of a multi-dimensional elasticity matrix, ITS working note, University of Leeds.

Ministry of Interiors, Local Finance Department " Expenditure in Rome Municipality" year 2000, 2007

Sansom T. et al. " Surface Transport Costs and Charges: Great Britain" 1998

Schaller, B. (1999) Elasticities for taxicab fares and service availability, Transportation Vol 26 pp. 283-297

TFL, "Details of Taxi Cost Calculations" 2006

Seidel, Matthes, Wieland, Schlag, and Schade (2004) “Political Acceptability and Perceived Legitimacy of Transport Policy Implementation” (Draft deliverable 4 from the Transport Institutions in the Policy Process (TIPP) Consortium

TREMOVE Database v.2.52, 2007

UNITE project; UNIfication of accounts and marginal costs for Transport Efficiency “Pilot Accounts - Results for the United Kingdom, Germany and other EU countries”, 2003, Brussels

UNITE project; UNIfication of accounts and marginal costs for Transport Efficiency “Deliverable 6: Supplier Operating Costs”, 2003, Brussels

UNITE project; UNIfication of accounts and marginal costs for Transport Efficiency “Deliverable 10: Road Econometrics – Case study motorways Switzerland”, 2002, Brussels

UNITE project; UNIfication of accounts and marginal costs for Transport Efficiency “Deliverable 7F: Urban Congestion Costs: Brussels urban transport”, 2002, Brussels

Vicario, A. J. B. (1999) Diversion Factors and Cross Elasticities, Dissertation, MA Transport Economics, Institute for Transport Studies, University of Leeds.

APPENDIX 1

SURVEY CARRIED OUT IN PRODUCTION/TRADING COMPANIES

APPENDIX 1: SURVEY CARRIED OUT IN PRODUCTION/TRADING COMPANIES

<table>
<tr><td rowspan="18">1.</td><td colspan="3">General company description</td></tr>
<tr><td colspan="2">Company name</td><td></td></tr>
<tr><td colspan="2">Address (street, town)</td><td></td></tr>
<tr><td colspan="2">Contact person</td><td></td></tr>
<tr><td colspan="2">Email</td><td></td></tr>
<tr><td rowspan="6">Line of business
(please, put „X”)</td><td>Production</td><td></td></tr>
<tr><td>Distribution</td><td></td></tr>
<tr><td>Trade</td><td></td></tr>
<tr><td>Transport – forwarding – logistics</td><td></td></tr>
<tr><td>Construction</td><td></td></tr>
<tr><td>Other</td><td></td></tr>
<tr><td colspan="3">Employment
(please, put „X” by the appropriate answer / give the number if it is possible</td></tr>
<tr><td colspan="2">Up to 10 employees</td><td></td></tr>
<tr><td colspan="2">From 11 to 50 employees</td><td></td></tr>
<tr><td colspan="2">From 51 to 100 employees</td><td></td></tr>
<tr><td colspan="2">From 101 to 250 employees</td><td></td></tr>
<tr><td colspan="2">More than 251 employees</td><td></td></tr>
<tr><td colspan="3"></td></tr>
<tr><td rowspan="6">2.</td><td colspan="3">What is the territorial range of your company’s activity?
(please, give the percentage share)</td></tr>
<tr><td colspan="2">Area</td><td>Share of orders</td></tr>
<tr><td colspan="2">Region</td><td></td></tr>
<tr><td colspan="2">Country</td><td></td></tr>
<tr><td colspan="2">Europe</td><td></td></tr>
<tr><td colspan="2">Rest of the world</td><td></td></tr>
<tr><td rowspan="8">3.</td><td colspan="3">Which of the factors below are your key selection criteria when choosing transport mode and means?
(please, put „X” by the appropriate answer – one or more)</td></tr>
<tr><td colspan="2">Price of the transport service</td><td></td></tr>
<tr><td colspan="2">Service quality</td><td></td></tr>
<tr><td colspan="2">Delivery time</td><td></td></tr>
<tr><td colspan="2">Flexibility of offer terms</td><td></td></tr>
<tr><td colspan="2">Service complexity</td><td></td></tr>
<tr><td colspan="2">Getting used to the applied solutions</td><td></td></tr>
<tr><td colspan="2">Other</td><td></td></tr>
<tr><td rowspan="7">4.</td><td colspan="3">What transport mode do you use for carrying goods?
(please, give the percentage share of each transport mode)</td></tr>
<tr><td colspan="2">Transport mode</td><td>Share</td></tr>
<tr><td colspan="2">Road transport</td><td></td></tr>
<tr><td colspan="2">Railway transport</td><td></td></tr>
<tr><td colspan="2">Maritime transport</td><td></td></tr>
<tr><td colspan="2">Air transport</td><td></td></tr>
<tr><td colspan="2">Intermodal transport (e.g. road – rail)</td><td></td></tr>
<tr><td>5.</td><td colspan="3">What are main barriers of using intermodal transport by your company?
(please, put „X” by the appropriate answer – one or more / if possible please rank your answers)</td></tr>
</table>

	No offers from transport operators	
	Necessity of using containers	
	Longer delivery time	
	Too small lots of transported goods	
	Goods are not vulnerable to intermodal transport (rail-road)	
	Transport price	
	Other	
6.	**Would you use intermodal transport if it was cheaper than other transport modes?**	
	Yes, I would choose the cheapest solution	
	No, why?	
7.	**What was taken into consideration when defining your company's logistics strategy?** (please, put „X" by the appropriate answer – one or more / if possible please rank your answers)	
	Existing transport infrastructure	
	Existing regional transport development strategy (e.g. promotion of transport modes which are alternative to road transport)	
	Ecological aspects of each transport mode	
	Cost minimization	
	High service quality	
	Customer's requirements	
	International commercial terms (incoterms 2000)	
	Other	
8.	**Would you change the transport mode if additional transport infrastructure access charges were introduced?** (e.g. in favour of railway transport if additional charges for road access were introduced)	
	Yes, I would choose the cheapest solution	
	No, the additional transport costs would be included in the prices of goods	
	Additional comments	
9.	**Would you change your way of distribution to cities if city access charges for delivery trucks were introduced?** (e.g. access in the peak hours would be 3 times more expensive than after 11.00 a.m., night deliveries would be free)	
	No, the load has to be delivered within fixed morning hours	
	Yes, I would choose the cheapest solution	
	I would choose other solutions	
10.	**Would you be able to cooperate with companies from the same business areas in order to organize common deliveries? It would result in reduction of costs and the number of trucks in the region and city.**	
	Yes, I would choose the cheapest solution	
	No, why?	

APPENDIX 2

POPULATION CHARACTERISTICS

APPENDIX 2: POPULATION CHARACTERISTICS

	Number of Trips (000)	Mode Share (%)	Average Generalised Cost (€)	Mean Distance (kms)	Mean Duration (mins)
All Trips:					
car (solo)	287.4	22.5	5.15	16	24.9
car (multi)	453.2	35.5	4.08	16	24.2
bus/coach	125.7	9.8	5.60	7	35.8
train	44.7	3.5	10.26	22	53.0
taxi	17.6	1.4	9.07	8	20.4
pedestrian or cycle	312.4	24.5	2.09	1	15.8
bus & train	14.0	1.1	13.29	29	74.6
taxi & bus or train	2.3	0.2	44.24	118	144.5
car (solo)& bus or train	11.0	0.9	21.55	75	104.2
car (multi)& bus or train	8.3	0.6	21.90	65	86.1
plane & bus or train	0.01	<0.1	179.49	638	237.5
plane & taxi	0.1	<0.1	175.30	608	204.4
Car (multi) & plane	0.1	<0.1	120.94	682	241.5
Car (solo) and plane	0.2	<0.1	150.22	646	237.1
Commuting or business	388.1	30.4	6.35	16	32.6
Weekday morning peak	277.7	21.7	4.81	12	26.7
All modes total	1277.0	100.0	4.76	13	26.3
Short distance trips:					
car (solo)	231.6	20.9	3.06	7	17.0
car (multi)	383.9	34.6	2.46	6	16.0
bus/coach	120.6	10.9	5.25	6	33.7
train	30.7	2.8	7.42	10	41.6
taxi	16.4	1.5	7.76	5	17.9
pedestrian or cycle	312.3	28.2	2.08	1	15.8
bus & train	7.9	0.7	9.49	13	57.6
taxi & bus or train	0.3	<0.1	15.91	13	60.0
car (solo)& bus or train	3.1	<0.1	8.19	13	48.9
car (multi)& bus or train	1.8	<0.1	8.63	14	50.7
Commuting or business	309.7	27.9	3.91	6	23.7
Weekday morning peak	243.0	21.9	3.17	5	19.9
All modes total	1108.8	100.0	3.08	5	19.3
Long distance trips:					
car (solo)	55.7	33.1	13.86	54	57.7
car (multi)	69.3	41.2	13.06	69	69.2
bus/coach	5.1	3.0	13.85	44	86.0
train	14.0	8.3	16.50	48	78.2
taxi	1.2	0.7	27.22	45	55.4
bus & train	6.1	3.7	18.18	50	96.5
taxi & bus or train	1.9	1.1	49.06	136	158.9
car (solo)& bus or train	7.9	4.7	26.87	100	126.2
car (multi)& bus or train	6.4	3.8	25.76	80	96.4
plane & bus or train	0.01	<0.1	179.49	638	237.5
plane & taxi	0.1	<0.1	175.30	608	204.4
Car (multi) & plane	0.1	<0.1	120.94	682	241.5
Car (solo) and plane	0.2	<0.1	150.22	646	237.1
Commuting or business	78.4	46.6	16.00	57	161.3
Weekday morning peak	34.7	20.6	16.24	60	74.4
All modes total	168.2	100.0	15.82	65	72.7

APPENDIX 3

ASSUMED EXTERNALITY COSTS

APPENDIX 3: ASSUMED EXTERNALITY COSTS

Externality (Environmental Costs + Delay and, for Taxi and Coach, Costs of Wear and Tear + Operation Imposed on Road System), € per pas km on Specified Mode											
			At X % of current demand (where x is:……..								
			50	67	75	90	100	125	150	200	300
Car (s)	short	p	0.072	0.104	0.117	0.144	0.180	0.228	0.280	0.350	0.500
	short	op	0.036	0.045	0.052	0.059	0.070	0.091	0.110	0.130	0.200
	long	p	0.031	0.044	0.050	0.064	0.080	0.098	0.120	0.150	0.300
	long	op	0.031	0.045	0.051	0.058	0.070	0.089	0.110	0.130	0.200
Car (M)	short	p	0.035	0.051	0.058	0.071	0.090	0.108	0.140	0.175	0.250
	short	op	0.017	0.022	0.026	0.029	0.035	0.046	0.055	0.065	0.100
	long	p	0.014	0.021	0.025	0.032	0.040	0.049	0.060	0.075	0.150
	long	op	0.015	0.022	0.026	0.029	0.035	0.044	0.055	0.065	0.100
Taxi*	short	p	0.136	0.176	0.188	0.227	0.270	0.325	0.380	0.450	0.600
	short	op	0.065	0.077	0.085	0.088	0.105	0.127	0.210	0.230	0.300
	long	p	0.062	0.077	0.086	0.102	0.120	0.140	0.220	0.250	0.400
	long	op	0.067	0.084	0.093	0.101	0.115	0.137	0.210	0.230	0.300
bus	short	p	0.050	0.052	0.055	0.058	0.064	0.071	0.095	0.145	0.245
	short	op	0.048	0.049	0.05	0.052	0.055	0.058	0.064	0.071	0.095
	long	p	0.048	0.049	0.05	0.052	0.055	0.058	0.064	0.071	0.095
	long	op	0.029	0.031	0.033	0.035	0.036	0.045	0.052	0.055	0.058
train	short	p	0.003	0.004	0.005	0.006	0.007	0.007	0.008	0.01	0.015
	short	op	0.002	0.003	0.004	0.005	0.006	0.006	0.006	0.007	0.008
	long	p	0.003	0.004	0.005	0.006	0.007	0.007	0.008	0.01	0.015
	long	op	0.002	0.003	0.004	0.006	0.006	0.006	0.006	0.007	0.008
plane	(long)		0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
Walk/cycle	(short)		0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001

* taxi costs assume 33% of mileage is "dead"

Key Sources:

CE Delft paper presented at the Seminar on the Internalization of External Costs of Transport on March 15 2007. Various sources, average of min and max values, converted to 2006 using the Eurostat inflation rate

UNITE project; UNIfication of accounts and marginal costs for Transport Efficiency "Deliverable 7F: Urban Congestion Costs: Brussels urban transport", 2002, Brussels

CE Delft Report on The price of transport in The Netherlands, 2004

APPENDIX 4

ASSUMED LENGTH OF "FEEDER" ELEMENT OF MULTI-MODE TRIPS

APPENDIX 4: ASSUMED LENGTH OF "FEEDER" ELEMENT OF MULTI-MODE TRIPS

Assumptions about Feeder Mode Distances (kms)					
	For trips whose total length is :				
	<3 kms	3 - 9.99 kms	10 - 19.99 kms	20 - 99 kms	>100 kms
Bus feeds train	0.8	1.61	4.83	6.44	6.44
Taxi feeds bus coach or train	0.8	1.61	4.83	8.05	8.05
Car feeds bus coach or train	0.8	1.61	4.83	8.05	8.05
Any mode feeding plane	n.a.	n.a.	n.a.	n.a.	24.14

For mixed modes, we assume that the journey will be affected by any change in charge, congestion or price (and will affect congestion and supplier charges) pro-rata to its length by the main mode and the feeder mode. Assumptions about the length of the feeder mode components were based on experience in the West Yorkshire metropolitan area.

APPENDIX 5

ASSUMED LEVEL OF CURRENT TAXES AND SUBSIDIES

APPENDIX 5: ASSUMED LEVEL OF CURRENT TAXES AND SUBSIDIES

Net Tax Revenue in € per pas km (Negative if Subsidy) (Tax to be Removed – and Subsidy Added to AGC of Trips for Scenarios where Taxes and Subsidies are Abolished).		
Car (Solo)		.050
Car (Multi -occupant)		.025
taxi		.087
Airplane*		.010
bus	Short , peak	-0.150
	Short, off peak	-0.350
	Long, peak	-0.190
	Long, off peak	-0.390
train	Short, peak	-0.566
	Short, off peak	-1.166
	Long, peak	-0.043
	Long, off peak	-0.083
Walk and cycle		-0.01

Key Sources:

UNITE project; UNIfication of accounts and marginal costs for Transport Efficiency “Pilot Accounts - Results for the United Kingdom, Germany and other EU countries”, 2003, Brussels

APPENDIX 6

ASSUMED ELASTICITIES

APPENDIX 6: ASSUMED ELASTICITIES

6a *Assumed Ratios of Generalised Cost to Price (used in Conversion of Price Elasticities to Generalised Cost Elasticities)*

Mode	**Price as a Proportion of Generalised Cost**				
	Distance <3km	**Distance 3-10km**	**Distance 10-20km**	**Distance 20-100km**	**Distance >100 km**
Sole occupancy car	5.5	2.9	2.6	2.1	2.0
Multi occupancy car	10.0	4.8	4.2	3.2	3.0
Bus or coach	7.0	6.5	5.1	2.5	2.1
Rail	4.5	4.0	2.4	1.8	1.5
Taxi	1.45	1.42	1.4	1.3	1.25
Plane	n.a	n.a	n.a.	n.a	1.4

6b *Own Generalised Cost Elasticities (for Peak Hour Journeys between 3km and 10km)*

	Mode	**Commuting**	**Employer's business**	**Personal business**	**Leisure**
1	car/ van (driver)	-0.50	-0.38	-0.91	-1.01
2	car/ van (multiple occ.)	-0.70	-0.53	-1.27	-1.41
3	bus or coach	-2.22	-1.66	-3.99	-4.44
4	rail	-2.95	-2.21	-5.30	-5.89
5	taxi	-1.82	-1.37	-3.28	-3.65
6	plane	-0.72	-0.54	-1.30	-1.44
7	walk and cycle	-0.12	-0.09	-0.22	-0.24
8	bus plus train	-2.66	-1.99	-4.78	-5.31
9	taxi plus bus/ train	-2.27	-1.70	-4.08	-4.54
10	car/ van (multi.) plus bus/ train	-1.37	-1.02	-2.46	-2.73
11	car/ van (solo) plus bus/ train	-1.09	-0.81	-1.96	-2.17
12	bus/ train plus plane	-1.39	-1.04	-2.50	-2.78
13	taxi plus plane	-0.90	-0.68	-1.63	-1.81
14	car/ van (multi.) plus bus/ train	-0.71	-0.54	-1.29	-1.43
15	car/ van (solo) plus bus/ train	-0.63	-0.47	-1.13	-1.26

6c Diversion Factors

The factors in a given row are used to allocate demand changes, implied by the own price elasticity for that row, to the modes identified in each column. Thus, with modes numbered as for Appendix 6b, 25% of any reduction in demand for solo car trips for commuting trips between 3 and 10 kms will be allocated to bus/coach trips for commuting trips between 3 and 10 kms)

Diversion Factors between Modes for Commuting 3km to 10km

Modes	**1**	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	**1.00**	-0.22	-0.25	-0.12	-0.01	x	-0.02	-0.02	-0.02	-0.04	-0.09	x	x	x	x
2	-0.17	**1.00**	-0.30	-0.12	-0.01	x	-0.02	-0.02	-0.02	-0.09	-0.04	x	x	x	x
3	-0.13	-0.19	**1.00**	-0.10	-0.02	x	-0.02	-0.02	-0.01	-0.01	-0.01	x	x	x	x
4	-0.13	-0.17	-0.30	**1.00**	-0.03	x	-0.02	-0.02	-0.01	-0.01	-0.01	x	x	x	x
5	-0.15	-0.10	-0.15	-0.13	**1.00**	x	-0.02	-0.09	-0.09	-0.08	-0.08	x	x	x	x
6	x	x	x	x	x	**1.00**	x	x	x	x	x	x	x	x	x
7	-0.12	-0.13	-0.19	-0.13	-0.06	x	**1.00**	-0.06	-0.07	-0.07	-0.06	x	x	x	x
8	-0.15	-0.10	-0.15	-0.13	-0.06	x	-0.02	**1.00**	-0.09	-0.08	-0.08	x	x	x	x
9	-0.07	-0.06	-0.15	-0.13	-0.15	x	-0.02	-0.05	**1.00**	-0.11	-0.06	x	x	x	x
10	-0.11	-0.10	-0.15	-0.13	-0.06	x	-0.02	-0.06	-0.13	**1.00**	-0.08	x	x	x	x
11	-0.15	-0.10	-0.15	-0.13	-0.06	x	-0.02	-0.06	-0.07	-0.08	**1.00**	x	x	x	x
12	x	x	x	x	x	x	x	x	x	x	x	**1.00**	x	x	x
13	x	x	x	x	x	x	x	x	x	x	x	x	**1.00**	x	x
14	x	x	x	x	x	x	x	x	x	x	x	x	x	**1.00**	x
15	x	x	x	x	x	x	x	x	x	x	x	x	x	x	**1.00**

Diversion Factors between Modes for Business over 100km

Modes	**1**	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	**1.00**	-0.22	-0.14	-0.60	-0.04	x	x	-0.02	-0.02	-0.04	-0.13	-0.03	-0.03	-0.05	-0.11
2	-0.15	**1.00**	-0.13	-0.91	-0.04	x	x	-0.02	-0.02	-0.13	-0.04	-0.04	-0.04	-0.11	-0.06
3	-0.11	-0.19	**1.00**	-1.15	-0.06	x	x	-0.02	-0.01	-0.01	-0.01	-0.09	-0.05	-0.05	-0.05
4	-0.11	-0.17	-0.38	**1.00**	-0.08	x	x	-0.02	-0.01	-0.01	-0.01	-0.09	-0.04	-0.04	-0.04
5	-0.13	-0.10	-0.11	-0.24	**1.00**	x	x	-0.09	-0.19	-0.12	-0.12	-0.04	-0.04	-0.04	-0.05
6	x	x	x	x	x	**1.00**	x	x	x	x	x	x	x	x	x
7	x	x	x	x	x	x	**1.00**	x	x	x	x	x	x	x	x
8	-0.13	-0.10	-0.11	-0.24	-0.16	x	x	**1.00**	-0.19	-0.12	-0.12	-0.04	-0.04	-0.04	-0.05
9	-0.05	-0.06	-0.11	-0.24	-0.40	x	x	-0.05	**1.00**	-0.15	-0.06	-0.04	-0.04	-0.04	-0.05
10	-0.09	-0.10	-0.11	-0.24	-0.16	x	x	-0.06	-0.29	**1.00**	-0.12	-0.04	-0.04	-0.04	-0.05
11	-0.13	-0.10	-0.11	-0.24	-0.16	x	x	-0.06	-0.11	-0.12	**1.00**	-0.04	-0.04	-0.04	-0.05
12	-0.13	-0.13	-0.14	-0.17	-0.08	x	x	-0.04	-0.04	-0.04	-0.04	**1.00**	-0.07	-0.08	-0.08
13	-0.13	-0.13	-0.14	-0.17	-0.08	x	x	-0.04	-0.04	-0.04	-0.04	-0.06	**1.00**	-0.08	-0.08
14	-0.13	-0.13	-0.14	-0.17	-0.08	x	x	-0.04	-0.04	-0.04	-0.04	-0.06	-0.07	**1.00**	-0.08
15	-0.13	-0.13	-0.14	-0.17	-0.08	x	x	-0.04	-0.04	-0.04	-0.04	-0.06	-0.07	-0.04	**1.00**

APPENDIX 7

ASSUMED COSTS OF CONGESTION

APPENDIX 7: ASSUMED COSTS OF CONGESTION

Table A7.1 Delay (€) to Road Mode pas kms per extra pas km

(applies to all road modes (with values being multiplied by mode-specific factors reflecting the vehicle's per-occupant contribution to congestion - carsolo =1.0, carmulti = 0.5, taxi = 1.75, bus coach = 0.10) Using the % change appropriate to that mode (after summing over purposes within a given period and area type)).

		At X % of current demand (where x is:……..								
		50	67	75	90	100	125	150	200	300
short	peak	0.040	0.035	0.030	0.022	0.0	.037	.057	.107	.207
short	o-p	0.011	0.010	0.008	0.005	0.0	.010	.015	.040	.090
long	peak	0.017	0.016	0.014	0.012	0.0	.016	.056	.081	.131
long	o-p	0.010	0.009	0.006	0.003	0.0	.008	.013	.028	.072

Table A7.2 Additional delays (€) to specified road modes (applies to specified mode in as a consequence of demand on that mode)

additional delay to taxi pas journeys per extra taxi pas journey [23]	0.12€ (i.e delay per taxi journey =(0.12 X Δtaxi journeys) / (new total taxi journeys) _
additional delay to bus pas journeys per extra bus pas journey[24]	= 0.06€ i.e delay per bus journey =(0.06 X Δbus journeys) / (new total bus journeys)

Table A7.3. Delays (€) to pedestrian or cycle journeys per extra journey of that type

i.e. delay per trip =(specified delay x Δtrips) / (new total trips)[25]

	At X % of current demand (where x is:……..								
	50	67	75	90	100	125	150	200	300
peak	0.010	0.008	0.005	0.003	0.0	.007	.022	.032	.047
Off peak	0.001	0.001	0.001	0.000	0.0	.001	.001	.002	.002

Table A7.4. Delay (€) to plane pas journeys per extra pas journey on plane

i.e. delay per trip =(specified delay x Δtrips) / (new total trips)

	At X % of current demand (where x is:……..								
	50	67	75	90	100	125	150	200	300
peak	0.020	0.018	0.013	0.010	0.0	.015	.032	.088	.212
Off peak	0.018	0.015	0.010	0.008	0.0	.012	.030	.070	.170

Table A7.5. Delay (€) to train pas journey per extra train pas journey

i.e. delay per trip =(specified delay x Δtrips) / (new total trips)

		At X % of current demand (where x is:……..								
		50	67	75	90	100	125	150	200	300
short	p	0.013	0.012	0.010	0.005	0.0	.015	.044	.102	.152
short	op	0.003	0.003	0.002	0.002	0.0	.012	.030	.045	.074
long	p	0.005	0.005	0.004	0.003	0.0	.013	.035	.057	.120
long	op	0.003	0.002	0.002	0.002	0.0	.010	.020	.035	.060

Key sources:

CE Delft paper presented at the Seminar on the Internalization of External Costs of Transport on March 15 2007. Various sources, average of min and max values, converted to 2006 using the Eurostat inflation rate
GRACE project, Generalisation of Research on Accounts and Cost Estimation, "Transferability requirements, cost drivers and cost functions for transferability/generalization, 2007, Brussels

23 Based on an assumed dispatch delay of 1 minute per extra customer
24 Based on an assumed 30 seconds queuing per extra passenger.
25 Although very small, an effect could exist due to queuing to cross roads etc.

APPENDIX 8

ASSUMED COSTS OF SERVICE PROVISION AND OPERATION

APPENDIX 8: ASSUMED COSTS OF SERVICE PROVISION AND OPERATION

Costs (€) of service and infrastructure provision on specified mode

Note that _Car , taxi, bus and train are shown per pas km whereas plane and walk/cycle costs are shown per pas journey

				At X % of current demand (where x is:……..								
				50	67	75	90	100	125	150	200	300
Car (s)	short	P or op		.035	.033	.032	.030	.029	.025	x	x	x
	long	P or op		.024	.023	.022	.021	.020	.018	x	x	x
Car (M)	short	P or op		.018	.017	.016	.015	.014	.012	x	x	x
	long	P or op		.012	0.11	.011	.010	.010	.009	x	x	x
Taxi	short	P or op		.273	.271	.270	.268	.267	.266	x	x	x
	long	P or op		.304	.303	.301	.299	.298	.297	x	x	x
Bus	short	P or op		.420	.410	.400	.398	.395	.384	.373	.365	.350
	long	P or op		.450	.445	.440	.438	.434	.421	.407	.398	.380
Train	short	P or op		.300	.295	.285	.279	.274	.257	.240	.230	.210
	long	P or op		.420	.410	.390	.370	.363	.343	.323	.306	.274
airplane		P or op		35.68	34.52	33.45	33.19	32.77	31.77	30.80	29.00	27.00
Walk or cycle		P or op		0.030	0.029	0.029	0.022	0.019	0.014	0.012	0.010	0.008

Key sources:

Road mode
wear and tear based on the UNITE UK Pilot, page 92 (road total road infrastructure costs at 2005)
and the German UNITE Pilot page 105 (share urban/non urban total road infrastructure costs)
UNITE project; UNIfication of accounts and marginal costs for Transport Efficiency "Pilot Accounts – Results for the United Kingdom, Germany and other EU countries", 2003, Brussels
Road system operating costs based on the TREMOVE Database UK costs at 2005)
TREMOVE Database Transport and Emission Model v.2.52, 2007
Urban Traffic Control and Policing costs based on costs in the Rome municipality.
Ministry of Interiors, Local Finance Department " Expenditure in Rome Municipality" year 2000, 2007
Operating costs for long trips -10% (traffic light and police) – Riccardo Enei

Train mode
Sansom et alt. " Surface Transport Costs and Charges: Great Britain" 1998, Pag 61

Plane mode
wear and tear: estimated through the University of Las Palmas methodology, GRACE project

(Fiumicino Airport) Assuming an average of 200 passengers per aircraft.

GRACE project, Generalisation of Research on Accounts and Cost Estimation, “Transferability requirements, cost drivers and

cost functions for transferability/generalization, 2007, Brussels

Supplier Operating Costs: UNITE Deliverable 6 Supplier Operating Costs, page 108, data 1998

converted to 2006 prices, value per hour flown at 2000 (European average aircraft), converted at 2006

through the inflation rate. The case study shows slightly increasing returns of scale as demand increases

Taxi

operating costs based on Transport for London study (include license, wages, vehicles, dispatching etc)

TFL, “Details of Taxi Cost Calculations” 2006

Cycling costs:

Cost Benefit Analysis of Cycling Infrastructure: A case study of Pilsen

Foltynova and Kohlova, “Cost-benefit analysis of cycling infrastructure: a case study of Pilsen”, Charles University Environment Centre in Prague, 2003

APPENDIX 9

ASSUMED REDUCTIONS IN USER GENERALISED COST PER UNIT INVESTMENT

APPENDIX 9: ASSUMED REDUCTIONS IN USER GENERALISED COST PER UNIT INVESTMENT

Mode	Reduction in average generalised cost achievable (%) per 100m€ invested on behalf of inhabitants of a medium size metropolitan area (pop 500k)		
	For short distance trips(peak) Low High	For short distance trips (off peak) Low High	For long distance trips Low High
Car	1.7 7.0	1.3 9.5	1.3 3.9
Bus/coach	2.5 7.4	1.3 9.9	1.3 4.0
Train	1.5 2.0	1.0 2.4	0.9 1.5
Taxi	2.5 6.9	2.5 6.9	1.5 2.9
Plane	n.a.	n.a.	2.5 5.0
Pedestrian or cycle	0.5 5.9	0.5 5.9	n.a.
Bus/coach + Train	2.5 5.0	2.0 5.5	0.9 1.2
Taxi + Bus or Train	2.5 5.0	2.0 5.5	1.0 1.3
Car + Bus or Train	1.8 4.5	1.8 4.5	0.9 1.8
Bus or Train + Plane	n.a.	n.a.	2.0 5.0
Taxi + Plane	n.a.	n.a.	2.0 5.0
Car + Plane	n.a.	n.a.	2.0 5.0

Source: discussions with industry experts

Notes :

- The figures in the tables reflect the range of estimates provided (in fact the range was larger than this but these figures are after allowing for differences in interpretation of the original request)
- these benefits accrue to users of the specified mode in the specified time period and location but
  - coach and taxi trips will also benefit from any (per km) improvement in car generalised costs (for short bus trips they receive 50% of the per km rate – to allow for the fact that only a part of the total generalised cost is based on on-road time, for longer trips the equivalent figure is 75%)
  - multimodal trips will also benefit from any benefit (per km) accruing to their constituent modes.
- Pedestrian trips can be made a bit faster via improved crossing facilities but part of the benefit comes from decreased disutility of travel time due to an improved environment.