Final Report

HANDBOOK

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FISCUS

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0 EXECUTIVE SUMMARY

This handbook aims to provide practical guidelines on the evaluation of the real costs of urban mobility and on the most appropriate ways to finance it, tackling a set of issues with increasing importance in the political agenda of urban transport.

The handbook is mostly directed to decision-makers on urban transport policy, urban planners, managers of operating companies and last but not least to the citizens, who often see their money being used to finance urban public transport, and are thus entitled to know how the system works from the economic and financial viewpoint.

FISCUS has opted for a review and estimation of all costs of urban mobility in the sense of *total resource costs,* that is, anything that consumes any resources of real or potential value, but disregarding issues that merely constitute transfers of money or of any type of rights. By adopting this position, the issue of internal versus external costs loses relevance for the total bill, although it is of course not forgotten, in particular when, on the other side of the coin (i.e. financing) the issue of "who pays or suffers what" is addressed.

Current use of the word "Financing" entails a double meaning: getting resources to pay for the creation and functioning of the systems; and anticipating the availability of those resources, namely by recourse to borrowing. FISCUS concentrates on the former (who pays for what), although we also dedicate some attention to the latter (who puts up the money) such is the current and likely future relevance of this type of instruments to get new projects under way. To some extent we may identify the first meaning of the term "financing" with "structural support" and the second with "leveraging instruments".

In this context, this handbook aims, with the help of examples that illustrate typical situations in the urban areas, to help decision-makers in formulating and answering questions such as:

- What are the transport' costs in my city?
- Who should bear what part of the mobility costs in my city?
- How can an efficient pricing policy contribute to a sustainable urban mobility policy?
- To what extent can policy initiatives enhance managing the financing of mobility?
- To what extent can costs be managed through a coherent system design?

The structure of this handbook follows the steps that a logical approach to the problems of the evaluation of real costs of transport systems and its financing would take. Firstly, a framework to characterise the different urban environments where transport systems operate is presented, followed by a chapter on the evaluation of the true costs associated to an urban mobility system. Finally, the issues of pricing and financing are treated in chapter 4, which is succeeded by a brief synthesis of the methods presented along the handbook and in addition a final chapter dedicated to concluding remarks and afterthoughts on the impact of political decisions on cost levels and financing options.

In order to design an overall structure for a Real Cost Scheme, we concentrate ourselves on the most important components and on its organisation. A common starting point is the characterisation of different transport aims and means as pointed out in the following tables.

PASSENGER TRANSPORT				
Type of transport	**Infrastructure** **Type of infrastructure**	**Level of privatisation**	**Traffic operation** **Means of transport**	**Level of privatisation**
Private motorised	- Inner-urban main roads - Inner-urban other roads - Urban / inter-urban motorways	- Public - Semi-private - Private	- Passenger cars - Motorcycles - Waterways	- Private (commercial, private households)
Private non motorised	- Walking and cycling areas and facilities	- Public	- Bicycles - Pedestrians	- Private
Urban public transport	- Road/Bus Lanes - Rail	- Public - Semi-private	- Buses - Light Rail - Underground	- Public - Privatised
Regional rail and bus transport	- Road/Bus Lanes - Rail	- Public - Semi private	- Busses - Underground - Railway	- Public (upper state level) - Privatised

Table 1: The most important dimensions of urban passenger transport systems

FREIGHT TRANSPORT				
Type of transport	**Infrastructure** **Type of infrastructure**	**Level of privatisation**	**Traffic operation** **Means of transport**	**Level of privatisation**
Inner-urban road transport	- Inner-urban main roads - Inner-urban other roads - Urban / inter-urban motorways	- Public - Private access	- HGV - Light duty trucks	- Private
Interurban road transport	- Interurban motorways	- Public - Public Private Partnership - Private	- HGV - Light duty trucks	- Private
Combined transport	- City logistics facilities	- Private - -Semi private	- Rail-Road	- Private
Railway transport	- Main tracks - Feeder tracks	- -Private - Semi-private	- Regional freight railways	- Private - Semi- private

The real cost scheme developed in FISCUS and presented in the handbook distinguishes between seven types of costs or effects transport can cause, which can be classified into two groups: (1) Provisions m*anagement and operating costs* incorporating all those costs borne by the provider of infrastructure or transport services (including the individual transport user in its role of private operator) and (2) other *social costs*, describing those effects transport is imposing on the ones using it, on the society or on other transport users, that is, social costs include both internal and external costs caused by transport. The following three basic questions frame the relevant issues in the cost category definition for the purpose of the real cost scheme:

(1) *Which type of costs or effects needs to be assessed?*

(2) *What are the decisive factors determining the cost level?*

(3) *Who causes and who bears these costs?*

To answer these questions FISCUS research focused on the economic rationale and justification for accounting for each of the seven following cost categories[1], i.e.: Infrastructure cost, vehicle associated costs, congestion costs, accidents costs, emissions costs, noise costs and other effects costs.

It is well known that transport - like other economic activities - is imposing a variety of effects on different parts of society. While some of the negative effects are directly or indirectly carried by the transport users themselves (internal), others are borne by parts of society, which might be not directly involved in transport (external). If we express all these effects by monetary units we talk of the "real costs" of transport. The knowledge of transport-related costs and their inter-relationship in a specific urban environment provides the basis to judge or - if necessary - to refine current pricing or financing mechanisms of individual and public transport and to analyse the development of the financial and social situation between modes and over time.

It is the aim of chapter 3 to introduce the reader into the philosophy and the techniques of social cost accounting. An overview of which cost items are considered of their most important drivers, sufferers and their degree of internalisation is presented by the following table.

Cost Category	Main Determinants	Most Relevant Final Payers	Degree of Externality
Costs due to infrastructure supply	Size, technology and age of transport networks, share of heavy traffic, maintenance policy.	Different state levels and private investors	Partly covered by user charges and partly earmarked vehicle-related taxes.
Costs related to vehicle operation	Density of P.T. provision Composition of vehicle fleet and traffic management sophistication, maintenance policy.	User in individual public transport frequently with strong contribution from taxpayer in public transport.	Totally internal in individual transport, partly covered by fares in public transport. (in some countries commuting costs can be deducted in income taxation in which case it can not be considered as fully paid for)
Costs of traffic congestion	Infrastructure capacity, traffic demand structure, traffic management.	Transport users occupying the same infrastructure.	Internal to the transport sector. Covered by user charges or via other users' time losses.
Costs of traffic accidents	Driver's behaviour, safety measures, traffic control.	Municipality, health system, economy and victims.	Partly covered by liability insurance payments.
Costs due to emissions into the air	Vehicle technology, energy mix, share of heavy traffic.	Health system, land owners and affected inhabitants.	Possibly covered by emission-related fuel or vehicle taxes
Costs due to traffic noise	Traffic volume and mix, settlement structure and land use.	Land owners and directly affected inhabitants.	Usually totally external.
Other transport-related effects	Traffic network, environmental structure, energy mix, etc.	General society, depending on effect	Usually totally external.

[1] Complete methodological development can be found in D3 report, available on request.

Given that the availability of data may vary from city to city, two levels of accuracy in cost evaluation (light / full approach) are offered. In order for the reader to choose which approach suits him best, data required for each cost component and level of accuracy is listed. At the same time, the advantages and disadvantages of the two approaches are described in a systematic way making use of illustrations. Also, for the purpose of clarity, the description of the evaluation procedure (light and / or full) are accompanied by a number of partial examples where typical problems are highlighted and the usual accuracy of estimates is discussed.

The second part of FISCUS research was dedicated to set out options for pricing and financing of urban transport. Pricing and financing are closely linked, as pricing represents one of the most important methods of raising finance. But pricing has another equally important role. It is a key mechanism for influencing the volume of traffic using each element of transport, in order to achieve other important aims such as economic efficiency and environmental sustainability. There is good evidence that existing pricing mechanisms and levels are contributing towards the problems of congestion and environmental pollution in urban areas by failing to provide appropriate signals to influence behaviour. FISCUS contributes to the solution of these problems by presenting alternative approaches to transport pricing and identifying their pros and cons.

Following this, we look at financing issues. It is perceived that in many urban areas, existing financing mechanisms, which typically rely solely on a combination of user charges and public budgets, are not providing sufficient funding for a sustainable transport policy. Thus there is a need for new funding mechanisms and packages based on those mechanisms. We examine in turn further user contributions, public budgets, value capture, cross-funding and private finance. The task of financing an urban transport system may be divided into two main alternatives – namely, financing the ongoing costs of the system, including servicing any debt, and the provision of capital for investment. Whilst some financing mechanisms, such as general taxation, may to some extent be used for both purposes, others – such as private finance – may only be used for one, with specific objective associated to each contract. In practice, it is almost inevitable that a variety of financing mechanisms will be used in any one city. Thus, as well as examining individual pricing mechanisms, we also put forward alternative packages of measures for consideration, and provide advice on the circumstances in which each package may be appropriate.

Although it may seem that the costing side is purely technical and the policy dimension is on the financing side alone, it became clear during the research that there is also a strong element of political decisions affecting the cost side. Many of the factors influencing the total social costs are strongly linked with long term policy decisions, in particular those in the area of allocation of urban space for various types of use, and in particular for the different transport modes. There, various pricing and financing options are highlighted in the framework of some recent policy documents from the European Commission, as well as of more general goals of urban governance.

Finally, the last part of the report besides presenting concluding remarks also address issues closely related with the effects of costing and financing in the overall urban transport policy that go beyond the contents of the previous chapters but reflect the conclusions accruing from the debates undertaken by the researchers responsible for the development of FISCUS. The key conclusion is that since all mobility costs are always paid by someone a systematic approach to these issues is strongly recommended, not only to ensure higher transparency in the estimation of magnitude and allocation of responsibility for the various cost items, allowing more justice in the allocation of these costs across society, but also the regular and sustainable performance of our mobility system with good overall quality levels.

The research presented here should contribute towards making such a systematic approach more widely accepted and practised.

1 INTRODUCTION

1.1 Description of contents

This handbook aims to provide practical guidelines on the evaluation of the real costs of urban mobility and on the most appropriate ways to finance it, tackling a set of issues with increasing importance in the political agenda of urban transport.

The handbook is mostly directed to decision-makers on urban transport policy, urban planners, managers of operating companies and last but not least to the citizens, who often see their money being used to finance urban public transport, and are thus entitled to know how the system works from the economic and financial viewpoint.

Nowadays one of the most striking problems concerning urban transport is that Government' subsidies is a financing source more and more under criticisms for several reasons, such as: potential to bias competition between different means of transport; demand from other sectors competing for the same public money, indirect promotion of low productive performance of the operating companies, institutional changes of public transport companies, etc. To the awareness of all this negative effects the European policies and principles on State Aid add new restrictions on the circumstances under which State Aid is allowed as well as on the limits of public budget deficits.

It is also commonly accepted that for urban public transport systems to reach efficiency both at consumption and production level, that is, matching the needs of the urban community with the lowest possible use of resources, transport prices should reflect the full costs of the journeys undertaken and should consider the principle of marginal social cost pricing[2]. Such goals are highly emphasised by the European Commission, namely in the Green Paper on Fair and Efficient Pricing and on the White Paper on Fair Payment for Infrastructure Use. Moreover, it is also largely consensual that an urban mobility policy should aim to achieve a balance between the different available modes and means and guarantee stable financial resources, in such a way that it provides an adequate answer to the differentiated segments of citizens with specific needs.

Although the principles outlined above may be well accepted and understood by those who have power over the implementation of mobility policies at European, national, regional and local level, an European-wide dissemination of a systematic and scientifically-based concerted *corpus* of the knowledge existing in these areas, which is spread across a number of different research projects carried in several countries as well as at supranational levels[3] is still to

[2] See glossary for definition.
[3] Such is the case of the RTD framework programs sponsored by the European Commission, among other carried by international organisations.

be carried out, although considerable work has already been done in the concerted action CAPRI (4th RTD framework). FISCUS research also gives a clear contribution to fill this gap by clarifying underlying concepts to those principles, as well as presenting simplified procedures, which allow for an estimation of real costs of urban mobility minimising the costs of data collection and information, providing guidelines on how to calculate real costs of urban mobility and presenting alternative ways to finance it.

Last, but not least, one of the missions of this handbook is to facilitate the understanding of cost and financing related issues, and also to indicate possible ways for assembly of solutions that will fit each local reality. The handbook does not provide a universal recipe to solve the financial problems of urban mobility. However, it does provide effective tools to understand and manage these problems.

FISCUS has opted for a review and estimation of all costs of urban mobility in the sense of *total resource costs,* that is, anything that consumes any resources of real or potential value, but disregarding issues that merely constitute transfers of money or of any type of rights. By adopting this position, the issue of internal versus external costs loses relevance for the total bill, although it is of course not forgotten, in particular when, on the other side of the coin (i.e. financing) the issue of "who pays or suffers what" is addressed.

Current use of the word "Financing" entails a double meaning: getting resources to pay for the creation and functioning of the systems; and anticipating the availability of those resources, namely by recourse to "other people's money". FISCUS concentrates on the former (who pays for what?), although we also dedicate some attention to the latter (who puts up the money?) such is the current and likely future relevance of this type of instruments to get new projects under way. To some extent we may identify the first meaning of the term "financing" with "structural support" and the second with "leveraging instruments".

In this context, this handbook aims, with the help of examples that illustrate typical situations in the urban areas[4], to help decision-makers in formulating and answering questions such as:

- What are the transport' costs in my city?
- Who should bear what part of the costs mobility in my city?
- How can an efficient pricing policy contribute to a sustainable urban mobility policy?
- Up to which extent can policy initiatives enhance managing the financing of mobility?
- Up to which extent can costs be managed through a coherent system design?

In answering these questions and raising a number of related issues, this handbook will also give a contributing step towards a future harmonisation of procedures regarding cost evaluation, pricing and financing at the European level,

[4] A booklet resuming the main findings of FISCUS research will be produced for wider dissemination.

so as to ensure comparability between transport systems, efficiency and fair competition between operators and modes.

Since the objective of the handbook is to provide insights with practical applicability, mainly directed towards political decision makers and managers of urban mobility systems at both strategic and operational, it can be used in the long-term transport/mobility planning and also as a useful reference in daily traffic planning and evaluation. The handbook is mainly addressed to an audience of politicians and non transport specialists with an interest in the area, reason why an easy reading format was adopted and, as much as possible, a non-technical language. Notwithstanding, a glossary is provided to facilitate the understanding of some concepts, words and specific expressions to this context or that have particular meanings within it .

1.2 FISCUS research project

FISCUS is a research project dedicated to the analysis of **"**cost evaluation and **FI**nancing **SC**hemes for **U**rban transport **S**ystems**"** launched within the 4th RTD framework programme of the European Commission and undertaken by a consortium under the overall co-ordination of TIS.PT Consultores em Transportes, Inovação e Sistemas s.a. (Portugal). The present handbook constitutes Deliverable 5 (D5) of the FISCUS research project.

The edition of the report was undertaken by TIS.PT – Portugal (Prof. José Viegas and Mrs. Rosário Macário). The report contains contributions from the following members of the consortium:

- Prof. José Viegas, Mrs Rosário Macário and Mr Paulo Bento, TIS – Transportes, Inovação e Sistemas (P);
- Mr Markus Maibach, INFRAS – Consulting Group for Policy Analysis and Implementation (CH);
- Prof. Werner Rothengatter, Mr Claus Doll, IWW – Institut für Wirtschaftspolitik und Wirtschaftsforschung (D);
- Prof. Chris Nash, Mr Brian Mathew, ITS – Institute of Transport Studies – University of Leeds (UK);
- Mr Tomas Otterström, Mr Harri Laurikka, Ekono Energy Ltd (FIN);
- Mr Christian Heschtera , IFIP - Institut für Finanzwissenschaft und Infrastrukturpolitik der Technischen Universität Wien (A);
- Mr. Kjell Jansson, DESU -SU – Stockholm University (S)
- Mr Janos Monigl – TRANSMAN – Közlekedési Rendszergazdálkodási Tanácsadó Kft. (HU).
- Ms Cristina Pascussi - FEDERTRASPORTI – Federazione nazionale trasporti pubblici locali (I)

The overall contractual objectives of the research were to analyse existing cost allocation methodologies and financial schemes as well as planned and/or new ones, that would be conceived in the project as a response to observed gaps and weaknesses, addressing two main issues:

- The evaluation of real transport costs (internal and external) with the objective of enabling cost comparisons between public transport and private car over the same journey;
- The financing of urban mobility here understood as corresponding to who pays, directly or indirectly the provision of infrastructure and services in this area, but also to who bears its (positive or negative) consequences without being directly involved.

The research produced the following reports, commonly designated as "deliverables"[5]:

- D1: Methodological framework to assess financial schemes
- D2: Methodological framework to evaluate real transport costs
- D3: Guide for the evaluation of real transport costs
- D4: Design of new financing schemes for urban transport systems
- D5: European handbook for the evaluation of real costs and design of financing schemes for urban public transport systems
- D7: Cost evaluation and financing schemes for urban transport in Hungary with reference to other Central and Eastern European Countries. (corresponding to a contract extension to the CEEC)

1.3 How to use this handbook

The structure of this handbook follows the steps that a logic approach to the problems of the evaluation of real costs of transport systems and its financing would take. Firstly, a framework to characterise the different urban environments, where transport systems operate, is presented (chapter 2), followed by chapter 3 on the evaluation of the real costs associated to an urban mobility system. Finally, the issues of pricing and financing are treated in chapter 4, which is succeeded by a brief synthesis of the methods presented along the handbook and, in addition, a final chapter dedicated to concluding remarks and afterthoughts on the impact of political decisions on cost levels and financing options.

As it can be seen, each chapter builds on the previous ones, the reason why a first complete reading is advisable. Notwithstanding, a reader with a special interest in some specific subjects or previous knowledge on these subjects might focus on particular chapters or sections, skipping the ones considered by him as less relevant.

Different aspects of cities / urban mobility systems have different relevance for cost evaluation and financing purposes. As an example, the structure of the public transport system defines the cost categories to be considered

[5] Deliverable D7 corresponds to a contract extension of FISCUS project to the CEEC countries, reason why its numbering does not follow a logic sequence.

when assessing real transport costs. However, in terms of financing, it may raise the need for funds for a new form of public transport (e.g. underground, new forms of collaboration between private entities and public authorities). The reader who decides for a full reading of the document will find these and other questions being raised in the second chapter of the handbook, addressing the different dimensions of transport and mobility in the context of urban areas, and alerting for the need to understand the dynamic of the system under analysis before starting the calculation of real costs and the definition of financing alternatives, or even to benchmark his own system against others.

It is worth noting that the urban mobility system represents only one of the components of a wider system - the urban area/conurbation. Not only the urban mobility system shows several overlaps and interactions with other domains of the urban area (e.g. economic, social, political, technological, ecological dimensions, etc.) but also it is by itself a very complex system by the number of agents and modes that can be involved.

As such, an urban mobility system is characterised by the inter-action of the different variables that it encompasses, each one presenting different behaviours depending on whether it is taken separately or as a part of the whole system. This complexity becomes more obvious when we observe the dimensions considered in the FISCUS research, regarding the cost evaluation and the financing of urban mobility systems, such as:

- Cost items;
- Means and modes of transport;
- Actors (e.g. users, transport operators, infrastructure suppliers, different state levels, society as a whole).

In turn, cost items can be classified according to the following categories:

- Infrastructure supply;
- Vehicle-associated costs;
- Congestion;
- Accidents;
- Emissions into the air.
- Noise;
- Other effects.

Other relevant criteria for classification of cost items can be its purpose (i.e. resource costs versus transfer payments[6]), financial type, variability in relation to output and upon whom they finally inside.

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[6] For a definition please check the glossary.

In FISCUS research means of transport are regarded as cost generators, in as much as each mode of transport and type of vehicle can be characterised by specific patterns of infrastructure use and by the actor groups using it.

Finally, it is likely that irrespective of the urban agglomeration characteristics, namely its size, a multiplicity of interests will also exist. This is due to the fact that different actors with different view points and interests interact in the urban environment. To handle these issues FISCUS identified the following relevant categories of actors:

Relevant categories of actors	
♦ users: ▪ of public transport; ▪ of private transport	♦ transport operators; ▪ road modes; ▪ rail modes; ▪ waterborne modes;
♦ different state levels; ▪ Local; ▪ Regional; ▪ National.	♦ Infrastructure suppliers; ▪ state ownership; ▪ private ownership;
society in general.	

It can be easily seen that some of these groups have potential conflicting interests, which may delay or even halt the decision making process regarding the transport system, as well as the implementation process for those decisions.

On the whole, urban mobility systems are more than the sum of its parts, making it necessary for the decision maker to consider that an urban mobility system might pursuit aims and values which cannot be described purely in terms of its constituents. To face such complexity a broad city typology is established in chapter 2, which will allow the reader to better identify his/her type of city. This exercise is fundamental for cost evaluation, price definition and financial coverage improvement, reason why this chapter should be consulted even by the specialised reader whose attention might be focused on particular issues of the subsequent chapters.

Among these, **chapter 3** (Evaluation of Costs of Urban Mobility) and chapter 4 (Financing and Pricing of Urban Mobility) address the issues of cost allocation, pricing and financing. Although these problems are very much interrelated, each one presents its specific goals and constraints and should receive special treatment besides the overall systematic approach also needed.

A first step in the process of establishing an efficient pricing system is the evaluation and allocation of costs, in order to comply with the principle that each actor in the urban mobility system should bear the costs it is responsible for. Like other cost accounts, the real cost scheme is providing economic information from today's or future states of urban transport in monetary terms. Although some internal costs may not be visible without a careful analysis, ultimately they are all expressed in monetary units, because there is a market for the transaction of the resources associated to them (e.g. an old vehicle will have a selling value, which reflects the real depreciation costs it has suffered during the operation).

On the other hand, by definition, there is not a market associated with external costs, which increases substantially the complexity of the process of translating these types of costs into monetary values. The specific issue here is the uncertainty about the validity of the estimates of the monetary values, since different methods, all of them showing a scientific basis, often produce different results.

A common problem to both internal and external costs is the form under which these should be presented, in order to be useful for price setting purposes. Although it is simple to work out average costs when in possession of values for total costs (e.g. number of total kilometres operated by a bus fleet) and the total units (e.g. number of vehicles operated by that fleet), the degree of complexity raises considerably if marginal cost estimations are to be obtained.

In view of these difficulties, chapter 3 will provide an illustration, which aims to provide the reader with a simple, step-by-step example of how to estimate the costs of a specific urban mobility system. The outputs of the example will be:

- the total costs;
- the cost generators;
- the actual payers; and;
- the cost-flow matrix[7];
- the variable costs (EURO/vkm) per vehicle type.

Given that the availability of data will vary from city to city, two levels of accuracy in cost evaluation (light / full approach) are offered. In order for the reader to choose which approach suits him best, data required for each cost component and level of accuracy are listed. At the same time, the advantages and disadvantages of the two approaches are described in a systematic way making use of illustrations. Also, for the purpose of clarity, the description of the evaluation procedure (light and / or full) are accompanied by a number of partial examples where typical problems are highlighted and the usual accuracy of estimates is discussed.

Chapter 4 deals with pricing and financing of the urban mobility, which also face specific constraints. In terms of pricing, one of the main problems concerns public acceptance of possible price increases or enhanced differentiation in the price structure (e.g. prices with hourly variation, instead of the “usual” peak / off-peak difference).

[7] Explanation available in the glossary.

Another constraint is the technological systems required to implement some of the pricing policies and associated packages of schemes. The available options (e.g. electronic road pricing, 'smart card' public transport ticketing and simpler solutions such as cordon tolls, area licensing and differentiated parking charges) are evaluated in terms of efficiency, acceptability and practical feasibility.

The most obvious constraint of financing is the necessity to fund simultaneously transport operations and investments. As stated above, the usual financing sources, besides direct revenues from users – public budgets – are facing strong criticism due to its potential for market distortion, which makes it worth analysing other possible sources. To bring some light to this problem a simple explanation of the following funding mechanisms will be provided, as well as a short presentation of its advantages and disadvantages also from the point of view of efficiency, acceptability and practical feasibility:

- Public budgets
- Value capture[8]
- Cross funding
- Private finance

Given the complexity involved and the frequent insufficiency of funds from any of these sources alone, a set of financing *packages* (constituted by a combination of several of the financing sources referred and pricing policies) will be suggested and analysed.

Despite the specific problems presented by cost allocation, pricing and financing, the integrated nature of these issues should not be forgotten. Transport pricing and transport financing cannot be completely treated in a separate way due to their close relationship, as user revenue (through pricing) is (and should normally be) one of major financing sources for the sector. But, since the amount of ticket revenue depends directly on the fare structure and levels not only of urban public transport but of the whole transport system, given the competing roles of public and private means of mobility, prices have to be consider in wider dimension than those related only to its contribution for financing.

Chapter 5 integrates the issues treated in the previous chapters and takes the point of view of the decision-makers of an urban mobility system. It encompasses the management of mobility costs through the design of the system and the policy initiatives oriented towards financing. It also addresses the most important issues of achieving consistency between strategic goals and its operational applications.

[8] For a definition of the concepts of value capture and cross funding, please check the glossary.

2 URBAN TRANSPORT DIMENSIONS

2.1 Urban transport on a European scale

A Real Cost Scheme and associated financing schemes, which were the main objective of this research, are expected to represent the state and the future of urban transport policy in monetary terms, focusing on the economic scope. In this perspective, policy evaluation systems and recommendations for urban transport must consider the different dimensions of urban transport and its function in general urban policy. It is the aim of this handbook to present specific tools in order to have an unbiased picture of the problems and the structure of urban transport policy. Being a European handbook, there is in addition the demand to consider the similarities and differences of urban areas in Europe. As certainly self-evident from the great diversity of existing situations, it is not possible to provide recommendations on a very specific level. This chapter therefore wants to provide an overview of the different dimensions in order to guide the reader more consciously through the analysis and recommendations presented in the following chapters. The figure below gives an overview of the most important dimensions to consider:

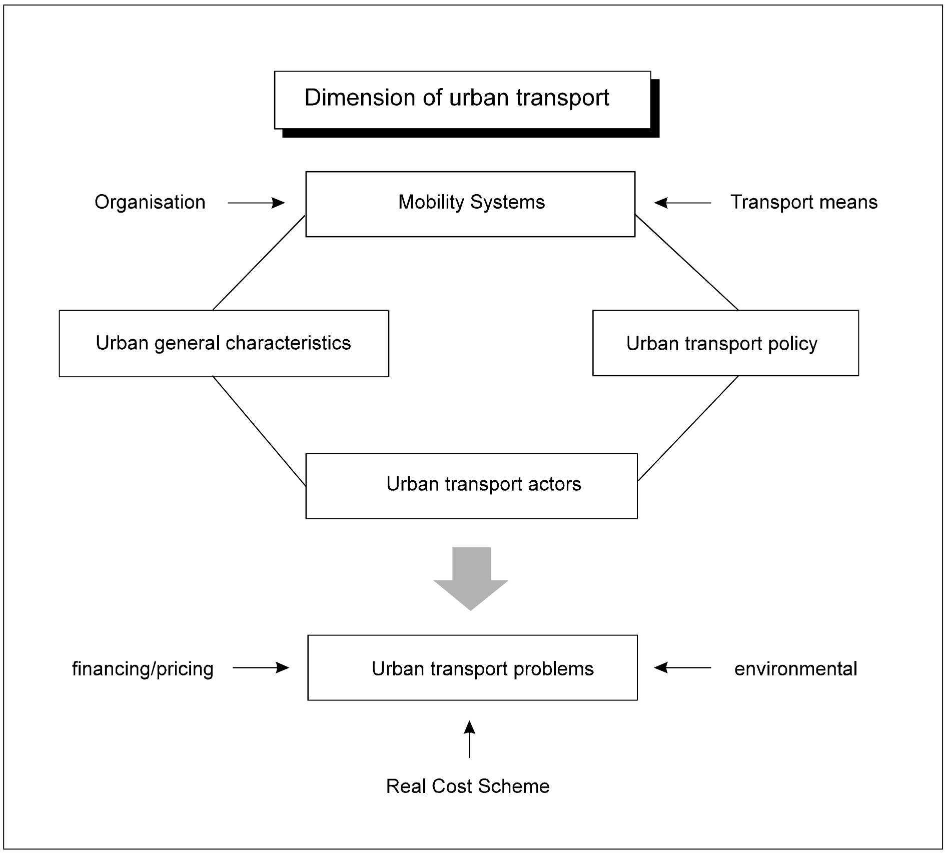

Figure 1: Aspects influencing the specific urban transport problems and their possible solutions

2.2 Urban mobility system dimensions

What is urban mobility? How can it be characterised? In order to design an overall structure for a Real Cost Scheme, we concentrate ourselves on its most important components and on its organisation. A common starting point is the characterisation of different transport aims and means as pointed out in the following table.

PASSENGER TRANSPORT				
	Infrastructure		**Traffic operation**	
Type of transport	**Type of infrastructure**	**Level of privatisation**	**Means of transport**	**Level of privatisation**
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Urban public transport	- Road/Bus Lanes - Rail	- Public - Semi-private	- Buses - Light Rail - Underground	- Public - Privatised
Regional rail and bus transport	- Road/Bus Lanes - Rail	- Public - Semi private	- Busses - Underground - Railway	- Public (upper state level) - Privatised

Table 1: The most important dimensions of urban passenger transport systems

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Interurban road transport	- Interurban motorways	- Public - Public Private Partnership - Private	- HGV - Light duty trucks	- Private
Combined transport	- City logistics facilities	- Private - -Semi private	- Rail-Road	- Private
Railway transport	- Main tracks - Feeder tracks	- -Private - Semi-private	- Regional freight railways	- Private - Semi- private

Table 2: The most important dimensions of urban freight transport systems

With regard to financing issues, the institutional organisation of the infrastructure (road, rail and waterways) and the organisation of public transport are most important topics. Depending on the level of privatisation and the institutional and decision power of urban and upper state level, the designs of financing schemes face different options, as we will see in chapter 4.

2.3 Characterisation of urban areas

As already said the application of a Real Cost Scheme and recommendations for improved financing schemes depends very much on the situation of a specific urban area. Considering the procedure of cost estimation and the cost influence factors, one can derive the most important features of the Real Cost Scheme. These features are also relevant for the financing schemes. Most important are the general city dimensions, the geographical features, the institutional set-up, the traffic performance and the existing related policies. In order to apply the recommendations within this handbook properly, it is necessary to have an idea of the relevance of different city characteristics. The following table provides an overview and addresses the relevance for transport costs (as part of the Real Cost Scheme) and for the application of financing schemes.

Aspect	**Relevance for Costs**	**Relevance for Financing Schemes**
CITY DIMENSION		
Size of city/agglomeration	High relevance for the complexity to estimate cost and the cost levels.	High relevance for the level of financing needs and the complexity of financing systems.
Population density	Relevance for the cost levels: Economies of scale (for infrastructure and operation), higher concentration level per capita leads to higher environmental cost (e.g. noise, air pollution).	Complexity of financing schemes (i.e. spatial differentiation).
INSTITUTIONAL SET-UP		
Vertical organisation: Relation to upper state level (national/international)	Fragmentation of decisions on related systems may lead to cost increases.	Independence to elaborate own financial solutions; Legal compliance for new pricing and taxation measures
Relation to the agglomeration (surrounding area)	Import/export balance of external costs; Burden sharing of Public Transport deficit.	Institutional power of the city compared to surrounding municipalities
Institutional set-up of transport system, responsibili-ties (e.g. private, city owned, upper state owned etc.)	Actor relation of public transport déficit (infrastructure, operation).	Responsibility and potential of the city to develop new solutions / Level of control by public authorities.
TRAFFIC PERFORMANCE		
Structure of public transport	Costs for different P.T. means of transport (total and average).	Need for financial investment in new systems (e.g. underground).
Level of public transport system	Modal split, level of P.T. costs / deficits.	Need for financial means.
Capacity of public transport	Level of P.T. costs / potential to decrease deficits.	Need for new investments.
Capacities for private transport	Level of congestion and related externalities.	Need for new investments.
Existing financial performance of the transport systems	Deficit level, Under-coverage of infrastructure and operation costs.	Problem pressure to improve current situation.
Level of non motorised traffic	Level of external costs.	Need for investments in traffic calming and other related measures.

Table 3: Different urban characteristics and their relevance for the applications of the Real Cost Scheme and improved financial solutions

Aspect	Relevance for Costs	Relevance for Financing Schemes
RELATED EXISTING POLICIES		
Existing monitoring and controlling means	Data availability; Accurateness of cost estimation.	Awareness of financial problems in urban transport.
Fare level and structure in public transport	Level of user contributions Level of public transport deficit.	Need for additional financing means.
Existing means of deficit financing of public transport	Clearer responsibility on the financial side induces greater control of costs.	Potential to introduce new schemes.
Existing means of private transport pricing	Level of user contributions.	Potential to introduce new schemes.
Experience with road user charges	Level of user contributions.	Potential to introduce new schemes.
Experience with integrated financing systems (cross funding packages)	Level of cross-subsidisation.	Potential to introduce new schemes.
Existing experience with public private partnership	Actor related deficits.	Potential to introduce new schemes.

Table 3: Different urban characteristics and their relevance for the applications of the Real Cost Scheme and improved financial solutions (continued)

The table demonstrates that the following relations are of the utmost importance, in particular if comparisons between cities are made:

- The bigger the city, the more traffic, the more severe are potential problems, the more complex the traffic structure and its financing dimensions, on the other hand, we should expect more developed data monitoring systems as well as more relevant and comprehensive policies for transport pricing and financing.
- The more complex the institutional set-up and the weaker the principle of subsidiarity is applied, the weaker the institutional and decision power of city authorities.
- The stronger private structures in public transport (operation and infrastructure) and private transport (infrastructure) are applied, the more possibilities for differentiated financial and institutional solutions are existing.

Due to the complex dimensions and the number of influencing factors, this handbook does not address specific comprehensive urban clusters, what is in line with our aim of producing a general consistent approach of practical added value for all cities, although without pointing out any “best” or even “ideal” type of urban organisation. The recommendations given in this handbook distinguish between several urban issues in a problem-oriented way. The most important are:

- The recommendations in the Real Cost Scheme in chapter 3 are differentiated according to the availability of data and the foreseen accurateness of the results. Two different (light-full) estimation levels are addressed.
- The recommendations for improved financing schemes consider mainly the size of the city and their financial position based on the institutional set-up (level of privatisation, importance of upper state level). Thus a differentiated view by city authorities is necessary.

2.4 Urban transport problems

A handbook is aimed at helping to solve existing or upcoming problems properly. Whereas the Real Cost Scheme is the tool to identify problems by evaluating costs of transport systems and to provide basic information for improved pricing systems, the recommendations for financing schemes are in turn oriented to problem solving. The following table identifies the most important possible problem areas.

Problem	Possible solutions	Use of the real cost scheme: Which information is most important?	Relevance of improved financing schemes: Financing what?
TRAFFIC PROBLEMS			
Congestion, limited capacity	Introduction of congestion pricing. Investments in capacity increase.	Level of congestion costs: Total costs to show the relevance; marginal costs as a leverage point for congestion pricing. Reactions of costs for different solutions.	Financing schemes for new infrastructure. Reduce demand through pricing.
Low modal split for P.T.	Introduction of measures which influence modal split.	Level of costs and cost coverage of transport means in general.	Increased user contributions/ pricing measures, especially for the road sector.
ENVIRONMENTAL AND SAFETY PROBLEMS			
Environmental problem, avoid and reduce aggression	Pricing measures. Investments in avoidance measures.	Level of environmental costs: Total costs to show the relevance, marginal costs for pricing information.	Financing possible avoidance measures Use of revenues. Reduce aggression levels in peak periods through pricing.
Safety problems	Investments in avoidance measures. Change of liability for insurance's.	Level of accident costs: Total costs and level of change due to different measures.	Financing possible security measures. Stimulate safer solutions through pricing.
FINANCIAL PROBLEMS			
Limited financial means for transport investments	Improved financing schemes.	Cost coverage of infrastructure costs of different transport means.	Financing schemes for new infrastructure.
Limited financial means for environmental measures	Traffic calming measures, Specific noise abatement programmes.	Level and cost coverage of environmental costs.	Evaluation and financing schemes (esp. user contributions).
Public transport deficits	Deficit spending, increase of cost coverage.	Cost coverage of Public Transport means (actual and future state).	Improved financing schemes (i.e. cross subsidisation). Market segmentation through service and pricing.
Unequal burden share between city and agglomeration	Compensation measures.	Level of external cost of transport between city and agglomeration; Cost coverage by originators.	Improved burden-sharing schemes (Involvement of private actors).

Table 4: Problems to be addressed and related information within the handbook

2.5 Actors and their interests

Urban mobility involves many different actors, each of them playing roles of user, beneficiary, victim and part of the political system in successive moments. In order to have a common understanding of current problems and to develop acceptable solutions, a fair treatment of the different actors and roles is desirable and an involvement in the political process becomes inevitable. Three dimensions are important to identify possible conflicts:

- Which actors cause which problems in the transport sector? This is addressed to transport users: Do they pay their external costs in a fair and efficient way?
- Which actors do suffer from existing problems? This is addressed to urban citizens, which have to bear transport deficits and/or face high noise and air pollution concentration levels. Can their situation be improved in a fair and efficient way?
- Which actors do benefit or suffer from policy measures? Are the costs and benefits of political decisions distributed in a fair and efficient way? In regard with new financial schemes: Are possible beneficiaries properly involved?

In the following table the main actors and stakeholders of the urban transport policy are identified according to their relationship with the transport system.

AGENTS AND STAKEHOLDERS

Relationship with transport system	Cluster designation	Groups included
Agents with a direct relationship to the transport system, and as such economically affected	Direct beneficiaries, users	- PT users - Private transport (users) of: - Passenger - with low income - with high income - freight transport users
	Suppliers of	Services: - PT operators - Other services Capital: - Infrastructure - Equipment
	Direct victims of transport impacts	- Accidents victims - Environmental health damage - Negative impact from congestion
	Regulators	Direct: - Transport authorities - Policy-makers Indirect: - Land-use authorities - Environmental authorities
Agents without a direct relationship with the transport system	With an indirect economic stake	- Real estate business - Commercial activities - Tax payers
	Without an economic stake	- Ecologists

Table 5: Overview of the most important urban transport actors

The actors dimension addresses distributional problems being usually the most sensitive part in urban transport pricing policy, since everybody is affected in some way (and more often in several ways). Acceptability of new measures, in particular financing schemes, can only be increased, if the most important interest conflicts can be anticipated and adequately mitigated or compensated. The Real Cost Scheme presented in the next chapter allows an actor-related presentation of transport performance, in particular cost coverage, and is thus able to identify current efficiency and fairness problems. The following conflicts of interest are usually of major importance:

- Public and private transport users: Whereas private transport users do not cover congestion and environmental costs, public transport users pay fares below average costs and cause financial deficits. This result of the ongoing second best policy leads to a situation in which most users of the urban transport system in all modes are paying prices below the corresponding costs and are thus unwilling to accept changes that force higher prices upon them without at least a partial improvement of the service they receive;

- Citizens and Transport users: Citizens claim improved environmental quality and improved access at the same time. Being as well transport users, an increase in transport prices for example might not be sufficient, since the environmental effectiveness might be limited;

- Rich and poor citizens and transport users: Improved financing schemes applying the polluter's pay principle properly might cause social conflicts, since regressive income distribution effects might occur;

- Citizens, transport users and inner-urban commercial activities: Specific transport measures (i.e. parking price policy) might lead to modal shifts with lower city attractiveness for business, but improved environmental conditions for citizens.

- Urban actors and actors on upper state level: All urban transport activities and policy measures have as well an effect in the surrounding areas of a city. One example is the transport and financial burden shifts from/towards a city or surrounding residential area.

- Business and citizens in general: Institutional changes (i.e. towards privatisation) might entail a potential trade off between potential increased efficiency and reduced fairness, if individual mobility costs increase and a privatisation of benefits would occur.

The complexity of the urban system implies, not only the presence of these multiple actors and interests, but also a very rich and poorly understood set of links between the conditions of operation of those actors. This has led to the development of sophisticated behavioural patterns, in response to the complex environment on which all these actors are performing, and we should realise that any actor will oppose any measure that is perceived as inducing radical changes in his own operating environment, because the fear of bad adaptation to such changes (and big loss resulting from it) is overwhelming.

Also considered globally, the dependence of our societies' welfare on the proper performance of cities is such that adoption of radical and sudden changes of the rules might well create bigger losses than gains. So, whatever solution is considered more appropriate by the decision makers of each country and city, the implementation of that solution has to be based on a clear announcement of the underlying principles accompanied by gradual adoption of corresponding partial measures, on a trajectory that should have a stable purpose but variable speed, according to the shock waves caused by previous measures and their digestion by the urban system.

3 EVALUATING THE REAL COSTS OF URBAN TRANSPORT

It is well known that transport - like other economic activities - is imposing a variety of effects on different parts of society. While some of these effects are carried by the transport users themselves, others are borne by parts of society, which might be not directly involved in transport. If we express all these effects by monetary units we talk of the “real costs” of transport. The knowledge of transport-related costs in a specific urban environment provides the basis to judge or - if necessary - to refine current pricing or financing mechanisms of individual and public transport and to analyse the development of the financial and social situation between modes and over time.

Before starting the discussion on the composition of transport-related effects and the possibilities of their quantification, in the first section of this chapter an overview of the idea of social cost accounting is presented. The contents of this chapter should give valuable information for less experienced as well as for expert readers as it summarises the current scientific discussion in a commonly understandable manner. As the practical aspects of cost evaluation are rather complex and hence an in-depth discussion of technical details would go far beyond the scope of this handbook , for further information the interested reader is thus referred to the glossary and the worked example of a fictitious city presented in the annex to this handbook and in a detailed manner for the city of Budapest, as well as to Deliverable 3 of the FISCUS project.

3.1 Concepts underlying real costs evaluation

In order to come closer to a broad understanding of the complexity of urban cost evaluation, this section introduces a number of expressions and definitions around social cost accounting, which are used in subsequent parts of this chapter.

Real costs, resource costs and transfer payments

From the viewpoint of a single economic subject, his total periodical costs are the sum of all expenses and opportunity costs allocated to the considered period of time. However, regarding a system of agents, such as an urban transport environment, one needs to separate cost elements, which are going along with the use of resources (such as infrastructure, vehicle assets, manpower, capital or environmental quality) and the pure transfer of money between these agents (e.g. taxes, charges, fees, fares, subsidies, etc.). In the notation of this handbook, the first category of costs is entitled as *resource costs*, while the latter one is called *transfer payments*. In some cases transfer payments are earmarked (dedicated) to particular resource costs (e.g. material damages caused by traffic accidents and liability insurance premiums or mineral oil taxes and infrastructure expenditures in some countries), but this does not imply that the respective cost figures are equal. In case transfers are remunerated by (private) users, we talk of *user contributions* or *private transfers*, otherwise, when the source of transfer payments is the public hand, we talk of *social transfers*. The sum of resource costs and transfer payments carried by all actors are called the *real costs of transport*.

Private, social, internal and external costs

In a system of social cost accounting the relationship between those who are causing costs (cost generators) and those who are bearing them (cost carriers) are of essential importance. In case resource costs are caused and carried by the same individual, we talk of *private (resource) costs*, while otherwise we talk of *social (resource) costs*. Examples for the first category are vehicle-operating costs in individual transport, including the users' time consumption or directly covered damages to property due to traffic accidents. In contrast, social resource costs subsume all those costs, which are not directly borne by the users, e.g. the costs due to infrastructure supply, transport service, environmental damages and effects on other people's property, health or life due to accidents, exhaust emissions or noise. The carriers of social resource costs might be within the transport sector (Infrastructure suppliers, operators, users) or outside the transport sector (state, municipalities, health insurance, directly affected inhabitants, etc.). While congestion costs are a typical example for system-internal social resource costs, all remaining social costs of transport have implications outside the transport sector and are hence called system-external.

Parts of social resource costs caused by the cost generators are covered by transfer payments remunerated by them; these resource costs are called *internalised (social) costs*. The sum of internalised social costs and private costs are called *internal costs*, while the remaining social resource costs are called *(uncovered) external costs*. In other words, external costs are those social resource costs, which actors do not take into consideration when they are planning or undertaking activities. Figure 2 illustrates different types of costs.

Fixed, variable and marginal costs

In order to express the behaviour of total resource costs (or transfers payments) when traffic demand is changing, costs are classified in a fixed and a variable part. Typical fixed costs are the majority of the costs of infrastructure provision, the capital costs of vehicle investments and other social costs stemming from the presence of transport infrastructure. Most operation-related and environmental costs are variable to transport demand. However, the attribute "variable" itself does not allow conclusions on the real cost behaviour with respect to changing traffic volumes. Costs might grow increasingly (e.g. congestion costs) or grow regressively (e.g. noise costs) with traffic demand. Furthermore, a considerable time lag between the generation and the visibility of costs might occur (e.g.

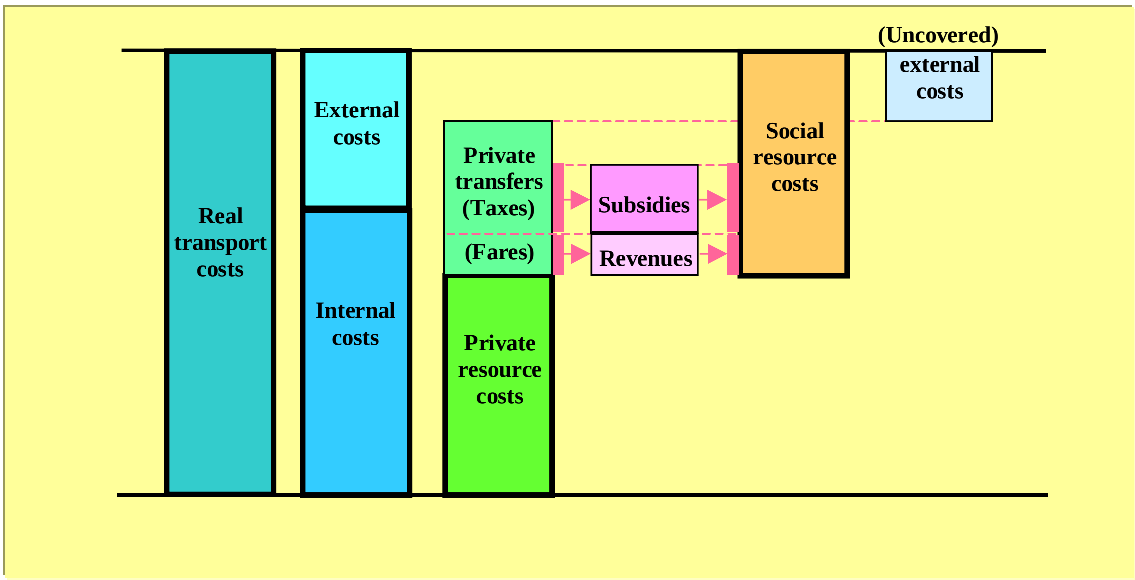

Figure 2: Interrelationship between private, social, internal and external costs and transfers payments

impacts of air pollution on human health). Finally it needs to be noted that in the long run all costs are variable; the above classification requires thus the consideration of the underlying time horizon. The picture below demonstrates the different degrees of variability and provides some examples for typical cost categories.

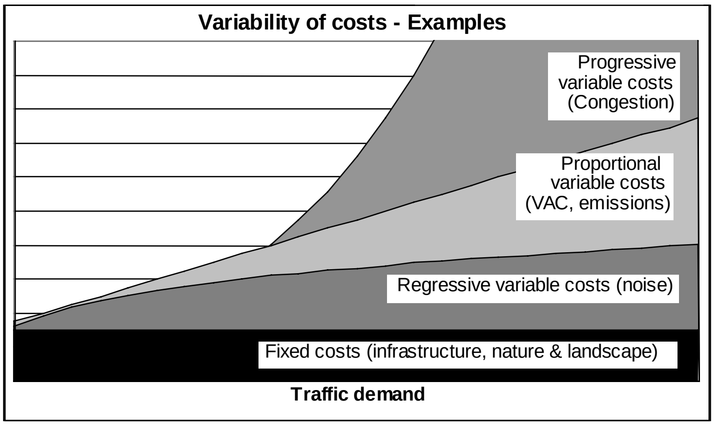

Figure 3: Degrees of variability of costs

Marginal costs describe the development of total costs when an additional traffic unit is demanded. An additional traffic unit denotes one vehicle, passenger or ton kilometre driven by (or in) a particular type of vehicle and consequently marginal costs are presented by transport mode. Depending on the cost category the marginal costs of an additional traffic unit can vary by traffic situation, travel speeds, vehicle technology, time of day, surrounding environmental and socio-demographic conditions or even by the experience and attitude of vehicle drivers. These influencing variables must be taken into account when marginal cost figures are presented. Ideally, marginal costs are calculated bottom-up (e.g. by applying impact-pathway approaches) or by deriving the total cost function with respect to transport volume. As in practice the quantification of both variants is often extremely difficult, average variable costs might be used as an approximation to marginal costs.

Payments, expenses and opportunity costs

Considering the time-relationship of monetary flows, a distinction can be done between *payments* (= financial movements allocated to the period of remuneration) and *expenditures* or *expenses* (= payments allocated to the periods of time, in which the corresponding economic value is actually used). Expenses are determined by depreciating payments over the economic life span of the associated assets and hence they reflect the true economic value of a good over a particular period of time. Typical expenses in transport are the annual costs due to operation, wear and tear, maintenance, repair and administration of infrastructure assets and vehicle fleets.

In addition to expenses, there is a considerable amount of costs, which are not related to financial movements, but to the lost benefit of options which have not been realised. These costs are called *opportunity costs*. In entrepreneurial cost accounts opportunity costs either reflect the surplus expected from investments or the scarcity of resources; such costs are used to consider also non-financial properties of goods and alternatives in the enterprise's decisions. In the same way in social cost accounting opportunity costs reflect the scarcity of public goods, such as good air quality, silence, safety, infrastructure capacity, as well as the possible benefits, which could have been realised when the financial resources currently tied up in infrastructure assets would have been invested differently. The decrease in quality of life due to environmental pollution, noise nuisance and other transport-related effects are commonly evaluated by the willingness of people to pay for better conditions and thus reflect the social attitude towards transport-related impacts rather than real economic losses.

3.2 The relevant cost categories

The social costs arising from urban traffic are manifold, and such are their properties. Besides the private costs of operating individual and public transport, the costs transport users impose on each other (congestion), on different state levels (provision of transport infrastructure), on society (accidents, noise) and on the environment need to be taken into consideration. Each of those cost categories can be characterised by:

1. The most important determinants of the costs;
2. The relevant final payers carrying these costs;
3. The mechanism and degree of cost coverage.

The table below gives a brief overview of the most relevant cost categories and their properties. As total costs are naturally varying with traffic demand, with the exception of the huge fixed cost block due to infrastructure provision, the second column (Main Determinants) mainly addresses to the factors influencing marginal cost levels. The most relevant final payer (column 3) refers to the categorisation of actors in table 5 in the previous section 2. Finally, the degree of externality (column 4) provides input information to chapter 4 (Pricing and Financing) of this handbook as it indicates the needs for refining current charging systems and provides possible mechanisms of cost internalisation.

Cost Category	Main Determinants	Most Relevant Final Payers	Degree of Externality
Costs due to infrastructure supply	Size, technology and age of transport networks, share of heavy traffic, maintenance policy.	Different state levels and private investors	Partly covered by user charges and partly earmarked vehicle-related taxes.
Costs related to vehicle operation	Density of P.T. provision Composition of vehicle fleet and traffic management sophistication, maintenance policy.	User in individual public transport frequently with strong contribution from taxpayer in public transport.	Totally internal in individual transport, partly covered by fares in public transport. (in some countries commuting costs can be deducted in income taxation in which case it can not be considered as fully paid for)
Costs of traffic congestion	Infrastructure capacity, traffic demand structure, traffic management.	Transport users occupying the same infrastructure.	Internal to the transport sector. Covered by user charges or via other users' time losses.
Costs of traffic accidents	Driver's behaviour, safety measures, traffic control.	Municipality, health system, economy and victims.	Partly covered by liability insurance payments.
Costs due to emissions into the air	Vehicle technology, energy mix, share of heavy traffic.	Health system, land owners and affected inhabitants.	Possibly covered by emission-related fuel or vehicle taxes
Costs due to traffic noise	Traffic volume and mix, settlement structure and land use.	Land owners and directly affected inhabitants.	Usually totally external.
Other transport-related effects	Traffic network, environmental structure, energy mix, etc.	General society, depending on effect	Usually totally external.

Table 6: Possible approaches for the estimation of social costs of transport

The following subsections give an introduction to the composition of these cost categories and provide a more in-depth discussion of their properties. A more detailed description on the techniques for its quantification is presented in the following section 3.3.

3.2.1 Infrastructure costs

The costs associated with traffic infrastructure comprise the capital costs of their instalment and running expenses for maintenance, operation and administration. Capital costs consist of construction expenses as well as of the opportunity costs of the capital invested (= interest costs). The underlying techniques of cost accounting stem from entrepreneurial cost calculation schemes. To address its properties concerning life expectancy and the requirement for maintenance, road and rail infrastructure assets are grouped into structures (embankments, bridges, tunnels), surfaces (pavements, rail track surfaces) and associated assets (stations, signalling, electrification, etc.).

The vast majority of infrastructure costs are fixed sunk costs dominated by capital costs. Only the costs due to road and rail track surfacing are varying with traffic loads and hence can be considered as variable. The main factor responsible for the wear and tear of infrastructure surfaces is the axle load of vehicles, therefore variable and marginal costs are usually allocated to freight or peak traffic. The social costs of traffic infrastructure are currently partly internalised (or sometimes even over-compensated) by transfer payments (e.g. motor vehicle taxes or mineral oil taxes).

However, the determination of infrastructure cost coverage ratios is not without controversy as institutional settings are of major importance in this field. In road transport the variability and the dedication of user payments (general budget or earmarked budget for transportation) has to be considered. In rail transport, and in particular in urban public transport , were infrastructure supply and service operations are usually not separated, the allocation of ticket sales to vehicle operating costs and infrastructure costs is often subject to accountancy traditions rather than to social cost accounting principles.

3.2.2 Vehicle-associated costs

Vehicle-associated costs are defined as the total of all financial and opportunity costs arising from the provision, operation and maintenance, of the total urban vehicle fleet, including private cars, freight vehicles, buses, rail and water vehicles. This category accounts for capital costs, running costs (staff, fuel, tyres, maintenance, etc.), as well as for transfer payments supported by the users. The latter also include revenues taken by the state, by local governments (e.g. taxes on fuel or vehicle purchase / possession) and by the infrastructure supplier, as long as the corresponding infrastructure assets have been included in the social resource cost accounts (e.g. road charges or parking fees) or by the liability insurance system.

Vehicle-associated resource costs in individual transport are completely private costs while the cost related to the operation of collective transport are social costs as they are partly financed by the tax payer through public sector contributions.

Vehicle associated costs are dominated by variable costs as public and private vehicle fleets can be enlarged or diminished in relatively short term . The consideration of private user costs, as vehicle operating costs in private transport and time costs of people and goods in individual and in public transport depends on the goal behind the real cost analysis. Consequently, for the determination of total cost accounts private time and operating costs of transport users can be neglected. At the opposite, for cost benefits analysis, which may be done by comparing average cost accounts of different years, private costs are highly relevant, while for pricing purposes only congestion costs are to be considered due to the development of private costs accruing from users interaction.

3.2.3 Congestion

Congestion costs arise from a common use of the same scarce infrastructure, and are defined as the additional time delay and associated operating costs users impose on each other due to mutual disturbance. Congestion should thus be interpreted as an external cost of an economic nature, caused by an overuse or a misallocation of the infrastructure. The effects caused are increased time delay, emissions, accidents and other operating costs.

While the quantification of the marginal costs of congestion is widely consensual in current economic research, for the definition of the total congestion costs there is no such convergence of ideas in the research world and some different methods are known, such as:

- The *welfare economics approach* provides the real economic definition of congestion, which is based on the argument that the users' unawareness of the increased costs they impose on others leads to a sub-optimal allocation of traffic to the existing infrastructure. For the quantification of the respective dead-weight-loss the external congestion costs at the current level of traffic demand and the optimal traffic demand – resulting from the internalisation of the external congestion costs by raising congestion charges is required. Total congestion costs are then computed as the cumulated difference of the users' willingness-to-accept particular operating costs plus congestion charges and the social marginal costs, which they ought to bear. This data can be generated by sophisticated techniques of transport demand and supply side modelling.

- The pragmatic *additional cost approach* defines congestion as the additional operating costs compared to a certain traffic condition, considered as "still acceptable". The definition of the acceptability traffic quality threshold is of course rather arbitrary. Usually, off-peak conditions are considered as a reference situation. Congestion costs defined according to this definition provide indication on the demand for enlarged infrastructure capacity, or service supply, rather than real costs in an economic sense. The method is of course subject to critics since depending on the selection of the acceptable traffic situation, the results of the additional cost approach might be two to ten (!) times above the estimates done according to welfare theory.

Apart from increased vehicle emission due to stop-and-go traffic conditions, congestion costs are internal to the transport sector, since financial burdens of private economy due to late arrival of employees or customers are included in the value of travel time chosen for different user groups affected by congestion.

However, the quantification of congestion costs in public transport is not so straightforward as in the individual transport because the interdependency between traffic volume and additional user costs is difficult to be measured . Besides, in public road transport, which is the one directly affected by road congestion, the main source of increased user costs is in-vehicle crowding effects rather than enlarged travel times. In a pragmatic approach it may therefore be assumed that public transport is not a source but a sufferer of congestion.

The level of total congestion costs is determined by the balance between transport demand and supply and hence indicates the increase in social welfare resulting from infrastructure investments or the introduction of traffic control or pricing measures. Figures of total costs should generally be presented separately from the system-external costs of transport, as they are not affecting society. Of much more relevance than total costs are marginal congestion figures, which are highly pricing-relevant in either transport system.

3.2.4 Accidents

The costs associated with traffic accidents are manifold: depending on the accident severity it is accounted for the damages to the driver's and other peoples' property, for the administrative costs of police and justice, for the costs of the medical treatment of the victims, for effects on economy due to the production losses borne by the victim's employer and finally - which is most important - for the suffer and grief the victims' relatives and friends are going through. While the material-based cost components can be estimated more or less precisely by analysing the accounts of insurance companies, local authorities or business enterprises, the opportunity costs of a person getting killed or permanently disabled in a fatal accident need to be assessed indirectly by willingness-to-pay studies. It has proved to be very difficult to express such painful, but extremely seldom events, by monetary figures; this fact is reflected by the wide range of values reported by different recent studies.

Accident costs are mainly external because the parties involved or their liability insurance cover only parts of property damages and usually only very small portions of the costs due to health care and expenses of public administration. The number and severity of traffic accidents is determined by driving habits (e.g. speed, risk awareness, etc), safety measures in vehicles and on roads as well as by the type of infrastructure considered. The relevance of traffic density for accident rates is not empirically proved. The combination of regulatory measures and flexible insurance systems, covering all social accident-related costs and eventually differentiated by user' risk categories, are considered to be more effective for cost internalisation than road pricing.

3.2.5 Emissions into the air

Exhaust emissions of combustion engines and power plants serving electric-powered vehicles include particulate matter (PM), nitrogen oxides (NOX), sulphur dioxide (SO2) and hydrocarbons and volatile organic compounds

(HC/VOC). In addition, transport also contributes significantly to the production of greenhouse gases like carbon dioxide (CO2). In urban areas social costs are caused by impacts of air pollution on public health, corrosion of emission-exposed real estate, increased risk of climate change and site-specific effects (e.g. impacts on historical monuments). While the emitters of exhaust fumes can be identified rather well, it is not that straight-forward to say which system participants suffer from transport emissions, because symptoms that pollutant concentrations have been found to cause (e.g. chronic cough) may also have other causes (e.g. smoking). In addition, emissions from transport contribute only to the pollutant concentrations caused by other sources. Further a significant level of uncertainty is contained in the quantification of the effects of global warming.

The estimation of costs due to air pollution is of particular relevance for densely populated areas suffering of heavy traffic, for communities having a low standard in vehicle technology and for sites of cultural and historical importance. To reduce transport-related emissions a combination of emission-related and kilometre-dependent charges and incentives like the enforcement of more advanced vehicle technologies is considered as appropriate. The positive effects of speed limits or incentives to use public transport should also be considered.

3.2.6 Noise

Noise is decreasing the quality of life by disturbing peoples' concentration, relaxation and sleep. The results are different among people and range between simple nuisance up to substantial physical and psychological damages. As the empirical evidence on the inter-relationship of noise exposure and health effects (e.g. increased risk of heart attack) is still rather thin, the assessment of traffic noise according to the willingness-to-pay of people for quieter residential areas is recommended. The noise exposure of people is expressed as the noise level outdoors exceeding a region-specific target level. Target levels are varying by the time of day and describes an acceptable level of noise exposure.

As an extremely local phenomenon traffic noise must be evaluated on a disaggregated spatial level. It is influenced by traffic volumes (regressively growing), by travel speed, building structure, regional sensitivity, abatement measures and by the time of day, rather than by vehicle technology. Due to the logarithmic relationship between traffic volume and the noise level alongside transport facilities, noise costs are rather an indicator for the necessity of traffic regulation or abatement measures (e.g. speed limits or noise protection walls) than relevant for road pricing.

3.2.7 Other effects of transport

This final cost category subsumes a number of effects, which are of special interest when assessing the effects of urban traffic. The following cost categories are relevant for build-up areas and for the traffic using the infrastructure:

- Effects on the urban sprawl;

- Separation effects for pedestrians;
- Space availability for bicycles.

Some further effects can be relevant in case sensitive natural areas in the outskirts of the city in particular as a consequence of infrastructure existence:

- Additional costs and risks of energy production;
- The distortion and separation of natural habitats or biotopes by traffic infrastructure;
- Damages to soil and groundwater due to infrastructure and operation;

Possibilities to assess these effects in monetary terms are through estimating the costs for replacement or repair measures and/or estimating the value of human health or time. The importance of these effects might differ widely between different urban areas and accordingly a relevance analysis is recommended in advance to the cost estimation process. As most of these cost items are fixed, their pricing relevance is limited.

3.3 Cost Evaluation and Data Requirements

This section provides technical guidance on how to evaluate real costs. A stepwise approach consisting of 9 working steps is presented in order to list data requirements and necessary actions in a systematic way. Depending on the availability of data, of sophisticated traffic simulation models or of other resources, for most of these working steps a detailed and a cut-down procedure has been worked out. The table below provides an overview of the 9 working steps, the data requirements under varying levels of resource availability and the principles for allocating total costs to different modes of transport.

Step	Data Requirements for Determining Total Costs		Cost Allocation
	Minimal	Optimal	
Step 1: General Data	• Number of vehicles, average annual mileage, speed, occupancy, time costs, etc. of all modes involved in urban transport		-
Step 2: Infrastructure	• By type of asset: average unit value, age and life expectancy • Average running costs and overhead rate	• Detailed inventory of infrastructure assets by unit value, designed life span, age, annual running costs and administration requirements	PCU-km / Axle-load-km
Step 3a: Vehicle-associated costs	• By type of vehicle: average unit value, age and life span • Average rates for running costs and administration	• Detailed statistics on vehicle fleets in individual and public transport • Accounts of running expenses, administration and time consumption	Directly evaluated by mode

Table 7: Working steps to evaluate real costs

Step	Data Requirements for Determining Total Costs Minimal	 Optimal	Cost Allocation
Step 3b: User contributions	• Average kilometric or annual rates of taxes, charges, fees, fares and insurance payments	• Statistics on tax returns, charge and fare collection and liability payments	Data is collected by user group
Step 4: Congestion	• Average speed reduction and share of traffic affected by congestion	• Speed-flow curves and traffic counts for highly occupied roads at several hours of the day	PCU-km
Step 5: Emissions into the air	• Emission factors per vehicle type and cost values per ton of pollutant from external studies	• Population and real estate exposed to pollutants and respective exposure-response functions per pollutant • Damage cost values	Vehicle-km by emission classes
Step 6: Accidents	• Average accident, injury and fatality rates per vehicle type and respective cost values from external studies	• Police reports, accounts of health and liability insurance companies; local cost functions	Direct / Kinetic-energy-km
Step 7: Noise	• Estimate of affected population by area and exposure level; national cost functions	• Emission-dispersion-models • Local cost functions	Vehicle-km by emission classes
Step 8: Other externalities	• Information on bio-topes separated or destroyed • Obstacles for pedestrians and additional space required for bicyclists	• Application of replacement and abatement approaches, valuation of additional time costs	Direct / PCU-km
Step 9: Social Cost accounts	• General data (step 1) • Resource costs and transfer payments step 2 to 8		

Table 7: Working steps to evaluate real costs (continued)

3.3.1 Step 1: Collection of General Data

The first step in calculating real costs of urban traffic is to collect a set of general data, which provides an overview of the traffic activities in the agglomeration under analysis. This basic data set is then individually extended according to the additional information required for the computation of each cost category in the working steps 2 to 8.

STEP 1. COLLECTION OF GENERAL DATA

1.1 Transport Modes and types of vehicles used:

a) Individual road transport (obligatory): Private Cars / Motorcycles / Vans / Lorries
b) Collective transport: Bus (fuel powered) / trolley bus / tramway / light rail / rail / metro / ferry

1.2 Characteristics of urban traffic (for each type of vehicle identified in 1.1)

a) Vehicle fleet: Units operating in the urban area (including commuters to/from suburban areas)
b) Average annual mileage performed by vehicles in urban area [in km per year]
c) Average occupancy / load rate per vehicle [in passengers / tons per vehicle]
d) Average travel speed in off-peak per mode, including waiting times in public transport [in kph]
e) Average value of (no congested) travel time by mode [in EURO / h]
f) Passenger car units of each vehicle type (contribution to traffic loads compared to passenger cars)

The private and public transport vehicle fleets should at least be differentiated by transport segment (passenger / freight) and by type of fuel or energy use (diesel / petrol / electric powered). Further differentiation by weight or noise emission factors, occupancy, main area of use or age of course allow to generate more reliable figures of urban transport's social costs.

Some of the parameters under item 1.2 (c, d and e) are specific to particular traffic situations. However, for the requirements of the general data set, average annual occupancy factors (c) are sufficient. As they are used later on to transform vehicle-specific results into passenger- or ton-kilometric figures. On the contrary, in relation to the value of time (e) and travel speeds (d), off-peak values are required as additional costs due to congestion are evaluated separately.

3.3.2 Step 2: Determination of Infrastructure Costs

The calculation of annual infrastructure costs requires the collection of an inventory of assets, characterised by type of infrastructure, production costs, design life and age. After choosing an appropriate depreciation variant and an interest rate of capital, depreciation and the opportunity costs of capital are either determined separately based on the current residual value by the perpetual inventory method or commonly by the annuity factor method. Direct running and administrative costs are obtained from current accounts. Possibilities to ease the process of data collection on infrastructure include the application of aggregated and average values for administrative costs. The procedure is summarised by the box below:

STEP 2.	**CALCULATE THE REAL COSTS OF TRAFFIC INFRASTRUCTURE**
2.1	Update or create an inventory of assets including road, rail and ferry structures, surfaces and associated elements.
2.2	For each element of the inventory, determine age, average life span and production costs (historical or future).
2.3	Choose a depreciation variant (linear or proportional) and determine annual depreciation costs.
2.4	Determine an appropriate interest rate of capital and determine capital costs.
2.5	By analysis of accounts identify operating, maintenance and administrative costs.
2.6	Allocate the costs to means of transport (fixed costs by PCU-kilometres, variable costs by the 4th-power-rule).
2.7	Esimate marginal costs as the variable costs per vehicle kilometre by vehicle axle load and infrastructure type

The infrastructure inventory describes types of infrastructures and respective economic parameters, such as:

- Quantity and unit costs by type of assets;
- Designed life span and age (or percentage of assets already written down);
- Running costs (administration, maintenance, repair, cleaning, energy, etc.).

Depending on the national institutional settings the availability of such data will differ widely between countries. In case urban data is not available, it should be referred to national experiences on the average kilometric amount of capital costs and running expenses by type of asset. For the application of average figures, the following aggregation of infrastructure assets is recommended:

- Road and rail structures, comprising all costs due to the provision, operation and maintenance of the horizontal and vertical alignment of road or rail track segments;
- Surface costs (including road surface and rail track costs) occurring periodically due to wear and tear of the infrastructure asset;
- Associated infrastructure costs comprise lighting, signalling, fencing, rail electrification and telecommunication, etc. These elements are most probably of minor importance when compared to those mentioned above.

For these types of assets capital and running costs need to be evaluated according to the following principles.

Depreciation and interest costs - As the two elements of capital costs can either be determined separately by applying the perpetual inventory method or simultaneously by using the annuity factor approach. According to the perpetual inventory method, depreciation is calculated by subtracting the loss in value of the current period from the actual residual value. The latter is also used for determining interest costs. From a strictly economic perspective social interest rates might range between 2% and 3%, but it is recommended to refer to national values were available. Alternatively the annuity factor method assumes an equal distribution of capital costs over the whole life span of the asset. The question which variant to chose is depending on the data situation. While the perpetual inventory method provides more reliable and differentiated values, it requires a full set of historical data on traffic network-related activities. The two variants are displayed below.

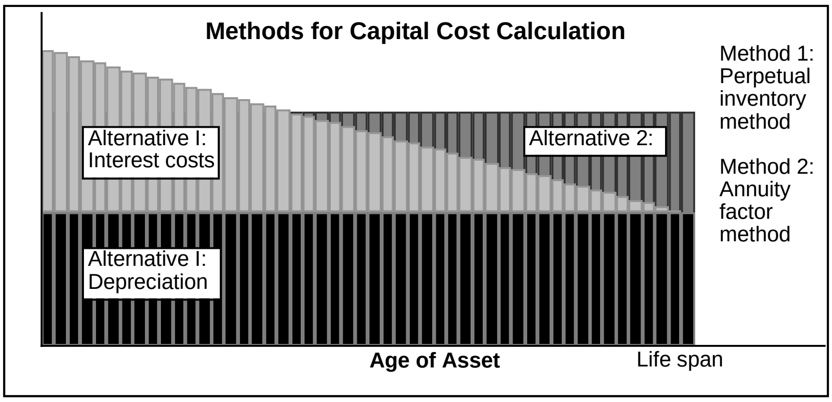

Figure 4:Variants for capital cost calculation

Running costs include the expenses for maintenance, repair, cleaning and administration of the urban transport infrastructure network. In contrast to asset inventories, running expenses should usually be well documented in municipal accounts and are influenced by local wage rates and material costs.

The costs of road and rail track surfacing should be allocated to transport modes by axle-load kilometres because it is estimated that the severity of road damages is increasing with the fourth power of axle loads. If we e.g. assume a lorry to weight five times more than a passenger car, the damage to the road surface is 625 (five raised to the fourth power) times as high as the damages caused by passenger cars. In contrast, the mainly load-invariant costs arising from the provision of road, rail and ferry structures and general running costs might be allocated to the means of transport using them by passenger-car-unit (PCU) kilometres. The PCU of a vehicle describes its road occupancy compared to passenger cars and is around 2.5 for lorries or 0.5 for motor cycles.

3.3.3 Step 3: Determination of Vehicle Associated Costs

The resource costs associated with the purchase and operation of vehicles comprise capital costs, running expenses for operation, maintenance and administration as well as opportunity time costs of passengers and goods. The respective transfer payments[9] from the transport sector to the providers of capital and services consist of taxes, charges or public transport fares. The basis for the cost analysis is an inventory of the vehicle stock operating in individual and collective transport services. The box below briefly describes the working steps towards the estimation of vehicle-associated costs and transfer payments.

STEP 3. COLLECT AND ESTIMATE THE VEHICLE-ASSOCIATED DATA AND CALCULATE THE REAL VEHICLE-ASSOCIATED COSTS

3.1. Collect and estimate the vehicle-related parameters such as:
- unit cost of purchase
- design life
- average vehicle age
- cleaning and servicing need
- tyre renewal need
- fuel price
- driver wages etc.

3.2. Calculate the vehicle-associated resource costs

3.3. Calculate the vehicle-associated transfer payments

3.4. Determine the marginal costs taking into account the local features and the study objectives

For the vehicle fleets of urban transport operators and - if required - for passenger cars and freight vehicles the following information needs to be collected on a detailed or average basis:

- Average age, life span, costs of purchase and disposal value;
- Fuel or energy consumption under usual traffic conditions;
- Running costs for tyres, maintenance, repair, cleaning, etc. and;
- Vehicle tax and insurance payments.

For the company or the entire transport sector the interest rate of capital, fuel and energy prices and tax rates and wage rates are required additionally.

[9] See glossary for definition.

Capital costs as the sum of depreciation and interest costs are determined for all investments in the vehicle stock and in other operating equipment, which is subject to depreciation. Capital costs are a decisive part of the cost structure of public transport enterprises but are of minor interest for individual transport.

Running costs subsume all those expenses, which are not subject to depreciation, i.e. where the costs for purchase of production are consumed within one year. Running costs associated with collective transport vehicles should be determined by analysing respective company accounts. For the individual transport, fleet average values, published by national statistical offices or other bodies might be consulted, is nuclear. Important running resource costs are:

- Fuel and energy costs are calculated according to fuel consumption under usual driving conditions (off-peak) and the prices for fuel and energy (excluding tax);
- Tyres in many cost calculation schemes are stated as extra cost category;
- Consumables including oil, working and replacement parts, etc.;
- Maintenance and repair excluding repair costs due to traffic accidents;
- Wages and additional payroll expenses (commercial transport only) and;
- Administrative costs (commercial transport only).

Commercial transport here referred describes all types of passenger and freight transport services performed for business reasons. This list is of course not exhaustive, thus the respective accounts should be checked carefully for other running costs directly related to vehicle operation.

Time costs are accounted by the average annual mileage and occupancy rate of each type of vehicle used for passenger transport weighted by a certain value of time. Different European studies recommend taking the value of working time that ranges around 20 ECU per passenger and hour. In freight transport a value of 37 ECU per shipment and hour is used in a number of European studies. These values might be used in case local figures - which are recommended to be applied - are not available. Time costs must not be calculated for driving personnel. Care should be taken as the economic assessment of the total time spent in transport is rather sensitive to the unit values used and generally clearly dominate the total resource costs.

The transfers from transport users and operators to service providers, insurance companies or to the general budget can either be determined by the analysis of local accounts of based on average figures per vehicle, vehicle kilometre or passenger. For the selection of the appropriate data source the following recommendations can be made:

- Direct user contributions, which are earmarked to the use of infrastructure (road user or track charges, parking fees, public transport fares, etc.) should be well documented in local accounts and hence the use of average figures is not recommended;
- Taxes on vehicle purchase, possession and fuel or electric energy are usually well documented in national

statistics. To calculate the returns remunerated by local users and operators, however, average figures should be consulted.

- General taxes, such as the value-added tax (VAT), must be considered neither as private resource costs nor as transfer payments. It can be assumed that people would remunerate it anyway - if not for transport than for other consumables.

Except for capital costs, all vehicle associated costs and transfer payments can be regarded as variable and hence serve as a basis for determining marginal user costs. The relevance of directly internalised private costs, such as operating and time cost in individual transport and user time costs in public transport, depends on the purpose of the real cost account. Private costs are not relevant for pricing issues and cost coverage analysis, but its development raises interest as soon as the results of investments or policy programs is to be assessed. (Uncovered) external social costs by cost category may be determined by considering transfer payments in the steps 2 to 8 as the internalised part of social resource costs.

3.3.4 Step 4: Assessment of Traffic Congestion

If conditions in road or rail transport are considered a problem, it has to be decided whether to apply the social welfare approach or the more easy and transparent additional cost approach. Both methodologies require information on which share of traffic is affected by congestion and to what extent. This information may be raised based on particular routes or on more rough and general estimates. Moreover, a reference situation needs to be defined, either through the application of demand models or more intuitively by laying down traffic conditions which are regarded as "still acceptable". Congestion costs are then calculated as the difference between time, operating and environmental costs under current and reference traffic conditions.

STEP 4. ESTIMATE THE REAL COSTS DUE TO CONGESTION
Full approach:
4.1. Find out whether congestion is considered a problem in the city. If no, proceed to step 5.
4a.2. Determine the congested routes, their optimal and real flow rates, modal split and suitable speed-flow functions.
4a.3. Calculate the additional time costs and their payers.
4a.4. Calculate the additional operating costs and their payers.
4a.5. Allocate the congestion cost to transport modes on the basis of Passenger-Car-Units.
4a.6. Calculate the pricing-relevant marginal external costs on the basis of local speed-flow relationship
Cut-down approach:
4.1. Find out whether congestion is considered a problem in the city. If no, proceed to step 5.
4b.2. Assume optimised inner-urban traffic and measure the average waiting times at the outer urban cordon.
4b.3. Estimate the additional time costs.
4b.4. Marginal costs: see 4a.6.

The basis of traffic flow modelling is speed-flow diagrams, which describe the developments of travel speeds as a function of traffic flow. Observations of traffic conditions show a rather sharp transition from free-flow traffic to a congested condition, while below and above this transition volume the effect of an additional vehicle can nearly be neglected. In order to systemise the description of traffic conditions the U.S. Highway Capacity Manuals defines six Levels-of-Service (LOS) from "A" (free flow) to "F" (Congested).

In addition to vehicle operating costs, opportunity costs of travel time in passenger and goods transport are usually reported in national investment manuals or can be taken out of national studies (compare step 1 and 3). These time values depend on travel purposes and traffic conditions; congested time is commonly valued 25% to 100% higher than the time spent under uncongested traffic conditions.

Based on speed-flow curves and the value of travel time the social marginal congestion costs are derived as follows:

- Average private user time costs per kilometre are calculated by dividing the value of travel time by the average travel speed.
- Marginal congestion costs per vehicle-km are calculated by deriving the function of total user (time and operating) costs by the related number of vehicle-kilometres.
- Marginal external congestion costs then are computed as the difference of marginal and average user costs.

It is worth referring that even private costs, such as user time and operating costs, are considered to be out of the scope of vehicle associated costs, for congestion all elements of private costs are relevant if they vary with traffic conditions. The reason for this is that congestion does not describe absolute cost figures, but cost differences similar to cost-benefit analysis. The interdependency between travel speed, private costs, social costs and social external costs is shown in the following illustration

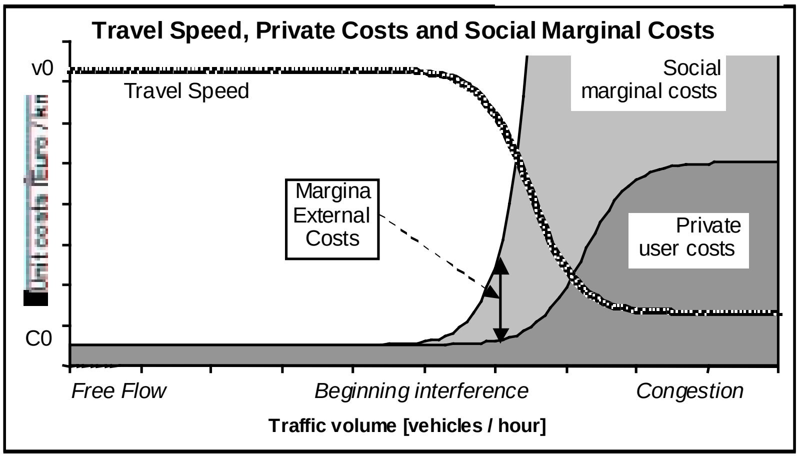

Figure 5: Interdependence between travel speed, private costs, social costs and social external costs

Besides time costs also fuel and maintenance costs are increasing due to congested traffic conditions. Fuel costs in average are increasing by 100% for passenger cars and by 200% for freight vehicles. Fuel costs and consumption rates are to take from step 3 (vehicle-associated costs) Further accident costs and the effects of air pollution (especially CO and CO2-emissions) are affected by the traffic situation. However, these cost components are evaluated on a full cost basis considering current traffic situations in the respective chapters.

Total congestion costs are evaluated as the difference between current and optimal user costs over the whole congested traffic network. The optimal user costs can either be evaluated by equilibrium modelling, which is resulting in the maximisation of total social welfare, by choosing a designed travel speed or by considering the off-peak conditions as optimal. Alternatively, delays at the city borders can be taken as a rough estimate of increased time consumption due to congestion.

3.3.5 Step 5: Assessment of Traffic Accidents

The social costs of traffic accidents are determined based on the number of accidents and accident consequences, including fatalities, injuries and pure material damages. This data set can either be determined by consulting local statistics or by the application of appropriate accident rates[10]. The economic assessment of damages to property, medical costs, production losses and the opportunity costs of a human life should be based on national studies; merely the costs for police and justice might be valued according to local accounts. The question of cost responsibility can be answered by referring to police records, but should better be handled by the kinetic energy approach. A detailed stepwise approach is presented in the box below.

STEP 5.	**ESTIMATE THE COSTS DUE TO TRAFFIC ACCIDENTS**
5.1	Determine the unit costs for various damages to human health and property
Full approach:	
5a.2	Determine the annual number of traffic accidents and victims by severity out of local statistics.
5a.3	Adjust the local statistics with underreporting factors.
5a.4.	Estimate the total accident costs.
5a.5	Allocate the costs arising from inter-modal accidents to traffic modes by the kinetic energy approach.
Cut-down approach:	
5b.2.	Estimate the number of accidents by applying risk rates to the annual mileage per vehicle category.
5b.3.	Determine the total costs by vehicle type
5b4:	Determine marginal costs = average costs per pkm / tkm / vkm for each vehicle type

The recommended first-best approach towards the collection of quantitative data is to analyse local accident statistics, which are based on police reports. According to the spatial diversification of the final results of the cost evaluation process required, the accident data set should contain the following information:

[10] The use of foreign figures to derive urban figure from a national data set is not recommend as driving behaviour, traffic management and safety standards might present strong divergence between countries (see INFRAS/IWW 2000).

- The number of fatalities comprising those victims dying within 30 days as a consequence of a traffic accident;
- The number of injuries, including slight injuries as well as victims becoming permanently disabled;
- The number of pure material damages finally comprises all those accidents not affecting human health or life.

With decreasing degree of severity the number of accidents not reported to the police is increasing, as drivers try to avoid rising insurance premiums. This factor might range between 500% for pure material damages to 0.1 % for fatal accidents.

If reliable statistics are not available, accident rates based on national experience might be used to compute the accident data set. Accident rates are strongly varying with the type of road (considering standards of local vehicle technology and safety measures, speed limits, presence of line separation, junctions and driving habits) and hence they should be related to recent or medium-term past local or national experiences. The use of accident rates recorded in other countries is not recommended.

According to the degree of severity the social costs of a traffic accident might range up to several million Euro for a fatal accident. These costs consist of the following components:

- The average material damage associated with the different accident categories should be set according to liability insurance statistics on local or national experience;
- Administrative costs for police and justice should be determined according to local administrative accounts. European estimates assume a range of values of about 10% of the costs for material damages;
- The costs arising from medical care, replacement at the victim’s working place and reintegration measures in an optimal case are taken from social insurance companies;
- The (net) production loss is defined by the difference between the potential future income of a killed or disabled victim and its probable future consumption. This value should be taken out of national or European studies;
- The value of human life usually is estimated on the evaluation of stated preference analysis on the willingness of people to pay for increased traffic safety. This opportunity value, which might range from around 50,000 ECU for injuries and around 1,300,000 for fatalities, is to apply to reported accidents only. On average, the value of human life accounts for about 50% of the costs associated to the damage of loss of a human life.

The possible share of these cost components and the costs per accident / victim is presented by the figure below. The values represent average European estimates and are derived from the worked examples in the annex to this handbook.

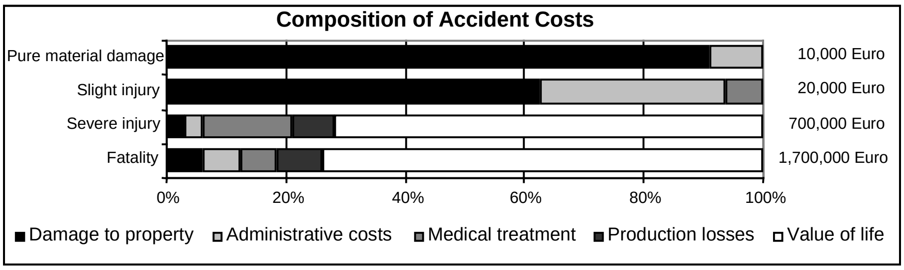

Figure 6:Composition of accident costs

A great level of caution is required when dealing with the question of guilt. In most cases multiple actors involved in an accident have partial responsibility and hence it is recommended to allocate accident costs to the means of transport sharing the same infrastructure by the kinetic energy method. This approach uses the product out of mass, speed and annual mileage as equivalence figures.

3.3.6 Step 6: Assessment of Emissions into the Air

The basis for calculating the costs due to emissions into the air is the impact-pathway approach. In this bottom-up methodology the quantity of emissions generated by combustion vehicles and electricity production per type of pollutant, their dispersion in the air, their effects on the prevailing pollutant concentrations and, finally, their impacts on public health and buildings are estimated. A rough but easy second-best solution for estimating the costs caused by air pollution is provided by the benefit-transfer method, which is directly valuing the amount of pollutants by monetary units.

STEP 6. ESTIMATE THE REAL COSTS DUE TO EMISSIONS INTO THE AIR

Full approach:

6a.1. Collect and/or estimate the data needed: emission factors or electricity consumption for vehicles and specific emissions of the electricity

6a.2. Estimate the local and regional pollutant concentrations caused by local combustion-engine based traffic.

6a.3. Estimate the local and regional, population and material exposed to the concentrations in 6a.2.

6a.4. Using exposure-response functions, define the impact categories which the emissions cause and define the unit costs of for those impacts.

6a.5. Calculate the health impacts using exposure-response functions and unit costs from step 6.4.

6a.6. Calculate the material impacts similarly.

6a.7. Redo the steps 6a.2. - 6a.6. for electric traffic using appropriate data, e.g. data on emissions from energy production and population and stock exposed in the country as a whole.

6a.8. Allocate the costs to transport modes and derive the marginal costs.

Cut-down approach:

6b.1. Collect and/or estimate the data needed: emission factors or electricity consumption for vehicle: specific emissions of the electricity; local population density within 35 km from the source ; region type (up to a few thousand kilometres)

6b.2. Estimate the costs for combustion-engine based emissions using benefit transfer.

6b.3. Estimate the costs for electric vehicle based emissions using benefit transfer.

6b.4. Allocate the costs to transport modes and derive the marginal cost.

The first step to be carried out for both the full and the rough variant for estimating emission-related costs is the collection of data on the specific emissions per vehicle kilometre for fuel powered vehicles and for electric powered vehicles. These emission factors concern the pollutants PM_{10}, NO_X, SO_2, CO_2, and HC/VOC. The damage caused by the evaporative emissions hydrocarbons (HC) and volatile organic compounds (VOC) is estimated to be minor and hence the resources should be focused on the remaining combustion products. In particular the attention for particulate matter with a diameter less than 10 mm (PM_{10}) has grown during the past decade.

Exposure-response functions describe the effect of pollutant concentrations, for instance, on human health and on real estate. Exposure-response functions related to human health can be classified into increments in acute mortality, chronic mortality and morbidity. Mortality impacts are valued with the estimated lifetime lost and the value per year of life lost (YOLL). YOLL is derived from the value of statistical life (VSL) and the annual interest rate. Morbidity impacts are usually valued with stated preference surveys. Currently exposure-response functions exist, for example, for the following morbidity effects:

- Asthmatic problems (bronchitis, cough, wheeze of asthmatic children and adults);
- Children with chronic cough and bronchitis;
- Restricted activity days, respiratory hospital admission and new cases of bronchitis;
- Congestive heart failures for elderly people;

The number of exposed inhabitants should be expressed at least in 4 age classes, which are (1) children, (2) adults under 30, (3) adults aged 30-65 and (4) adults over 65. Moreover, the average annual mortality must be identified or estimated. In order to do so, the proportion of asthmatics and the average annual mortality rate are to be provided. In absence of a sophisticated dispersion model, the European urban average value of 80 inhabitants per m^2 could be used or national averages for urban areas if available. In terms of fowling and corrosion effects the size of exposed surfaces is to be determined. Of special importance are painted and ribbon-coated metal, parking and wood surfaces.

In case detailed exposure-response-functions are not available the full pathway approach can be replaced by general estimates of the social costs imposed by a ton of each pollutant. This method is called benefit transfer approach.

Carbon dioxide is not an immediate pollutant, but it may have vast negative effects on the atmosphere in the long-term by increasing the risk of climate change. It must be recognised in the social cost calculations that due to the extremely uncertain effects the climate change may have and the political/ethical nature of many of the arising costs, the marginal cost for CO_2 may vary substantially. Values ranging from 0,05 to 120 ECU/tCO_2 have been discussed in the EC funded ExternE Core/Transport project (JOS3-CT97-0015) as possible damage costs. The marginal cost seems to depend mainly on:

- *the discount rate for the impact costs*: the higher the discount rate, the lower the marginal cost.
- *the geographical extent:* the more weight one places at impacts outside the European Union, the higher the marginal cost.
- *the valuation of impacts:* the marginal cost is higher, if also the impacts in the developing countries are valued with unit costs from the industrialised countries.

It has to be emphasised also that not all possibly relevant impacts have been quantified in these results. Referring to the unit values per ton of the most important pollutants and to the average emission factors for four different vehicle types used in German investment planning, the diagram below gives an impression on the importance of some exhaust fumes.

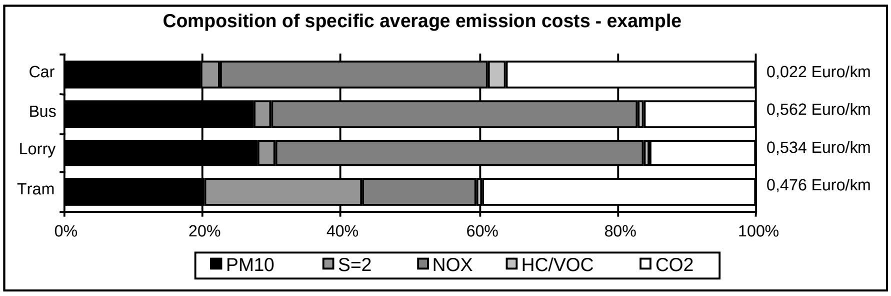

Figure 7: Example of average emission costs

Due to the bottom-up approach proposed for the determination of emission costs and due to the fact that usually exposure-response-functions are assumed to be linear, average costs can be used as proxy for marginal costs for all vehicle types.

Some of the cost components summarised under "additional costs" are closely related to previous working steps. Additional risks of energy production must be cross-checked with the valuation approach used in step 5. In case the risk of nuclear power production is considered in the value per energy unit, the step must not be treated here. Extra time costs for pedestrians and the shadow price for missing bicycle lanes could alternatively be treated in atep 3 (congestion) or in step 4 (accidents).

3.3.7 Step 7: Assessment of Traffic Noise

The estimation of the social costs due to noise disturbance requires two basic working steps: (1) the determination of the number of inhabitants who are exposed to traffic noise and (2) the economic assessment of different levels of noise exposure. A degree of freedom is given in terms of the first step, which can be determined by sophisticated emission-dispersion modelling, by the use of existing noise inventories (recommended) or by evaluating inhabitant questionnaires. In any case the local context must be taken into consideration because the nuisance stemming from noise exposure is strongly depending on the type of land use.

STEP 7. ESTIMATE THE COSTS DUE TO TRAFFIC NOISE
Alternative1: Cut-down approach

7a.1.	Use of an existing traffic noise inventory or collection of data on noise levels in several key areas of the system. The greater the number of the measurement points, the higher the reliability of the results. Main parameters are: - situation of the measurement point (area type, special features) - average day- and night-time noise levels - estimated contribution of traffic to the noise level by eliminating background noise levels
Alternative 2: Sophisticated approach	
7b.1.	Rough approach: estimate the noise levels using noise dispersion models, based on traffic levels by time of day under consideration of the surrounding environment and population density.
7.2.	Compare the measured noise levels to the target levels and derive the noise exposure.
7.3.	Estimate the population in different kinds of areas (residential, commercial, industrial etc.) that is exposed to the following noise above the target levels: 0-5 dB, 5-10 dB, 10 or more dB.
7.4.	Estimate the unit costs for noise exposures above the target levels, and the consequent total cost.
7.5.	Allocate the total cost on the basis of noise-equivalent-rated traffic performance to transport means.

The recommended first-best methodology for determining noise exposure levels is the use of the existing noise inventories based on measurements. Noise levels should be determined outside peoples' homes, because it is a considerable decrease in quality of life if windows need to be kept close and outdoor space can not be used. The same noise exposure level will not be equally disturbing under different spatial and temporal circumstances. For this reason noise measurements must be diversified at least by time of day and by type of land use.

The decisive factors influencing noise levels alongside roads and railway tracks are:

- Traffic volume: Noise levels are increasing linearly with the growing of traffic volumes as a consequence of the interdependency of sound energy and its perception by the human ear. A doubling of traffic volumes leads to a constant increase of noise levels by 3 dB(A).
- Traffic composition and travel speed: Heavy-duty vehicles emit about eight times more sound energy than passenger cars. On the other hand, heavy traffic usually slows down the overall travel speed and therefore decreases noise emissions. In rail traffic the number of wagons equipped with quiet disk breaks is affecting the decibel level.
- Road surface, gradient and curvature as well as topographical and meteorological conditions also have a major impact on the noise levels along roads and railroad lines.

The figures below describe the shape of an emission function for different heavy traffic shares (left) and the variance of noise emissions with different vehicle speeds and heavy traffic shares (right).

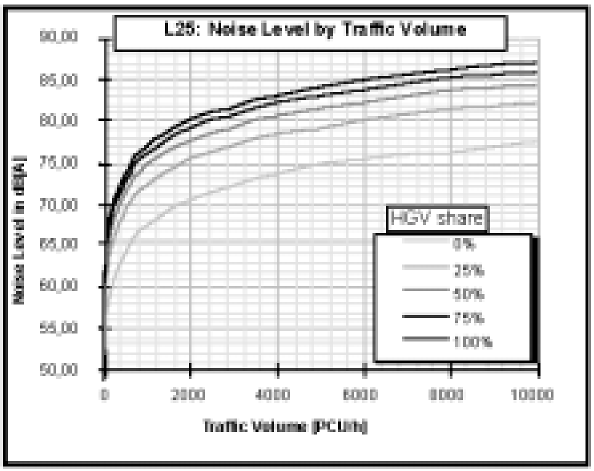

Figure 8:Emission function for different heavy traffic shares

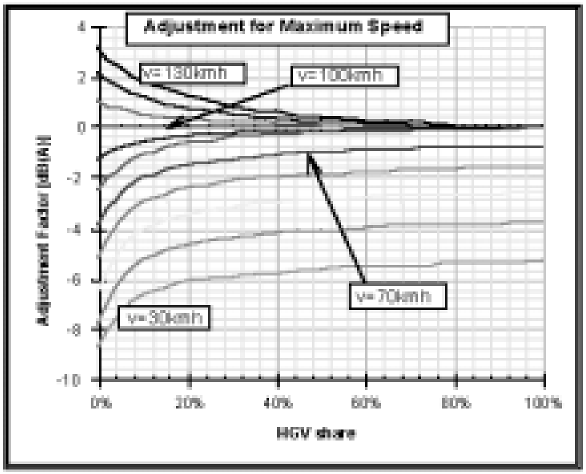

Figure 9:Variance of noise emissions with different vehicle speeds and heavy traffic shares

The number of inhabitants affected by traffic noise can either be determined by questioning, noise measurements or by emission-dispersion modelling. The usual differentiation of affected inhabitants is by:

- type of area (residential / mixed / commercial / industrial);
- time of day (day / night / evening) and by
- noise classes (5 dB(A)).

The type of area and the time of day are determining the target level, which describes that noise exposure level, which is considered as still acceptable. Daytime noise levels are usually 10 dB(A) above those accepted at night. Usual daytime-values are 55 dB(A) for residential areas and 65 dB(A) for mixed commercial areas.

The willingness to pay for the reduction of noise pollution by 20 dB(A) has found to be 1% to 3% of the average income of a household. Further newest research has found some evidence for a increased risk of heat attacks above an average exposure level of 65 dB(A).

The cost allocation should be carried out by the annual mileage per mode weighted by noise emission factors. These should be taken from national experience as they vary according to technology and age structure of the vehicle fleets.

3.3.8 Step 8: Evaluation of Additional Effects of Transport.

The first and most decisive step on the assessment of other costs of transport is the screening of the current situation. In case negative effects of transport on nature, soil groundwater and on the urban environment are detected to be a problem, a set of possible action plans to repair or compensate them needs to be implemented and assessed in monetary terms. In case damages can not be repaired, the allocation of an increased interest rate to the respective infrastructure might be used to express the time preference of future generation for more scarce nature.

STEP 8.	**ESTIMATE THE REST OF THE POSSIBLY RELEVANT TRAFFIC-RELATED COSTS**
8.1.	Make a relevance analysis for the remaining cost categories such as:
	- loss of existing biotopes
	- deterioration of historic buildings
	- indirect emissions and risks of energy production etc.
8.2.	Determine the quantitative data set for the relevant cost categories and estimate the cost.
8.3.	Allocate the cost to the transport modes using a suitable driver, such as traffic performance.

The action plans, which could be assumed to repair the damages to nature and landscape might include the construction of green bridges, the installation of additional biotopes, the upgrading of existing biotopes and other additional replacement measures. The costs of these measures should be based on national experience. Average repair costs used in Germany, for example, range between 500,000 EURO/ha for natural biotopes and 60,000 EURO/ha for green land.

The improvement or the recovery of soil and groundwater quality could be carried out by supplementary measures, in terms of soil contamination, and by additional groundwater protection measures, in terms of groundwater pollution. The provision of international unit values for these tasks is not possible and hence national sources need to be consulted.

Measures towards the improvement of the urban environment could be:

- the introduction of traffic calming measures;
- the installation of pedestrian zones;
- the covering up of urban transit roads and
- the cleaning and renovation of historic buildings and monuments.

For a number of these measures most probably urban experiences on the costing side are available. It is recommended to use them or national recommendations.

The negative effects of energy production are assessed by valuing the risk of fossil and nuclear energy production. As these effects are rather global it is recommended to refer to national or European shadow prices for the additional costs caused by energy production.

According to German experiences, among others, the waiting times of pedestrians willing to cross a particular road is assumed to be a logarithmic function of traffic volume, where for main roads with dense traffic, additional detours should be considered. The number of affected pedestrians are estimated by road types, per 100 m and day, ranging between 7 and 20 for local roads and between 0 and 5 for inter-city roads. The value of waiting time needs to be set according to the assumptions of step 2 (vehicle-associated costs).

The opportunity costs of missing space availability for bicycles is an important effect for all those road segments, which are not consisting of bicycle lanes and where the average daily traffic exceeds 10,000 vehicles per day. The economic assessment is done by estimating the hypothetical costs for installing additional bicycle lanes and assessing the respective benefit.

Though a number of those effects described above are fixed, for all cost components an allocation of cost responsibility to different modes of transport is recommended by their annual mileage, weighted by passenger car units. The costs of nature and landscape, soil, groundwater and urban environment are stemming from the existence of infrastructure and hence are fixed and the respective short-run marginal costs are zero. Marginal costs for additional effects of energy production and parts of separation effects and the costs accounted for missing space for bicycles are depending on traffic volumes and are thus marginal in the short-run.

3.3.9 Step 9: The Presentation of Results

Annual total costs by cost category (steps 2 to 8) and by means of transport is the first output of the cost evaluation process described above. By identifying the most important users of each mean of transport, the cost responsibility can easily be transformed in total costs by cost generators. The actual payers are identified separately for each cost item as those individuals or social groups bearing costs.

Similar analyses can be made using average costs per vehicle or passenger.kilometre. Such average cost figures often are more powerful than total cost values. Moreover, they allow a comparison of costs caused by each transport mode and hence are useful as an additional information to decide on the justification of public interventions in transport. The resulting output tables might look as shown in the text box below. The values in the tables are not resulting from a real calculation exercise and are hence only of qualitative relevance.

STEP 9. COMBINE THE RESULTS IN SUMMARY TABLES.

9.1. Make a summary table of the total costs by mode using the outputs from steps 2-8. Present the results by vehicle-passenger and tonne-kilometres.

TOTAL COSTS	TOTAL, MECU	Fuel-powered buses	Tramways	Cars	Lorries
Infrastructure costs	359	36	25	252	45
Vehicle associated costs	3229	1211	147	1503	367
Congestion	33	6	0	21	6
Emissions (average)	85	28	2	28	27
Accidents	89	10	5	63	12
Noise	24	2	0	19	3
Other costs	17	0	0	16	0
TOTAL	**3836**	**1294**	**179**	**1903**	**459**
Traffic performance (million km)		100	7	1400	100
per vkm (ECU)		12,9	25,6	1,4	4,6
per pkm (ECU)		0,9	1,3	1,0	-
per tkm (ECU)		-	-	2,7	0,9

9.2. Derive the actual payers of the total costs from steps 2-8.

ACTUAL PAYERS	Infrastructure	Vehicle-associated costs	Congestion	Emissions	Accidents	Noise	Other	TOTAL
	MECU							MECU
Car users		1503	14		11			1528
Public transport users		1140	11					1151
Public transport operators	4	218	3		2			227
Freight transport operators		367	5		3			375
Public Infrastructure suppliers	349							349
Private Infrastructure suppliers	7							7
Society with a strong potential for immediate claim					68	24	0,28	93
The rest of society				85	4		16	106
TOTAL	359	3229	33	85	89	24	17	3836

Cost coverage is defined by the ratio of costs borne to the costs caused. Cost coverage ratios can be determined on the basis of total annual costs or on the basis of average costs per vehicle, passenger or ton kilometre. Depending on the types of costs included different cost coverage ratios can be defined:

- The **Full Cost Coverage** is determined by the totality of costs borne by an agent in relation to the sum of resource costs caused by him. The costs borne comprise internal costs and transport related taxes, charges and fees (here denoted as transfer payments) . The costs caused also consist of internal, as well as of external costs. Due to the decisive cost element (internal costs), which is contained in the denominator as well as in the counter of the quotient, the sensitivity of this indicator towards changes in the structure of social costs is limited.
- The **external cost coverage** as the quotient of transport related taxes, charges and fees (here denoted as transfer payments) and costs borne by other than the responsible operator, provides indication on how much of the social damage caused by transport is paid. Since it neglects the internal cost block this indicator gives much more evidence to social issues than the full cost coverage indicator does.
- **Variable cost coverage** can be used to give evidence to the question whether current transport prices are effective in terms of making external costs visible or not.

The determination of those cost indicators is supported by the identification of cost flows, which in turn allow the identification of cost generators and corresponding actual payers. An example of the structure of a fictitious cost flow table is given below.

9.3. Using the output from steps 9.1.-9.2. And taking into account transfer payments, perform a cost flow analysis for the total urban transport system.

9.4. Make a summary table of the marginal costs by mode using the outputs from steps 2-8.
Note: Marginal cost calculation in the steps referred is affected by the specific research question and the time horizon of the analysis. Additional units analysed can be vehicles, tons, actors, vehicle-kilometres, passenger-kilometres or ton-kilometres.

MARGINAL COSTS	Fuel-powered buses	Tramways	Cars	Lorries
Infrastructure costs	0,02	0,16	0,0	0,05
Vehicle associated costs	2,1	1,0	0,4	2,4
Congestion	0	0	0	0
Emissions (average)	0,3	0,3	0,0	0,3
Accidents	0,1	0,7	0,0	0,1
Noise	0,0	0,0	0,0	0,0
Other costs	0,0	0,0	0,0	0,0
TOTAL (ECU/vkm)	**2,5**	**2,1**	**0,5**	**2,9**

A rough but comprehensive computation example of the real costs of urban transport and its allocation of actor groups is presented in annex 2 to this report. Similar techniques may be applied in case detailed values are not required or the computation capabilities are limited. In addition, annex 3 presents how the application of a full model-based cost estimation may be carried out. The example is based on real calculations for the city of Budapest, using the TRANSURS model. Further detailed information is presented in deliverable 3 of the FISCUS project.

3.4 Conclusions - Use of the Real Cost Scheme

The Real Cost Scheme provides periodic information on the state of cost of the urban transport system. It can be used for different purposes:

- **Monitoring transport costs**: Annual total and average costs and as well cost coverage can be used as an important statistical information on the relevance of different cost elements by means of transport, their development over time and their deficits with regard to cost coverage.
- **Evaluation of future developments and projects:** The Real Cost Scheme provides a very sound basis for the comparison of policy scenarios based on Cost-Benefit-Analysis. Different policy options (e.g. infrastructure projects, other policy instruments) can be compared by their impacts on the cost situation by means of transport. Thus the Real Cost Scheme is an important tool in order to implement least cost strategies in the transport sector.
- **Transport Pricing:** Although the Real Cost Scheme is providing information on the full costs of transport, marginal costs can be derived in order to have a sound basis for transport pricing. In many cases, variable average cost figures (such as accidents, air pollution, climate change) are a satisfactory proxy for pricing purposes. With regard to noise, average noise costs, although different from marginal costs, can be used as well. One important difference is congestion, where external marginal costs differ considerably from average costs. However the Real Cost Scheme presents both outputs.

Cost coverage indicators provide a tool to refine the current transport-pricing situation for the various transport modes. While figures of total cost coverage give evidence to the question of fairness in the distribution of financial burdens among actor groups is, variable cost coverage ratios indicate the sustainability and adequacy of pricing systems. A basic rule to be considered in terms of designing a pricing regime is that variable resource costs should be covered by variable user contributions in order to make the underlying social costs visible . Cost coverage ratio may also be computed for a selected set of social cost categories (e.g. infrastructure or P.T. operation costs), in this case it must be made sure that the considered transfer payments have any relation to the resource costs.

For a worked example demonstrating how the real cost scheme might be applied and how the results might be presented the interested reader is referred to the annex of this handbook. Different pricing principles as well as financing needs and strategies to which the real cost scheme can provide valuable input information are described in the following chapter 4.

4 PRICING AND FINANCING OF URBAN MOBILITY

4.1 Introduction

Earlier chapters in this handbook have shown how to quantify both the total and marginal costs of the urban transport system. The aim of this chapter is to set out options for the pricing and financing of urban transport. Pricing and financing are closely linked, as pricing represents one of the most important methods of raising finance. But pricing has another equally important role. It is a key mechanism for influencing the volume of traffic using each method of transport, in order to achieve other important aims such as economic efficiency and environmental sustainability. There is good evidence that existing pricing mechanisms and levels are contributing towards the problems of congestion and environmental pollution in urban areas by failing to provide appropriate signals to influence behaviour. In the first part of this chapter, alternative approaches to transport pricing will be considered.

Following this, we look at financing issues. It is perceived that in many urban areas, existing financing mechanisms, which typically rely solely on a combination of user charges and public budgets, are not providing sufficient funding for their transport systems. Thus there is a need for new funding mechanisms and packages of mechanisms. We examine in turn further user contributions, public budgets, value capture, cross funding and private finance. The task of financing an urban transport system may be divided into two main elements – namely, financing the ongoing costs of the system, including servicing any debt, and the provision of capital for investment. Whilst some financing mechanisms, such as general taxation, may to some extent be used for both purposes, others – such as private finance – may only be used for the latter. In practice, it is almost inevitable that a variety of financing mechanisms will be used in any one city. Thus, as well as examining individual pricing mechanisms, we also put forward alternative packages of measures for consideration, and provide advice on the circumstances in which each package may be appropriate.

4.2 Fair and efficient pricing in an urban area

4.2.1 Introduction

User contributions, in the form of prices, charges or fees, represent one of the most important ways of financing urban transport systems. They can be set according to either a cost-orientated approach or a demand-orientated approach. In the first approach, prices should reflect the (additional or full) costs incurred by the use of the transport

system, while the second one seeks to reflect the benefits derived from that use (according to the users' willingness to pay).
One of the cost-orientated approaches is the social marginal cost pricing principle. According to economic theory, an efficient urban transport system would imply prices set according to the additional cost that extra use of the system - an extra journey- would generate, including both the operating costs and the costs associated with all types of external effects (pollution, congestion, accidents and noise). In other words, transport prices should reflect the marginal social cost. This means that, in considering whether to make a particular journey, or what means of transport to use, transport users will compare the benefits of the trip with what the trip will cost, and the cost to them will reflect the cost to society as a whole.

What fair pricing for urban transport implies is, however, much more difficult to describe since the concept of fairness is controversial. Fairness can be defined and interpreted in different ways. The first one refers to an equal treatment of the different transport modes. Under this view, by applying similar and transparent pricing principles to all transport modes, a fair treatment is guaranteed. In this respect, social marginal cost pricing contributes not only to efficiency, but also to fairness by making the prices of the different modes reflect their own social costs.

Fairness can also be interpreted as social equity. From this point of view, the distributional impacts (how costs and benefits from the different measures are distributed among the different income groups) of the different pricing principles should be considered. Thus, fair pricing can also be interpreted as pricing which does not have negative distributional impacts or regressive effects, i.e. lower income groups paying relatively more than higher income groups. In this respect, efficient prices might not contribute to a fair pricing of the transport system since the social marginal cost principle does not allow for differences in income levels. Therefore, there can be a trade off between allocative efficiency and equity, and efficient pricing may need to be accompanied with some kind of compensation measures in order to generate a fair and efficient transport system. Equity concerns can be most efficiently addressed with direct income transfers or tax reductions. For instance, additional user charges in the form of urban road pricing could be used to reduce fixed taxes on motoring, such as vehicle excise duty, on those vehicles which have electronic road pricing devices fitted. This would help those poorer members of society who are in a position where they need to own a car. Alternatively, or as well, the charges may be used to reduce public transport fares. Ideally, such compensation measures would be targeted specifically at poorer groups, but that may be difficult to achieve in practice.

4.2.2 Current situation

In the current situation, users normally pay for public transport use via single journey tickets or travel cards, and for private transport through annual vehicle charges and fuel tax. Often there will also be parking charges, and in a very small number of cities also some supplementary charge, such as the ring tolls for entering Oslo, Bergen and Trondheim.

In general, the reality shows that both public and private transport charges are not reflecting marginal social costs. Given the time pattern of travelling (high traffic during the peak hours and lower traffic during off-peak hours), a proper implementation of the marginal social cost approach would require a set of differentiated prices with higher prices implemented during the peak periods and lower during the off-peak ones.

As mentioned in previous chapters of this handbook, the problem of congestion is highly related to the problem of scarcity of infrastructure in urban areas. For an optimal outcome, therefore, the options of restraining use of the existing infrastructure and of expanding infrastructure capacity need to be considered alongside each other. It may be assumed, however, that the cost and damage of building new infrastructure in urban areas are such that infrastructure scarcity will remain a major issue. Currently, in most cases, infrastructure charges do not account for the actual costs of using the infrastructure. Decisions on that use are made on the base of actual prices being paid, and not on the base of actual costs being imposed. The demand for infrastructure use in congested situations is, therefore, higher than it should be. In order to put this right it is necessary to charge for the additional costs of the delay caused to all other road users by an extra journey (i.e. marginal external congestion cost). Charging for congestion costs will also contribute to an efficient provision of infrastructure, since only an efficient use will reveal the willingness to pay for an increased level of infrastructure provision.

Regarding environmental costs, the same picture is shown. Urban transport users do not bear at all, or only to a small extent, the environmental costs their transport decisions cause. The costs of air pollution from transport emissions are considerable and effects extend to local, regional and global levels. Some environmentally orientated taxes can be found in the Member States aiming at reducing the environmental impacts of the transport sector[11].

Despite these attempts, environmental costs remain largely external. In general there is no attempt at quantifying all the costs in terms of air pollution, noise, global warming and additional accident costs caused by an additional journey (i.e. the marginal environmental cost) and to reflect these in the price. Different instruments have been proposed to charge for the marginal environmental cost. Although an emissions tax is in theory the best instrument, the high transaction costs associated with implementation make it not feasible. Alternatively, actual emissions can be estimated according to the distance driven and the environmental performance of vehicles (emission per kilometre

[11] In Sweden, for example, different differential taxes have been implemented: a differential gasoline fuel tax that favours unleaded gasoline against leaded gasoline; a differential tax on diesel fuel based on its environmental characteristics and promoting the use of cleaner diesel fuels; and a differential vehicle taxes in order to stimulate the sales of vehicles with lower emissions. Vehicles or sales taxes are also found in other Member States. In some of them (Austria, Finland, Greece, Netherlands and Germany) tax reductions have been temporary introduced to promote cars with catalytic converters. (The EU Green Paper, 1995).

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for each vehicle type). A set of distance and vehicle-differentiated user charges would then be needed.

Given that certain minimum load factors are obtained, external costs (congestion, air pollution) from public transport are lower than those derived from private transport. However current public transport fares, especially in peak periods, do not reflect them. Even more, it is generally common in European cities that fares are not sufficient to cover the marginal operating costs in peak periods. Deficits on operations have traditionally been covered by subsidies from the general budgets.

This situation is to some extent the result of a pricing policy that has not clearly aimed at getting an efficient public transport system. In many member states public transport is not only regarded as a service for everyone but also as a basic right for the population. Equity considerations have then dominated the setting of the fares system. Additionally, other (macroeconomic) policy objectives have been pursued in the setting of public transport fares, for example, the control of inflation and support to other sectors.

Given the current restrictions on the use of public resources and the need for an equal treatment of the different transport modes, public transport should also move towards efficient pricing. In order to reflect social costs, fares should charge for the additional (external and operating) cost imposed by an extra passenger. As in the case of private transport, the additional cost imposed will vary according to the time of the day and the length of the journey. The application of the social marginal cost approach to pricing public transport will then require a time and trip length variant fare structure.

Some degree of subsidy would still be needed to implement marginal social cost pricing. But it is the case that public transport fares tend to be based on historical accident rather than a carefully assessed case for subsidy. Politicians frequently fear the consequences of increasing public transport fares and provide subsidies to avoid the necessity to do so, rather than for any well thought out strategy.

Finally, the current situation is also characterised by a lack of finance for investments. The level of infrastructure charges does not provide sufficient resources to cover both operational and capital costs. On the public transport side, fares can hardly cover operational costs. Therefore, not enough resources are generated to finance new investments.

The move to an efficient price system does not guarantee, however, that sufficient resources will be raised for all and future financial needs. It is likely that the implementation of marginal social cost pricing for roads in high congested cities would lead to a surplus that can be used to recover possible deficits in the public transport (through cross-funding) and/or finance future infrastructure investments. Otherwise, the finance of new investments should rest not only on appropriate charges for infrastructure use, as mentioned above, but also on other types of financing mechanisms, like value capture.

In the Stockholm Case Study, the efficient price structure for private transport and fare structure for the public transport sector are estimated illustrating how current fares do not reflect appropriately the social costs. Both the efficient and current fare structure and the corresponding fare levels are shown in the following box.

Box 1 - EFFICIENT PRICING - the example of Stockholm

Current pricing policies lead to under-pricing of private transport, particularly in the peak, and also often off peak public transport. This may be illustrated by the case study of Stockholm, in which it is found that private motoring does not pay for the congestion and pollution it creates particularly in the peak. Whilst peak public transport users who buy single tickets do more than cover both extra operating costs and the congestion and pollution they cause, this is far from true for the majority, who buy heavily discounted season tickets. By contrast, in the off peak, the public transport system could take a lot more passengers at virtually no additional cost.

(Example from Stockholm case study)

Charge per journey (SW K)	**Existing**	**Proposed**
Road pricing for car (in addition to current fuel tax)		
Peak	0	4.52
Off-peak	0	1.63
Public Transport (single fares)		
Peak	15.44	12.39
Off-peak	16.99	0
Public Transport (Travel card)		
Peak	8.99	14.51
Off-peak	0	0

4.2.3 Measures to reflect social marginal social costs in prices

In the previous section it has been pointed out that the current transport prices in urban areas are far from reflecting social costs. In order to move towards a fairer and more efficient urban transport system, a system of differentiated prices should be introduced to reflect differences in costs according to time (and location) and duration of journeys.

The full introduction of such a system would require the implementation of electronic road pricing. This type of pricing equipment has significant advantages in terms of flexibility and non-interference with the traffic flow. However, they still rely on expensive and unproven technology, which imposes practical feasibility constraints on their use in terms of costs and reliability. As a consequence, there is a trade off between efficiency and practical feasibility that should be taken into consideration.

The full adoption of prices based on social marginal costs by means of electronic road pricing will also face problems of acceptability by some transport users. It is considered that the main opposition to such systems will come from poorer private road users, road freight operators and local commercial interests. The first two will experience an increase in their transport costs leading to a reduction of available budget for the first, and an increase in production costs for the second. Commercial interests may experience a loss of clients when alternative similar sites are available and cheaper in terms of mobility costs. All these oppositions can, however, be mitigated by accompanying measures. Use of the revenues raised to improve public transport, facilities for walking and cycling and the city environment, provided that the money is spent wisely, may also offset some of the immediately perceived disadvantages.

Because of the above mentioned problems in terms of costs and risk of unreliability, only in dense urban areas where a highly differentiated price system is required, is electronic road pricing likely currently to be appropriate and justified. It should then be implemented only in large cities with high externality problems. For small/medium cities and large cities with no important externality problems, the use of sophisticated pricing equipment will probably not be justified in the short/medium term. Therefore, other kind of measures should be adopted in those cases.

Much simpler solutions such as parking charges (including measures to tax private parking spaces), cordon tolls and area licensing for the central areas can provide an approximation to social marginal cost pricing. Although a fully differentiated price system cannot be implemented, some degree of differentiation might be achievable through charging high prices during the peak hours and lower prices during the off-peak periods. Therefore, these measures might provide an increase in efficiency in relation to the current situation, forming useful starting points towards full road pricing.

Parking charges are commonly used in urban areas to cover scarce public space and/or private infrastructure costs. However, with an extended approach to accounts, to include environmental and congestion costs, they may provide a further contribution to efficiency. Environmental and congestion costs can be charged by including a surcharge in parking prices. There is a problem however in dealing with private parking spaces. In particular private non-residential parking areas in cities tend to be heavily used by commuters. Some form of tax or levy on such spaces is therefore needed, which would be intended to reduce private commuter journeys during the peak period which are generated because of the existence of free or cheap workplace parking. Even then, parking charges will not affect through traffic, which may actually increase as a result of the reduced congestion.

In terms of practical feasibility parking charges, cordon tolls and area licenses face much less constraints than full electronic price systems. Those measures often use manual collection systems, which are slow and costly, but implementation of which is not subject to any technical obstacle. With cordon tolls there is additionally the problem of the space needed for the collection stations. Again, this may be minimised by the use of electronic systems. Use of this mechanism is becoming more common. Area licences, on the contrary, do not have most of these disadvantages, but they are, however, subject to important enforcement problems.

Box 2 - ROAD PRICING

Road pricing is increasingly seen as a major part of the answer to both the problem of efficient pricing and the problem of financing urban transport systems. It is slowly being implemented across the world as shown below.

Singapore implemented road pricing, in the form of an 'Area Licensing Scheme', in 1975 and in 1998 an electronic system was implemented so that motorists could pay electronically for the use of a major expressway in the city. The new system is based on a relatively simple dashboard-mounted stored value card, detected by card-readers mounted on overhead gantries along the strategic roads. The card-reader is activated by a microwave signal and the toll is deducted. A key feature of the new system is that the prices may be adjusted according to time of day and traffic volume. However, care should be taken in comparing Singapore to European cities as it is accustomed to a lot of government control and people are worried less about privacy than the extra charges they will have to pay to use the highways.

Trondheim in Norway, a city of 140,000 population, implemented the World's first fully automatic toll ring in 1991. The pricing scheme is based on a cordon, which surrounds the city and has 12 entry points. At each entry point there is a paying station where road users have to pay a toll rate of 8 nok with a reduction in off peak hours of 30% of the price. Tolls have been used both to raise funds for investing in the improvement of mobility and to influence the times that people travel and the routes/modes that they choose in order to reduce congestion. Since implementation, the city has experienced a 10 percent drop in rush-hour traffic and opposition to it has declined from 70 percent to fewer than 50 percent.

Simpler systems, based on prepurchased data cards or chips, are operated on New York and New Jersey roads in the United States, and on toll roads leading into Oslo, where vehicles have a data chip to put in the windshield and there are cameras to record violations.

Finally, regarding the acceptability of these measures, the same kind of opposition can be expected whenever their implementation associates additional costs to transport use. The greater the cost increase, the greater the opposition will be.

Similar to the case of road transport, the application of a fully efficient system of public transport fares would require the use of sophisticated pricing equipment. Highly diversified tariffs are difficult to implement without a system like smart cards, which would allow debiting a fare according to the time of travel and the length of the journey without the need to handle cash. The use of this type of card is considered the most effective one not only to allow a differentiated fare structure for public transport users but in general to improve the ease of use of public transport as part of a chained service between different modes of travel (park and ride, bus, metro, train and so on).

The technology for installing smart-card systems is in principle available, but it has still only been proved to a limited extent in practice. Furthermore, there are managerial issues to resolve if they are to cover a variety of modes of transport and operators. Therefore, as in the case of road transport, there are practical constraints associated with the use of more sophisticated public transport fare systems, and the fixed costs of doing so may currently only be justified in cases where highly differentiated fares are required, i.e., in large cities with a wide variety of modes and trip lengths. But the number of cities (and operators) making preparations for the use of smart-card systems is quite high, suggesting that fully operational and reliable systems will be generally available within a few years.

For small/medium cities, measures towards more efficient pricing might just require a system of differentiation in levels of fares between peak and off-peak. This relatively simple pricing system poses no significant technical problems, although a practical problem still exists in dealing with the problem of artificial peaking of trips at the start of the cheaper period. Nevertheless, some cities, including Leeds, have long had successful differentiation of bus and train fares between peak and off peak.

In terms of the effects on stakeholders, the introduction of efficient prices might have the opposition of the poorer public transport users especially when a high price increase, mainly for the peak hours, is proposed. As in the case of road transport, the key to overcoming this opposition is a careful design of accompanying measures and a sensible use of the revenue accruing from higher transport prices.

4.3 Financing needs and ways of meeting them

The first and most obvious way of meeting the financing needs associated with the provision of transport services is to charge users for the use of those transport services. However, it is widely accepted that, efficient user prices will not necessarily yield sufficient revenue to meet all financing needs. Evidence from the FATIMA (1997) research project suggests that, if efficient prices for transport services were levied, those efficient prices would, in certain situations, cover financing costs. The percentage of costs covered by efficient prices varies for a number of reasons, including:

- the city size;
- the scale and characteristics of the local public transport network; and
- the levels of traffic congestion and other external costs.

Therefore, efficient prices will, in certain circumstances, fully meet the financing needs associated with the provision of transport services[12]. At least in these sorts of circumstances, the first recommendation is that efficient pricing principles, where prices are set to equate with social marginal cost, are used to calculate prices for the use of:

- Roads services - through road pricing;
- parking services - through parking pricing; and
- public transport services - through public transport fares.

Even in this situation, however, there may be needs for capital finance to pay for new projects, even if ultimately user contributions will suffice to service this capital.

However, there may be barriers, related to feasibility or acceptability, which prevent efficient prices from being charged; in this situation some kind of second best set of prices must be devised. When devising this set of prices, cost recovery is often one of the objectives considered.

The following sections highlight different ways in which the financing needs, resulting from the failure of efficient prices to cover financial costs or the inability to implement efficient prices, may be met.

4.3.1 Further contributions from users

Where efficient prices do not provide a sufficient means of financing, one of the available options for bridging the gap between user contributions from efficient prices and the full financial cost is to secure further contributions from users. There is a variety of ways of doing this. One option is simply to increase all prices to reflect the average costs of the services in question. Some will consider this the fairest way of doing so. However, in terms of efficiency, it is

[12] This does not allow for the fact that part of the charge might arguably be used to provide compensation to victims of accidents or pollution. However, the major sauce of revenue is congestion charges.

better to seek the price increases that least distort user decisions, via the adoption of second best pricing strategies such as 'two-part-tariffs' and Ramsey Pricing.

'Two-part-tariffs' combine efficiency, through marginal cost pricing, with cost recovery. Users are charged according to their marginal costs (differentiated according users) and an additional flat charge in order to reach full cost recovery. The flat charge can be seen as an entry fee to the system, and may itself be differentiated according to the willingness to pay of the user. The combination of the (fixed) vehicle tax and the (variable) fuel tax applied in most countries can be seen as an indirect two part pricing system. Two Part pricing systems for public transport are less common, but exist in the form of cards, valid for a particular period, but which allow tickets to be bought at a discount. Again, the ticket price may then be aligned to marginal social cost, whilst the desired level of cost recovery is achieved through the fixed charge.

The problem with two part tariffs is that the fixed element itself may induce a change of decision – for instance as to whether to own a car, or whether to use public transport at all. In general, the likelihood of such an effect is less likely in the private transport sector, for the fixed cost is typically a small part of the total cost of owning and running a car.

Ramsey Pricing is an approach which differentiates prices according to users price elasticity of demand. The lower the sensitivities of different user groups to price, the higher are possible prices without having a big effect on demand. Such schemes are widely applied in long distance travel markets. Examples of the Ramsey Pricing approach within the transport sector include different classes of travel, or prices according to length of stay, designed to differentiate according to whether, for example, it is business or leisure travel. It is more difficult to apply such measures in urban areas. The main difference in elasticities which may be exploited is the much lower price sensitivities of journeys to work compared with optional journeys for leisure purposes. This again suggests higher peak than off peak prices. Similarly, in business areas for example, parking prices could be higher than in residential areas . There is also the possibility of giving lower prices to specifically identified groups believed to be more price sensitive than the average. For instance, lower public transport fares are often offered to pensioners, although more on social grounds than grounds of economic efficiency.

Although such measures are generally feasible, acceptability may be an issue particularly where they lead to significantly higher peak fares.

Box 3 – POSSIBLE SUPPLEMENTARY USER CONTRIBUTIONS

1. Average cost pricing

Everyone pays the same. Simple, may be seen as fair but inefficient. Some people who would be willing to pay their marginal cost are priced off the system, whilst others who are not willing to pay marginal cost (e.g. in the peak) continue to travel.

2. Two part tariffs

Car use is almost always charged on a two-part tariff, with an annual vehicle excise duty plus fuel tax or other user charges. If the annual charge does not affect how many people own cars then it is non-distorting.

Two part tariffs may also be used on public transport (e.g. cards giving a discount on the price of tickets) but the fixed part of the charge is likely to have a bigger effect on public transport use.

3. Charging according to willingness to pay.

This approach, technically known as price discrimination, attempts to charge more those users willing to pay more. Generally it involves dividing the market into segments (e.g. peak and off peak), and raising charges most in those segments that are least sensitive to price. Although it minimises distortions, it cannot prevent them altogether (unless each traveller is charged a different price, which is an impossible degree of price discrimination).

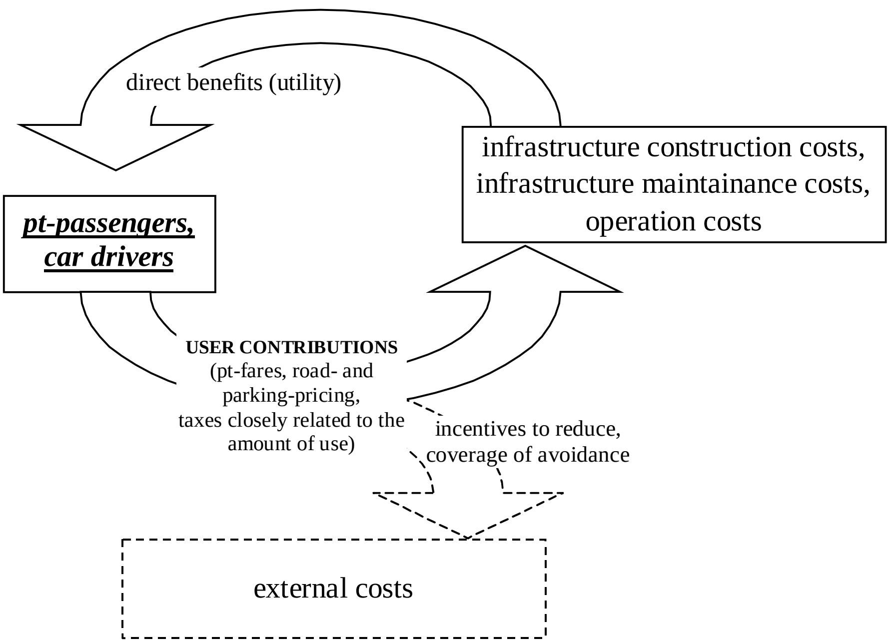

Figure 10: Financing by User Contributions (conceptual) – IFIP 1999

4.3.2 Public budgets

Public budgets are clearly a second source from which the financing needs, resulting from the failure of efficient prices to cover financial costs or the inability to implement efficient prices, may be met. Where there is market failure there is the theoretical basis of a case for public intervention in the market place. In transport, this case exists as externalities are common and there are elements of the infrastructure, which exhibit decreasing costs. A particular characteristic of public transport is that increases in traffic either raise load factors or lead to improved service frequency. In either case, the marginal social cost of the increased traffic is likely to be below the average. Where there is evidence that ‘market failure’ is resulting or will result in efficient prices failing to fully meet the financing needs associated with the provision of transport services, there is, therefore, a clear case for public subsidy. However, efficient prices may fail to meet the financing needs associated with the provision of transport services for other reasons than that of market failure, e.g. due to insufficient demand for or over-supply of those services; in this example, this is evidence of a failure in the project appraisal process rather than in the market system. Even where there is evidence that efficient prices are failing to meet financing needs as a result of ‘market failure’ and the prima facie case exists for public subsidy, the public finances may be insufficient to meet financing needs. This is because there are reasons for governments not wanting to increase the overall size of public budgets and because other calls on the public purse may offer better ‘value for money’ or take political priority. In these situations, the result may be that financing needs are left unmet or only partly met by support from public budgets. Therefore, it is important to be clear about the reasons why efficient prices fail to meet financing needs, to develop a robust appraisal of ‘value for money’ and to be clear about prevailing political priorities.

Public expenditure can occur directly as either payment for goods and services or as transfers to producers, such as subsidies. It can also occur indirectly as losses in receipts/negative revenues. It may be financed from general taxation, specific ear-marked taxes (but these often have more the character of user contributions, as for instance the surcharge on petrol to fund transport infrastructure in Germany), public borrowing, or profits on other activities. The latter will however be considered separately as ‘cross-funding’ below.

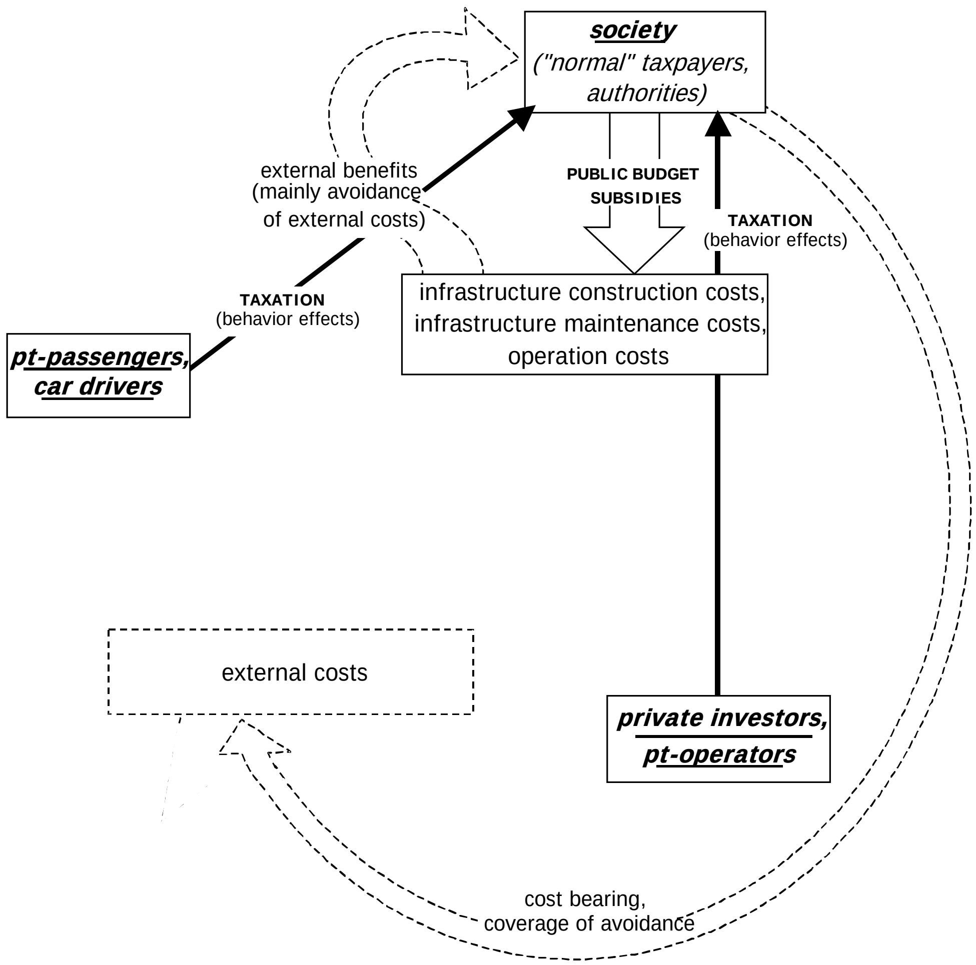

Figure 11: Financing by public budget (conceptual) IFIP 1999

4.3.3 Value capture

Value capture describes a group of financing instruments, which seek to recover secondary benefits, which would otherwise be uncharged. The approach relies upon the existence of such secondary benefits, which are benefits to 'third parties' or to the economy as a whole, and upon the capturing of these benefits being possible.

For instance, improved transport may make an area or more desirable one in which to live, work or shop, and thus raise land values, improve business sales or make recruitment of a suitable labour force cheaper and easier.
For the most part, such benefits represent a transfer of the benefit of better or cheaper transport from the user to the owner of property or the employer (technically they are known as pecuniary external benefits). Thus value capture is to some extent an alternative to user contributions.

All these effects offer opportunities for value capture. Attempts have been made in many countries to tax the increases in site values due to public decisions, including improving transport infrastructure, but these have many practical problems including identifying the increase in value due to the measure in question. A simpler, if less precise measure such as a tax on property values, turnover or employment in the locations in question (the French 'versement transport') is likely to be more feasible.

Box 4 – VALUE CAPTURE

Whilst significant examples do exist of value capture in the form of voluntary contributions they are not common. In the case of the City Extension to the Docklands Light Railway in London, developers contributed £100m of the total £280m capital cost. However, this was a situation in which the extension was in doubt, and it was seen is very important by a single major developer. So the usual temptation to free-ride was not present.

Value capture through dedicated employment taxes have been most successful in France. The 'Versement Transport, introduced in 1971,is now applied in all French urban areas of more than 100,000 population and is credited with making possible the large number of Metro and Light Rail systems which exist throughout France. All employers with more than 9 employees, unless employees live on the premises or the employer provides transport, are subject to the tax and the tax rate, a proportion of payroll costs, is set by the Autorite Organisatrice within nationally set limits. It raises significant amounts of money - in excess of 2.5 bn Euro in 1993 - 40% of which is used for capital investment in the provinces but only 15% in Paris; the balance being taken up in operating subsidies.

The main worry about this crude approach to value capture is that it might have undesirable effects on city employment. More sophisticated approaches, designed to capture the benefits enjoyed in the form of increased land values, have generally been hard to administer.

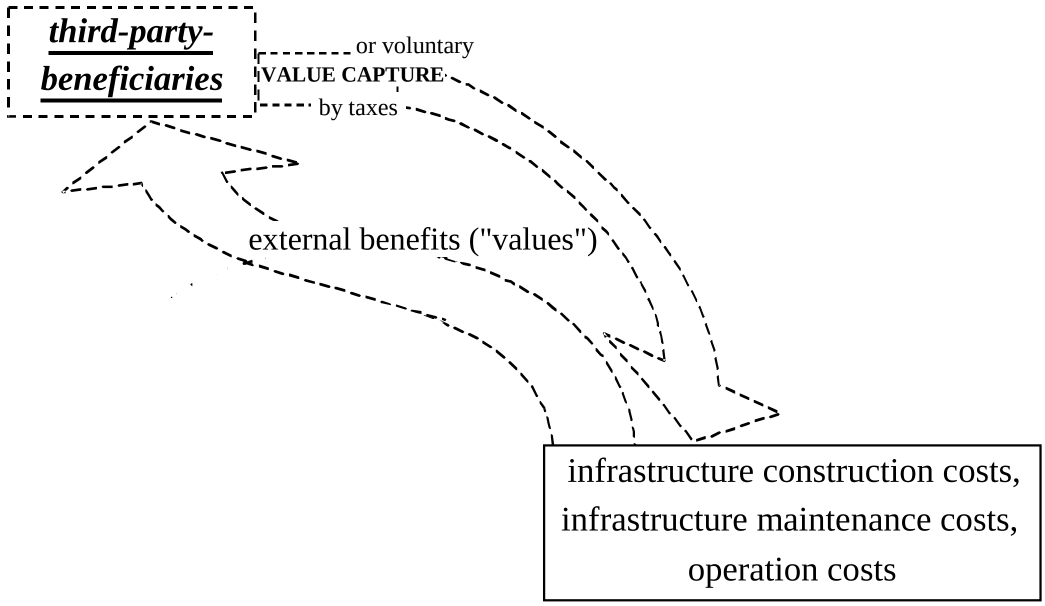

Figure 12: Financing by value capture (conceptual) – IFIP 1999

4.3.4 Cross funding

Cross funding is the approach of using profits from some activities to cover losses on others. It is common in countries where the local authority is responsible for activities such as electricity, gas and water as well as transport. However, it involves the risk of inefficiencies in both the source and the recipient market. In the source market, prices are raised above marginal costs, whilst in the recipient market, subsidies are provided which may lead to inefficiency. Generally speaking cross-funding is associated with monopoly in both markets, and with the spread of deregulation the extent to which markets in which local authorities can make the necessary profits exist is declining. Cross-funding may be achieved by means of competitive franchising in both markets, and here the risk of inefficiency is reduced.

Generally speaking, cross funding may be disregarded as an important source of funding for transport with one very important exception. That is where the characteristics of the two markets make it efficient to raise profits in one market and to subsidise the other. This is exactly true of private and public transport, where the existence of congestion and environmental costs lead to a financial surplus on private transport, whilst economies of scale demand subsidies for public. Cross funding of public transport from private is expected to become an even more important source of funding in the future as more sophisticated road pricing schemes spread.

Box 5 – CROSS FUNDING

The most attractive form of cross funding for transport appears to be actually within the transport sector, using profits from road user charges for public transport subsidy and investment.

A simple form of this has been in use in Germany for more than 30 years. Under this a surcharge on petrol is used to finance approved public transport infrastructure schemes. It is this funding that has led to most German cities having excellent rail, metro or light rail systems.

In Switzerland, it is proposed to use the funding from increased HGV taxes to finance the rail base tunnels under the Alps.

In Britain, it is proposed that the proceeds from introducing road pricing, or a tax on private non residential parking spaces, should be earmarked for local transport improvements for at least 10 years.

It should be noted that whilst such earmarking may go a long way to improving the acceptability of new pricing measures, it could lead to transport schemes being undertaken which were not the best use of the money available, or to transport projects being financed in a manner which was not the most efficient. Furthermore, it should be noted that this method very often corresponds to an indirect form of cross funding since fuel and/or road user charges are collected by central government while public transport is in most countries a responsibility of local governments

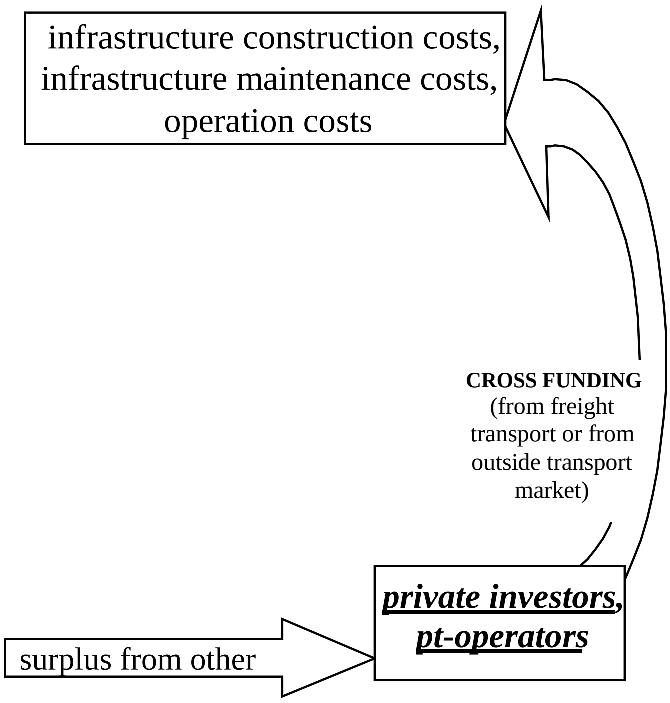

Figure 13: Financing by cross funding (conceptual) – IFIP 1999

4.3.5 Private finance

The use of private finance in the transport sector is growing, both as a way of relieving existing capital shortages and because it is perceived as bringing with it the added efficiency of private sector management. On the other hand, the cost of capital to the private sector is generally above that to the public, so it will not be sensible to use private finance in the absence of advantages such as these.

The most obvious form of private finance is the outright provision of facilities by the private sector. However, this could lead to decisions strongly at odds with public policy in terms of the facilities and service levels provided and the prices charged. It is therefore more common in the transport sector to go for some form of public-private partnership.

The private sector may take on any of the following functions – design, build, operate, maintain, finance and transfer – leading to acronyms such as DBFO or DBOM to represent the particular combination in the projects concerned. Of course we are here concerned only with projects where one of the private sector functions is to finance, at least in part.

An innovative form of private finance used in some countries is the ‘shadow tolls’ approach. Under this, the government pays the private owner of the facility a toll according to the volume of traffic using it. This toll need not correspond therefore to any charge actually levied on the users. A disadvantage of this form of funding is that it gives the private owner a strong interest to promote traffic growth even where that is not consistent with public policy. A more orthodox system of franchising, in which the government authority controls prices and pays any necessary subsidy resulting from a competitive franchising process, may therefore be more desirable.

Still, private finance by itself must be seen as a financing instrument of a different nature from those described above, as the money put up by the private financier has to be paid back through one or several of the other financing instruments. It is thus, above all, a project leveraging instrument.

Box 6 – PRIVATE FINANCE

The proportion of finance for transport, which comes from the private sector, is growing but still quite small; "the availability of commercial bank finance for European transport infrastructure is conservatively estimated to be around EURO 2.4-6.0b per annum. In relation to expenditures of over EURO 70 b per annum" (Farrell, 1998). Also, much of that which exists has been focused on large-scale inter-urban projects.

The well-established tradition of contracting out of municipal services in France has aided the development of public private partnerships there. An example of a successful public private partnership project is the Pont de Normandie, which opened in 1994 under a 35-year concession granted to the Chamber of Commerce and Industry of Le Havre. The project cost was approximately 265 MEuro, which was funded by a syndicate of 20 banks with loan guarantees from regional and local government. A number of 'Design Build Finance and Operate' contracts have been let for 'shadow toll' roads in the UK. These include the M40, the A19 and the recently opened A1M1 link road.

A notable example of private finance for an urban transport project is that of Manchester metrolink. The project was developed under a Design Build Operate and Maintain concession agreement and was successfully opened in 1992. Initially the payment for the operating concession, i.e. the private sector financing contribution, was only £5m, a small proportion of the £140m total system cost. However, when a subsequent replacement contract to extend the system and to operate the whole resultant metrolink system was let two years later, a £90 m private sector financing contribution was secured in contrast with an additional construction cost of £100 m.

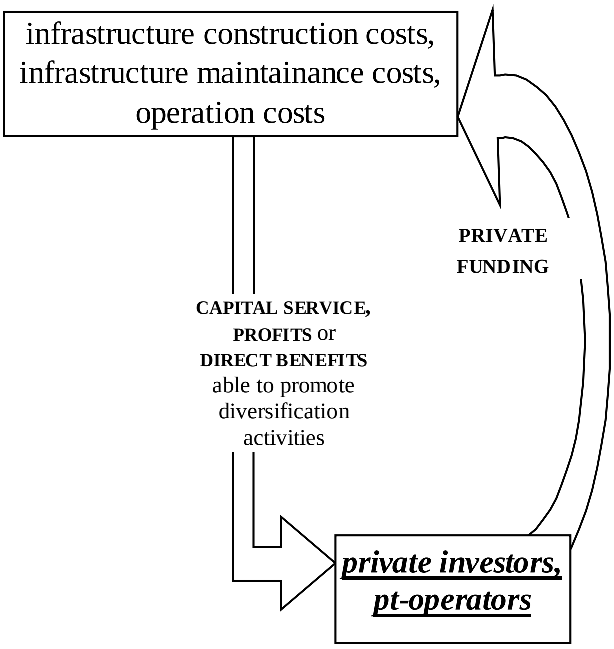

Figure 14: Private financing (conceptual) – IFIP 1999

4.4 Financing packages

4.4.1 The need to examine packages as a whole

There are three main reasons that explain why packages of measures may be more appropriate for financing urban transport systems than individual financing mechanisms.

First, it is of general acceptance that urban transport systems cannot be financed from a single source. In the presence of decreasing costs, user contributions set according to the social marginal cost principle might not cover total costs from some services.

Deficits from the transport sector are generally covered by subsidies from the general budget. However, this financing source is now being questioned given the current pressure to reduce public expenditure and the existence of other sectors also demanding public support. The profits from transport and non-transport activities/services can also be used to cover (public) transport deficits.

Cross-funding within the transport sector is mainly justified when there are high external costs in some markets and economies of scales in others.

Finally, value capture is seen as a funding source that may contribute to covering operating costs and, especially, financing investment, in a fair way since it is paid by beneficiaries of the system.

When the resources required to finance new investments are added to the operating costs of current transport infrastructures and facilities, the role of single sources in financing urban transport systems is even lower. Private finance constitutes a major and growing additional source of funding for investment, but it cannot usually be used to cover operating costs; on the contrary it creates a need for a method of funding to service the capital in question.

And thirdly, the previous section has also illustrated how the different financing mechanisms trade off between efficiency, acceptability and practical feasibility. The use of a combination of different mechanisms might offset the disadvantages of one instrument with the advantages of another.

4.4.2 Suggested alternative packages

Clearly, a large number of alternative funding packages may be put together, and what is seen as most suitable will vary very much with the situation in the city in question. What follows should therefore be taken to be illustrations rather than a definitive list. They have been chosen rather to illustrate the range of options available, and therefore tend to be rather concentrated at the extremes of what is available.

Table 8 summarises the financing instruments considered in the previous section. It also identifies which instruments are generally available to local authorities and which are under the control of central government. Of course it is always open to central government to earmark part of the revenue from instruments they control for use by local authorities, but although they may lobby for it, local authorities generally cannot ensure that this will happen. Moreover, in some countries even the use of the instruments shown as being available to local authorities will be subject to authorisation by central government.

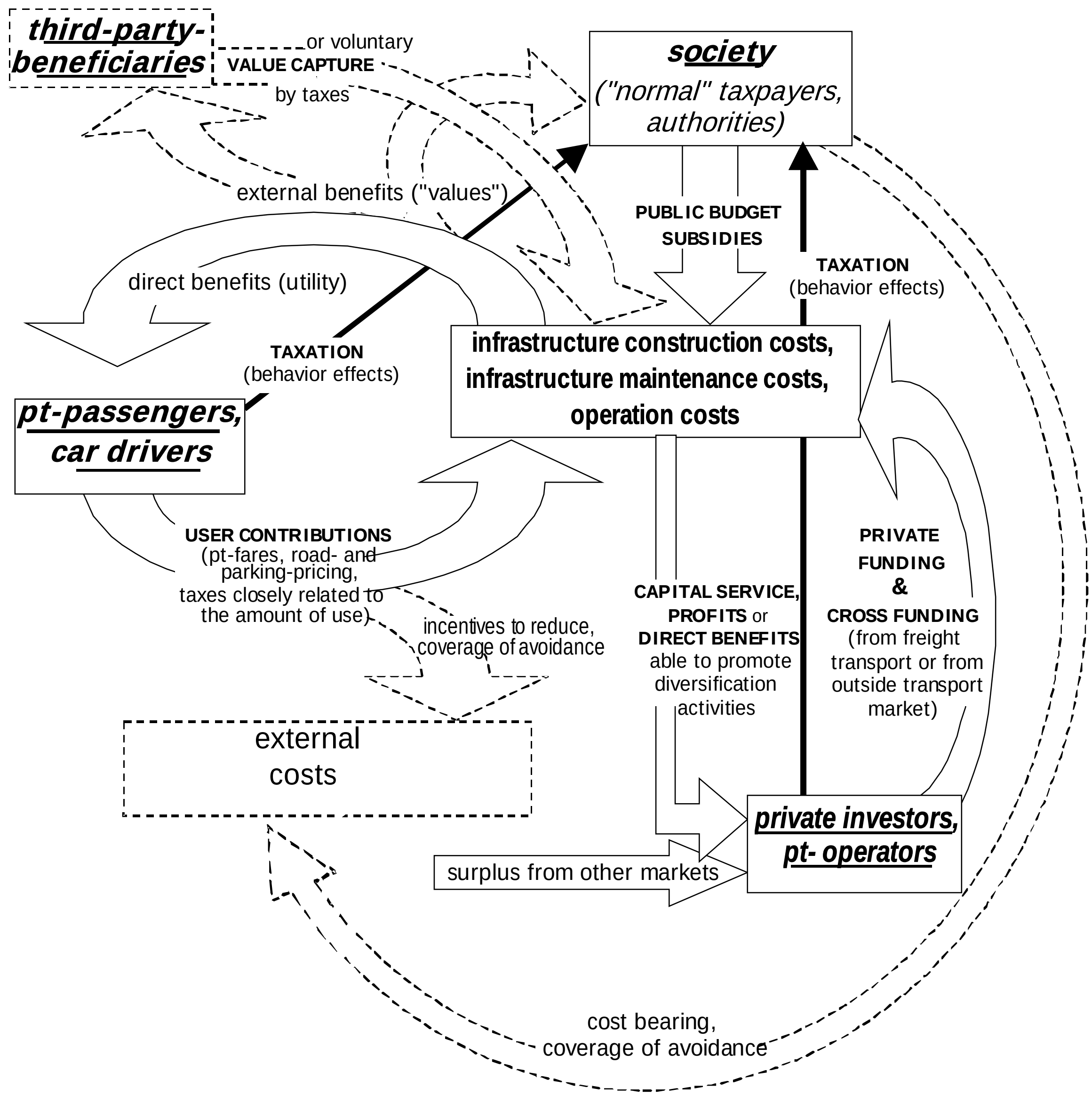

Figure 15: Financing alternatives in Urban Transport

Financing Means – Summary Table

	Usual Decision-Making Body
1. User Contributions	
Public Transport Fares	Local
Vehicle Licensing	National
Fuel Tax	National
Area licensing, cordon tolls, electronic road pricing	Local
Parking charges	Local
2. Public Budgets	
General taxation	National
Local budgets	Local
3. Value Capture	
Property or employment taxes	National or Local
4. Cross Funding	
Profits from road pricing or other local enterprises	Local
5. Private Finance	
Privatisation	National or Local
Shadow tolls	National or Local
Franchising	National or Local

Table 8: Financing alternatives in Urban Transport

The specific funding packages are as follows:

1. <u>Public Sector</u>

The package aims to implement social marginal cost pricing by:

– in large cities, electronic road pricing with a charge varying with distance travelled and time of travel (high peak, low off peak); and a similar tariff implemented for public transport by means of smart cards.

– in small cities, a more crude approximation by means of parking charges or a cordon charge for entering the central area (high peak, low off peak), plus flat fares for public transport (high peak, low off peak).

- subsidies (where needed) and capital requirements met from public budgets.

The starting point is pure efficiency pricing. It is assumed that either revenue raised is sufficient to cover all current costs and service all capital; being capital or that subsidies are provided from general taxation: capital requirements being met by public sector borrowing. The coverage of all operating costs might well involve cross funding of public transport deficits from road pricing.

2. Public-Private partnerships

The aim of this package is to eliminate need for contribution from general taxation whilst maintaining efficient pricing, and maintain public control of fares/services e.g. by franchising. It comprises:

– social marginal cost pricing of users as in package 1.
– but with capital requirements met by private finance, and operating and capital servicing costs covered and remunerated, respectively, through a combination of efficient user charges and subsidies funded by value capture (to be broadly interpreted to include voluntary developer contributions and specific taxes, e.g. on employment), and supplementary user charges.

3. Commercial

This package would make each mode commercially viable, possibly on the basis that this is necessary for equity reasons, or possibly to facilitate privatisation.

– user charges to be set at a level which makes all transport facilities profitable, so that no subsidies are needed. Pricing instruments are as in other packages. Ramsey pricing and two part tariffs are to be used as necessary, so that charges, especially in the peak, may be higher than socially optimal (but regulated to follow ‘second best’ principles);
– taxes are imposed to cover environmental and accident externalities;
– no cross financing exists between modes. Each mode is self sufficient, servicing its own capital requirements as well as covering current costs.

However, specific subsidies for certain unprofitable routes or types of rider (e.g. pensioners) may be present, funded from general taxation.

4.4.3 Evaluation of the packages in terms of efficiency and other economic criteria, acceptability and practical feasibility

Package 1 constitutes the most efficient way of financing urban transport systems, providing a fair treatment between the different transport modes. There is, however, a general concern about the social marginal cost approach in terms of financial stability.

Social marginal cost pricing might generate sufficient funding where externalities are very important, i.e. in large congested cities, allowing cross funding between road and public transport users. For smaller and less congested cities, Package 1 may give an efficiently financed transport system, although its use depends on the budgetary position of the corresponding authority.

Otherwise, and in order to secure additional resources for new infrastructure investments, Package 2 (public-private partnerships), and the use of value capture, may turn to be more desirable since efficiency is still attained, and fair since possible beneficiaries are also considered in the financing system.

When none of the previous packages generate sufficient funding, the commercial approach of package 3 might be preferred. The full cost-pricing package may be also more advantageous in providing additional incentives for managerial efficiency.

However, it raises major problems as a consequence of the price increase in public transport that might give rise to the undesirable effect of modifying mode split in favour of private transport rather than public, with the consequent increase in externalities and undesirable distributional impacts.

In terms of acceptability or effects on stakeholders, it appears that the main opponents to more efficient prices will be low-income private car users, road freight operators and local commercial interests.

Poorer motorists because the increased price for both car and its second best alternative, i.e. public transport, will impact negatively on their net income representing a direct constraint in their mobility.

Freight operators will fear an increase in their cost structures, although this may be largely offset by the benefits of less congestion. And commercial entrepreneurs will expect price changes affecting mobility patterns and making some areas of reduced attractiveness. Problems with social marginal cost pricing may be overcome in congested cities by sensible use of the revenue.

In package 2, and even more so in package 3, these opponents will be joined by poorer public transport users, that will fear the raising of user charges due to the profit oriented attitude of private finance (although the authority should be able to avoid this happening by appropriate specification of fares in package 2; it is only in package 3 that it is a real, rather than merely a perceived, problem).

The key to overcoming this opposition is the careful design of accompanying measures and the use of revenues accruing from higher transport prices.

In terms of practical feasibility, the relatively simple systems proposed for small cities pose no technical problems, but the more sophisticated systems of link based electronic road pricing and smart card based public transport fares varying with time of day rely on less well proved and more expensive technology.

Although package 1 is subject to some legal and managerial concerns – derived from the implementation of social marginal cost pricing-, the main obstacles are the difficulties arising from implementing those sophisticated road and public transport systems. Package 2 is, however, affected by problems arising from the influence of private capital. Concerns arise regarding different types of investment risks and the decreasing power of the state to influence decisions. Finally, package 3 causes some concerns regarding its managerial and legal feasibility.

The commercial orientation of the charges might cause serious problems with equity requirements and hence with social laws. On the managerial side the controlling function of the public sector is also very important in this package. The following boxes summarise the different packages and their advantages and disadvantages.

Box 7 - Package 1: Public Sector

Package characteristics	**Pricing approach** - Social marginal cost **Funding mechanisms** - User charges by • in large cities, electronic road pricing and smart cards for public transport fares • in small cities, parking charges, cordon tolls and/or area licenses, and flat public transport fares varying between peak and off peak - Subsidies from general taxation (where needed) - Public capital for investments
Advantages	- Efficiency - Sufficient funding in highly congested cities, where high road user charges justified, and in smaller cities where funding for subsidies available - No technical feasibility constraints on the simpler pricing technologies where they suffice
Disadvantages	- Only feasible where budgetary position of authority allows - Opposition from poorer motorists, road freight operators and local commercial interests - Technical feasibility constraints on the more sophisticated technologies - Subsidies must be carefully administered to avoid inefficiency

Box 8 – Package 2: Public-private partnerships

Package characteristics

Pricing approach
- Social marginal cost

Funding mechanisms
- User charges by
  - in large cities, electronic road pricing and smart cards for public transport fares
  - in small cities, parking charges, cordon tolls and/or area licenses, and flat public transport fares
- Value capture and supplementary user charges
- Private capital for investments

Advantages
- Efficiency
- Sufficient funding in less congested and small cities where subsidies from general budget are not possible
- No technical feasibility constraints on the simpler pricing technologies

Disadvantages
- **Opposition from poorer motorists, road freight operators and local commercial interests and poorer public transport users**
- Technical feasibility constraints on the more sophisticated technologies
- Only feasible where authorities have sufficient legal power
- Decreasing power of authorities to influence decisions

Box 9 – PACKAGE 3: COMMERCIAL

Package characteristics

Pricing approach
- Full cost (Ramsey pricing where necessary)

Funding mechanisms
- User charges by
  - in large cities, electronic road pricing and smart cards for public transport fares
  - in small cities, parking charges, cordon tolls and/or area licenses, and flat public transport fares
- Taxes on externalities
- Specific subsidies for certain unprofitable routes or types of rider

Advantages
- **Managerial efficiency**
- Sufficient funding in all cases
- No technical feasibility constraints on the simpler pricing technologies

Disadvantages
- **Economic inefficiency**
- Regressive effects (inequality)
- Modal split modification in favour of private transport
- Opposition from poorer motorists, road freight operators and local commercial interests and poorer public transport users
- Technical feasibility constraints on the more sophisticated technologies
- Only feasible where authorities have sufficient legal power
- Decreasing power of authorities to influence decisions

4.5 Relating solutions to circumstances in individual cities

4.5.1 Characteristics of cities

There are a number of characteristics of cities that are likely to influence the solution to be preferred. What we see as the most important ones are discussed below:

(a) size

As discussed above, size is likely to have a direct influence on the sophistication of the pricing system that can be justified. Large cities generally have a wide variety of trip lengths, leading to a case for a high degree of price differentiation. The high fixed costs of systems such as electronic road pricing may only be justified in larger cities.

Large cities also typically have, or look to introduce, a more capital-intensive form of public transport, such as metro or heavy rail, than smaller cities. Their capital requirements may also therefore be relatively higher, further leading to the case for sophisticated pricing measures, as well as other ways of meeting financial needs such as value capture or cross funding.

(b) Institutional organisation

Institutional organisation is important, both in terms of horizontal organisation (does the authority cover the whole of the built up area in question, or is it one of a set of linking authorities) and vertical organisation (to what extent does it share power with other layers of government?). Generally speaking, the more autonomous the authority and the more wide ranging its powers, the easier it is likely to be to introduce new measures, as the complications of reaching agreement with other authorities or tiers of government are reduced.

(c) Existing policies

It seems likely that the existing policies being followed will influence the future choices although it is not always clear what is the direction of causation. For instance, there are clearly costs associated with change, so a city with existing high charges and private ownership of public transport is more likely to follow a commercial approach than one where public transport is government owned and very cheap. On the other hand it might be argued that it is exactly where existing policies are extreme in one direction that a policy change is most needed.

(d) Perceived problems

Possibly this is the most important characteristic of the city of all. For instance, a move to efficient pricing is far more likely to be supported where there are perceived to be major problems of congestion, pollution or lack of finance for investment. On the other hand, if the big problem of the area is seen to be difficulty in attracting businesses, jobs and economic development, there will be considerable doubts about the wisdom of a more efficient pricing structure if it serves to raise prices.

4.5.2 Relating financing packages to specific cities

In what follows, we try to illustrate with real examples how the magnitude of the externality problems, the size of the city, the high/low capital intensity of the public transport and the financial position of the transport authority influence the selection of the most appropriate funding package(s).

When high external costs exist, likely to occur in very large/large cities, it seems then to be the case for adopting package 1. Correct prices for private transport will generate sufficient resources to (cross) fund the subsidies that efficient public transport fares might still require and service the (likely high) capital requirements.

The results of the case studies in the TRENEN (1999) research project suggest that this package could be appropriate, for example, for Amsterdam, Brussels, Dublin and London. In all these cases, efficient pricing generates an important net increase in tax revenue, defined as all taxes minus all subsidies to public transport. The net increase might therefore be used to service additional capital requirements.

According to the results of the FATIMA (1997) project, package 1 would also be appropriate for Oslo, Torino and Vienna. Oslo represents a large urban area with a public transport highly intensive in capital and where congestion has become a major problem.

Torino is a relatively large city with considerable congestion and environmental problems and with a public transport with low capital intensity. Vienna, on the contrary, represents the case of a large city with highly capital intensive public transport but with no severe environmental situation. The existence of very scarce parking areas (in Vienna, the city centre is mostly pedestrianised) and, therefore, very high parking costs might explain why with no important external costs public sector can be self-financing.

In general, however, in large cities with no big external costs we would not expect enough surplus from private transport prices to cover public transport deficits and serve capital requirements. Subsidies from general taxation could then be used. The use of this package is however conditional on a good budgetary position of the authority.

This might represent the case of Stockholm. In the corresponding case study, it is shown that the revenues from efficient fares and road prices cannot cover all public transport costs, although they increase the percentage of cost coverage from 49% to 69%. In other words, the need for subsidies decreases from 51% to 31% of total costs. This is also the case in Helsinki and Merseyside, large cities where the environmental situation is not severe.

According to the FATIMA results, in both cases there was found to be an on-going need for subsidies in the presence of efficient transport prices.

When subsidies from public budgets cannot be used at all or to the extent required, alternative funding mechanisms should be implemented like value capture and supplementary user charges.

Capital requirements might still be provided through public sector borrowing (package 1 with additional user/beneficiaries charges instead of subsidies). Where there is a shortage of funds for investment there is also a case for meeting capital requirements through private capital, i.e. the case for package 2.

The application of package 2 requires however that the transport authority have the adequate degree of legal independence or power to allow for private involvement.

Only when none of the previous packages generate sufficient resources, should the implementation of package 3 be considered. The package, as stated above, will provide sufficient funding in all cases. Even more than for package 2, the adoption of package 3 requires a highly independent and powerful transport authority. The disadvantages associated to this package might discourage its implementation.

Regarding small and medium cities with relatively low capital intensive form of public transport, package 1 seems to be the most appropriate one when there exists severe congestion costs.

The FATIMA case studies of Edinburgh and Salerno demonstrate that. In both cases, efficient prices were found to be self-financing. The same result was obtained in the Eisenstadt case study despite the city does not suffer from severe congestion and environmental problems. As in the case of Vienna, this might be due to the fact that parking areas are very scarce and, therefore, parking costs very high, efficient prices generating, thus, sufficient revenue.

As in the case of large/very large cities, revenues from efficient prices may just be sufficient to cover all current costs. Additional user/beneficiaries charges should be implemented to serve new capital requirements that should be privately financed if the authority is subject to capital borrowing constraints.

When small/medium cities do not suffer from substantial congestion and environmental problems, efficient road prices will, in general, not generate enough resources to cover public transport deficits.

Again the financial position of the authority may allow for the subsidisation of these deficits. A weak financial position will require, instead, the use of additional user/beneficiaries charges to cover the on-going deficits (package 1 with value capture and supplementary user charges instead of subsidies). If new infrastructure investments are required then public-private partnership might be needed, i.e. package 2.

The above discussion regarding the adoption of package 3 in large cities also applies for small and medium cities. In this case the implementation might face greater problems since one would not expect highly independent and powerful transport authorities in small/medium cities.

In general, package 3 is likely only to be feasible where central government has provided the required legislation. The following box summarises the main findings from our previous discussion:

City characteristics	Financial Position	Possible Packages
Very large/large		
Severe environmental problems	Strong	Public sector self-financing
High/low capital intensive public transport		
Very large/ large		
Severe environmental problems	Weak	Public/private partnerships,
High/low capital intensive public transport		full commercialisation
Very large/large		
No severe environmental problems	Strong	Public sector with subsidies
High/low capital intensive public transport		
Very large/large		
No severe environmental problems	Weak	Public sector with additional
High/low capital intensive public transport		User/beneficiaries charges
		Public/private partnerships,
		Full commercialisation
Small/medium		
Severe environmental problems	Strong	Public sector self-financing
Low capital intensive public transport		
Small/medium		
Severe environmental problems	Weak	Self-financing and additional
Low capital intensive public transport		User/beneficiaries charges to serve
		Self-financing, private finance and
Small/medium		
No severe environmental problems	Strong	Public sector with subsidies
Low capital intensive public transport		
Small/medium		
No severe environmental problems	Weak	Public sector with additional
Low capital intensive public transport		User/beneficiaries charges
		Public/private partnerships,
		Full commercialisation

4.6 Conclusions

A move to a more efficient pricing structure will both serve to reduce the problems of congestion and environmental externalities, and very often help to solve the financing problems of transport in urban areas. Indeed the evidence suggests that in many larger cities such charges will cover all operating and capital servicing costs, although there may still be a need for public or private capital for investment projects.

There will be many cases where efficient pricing leaves a need for more funding, however. In this case a wide variety of mechanisms is available and should be examined. In most cases a mix of measures will be needed. In this chapter we have examined both the individual mechanisms and some examples of packages, as well as giving some advice on when each mechanisms or package is most likely to be appropriate.

In general, a combination of efficient pricing, with the use of public budgets to meet any remaining financing needs, has many attractions, but may not be financially sustainable and provide adequate resources for investment. In these circumstances, we would recommend exploring a mix of private sector funding, perhaps through franchising, and simple approaches to value capture to service the debt. But there are many options available and each city must select what best suits its situation.

5 CONCLUDING REMARKS AND AFTERTHOUGHTS

As stated in the beginning of this handbook, FISCUS is a research project looking at both the total and marginal costs and the financing solutions for urban mobility. Although it may seem that the costing side is purely technical and the policy dimension is on the financing side alone, it became clear during the research that no strong inter relation exists between the Real Cost Scheme and the financing schemes (RCS).

Financial packages cannot be derived from an RCS, however the RCS provides important information to enable the right decision with regard to the cost situation revealing that there is also a strong element of political decisions affecting the costs side.

In fact, not only are many of the cost items heavily influenced by policy decisions (on land use, on design of the transport systems), but also there is no such thing as "objective" or "technical" social cost calculation since several value judgements have to be made by the system, person or organisation performing the calculation. In addition, the uncertainties contained in the results are often large.

Hence the future challenge of social cost calculation and urban transport policy is:

- to identify the distributional and environmental impacts to be taken into account;
- to link the actors causing the impacts to the actors paying them;
- to measure these impacts and express them in monetary terms; and
- to make the fundamentals of decision-making more transparent - not just to find *the* values for social and environmental impacts.

The following table summarises variables affecting the real cost of the urban transport system that can be influenced by politicians and decision-makers and gives examples of how those variables can be influenced.

Many of the influencing factors have more to do with long term decisions, especially those in the area of allocation of urban space for various types of use, and in particular for the different transport modes.

Main variables in the urban transport policy	Can be influenced, e.g., through:
Number of vehicles	- urban and regional planning - vehicle taxation - road and rail infrastructure supply and financial policy - tolls - promotion of car sharing and car pooling
Specific traffic performance per vehicle (km/year)	- urban planning / regional planning - fuel taxation - public transport service level - pedestrian and bicycle lanes and service level - tolls, parking space and fees
Average travelling speed per transport mode	- urban planning - road capacity planning - public transport service level - traffic priorities for public transport (special road lanes etc.) - Speed control measures/Telematics
Passengers per vehicle	- Public transport service level - Differentiated road tolling - Car sharing and car pooling in commuter traffic - Information campaigns
Future infrastructure investments	- Infrastructure supply/financial policy - Local policy statements - Infrastructure planning and evaluation instruments
Average vehicle age	- Public transport investment policy - Vehicle taxation and fees
Fuel consumption per vehicle (litre/vkm)	- Public transport operator's vehicle selection - Eco-driving campaigns - Traffic calming and speed control measures - Fuel tax - Vehicle taxation
Fuel price (ECU/litre)	- Fuel taxation
Number of congested roads and severity of congestion	- Urban planning - Infrastructure provision and capacity planning - Tolls - Telematic/traffic control instruments - Public transport service level etc.
Emission factors (PM, SO_2, NO_x, CO_2, VOC) of combustion-engine based vehicles (g/vkm)	- Public transport operator's vehicle selection - Vehicle taxation - Eco driving campaigns - Traffic calming measures - Fuel taxation
Electricity consumption per vehicle (kWh/vkm)	- Public transport operator's vehicle selection - Vehicle taxation - Energy taxation
Specific emissions (g/kWh) and risks of electricity production	- Public transport operator's power producer selection (deregulated markets) - Local power production strategy (all markets)

Table 9a: Variables affecting the real cost of urban transport system

Main variables in the urban transport policy	Can be influenced, e.g., through:
Number of accidents and their severity	- Road planning - Infrastructure maintenance - Infrastructure safety measures (e.g. pedestrian tunnels and overpasses) - Traffic calming and speed limits - Information and education campaigns - Insurance differentiation - Public transport service level
Average noise levels	- Urban planning - Contributions to noise reduction measures (noise barriers, house renovations) - Traffic calming measures - Eco driving campaigns

Table 9b: Variables affecting the real cost of urban transport system (cont.)

In preparing this handbook, we are aware that no scheme for allocation of costs and assembly of financing instruments, can be classified as "best for Europe", and thus this has not been our objective. Instead, this handbook aims to provide:

- a consistent approach to the whole costing and financing of problem of mobility in urban areas;
- a series of procedures for estimation of the most relevant items of urban mobility costs, clearly indicating what are the features of the urban landscape and background that more strongly contribute to the increase or decrease of each of those cost items;
- a list of archetypal financing solutions (schemes), indicating the merits and risks of each of them, as well as a small collection of packages of such schemes, which can be considered as an example of rather "pure" forms, not claiming to be ready for adoption in real situations – where several type of constraints will always be present – but allowing easy perception of the type of solutions that have to be sought in a wide range of real situations:
- synthetic inputs of possible ways to make the policy approach to the issue of total coverage of mobility costs at the urban level, trying to identify the main "solution building path" in connection with the political priorities that might be defined by the respective authorities

The mobility system, as complex as it is due to the number of interacting agents representing different groups of stakeholders, requires a consistent and balanced approach between transport, environment and economy. That is, at the strategic level of the system the aim is to achieve a sustainable balance between:

- Transport aims– Adequate balance between public and private modes in order to satisfy the needs of all market segments;
- Environmental aims – Keeping the total sum of pollution caused by the different modes below an acceptable threshold.

- Economic and social aims – Monitor costs and develop potential to create new financial resources while delivering “value for money” solutions, as well as capacity to induce users behaviour through pricing mechanisms without any sort of discrimination or exclusion.

As the perfect system is hardly reachable, the second-best solution lies in establishing trade-offs between these three domains according to the socio-economic and cultural reality of each specific environment (urban area), and conditioned by the political options that result from the interaction between the local, regional and national levels of State intervention (i.e. decision levels). It is thus a function of the strategic level of the system to assure a definition of objectives that provides an adequate answer to the stakeholders (individuals and collective) interests, in such a way that these objectives can be translated into operational solutions.

Traditionally, State interventions in Public Transport have been partly justified by equity considerations, namely to ensure that the transport network was available to all citizens, and that no one should be deprived of its services by considerations of price. The interpretation of this goal, (which is in itself still valid nowadays) in the implicit concept of public service, led the authorities to increase the financing of Urban Transport through the use of concessionary fares and subsidies to cover companies’ deficits. The main factors leading to this essentially political attitude were the aim to compensate the insufficiency of revenue caused by a loss of patronage in favour of private cars, together with the lack of freedom from the operators to establish competitive prices.

Along the years evidence revealed that this was not an efficient way of intervention and allocation of public money, once all users benefited from the same (subsidised) fares independent from their income levels.. Additionally, there is a growing awareness that to achieve a sustainable balance between private and public means of mobility pricing policies have to be able to send the correct signals in order to induce an adaptive behaviour by the users, which in turn will provide the system with a reliable feedback on the needs for further investment and expansion of transport facilities.

This switch of perspective is also reflected in the aims of the Citizens’ Network green paper, where the Commission states that it wants to assure that the needs of the citizens are put at the centre of decisions about transport provision. The goal must be the achievement of networks of public passenger systems. In addition Public Transport should ideally be a service open to all citizens in terms of accessibility to vehicles and infrastructure, affordability in terms of fare level, and availability in terms of coverage of services.

Also the link between the improvement of transport infrastructure and the accessibility of the regions is one of the issues highlighted by the EU Common Transport Policy. According to the main lines of this policy, citizens and enterprises should have access to a mobility level corresponding in quality and performance to their expectations and needs and at a reasonable cost.

In line with the previous political statements, in 1995 the European Commission launched another Green Paper under the title "Towards Fair and Efficient Pricing in Transport: policy options for internalising the external costs of transport in the European Union", advocating that:

- Pricing should be seen as a complement of regulatory and other market policies;
- The main aim of a fairer and more efficient pricing policy is to use price signals to curb congestion, accidents and pollution;
- Prices should reflect underlying scarcities to ensure sustainable transport;
- Appropriate infrastructure charging is needed to mobilise private capital and relieve the pressure on public budgets;
- The transport price structure should be: clear to transport users; differentiated across time, space and modes; non-discriminatory between modes and Member States.

More recently, a European Commission's White Paper on "Fair Payment for Infrastructure use: a phased approach to a common transport infrastructure charging framework in the EU", though not directly applicable to Urban Transport, reinforces that charging systems in the future should be based on the "user pays" principle, i.e. or a marginal social cost basis.

From this evolution we can conclude that the transport policy goals can be grouped into three main categories, which reflect the fact that equity and efficiency are still the main criteria for policy appraisal :

- allocative efficiency of resources within the transport sector and between this sector and other economic sectors;
- meeting individual requirements at minimum resource costs, that is market and productive efficiency objectives;
- equitable distribution of benefits and costs, that is equity objectives.

However, the definition of an Urban Transport policy is a complex issue since it is very much related with the specific characteristics of the local environment, as well as with the respective political options, which may change between localities within the same country, and even between neighbouring communities served by the same transport system. The diversity of variables involved causes a wide diversity of approaches to Urban Transport policy that are reflected in the definition of a number of elements of the system, among which pricing and financing policies have a special role.

The success of pricing and financing schemes in Urban Transport Systems is strongly dependent on the regulatory and organisational framework of the system, and in its potential to co-ordinate between the different policies with impact in mobility demand patterns (e.g. land-use, environment, etc.), as well as between the push and pull measures developed by different agents of the system - authorities and operators. It is often forgotten that one of the remote causes of the external costs caused by transport is the location and operating hours of the economic and social activities, which create the mobility needs.

In a market based economy the main (or even only) contribution for the financing of most systems in terms of their structural support is normally expected to come from its beneficiaries, through the price they pay. However, Mobility systems have special characteristics that often justify less than full adoption of this principle, such as:

- they constitute access to most possibilities of activity of any type in organised societies, which can create risks of social exclusion if their use is too expensive;
- in several cases, for reasons of standardisation and safety, the minimum dimension and sophistication in infrastructure is such that the expected flow of users could never be expected to pay for its full costs. But, again for reasons of non-exclusion, the infrastructure has to be built and maintained.

In general microeconomics it is recognised that prices equal to the marginal cost of production lead to maximisation of efficiency. However, not only some of the underlying assumptions of that theoretical result do not fully apply to transport systems, but there are also other objectives necessarily present in decision makers' minds that should prevent them from an exclusive concern with efficiency, which will lead to dismissal of those other concerns, namely at least:

- ensuring stable levels of cost coverage in order for systems to be built and kept operating safely;
- ensuring social peace through minimum levels of equity in access to publicly provided goods and services.

In addition, it is also the role of transport pricing policy to contribute to the control of the external costs produced by the system, this is a steering function, and success can only be achieved by the combined use of market based incentives together with control regulations. The former should persuade users to adapt their behaviour towards the policy aims, while the latter are mostly meant to restraint practices leading to the growth of external costs.

A move to a more efficient pricing structure will serve both to reduce the problems of congestion and environmental externalities, and very often help to solve the financing problems of transport in urban areas. Indeed evidence suggests that in many larger cities such charges will cover all operating and capital servicing costs, although there may still be a need for public or private capital for investment projects.

However, there will always be many cases where efficient pricing leaves a need for more funding. In this case a wide variety of mechanisms is available and should be examined. In most cases a mix of measures will be needed. In this handbook we have examined both the individual mechanisms and some examples of packages, as well as given some advice on when each mechanisms or package is most likely to be appropriate.

In general, a combination of efficient pricing, with the use of public budgets to meet any remaining financing needs, has many attractions, but may not be financially sustainable and provide adequate resources for investment. In these circumstances, we would recommend exploring a mix of private sector funding, perhaps through franchising, and simple approaches of value capture to service the debt. But there are many options available and each city must select what best suits its situation.

Finally, it is worth to highlight that pricing and financing policies imply the use of different mechanisms at the same time, that is single measures are never fully effective if applied in an isolated way. The risks involved in the implementation of each measure, their synergetic potential, as well as the assurance that the different measures involved in one policy package do not produce contradictory effects, are important issues that have to be included in the concerns of the decision-makers when choosing the most appropriate policies for their local context.

If we want to know the full costs of urban mobility, it is not acceptable to develop solutions of financial support of those costs that simply say “apply prices equal to marginal social costs” ignoring the consequences (or even the dimensions) of incomplete coverage of those costs. In the end, all costs are always covered, and it is not appropriate to defend a policy that deliberately ignores who those payers might be. Prices should be defined considering the marginal social costs of the systems at their current level of operation, but not necessarily so as to be equal to those marginal costs. In parallel to those marginal social costs other issues have also to be considered, and the definition of prices (as well as the possible contributions of non-users in order to ensure full cost coverage) has to be made with this wider view, keeping in mind that some pricing issues cannot be solved on urban scale alone.

The key conclusion is that, all mobility costs being always paid by someone, a systematic approach to these issues is strongly recommended, not only to ensure higher transparency in the estimation of magnitude and allocation of responsibility for the various cost items, allowing more justice in the allocation of these costs across society, but also the regular and sustainable performance of our mobility system with good overall quality levels.

The research presented here should contribute towards making such a systematic approach more widely accepted and practised.

❑

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7 ANNEX 1 - GLOSSARY

accident cost rate	(→ accident rate, fatality rate) ACR describes the average accident costs per 1,000 vehicle kilometres. They are determined by → accident rates, → fatality rates and the monetary assessment of material damages, injuries and fatalities.
accident rate	(→ Fatality rate, accident cost rate) Accident rates describe the probability of an accident per 1 million vehicle kilometres.
actual payer	Those actor groups bearing the costs imposed by transport (in the case of resource costs) or contributing to the coverage of resource costs via transfer payments.
area licensing	This is a → financing instrument in the form of charging car traffic for (a) parking within or (b) the access into a certain area, convenient to be done in a simple way (e.g. sticker + manual inspection) or with a more complicated technology. With the latter, approach (b) is capable to charge mobile traffic according to different types of roads and times of day. Thus area licenses can be easily used for → road pricing within cities.
asset valuation	This is the process by which the economic value of infrastructure is calculated. There are two basic methods of asset valuation: "replacement cost" and "historic cost". In broad terms, there will be a degree of equivalence between the two methods, and the choice between the methods will be largely determined by practical data availability considerations. The "replacement cost" method combines an inventory of asset quantities by asset type with corresponding unit costs for replacing the assets in their current condition. In contrast, the "historic cost" method relies on data on year by year investment figures for a long period of time, taking account of depreciation in value and adjusting to take account of changes in prices over time.
average costs	(→ marginal costs) Average costs are the simple result of dividing total (fixed + variable) costs by the number of outputs involved in its generation. Having a particular amount of fixed costs, a doubling of the number of users will not lead to a doubling of total costs. As in the Real Cost Scheme total costs are presented by cost responsibility, average costs can be determined separately for different types of (road, rail and water) vehicles.
average cost pricing	(→ pricing principle), where prices are set equal to average cost (i.e. Total costs divided by transport units. Usually such a pricing scheme is not differentiated.
benefit transfer	A form of secondary economic assessment that involves taking the results from one or more primary (original research) studies that estimates values for similar cases and/or impacts and modifying and transferring these values to the case being evaluated.
CO2	Carbon dioxide is a major greenhouse gas i.e. it contributes to the climate change.
compulsory	For the purpose of → value capture a local government might - instead of levying a tax - force

consumption	certain enterprises, who benefit from public transport, to purchase tickets or travel cards. Under convenient conditions this → financing instrument can lower the opposition against being taxed and give the affected firms incentives to promote public transport use by their employees or customers.
congestion	Congestion arises when traffic exceeds road capacity so that the speed of vehicles is slowed down. It can be defined as a situation where traffic is slower than it would be if traffic flows were at low levels (free flow conditions). The definition of these 'low levels' (reference level) is complicated and varies from country to country.
congestion pricing	This is a collective term denoting one group of feasibilities to specify → road pricing measures, comprehending those among other → financing instruments, that take into account the degree of → congestion in order to price actual car usage. This form of collecting → user contributions is capable not only to raise funds, but also to incite behavioural change and - as congestion is primarily an urban problem - preferably applicable within cities.
cordon tolls	This → financing instrument can be used as a simplified form of → road pricing, whereby the transit along or just the access to a certain cordon is charged either by using barrier gates or more sophisticated means (e.g. electronic system with smart cards). In both cases the toll rates can be differentiated according to the time of the day or specific routes. Some already existing examples (e.g. Norway, Germany) have shown as a result the shifting from private to public transport (mainly by daily commuters) and from peak- to off-peak times (mainly by non-periodical drivers).
costs	Periodic value of use of resources (→ resource costs). One can distinguish current costs which are equal to current expenditures and opportunity costs for the resource depletion of investments.
cost benefit analysis	(CBA) Denotes the comparison of the costs and benefits associated with the implementation of a particular infrastructure project or other policy measures.
cost generator	Those social groups or means of transport, who are responsible for the use of resources and hence for the generation of real costs.
cross funding or cross-subsidisation	When benefits arising from one economic activity (source market) are used in another economic activity (receiver market) without full compensation, this is to be seen as a → financing mechanism called cross funding. Since given no or at least no sufficient return, it also has the character of a ("cross-") subsidisation. In a more narrow sense and within the context of transport sector, it occurs as a transfer (a) from non-transport consumers to transport users (e.g. surplus of energy supply operation covering deficits of transport operation) or (b) among transport users (peak to off-peak travels, freight to passenger transport, car drivers to public transport users).
decibel	(dB(A). dB is a measure for the intensity of sound energy. According to the characteristic of human ears the relationship between sound energy and dB is logarithmic. Several filters have been

	defined to achieve a better adaptation of dB measurements and the loudness impression of human beings. The most commonly used type of filter is the (A) filter.
delayed costs	(→ variable costs) Costs which occur not at the same time as the cost-driving factor is caused. A typical example is air pollution, where health costs or building damages are occurring due to a cumulative effect of exposure and costs might occur in the near future. In terms of financing, these costs can be regarded as fixed costs, because they are not directly influenced by changing traffic volumes. However, if applying the "polluter-pays-principle", where each actor should pay for the damage caused, the origin of these costs is variable (e.g. the emitted amount of NO_X, SO_2 or vibrations. Thus, concerning pricing-relevance , costs related to long-term effects which are caused by vehicle emissions, are considered as variable (see footnote of table 11-2).
depreciation (economic)	Depreciation refers to the annual loss in value of assets over time due to their physical deterioration. The economic definition of this term relates to the expected lifespan of the asset, and depreciation may be calculated on the basis of an equal loss in value in each year (linear depreciation) or as a percentage of the asset value at the start of each year (declining balance depreciation). Note that the economic definition of this term seeks to distinguish it from that used in accountancy or taxation practice - where, for example, the depreciation period may differ from the likely lifespan of the asset.
earmarking	Direct inter relations between the financial source and the financial purpose, in order to secure financial resources. In practice, specific funds are used therefore (e.g. earmarking road pricing revenues and financing of road infrastructure or environmental measures).
electronic urban road pricing	This is a sophisticated form of → road pricing within an urban environment allowing to charge car usage according to more than one variable (e.g. area + daytime, distance + degree of congestion), achieved by the implementation of electronic pricing systems (e.g. smart cards, radio-controlling, GPS-positioning etc.).
emission factor	Gives the emission of observed pollutant per vehicle-km or passenger-km
exposure-response function	A mathematical relationship used to determine the biological response of organisms when they are experimentally exposed to specific quantities of a toxic or hazardous substance.
fatality rate	(→ accident rate, accident cost rate) The probability a person killed per 1 million vehicle kilometres.
financial costs	(→ opportunity costs, → shadow prices) A number of social costs allocated to transport are not directly associated to monetary payments (e.g. the willingness-to-pay for better air quality, time losses in traffic jam or less accident risks). These costs accordingly are called "opportunity" costs. In contrast, "financial" costs can be related to financial flows and hence can be accounted much more precisely than opportunity costs, which have to be estimated.

financing instruments	These are concretely defined single methods in order to finance certain investments or operations (infrastructure or service) applied by a private or public investor or operator (to ensure their return). Within the terminological framework of the FISCUS-Project they are the smallest terminological units describing the subject 'financing' and its context (some examples: → area licensing, → congestion pricing, → land value taxation, → shadow tolls, etc.).
financing mechanisms	These are compendious groups of → financing instruments, each instrument within a group passing through the same functional way, particularly exploiting the same type of financing sources. These mechanisms differ in financing by: (a) → user contributions, (b) public budgets, (c) private investment, (d) → value capture and (e) → cross funding.
financing schemes	These are comprehensive methods in order to finance investments or operations (infrastructure or service), consisting of different → financing instruments and applying different → financing mechanisms at the same time. The intention of creating such "packages" is to apply the optimal (as efficient as possible) combination for each a certain necessity under certain actual conditions.
fixed costs	(→ variable costs) Fixed costs are those costs, which do not change with traffic volume. It is necessary to distinguish short and long run perspectives. Important elements of fixed costs in the short run are capital costs for traffic infrastructure or permanent staff. In the long run however, all costs are variable.
franchising	Within the context of FISCUS exclusively used in order to describe public private partnerships, whereby the authority is always the franchiser and a private firm is always the franchisee.
free-flow situation	Traffic situation without congestion, used as a reference level. Usually an Off-Peak-Situation can be used for urban traffic.
fuel cycle	The life cycle of a fuel from raw material to energy, residues and emissions.
full costs	Full costs are those costs caused by the whole transport sector of an urban area. For analytic reasons and to get a more precise insight in the cost structure of a municipality, full costs are presented by vehicle types or actor groups responsible, by time of day or by actual payers. Full costs can be classified into → fixed and variable costs or into → financial and opportunity costs.
GDP	(= Gross Domestic Product). The GDP is the sum of all goods and services produced within a country and a year. Despite of its weaknesses GDP per capita is often regarded as the relative economic wealth of a country .
HC/VOC	Hydrocarbons / Volatile Organic Compounds contribute to ozone formation. Some like benzene, butadiene and benzo-a-pyrene have been found to have impacts on public health.
hedonic pricing	(→ Willingness-to-pay) Via hedonic pricing it is tried to compare the market value of a product to its utility. E.g. when comparing rent prices in areas of different noise exposure the → willingness-to-pay of inhabitants for quieter residential areas can be determined.

HGV	Heavy goods vehicles
impact pathway approach	The approach is used to value environmental externalities (e.g. air pollution and noise). The phrase “impact pathway” simply relates to the sequence of events linking a “burden” to an “impact”. The method consists of four steps: emission inventory, dispersion calculations, quantification of impacts by exposure-response functions and monetary valuation.
interest cost	A part of (→ capital costs; it denotes the opportunity costs of capital.
internal costs	(→ external costs) According to the definition of → external costs, internal costs denote those cost elements, which are caused and carried by the same actor. If this happens due to policy instruments (e.g. pricing), costs are internalised.
land value taxation	A tax based on the rental value of land (or on its increase) is one instrument of → value capture, seen to be rather underrating, since transport-derived benefits directly affect real estate utility and because its value indicates already a balance between positive and negative impacts, and those not only due to transport. Thus, besides a basic tax rating difficulty (pos. - neg. impacts = ?), a further constraint on its usage as a → financing instrument is given with a proper allocation of the tax revenue between transport, other value-creating public activities and the "normal" economies of density.
life-cycle based approach	An approach, where up- and downstream processes of transport services are included (i.e. vehicle production and disposal, fuel cycles of the electricity production etc.).
main cost category	(→ Partial Cost Component) (= MCC). Within the Real Cost Scheme seven MCCs are used to systemise the variety of costs associated with (urban) transport according to the principles of social cost analysis. Each MCC is further subdivided into a number of → Partial Cost Components (PCCs).
marginal congestion costs	Additional time and operating costs due to congestion of an extra vehicle. Marginal congestion costs rise progressively in relation to traffic flow. They depend on road capacity and specific time and operating costs and the split of different vehicles (e.g. Passenger cars and HGV). External marginal costs are the difference between average costs (every user has to bear) and total marginal costs. They reflect the additional costs to other users and are an important information for pricing issues.
marginal costs	(→ average costs) Marginal costs are equal to additional costs per additional unit. In transport they reflect those costs occurring, when an additional subject (or unit) is entering a system. In the terminology of the Real Cost Scheme, common units are additional passenger - or ton kilometres. Marginal costs usually are not constant, but depending on the number of subjects, who already are in the system. While in many cases the curve of marginal costs is growing progressively with the number of users

	in a system, in some cases (e.g. traffic noise) marginal costs even fall with increasing traffic load. For reasons of practicability, the RCS approaches real marginal costs by determining the "average variable cost" of passengers of goods. This assumes, that the current traffic load of roads or railway tracks remain constant, being considered as sunk costs. Marginal costs can be determined in the short run (as it has been done above) or in the long run. In the latter case, also those fixed costs, which do not remain unchanged in long terms due to changing transport demand, are added.
marginal social cost pricing	According to this → pricing principle, prices (both in private and public transport) are set equal to the → marginal costs arising to society from consuming transport facilities. Regarding the condition price = marginal cost, this form of collecting → user contributions is expected to lead to the best possible allocative efficiency. Its functional quality and practical feasibility depend on a proper calculation of the marginal costs and on the existence of techniques that are capable to differentiate the → cost generators according to the magnitude of their cost generation (e.g. peak versus off-peak, polluting versus non-polluting, noisy vs. low-noise, high vs. low abrasion etc.).
MCC	→ Main Cost Category.
noise absorption	By a number of factors the natural dispersion of sound waves is diminished. Such factors can be whether conditions, ground absorption, road pavement, etc.
NO_x	Nitrogen oxides, which are formed primarily by fuel combustion and contribute to the formation of acid rain. They also combine with hydrocarbons in the presence of sunlight to form ozone.
opportunity costs	(→ Financial costs, → shadow prices) The expressions "opportunity costs" and "shadow prices" are used synonymously within the Real Cost Scheme. They determine the value added for an individual in case a good would not have been bought or built or in case negative effects of transport would not be present. Opportunity values are used for the evaluation of investments (capital costs), lost lives (statistical value of human life) or for the assessment of noise nuisance.
partial cost component	(→ Main Cost Category) (= PCC). PCCs are a further subdivision of MCCs by equal cost properties or subjects.
passenger car unit	(= PCU) PCU is used in order to standardise vehicles in relation to a passenger car. Speed and lengths differentials are most common.
PCC	→ Partial Cost Component.
PM	Particulate matter. Fine particulate (PM_{10} with a diameter of less than 10 μm) can contribute to the chronic and acute respiratory disease and premature mortality, as they are small enough to be inhaled into the lungs. Larger particles decrease visibility and increase fouling.
pricing principles	Several options are given to set the prices to be paid by transport users (or, in case of infrastructure usage, by operators) according to pricing principles that take into consideration

	different variables; e.g. → marginal social cost pricing, → Ramsey pricing, → two part tariffs → average cost pricing.
Pricing relevant costs	The question "what is relevant for determining transport prices" strongly depends on the attitude of the municipality or the transport operator. E.g. shall infrastructure costs be fully covered by the transport system itself or is infrastructure provision regarded as the duty of the state or municipality? In recent economic theory, there are several viewpoints concerning the composition of pricing-relevant costs. Most common is the welfare approach of marginal cost pricing. This principle has been translated to EU policy: The White-Paper of the European Commission on Fair and Efficient Infrastructure Pricing recommends the application of short-run marginal cost pricing, which intends to minimise the social costs of transport and thus to achieve a sustainable structure of transport demand. To ensure efficient use of a facility, pure marginal prices only regard "short-run" marginal costs, while fixed costs are totally excluded from the price fixing. In order to address to practical restrictions of infrastructure suppliers and transport operators, in [PETS 1998] in contrast to the pure marginal cost pricing, a second-best variant including long-run marginal costs is proposed. Expressed in the terminology of the RCS this means, that pricing-relevant costs include marginal as well as average fixed costs. If full cost recovery is the aim behind pricing transport, total pricing-relevant costs are equal to financing-relevant costs. It should be noted that the pure amount of pricing-relevant costs has no implication on the value of marginal prices, as for their adjustment the functional interdependency of traffic volume and costs must be taken into account.
Purchasing power parity	(= PPP) The purchasing power parity describes the amount of goods or services, which can be bought in a particular country compared to a reference country. The PPP necessarily must be expressed relative to a particular currency.
Ramsey pricing	According to this → pricing principle, prices are set with consideration of the dedicated payers' price elasticities. Since the latter are to be measured based on empirical observations, this form of collecting → user contributions finally considers the → willingness to pay of the priced actors (in this case: car drivers, public transport passengers or operators paying for infrastructure use).
real costs	Real Costs in the FISCUS-terminology are the sum of resource cost and transfer payments for all actors. They express that not only financial, but also opportunity costs are evaluated for urban transport. They can be expressed as total costs or marginal costs. The handbook will provide methodologies and guidelines to calculate all real costs. What is left to the reader to decide is which of the MCC/PCC are relevant or not for its own town, given its level of development.
Resource costs	(→ transfer payments) Resource costs in general denote the monetary equivalent of resources

used by an actor. In the case of transport, resources may denote physically measurable goods, such as fuel, wages, time or taxes as well as public goods, e.g. clean air, silence or safety. In the first case, i.e. whenever resources are used and paid by the same agent, we talk of internal (resource) costs, otherwise of external costs.

road pricing	This is a → financing instrument to be implemented by charging the direct users of the road infrastructure (as → user contributions being one part of → financing mechanisms) generally due to the amount of use or to the magnitude of induced costs, in particular measured depending on distance, area, daytime or degree of congestion. For this measurement there are simple practices existing (e.g. barrier gates with manual collection) or also more sophisticated forms at higher costs (e.g. → electronic urban road pricing). Furthermore this can be made according to different → pricing principles.
shadow prices	The expressions "→ shadow value" and "shadow prices" are used synonymously,
shadow tolls	According to this → financing instrument a private investor (e.g. providing a new road) gets his return-on-investment not (or at least not only) from the direct users, but instead of from a public authority. The amount of public payment is usually measured corresponding to the actual demand ("as if the users would pay tolls"), whereby one should focus attention on the incentives given to the private firm and their consequences in the single case.
shadow value	(→ opportunity cost, shadow price) Addition to a market price considering external effects. Shadow values can be used especially for cost benefit estimations.
SO_2	Sulfur dioxide contributes to the formation of sulfate aerosols and is the primary pollutant in the formation of acid rain. It can also cause respiratory system damage in humans.
social benefits	Social benefits, accordingly, denote those (positive) effects, which are caused by transport on society. Besides the direct benefits (mobility, access, time gains etc.), there are indirect benefits. Examples would be increases in rent prices due to the connection to the public transport system or technological transfers from vehicle construction to other sectors of the economy. Whereas direct social benefits are at least equal to direct (internal) costs, indirect social benefits of transport are not considered in the Real Cost Scheme, because their definition is very diffuse and hence their valuation in monetary terms is extremely vague.
social costs	(→ real costs, → social benefits) , Sum of internal and external costs. Generally spoken, social costs are economic resource costs imposed on society. The simple value of social costs, which are generated by a particular agent does not contain the payments borne by him in order to compensate these costs.
social marginal cost pricing	→ marginal social cost pricing

speed-flow function	A mathematical or graphical relationship between the flow on a particular road, and the speed of that traffic flow. As traffic flows increase, traffic speeds eventually fall.
State preference surveys	(Willingness-to-pay) SP-.surveys are investigations where people are asked about their preferences. With this methodology it is tried to identify e.g. the → willingness-to-pay of people for a reduction of traffic noise, improved safety or better air quality.
Sunk costs	Costs which are paid and thus not relevant for future decisions. Marginal costs do therefore not consider sunk costs. Typical examples are capital costs of infrastructure investments.
Target level	Target levels are defined as that exposure level that is still acceptable for the inhabitants. They are most relevant for air pollution concentration and noise. Noise target levels usually are for instance depending on the time of day and on the type of land use. Average values in European noise legislation are 65 dB(A) for daytime and 55 dB(A) for night time.
Total congestion costs	The sum of time losses and additional operating costs due to congestion. From a mathematical point of view it is equal to the integration of the marginal cost curves according to the empirical traffic data by type of road and type of vehicle.
Transfer payments	(→ resource costs) Transfer payments are those monetary (financial) costs, transferred from one user group to another without any directly associated use of resources. Examples are fares in public transport, taxes (to cover parts of operating costs), road charges (to cover the costs of infrastructure use), parking fees, subsidies and payments for deficit spending in public transport. These payments denote the relevance for financing issues.
TSP	Total Suspended Particles. Particulate matter such as dust in the ambient air.
two part pricing or two part tariffs	Since → marginal social cost pricing under certain circumstances fails to recover the total costs of a transport facility supply, this → pricing principle can be applied in order to raise additional funds on the purpose of reaching full cost recovery. Thus, this kind of → user contribution is collected by charging the users differentiated according to their marginal cost generation (1st part) and by an additional, not differentiated flat charge (2nd part), to be seen as an entry fee (an existing example for two part pricing is the combination of a variable fuel tax with an additional fixed vehicle purchase tax). The fixed part can be differentiated as well (in order to consider distributional issues or environmental performance of the rolling stock).
UCPTE	(Union pour la coordination de la production et du transport de l'électricité) International mix of electricity production. It is the average mix considering the plant distribution in Western European countries. The values are published every year, based on the actual performance of the different plants. Today the mix is in average: 30% coal, 10% oil, 10% gas, 35% nuclear, 15% hydro
unit costs	Unit costs denote the costs per unit of a particular cost category. E.g. per ton NOx or CO2 in terms of air pollution or per fatality or injury in terms of traffic accidents.
user contributions	This is the basic one among the → financing mechanisms; it contains all kinds of payments by the

direct beneficiaries of a transport facility ("users", i.e. car drivers, public transport passengers or transport operators if not using self-owned infrastructure); simply, they pay prices (e.g. public transport tariffs, → road pricing, rail infrastructure pricing) according to several → pricing principles. The money collected from the users will "contribute" to the financing of the concerned transport facility (return on infrastructure or service).

value of statistical life — (=VSL) The value of statistical life is a methodology to find a monetary equivalent to a killed or injured human being. VSL is the opportunity costs of a saved human life.

variable costs — (→ Fixed costs) Full costs can be subdivided into fixed costs and variable costs. Fixed costs remain constant with varying use of a transport system (e.g. supplier- or capital costs for road and rail networks or administrative costs). The expression "fixed" in the way it is used in the Real Cost Scheme means "fixed in the short run" (without consideration of new infrastructure), as in the long run also infrastructure supply costs vary with the traffic demand, that is in the long run all costs can be made variable. Main relations of variable costs are km's driven or the amount of vehicles (e.g. crossing a specific section).

Variable costs depend on the amount of users and the traffic volume performed by then. This simple subdivision does not clarify to which degree or to which vehicle group these costs vary. E.g. road maintenance costs vary with the fourth power of axle loads, and hence can be regarded as invariant to the number of private road users.

willingness to pay — (= WTP). The willingness (or ability) of people to pay for the abolishment, reduction or reception of a particular matter can be estimated by two ways: (1) by → stated preference surveys and by → hedonic pricing methods.

8 ANNEX 2 - EXAMPLE ON A FICTICIOUS COST EVALUATION

To demonstrate and clarify the idea of the Real Cost Scheme, in the way it is presented in chapter 3 of the handbook, this section comes along with a practical example. Although the cost values and traffic counts used have been set with much care in order to obtain a realistic picture how the results might look like, it should be noted that the example is a totally fictitious one. The cost estimates for this example are made on a very rough base in order to cope with the limitation of a general handbook. For more details the reader should refer to the previous sections, FISCUS deliverable 3 or to further literature on the topic.

It reflects a city with 600,000 inhabitants. The public transport system constitutes bus and tramway systems while in individual transport only private cars and goods vehicles are considered. It is assumed that 90% of the road and rail infrastructure is financed and operated by public budgets while the remaining costs are raised by private investors. The share of private and public involvement in public transport is assumed to be equal (50% each). The public sector constituting of different state levels is regarded as a single actor; the same holds for the virtual actors "private investor", "transport user" and "other society".

The approach towards the estimation of social costs is following the 9-step-approach presented in the previous section 3.3. It is focussed on the estimation and presentation of those cost elements borne by private investors, the public sector and by the rest of society. Pure user-internal operating costs are regarded to the socially neutral and hence are calculated, but not considered when presenting the results of the cost accounting process.

Step 1: Collection of General Data

The fictitious city is assumed to have a motorization rate of 0.5 for passenger cars and a stock of goods vehicles, which is 5% of the number of private cars. It is assumed that an average car (lorry) drives 10 km (16 km) at 300 days per year. The number of buses and tramways are assumed to be 100 each with an annual mileage of 80,000 for buses and 100,000 for tramways. Occupancy rates, speeds and time values per passenger / ton of freight for each type of vehicle are estimated according to international experiences. The general data set respectively looks as follows:

1: General Data		Car	Lorry	Bus	Tram
Inventory	Vehicles	300000	15000	100	100
Traffic volume	km/veh.a	3000	5000	80000	100000
Average travel speed	Kph	25	30	15	20
Average value of time	Euro / h*	10	17	6	6
Vehicle occupancy	Pass.tons	1.3	5	15	30
Passenger car units		1	2.5	2	2
Axle load units		0.00002	0.16	0.411	0

Step 2: Infrastructure Costs

The infrastructure inventory contains positions for road structures, pavements and associated assets, bus structures and rail track, structures, signalling, etc. Gross asset values comprise the sum of all investments for each category of assets. For those assets which have not been written down depreciation and interest costs are determined considering linear depreciation and an average life expectancy. Other cost items stem from municipality accounts of the fictitious city.

Infrastructure Inventory	Gross asset values	Design life	Written down	Depreciation	Opportunity Cost	Maintenance
	MEuro	Years	%	MEuro	MEuro	MEuro
Road structures	1,296	80	50%	8.10	19.00	0.40
Road pavement	3,969	25	75%	39.69	23.83	14.69
Associated road assets	192	15	75%	3.20	1.12	6.84
Bus structures	0	100	25%	0.00	0.01	0.10
Tram structures	0	80	75%	0.00	0.00	0.00
Tram track	390	30	75%	3.25	2.39	1.10
Tram signalling system	1	10	10%	0.09	0.02	0.10
Tram communication system	1	5	20%	0.16	0.02	0.00
Tram electrification	13	30	3%	0.42	0.31	0.00

The overall infrastructure costs are estimated to be 125 MEuro per year. Traffic-independent costs of road provision are allocated to car, lorry and bus via annual passenger-car kilometres, while pavement costs are distributed according to axle-load-factors. The other cost categories are allocated to bus and tram directly.

Infrastructure Costs		Car	Lorry	Bus	Tram	TOTAL
Share by PCU-km		80%	17%	1%	2%	
Share by Axle-load-km		0%	78%	21%	0%	
Road structures 1)	MEuro	22.03	4.59	0.39	0.49	27.50
Road pavement 2)	MEuro	0.09	61.32	16.80	0.00	78.21
Associated road infrastructure 1)	MEuro	8.94	1.86	0.16	0.20	11.16
Bus structures	MEuro	0.00	0.00	0.11	0.00	0.11
Rail/tram total	MEuro	0.00	0.00	0.00	7.86	7.86
Total infrastructure costs	MEuro	**31.06**	**67.77**	**17.46**	**8.55**	**124.82**
Average infrastructure costs	Euro / km	0.027	0.181	0.145	0.028	

Step 3: Vehicle-Associated Costs and Revenues

For the estimation of vehicle-associated costs average figures per unit and year have been used, while for the computation of time costs the average speed, time value, vehicle occupancy and annual mileage are considered. As the cost calculation focuses on the social component of resource consumption, those costs directly paid by the user - which are operating costs in for private cars and lorries plus the user time costs for all modes) are subtracted from the total annual resource costs per vehicle. The resulting social vehicle-associated costs are zero for individual transport modes and comprise the operator's costs for public transport.

Social Vehicle-Related Costs		**Car**	**Lorry**	**Bus**	**Tram**	**TOTAL**
Depreciation	Euro	500	5000	20000	30000	
Opportunity cost of capital	Euro	400	4000	15000	25000	
Tyres and other consumables	Euro	169	9150	13250	5000	
Repair and Maintenance	Euro	250	1500	25000	25000	
Net fuel cost	Euro	250	938	24000	10000	
Cleaning and Servicing	Euro	0	1500	12000	15000	
Wages and Administration	Euro	0	30000	139500	15000	
Time costs	Euro	1560	14167	480000	900000	
Total Operating Costs	Euro	2629	61254	708750	995000	
Direct User Costs	Euro	2629	61254	480000	900000	
Annual Social Operating Costs	Euro	0.0	0.0	228750.0	95000.0	
Total social VAC	MEuro	**0.00**	**0.00**	**22.88**	**9.50**	**32.38**
Average social VAC	Euro / km	0.00	0.00	0.19	0.03	

The revenues of transport comprise the payments of users to the public sector and to public or private infrastructure suppliers and transport operators. Neither transfers between these sectors nor compensation payments to affected inhabitants (suffering from noise or air pollution) are taken into account. Ticket sales are assumed to cover 50% of the bus and tram operating costs while they are allocated to the payers by p.km per type of service. Infrastructure contributions and vehicle tax revenues are estimated on a unit-specific basis.

Transfers / User Contributions		**Car**	**Lorry**	**Bus**	**Tram**	**TOTAL**
Public Transport Fares	MEuro			4.6	11.6	16.2
Direct Infrastructure Charges	MEuro	5.5	13.4			18.9
Annual Vehicle Taxes 1)	MEuro	30.0	7.5	0.0	0.0	37.5
Fuel & Energy Tax 1)	MEuro	36.0	15.8			51.8
Total user contributions	MEuro	**71.5**	**36.7**	**4.6**	**11.6**	**124.3**
Average user contributions	Euro / km	0.06	0.10	0.04	0.04	

1) Private vehicle operators

Step 4: Congestion Costs

The basis of the estimation of traffic congestion is the assumption that 10% of all trips are performed in peak traffic, which is slowed down by 41% against uncongested traffic conditions. Congestion costs borne by each mode then are calculated as the extra time consumption valued by the value of congested time, which is 20% above the average value of travel time. The total costs then caused by the modes are allocated to each mode by annual PCU-km (step 1) to receive the mode-specific responsibility for congestion costs.

Additional Time Costs due to Congestion		Car	Lorry	Bus	Tram	TOTAL
Vkm affected by congestion	Mvkm	90.0	7.5	0.8	1.0	
Total extra time consumption	Mhrs.	3.1	0.8	0.5	1.0	5.5
Congestion borne by mode	MEuro	**31.2**	**14.2**	**3.2**	**6.0**	**54.6**
Congestion caused by mode	MEuro	**43.7**	**9.1**	**0.8**	**1.0**	**54.6**
Balance of Congestion costs	Euro / km	-12.5	5.1	2.4	5.0	
Average Balance per pkm / tkm	Euro / km	-0.011	0.013	0.020	0.017	

Step 5: Accident Costs

For the estimation of annual accident costs the number of material damages, light injuries, severe injuries and death casualties are collected by responsible traffic mode. Accordingly the total accident costs do not need to be distributed to modes artificially.

Assessment of Accident Consequences		Material damages	Slight injury	Severe injury	Death casualty
Assessment of Pollutants	Euro/case	1000	1000	100000	1500000

Accident Costs		Cars	Buses	Lorries	Trams	Total
Number of material damages		2979	117	12	34	3142
Number of slight injuries		1296	967	103	147	2513
Number of severe injuries		321	49	5	7	382
Number of death casualties		12	2	0	0	14
Total accident costs	MEuro	**54.38**	**8.98**	**0.62**	**0.88**	**64.86**
Average accident costs	Euro / km	0.060	0.120	0.077	0.088	

Step 6: Costs due to Emissions into the Air

The estimation of the costs arising from exhaust emissions of fuel-powered vehicles and electricity production is based on the assumption of average emission factors per pollutant (PM_{10}, SO_2, NO_X, HC and CO_2). Total mode-specific costs then are calculated by applying monetary values to each ton of pollutant produced.

Assessment of Pollutants		PM	SO2	NOX	HC	CO2
Assessment of Pollutants	Euro / t	96000	11000	15700	750	71.75

Costs of Emissions into the Air		Cars	Buses	Lorries	Trams	Total
Emission Factor for PM	g/vkm	0.045	1.6	1.54	1	4.14
Emission Factor for SO2	g/vkm	0.06	1.3	1.22	10	12.52
Emission Factor for NOx	g/vkm	0.54	19	18	5	42
Emission Factor for HC	g/vkm	0.77	6.2	5.6	5	16.8
Emission Factor for CO2	g/vkm	195	1200	1087	2500	4787
Emissions, PM	tonnes	40.5	120.0	12.3	10.0	182.8
Emissions, SO2	tonnes	54.0	97.5	9.8	100.0	261.26
Emissions, NOx	tonnes	486.0	1,425.0	144.0	50.0	2105
Emissions, HC	tonnes	693.0	465.0	44.8	50.0	1252.8
Emissions, CO2	tonnes	175,500.0	90,000.0	8,696.0	25,000.0	299196
Total emission Costs	MEuro	**25.22**	**41.77**	**4.21**	**4.68**	**75.88**
Average emission Costs	Euro / km	0.028	0.557	0.526	0.468	

Step 7: Costs due to Traffic Noise

The number of people affected by traffic noise is determined by exposure measurements in three different types of area. The target levels assumed are 50 dB(A) for residential areas, 60 dB(A) for mixed commercial areas and 65 dB(A) for industrial areas as average of day and night time noise exposure. The costs of an additional dB(A) of average noise exposure are estimated to be 0.1% of an average annual income or 18 Euro per dB(A) and year.

Noise Inventory		55	60	65	70	Total
Exposed in residential areas	inhabitants	60000	6000	600	60	66660
Exposed commercial areas	inhabitants	8000	1000	500	100	9600
Exposed industrial areas	inhabitants	200	250	100	100	650
Total costs in residential areas	MEuro	5.40	1.08	0.16	0.02	6.66
Total costs in commercial areas	MEuro	0.00	0.00	0.05	0.02	0.06
Total costs in industrial areas	MEuro	0.00	0.00	0.00	0.01	0.01

Costs due to Traffic Noise		Cars	Buses	Lorries	Trams	Total
Relative noise emission		1	5	9	10	
Share of noise emissions		62%	26%	5%	7%	
Total noise costs	MEuro	**8.37**	**3.49**	**0.68**	**0.93**	**13.47**
Average noise costs	Euro / km	0.007	0.009	0.006	0.003	

Step 8: Other External Costs of Transport

Other effects of transport on natural habitats and biotopes,, the risks and additional environmental costs of producing fuel and electric energy and separation effects are of minor importance compared to the previous cost elements.

Other Effects of Transport		Car	Lorry	Bus	Tram	TOTAL
Urban quality and heavy traffic	MEuro	0.43	0.01	0.02		0.47
Risks of energy production						
- petrol	MEuro	5.00				5.00
- diesel	MEuro	0.36	0.05	0.09		0.50
- electricity (risks)	MEuro				0.00	0.00
Separation	MEuro	0.21	0.06	0.03		0.30
Total costs	MEuro	**6.00**	**0.13**	**0.14**	**0.00**	**6.27**
Average costs	Euro / km	0.007	0.002	0.017	0.000	

Step 9: Presentation of Results

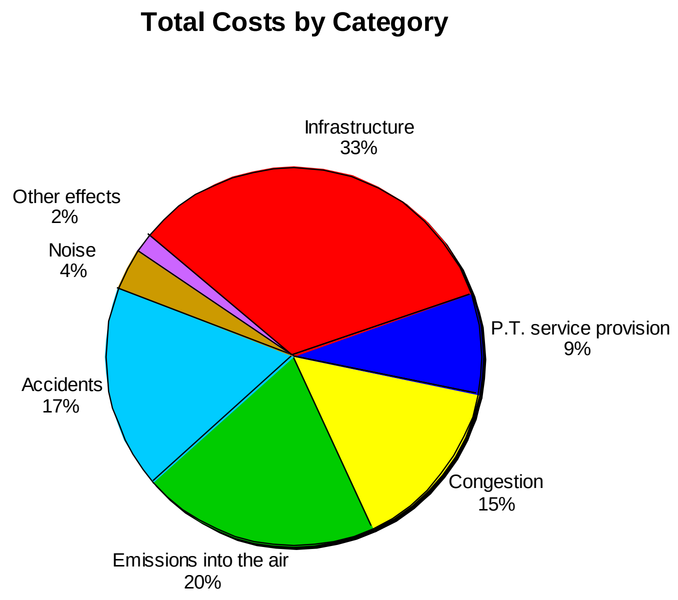
The first and basic output of this cost accounting exercise is total costs by category and responsible mode of transport (step 2-8). Subtracting the financial contribution of the vehicle operators to cover their social costs (step 3) and the congestion borne by them (step 4), the second output are the uncovered social costs by mode. Respective average figures can easily be derived under consideration of the respective pkm and tkm values.

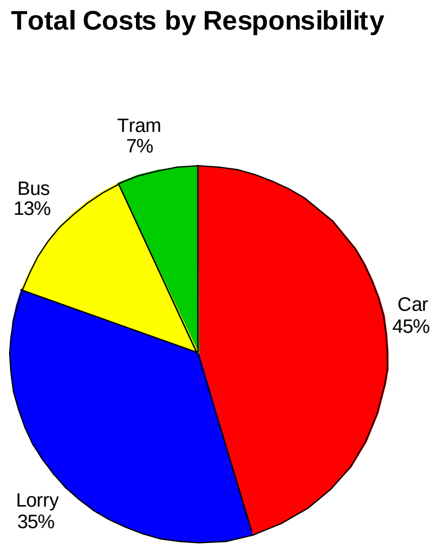
Total and Average Social Resource Costs		Car	Lorry	Bus	Tram	TOTAL
Infrastructure	MEuro	31.1	67.8	17.5	8.5	124.8
P.T. service provision	MEuro	0.0	0.0	22.9	9.5	32.4
Congestion	MEuro	43.7	9.1	0.8	1.0	54.6
Emissions into the air	MEuro	25.2	41.8	4.2	4.7	75.9
Accidents	MEuro	54.4	9.0	0.6	0.9	64.9
Noise	MEuro	8.4	3.5	0.7	0.9	13.5
Other effects	MEuro	6.0	0.1	0.1	0.0	6.3
Total gross resource costs	MEuro	**168.7**	**131.2**	**46.8**	**25.5**	**372.2**
User contributions	MEuro	86.5	40.4	4.6	11.6	0.0
Congestion borne	MEuro	31.2	14.2	3.2	6.0	0.0
Total net resource costs	MEuro	**51.0**	**76.7**	**38.9**	**7.9**	**587.3**
Average gross resource costs	Euro / km	0.144	0.350	0.390	0.085	
Average user contributions	Euro / km	0.101	0.146	0.065	0.059	
Average net resource costs	Euro / km	0.044	0.204	0.324	0.026	

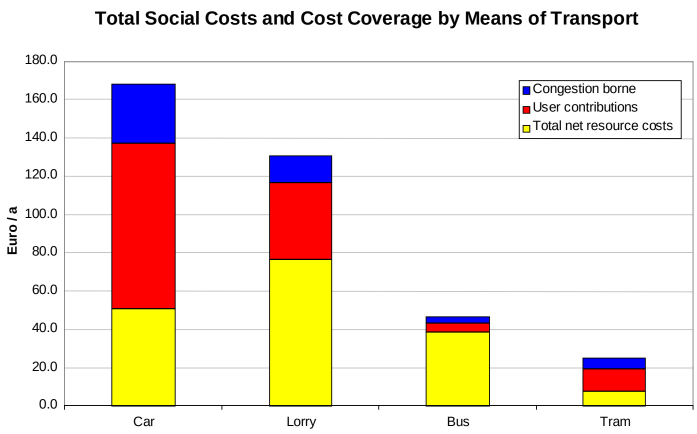
An assignment of resource costs and transfer payments to responsible actors (+) and to actual payers (-) leads to indices of effective loads of each actor. The sum over the cost components in this accounting method as well as all congestion costs equal out to zero. In the presentation of this exercise only four actors are considered, which are the totality of transport users (subsuming individual and public transport users), private investors in infrastructure and public transport (private sector), the public hand acting as infrastructure supplier, transport operator and tax collector and the rest of society.

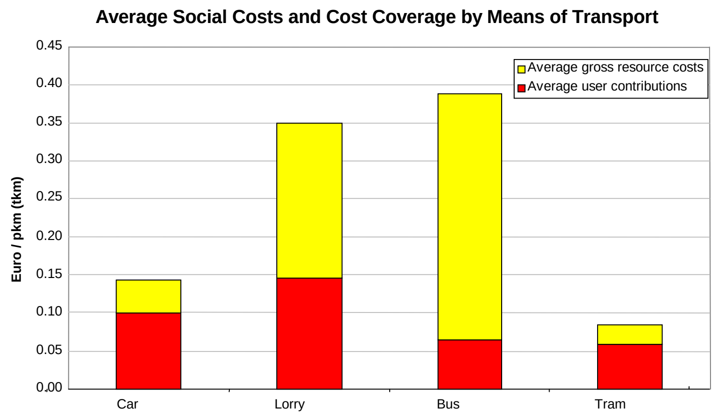
Actual Payers		Transport users	Private sector	Public budgets	Other society	TOTAL
Infrastructure provision	MEuro	124.8	-12.5	-112.3	0.0	0.0
P.T. service provision	MEuro	32.4	-16.2	-16.2	0.0	0.0
Congestion	MEuro	0.0	0.0	0.0	0.0	0.0
Emissions into the air	MEuro	75.9	0.0	0.0	-75.9	0.0
Accidents	MEuro	64.9	0.0	-38.9	-25.9	0.0
Noise	MEuro	13.5	0.0	0.0	-13.5	0.0
Other effects	MEuro	6.3	0.0	0.0	-6.3	0.0
Public Transport Fares	MEuro	-16.2	8.1	8.1	0.0	0.0
Direct Infrastructure Charges	MEuro	-18.9	13.2	5.7	0.0	0.0
Annual Vehicle Taxes 1)	MEuro	-22.5	4.5	18.0	0.0	0.0
Fuel & Energy Tax 1)	MEuro	-51.8	5.2	46.6	0.0	0.0
Total resource costs	MEuro	**208.3**	**2.3**	**-89.1**	**-121.6**	**0.0**

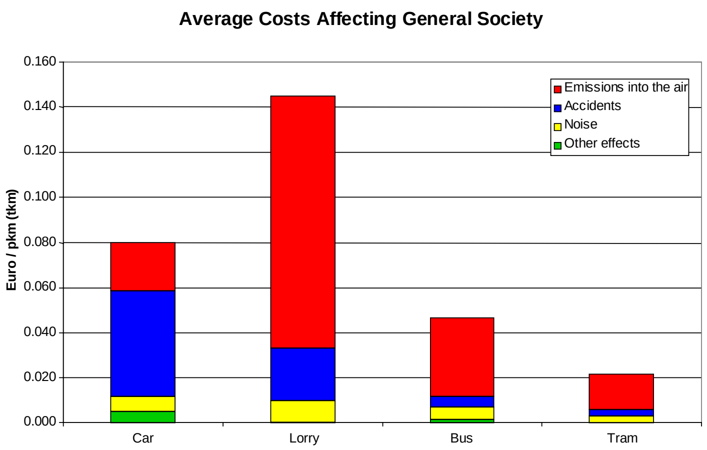
For a real analysis a more detailed consideration of actor groups is necessary, but for the purpose of this illustration example the summary presented is sufficient. The final column served as a control panel; for each cost or transfer component the sum of generated and carried costs must be equal. The six figures below show different cost indicators.

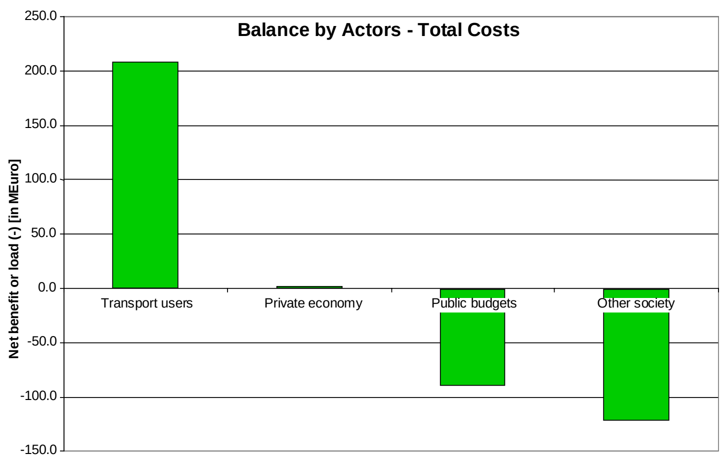

Total Costs by Category
Infrastructure
33%
P.T. service provision
9%
Congestion
15%
Emissions into the air
20%
Accidents
17%
Noise
4%
Other effects
2%


Total Costs by Responsibility
Tram
7%
Car
45%
Lorry
35%
Bus
13%


Total Social Costs and Cost Coverage by Means of Transport
Euro / a
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Congestion borne
User contributions
Total net resource costs
Car
Lorry
Bus
Tram


Average Social Costs and Cost Coverage by Means of Transport
Euro / pkm (tkm)
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Average gross resource costs
Average user contributions
Car
Lorry
Bus
Tram


Average Costs Affecting General Society
Euro / pkm (tkm)
0.160
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000
Emissions into the air
Accidents
Noise
Other effects
Car
Lorry
Bus
Tram


Balance by Actors - Total Costs
Net benefit or load (-) [in MEuro]
250.0
200.0
150.0
100.0
50.0
0.0
-50.0
-100.0
-150.0
Transport users
Private economy
Public budgets
Other society

9 ANNEX 3 - DISCUSSION OF FISCUS METHODOLOGIES IN CEEC

The need to know Transport Costs

In Hungary as well as in the other CEECs the transport sector cared only about internal transport cost (and especially of the public transport) for a long period of time. Even internal public transport costs were mostly covered by the State because of the low fares. After the political changes car traffic began to grow and - together with the appearance of financial difficulties in the public transport sector - environmental sensitivity of the society became a factor drawing attention to the importance of external costs of the transport sector.

In general it can be said that externalities have been recognised by scientific organisations as in the western world. The idea of externalities and their consideration in transport policy and measures is gaining acceptance but in a very slow process. This resulted in some early attempts in the beginning of the '90s to deal with the issues in the legislation.

The first and very relevant question in connection with externalities is the following: Why is the knowledge of real social transport costs important? The experience showed that there are four main reasons for it:

- To assess and influence the costs of urban transport by sectors over years.
- To provide arguments for a fair transport policy on the basis of internal and external costs to the society.
- To find transport system measures and solutions with minimal social (internal and external) costs.
- To internalise the external costs of the transport system by means of fiscal and legal regulations to influence the modal split and gain additional financing resources.

These three arguments prove that those bodies making transport policy and transport related decisions must be aware of the impacts of their decisions. The decision-initiated measures generate external impacts, which must be modelled to be able to assess the possible outcomes of such decisions. In connection with this decision-makers will ask many questions from planners regarding real urban transport costs':

1. How much does transport cost the individual and the community?
2. What are the main elements of real transport costs?
3. How can external costs be quantified?
4. What part of the costs is paid and not paid by the different user groups?
5. Which of the pricing relevant costs can be priced and how, considering the presently already paid taxes and fees?
6. Who should collect the new taxes/fees/tolls (municipal, regional or central government)?
7. What will be the main immediate effects (modal shift, environment improvement, more revenue) of the

taxes/fees/tolls after their introduction?

8. What will be the main similar effects of the taxes/fees/tolls in longer term?
9. Where could the new additional revenues be most efficiently used (e.g. improvement of collective transport)?
10. What will be the social political reaction of the community?

These theoretical questions could arise in the mind of each mayor whose city considers the pricing of external effects of transport. FISCUS should contribute to answering these questions and making their importance clear in order to be able to solve them.

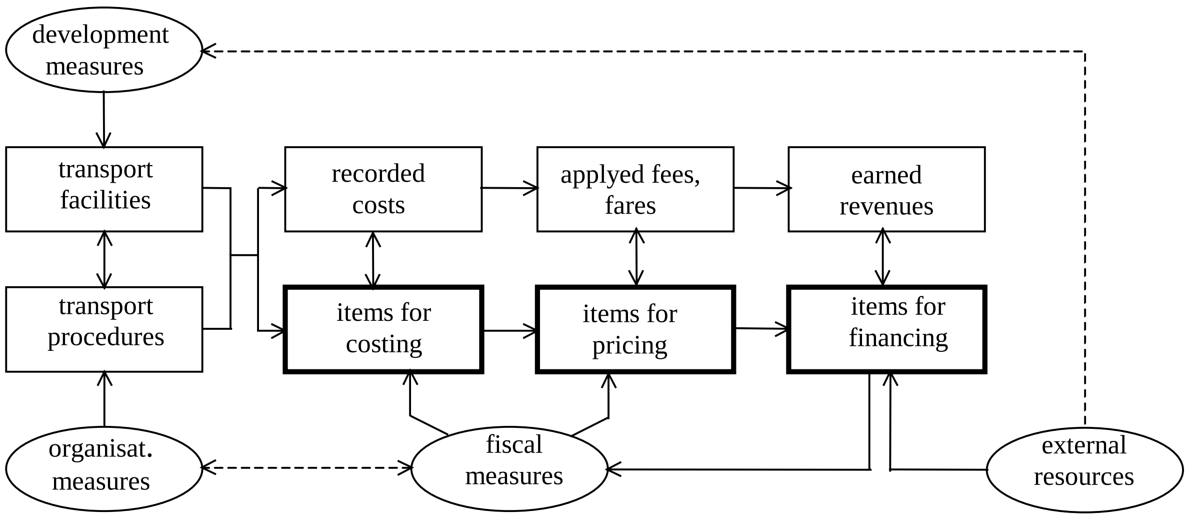


Figure A3-1: Correlation of transport costs, fees and financing

In transport costs emerge even if they are not recorded, enumerated or known. One would think that the internal costs of transport are known, but this is true only for organised transport and the costs of the service providers, where the accounting regulations for companies and the use of public money force the 'cost causer' to do so.

Concerning the not organised, private transport recording the costs is not compulsory, thus the various costs of this are not know most of the times (let us consider that the vehicle owners very often do not keep record of, or even knowledge about the different cost elements of the private vehicles: fuel, tyres, maintenance, parking, cleaning, taxes, insurance fees, etc.). After the setting up of infrastructure its costs are continuously 'generated' due to devaluation, but they are (partly) apparent only periodically, at the time of setting up and renewal.

In the course of costing it is important to consider the following: part of the costs in connection with the vehicles and infrastructure is permanent, while another part is use-dependant, thus variable.
The degree of the external costs is usually not known, as they appear outside transport (in the population, in nature),

where the costs/damages are generally not assessed.

In this case costing can be carried out with the help of various methods. The possibility for the direct determination of costs is rarely given, instead indirect procedures are applied for costing.

As regards to the degree of the most important impacts (transport time, cost, air pollution, losses due to accidents, etc.) two types of costs can be mentioned:

- total costs: total costs of the different impacts for the total traffic, which are estimated either in one amount on the basis of the input/damage of the bearer or as the products of the transport volume or consequence quantities and unit costs.
- unit costs: specific costs for the units of performance/used resources, which can be of two types again according to the method of determination and content:
  - marginal costs: additional cost caused by a new unit appearing in the traffic (e.g.: private car or public transport vehicle), the process of which is not linear, but it continuously increases as a result of congestion
  - average costs: cost per one participant of transport derived from the total costs

Although average costs do not reveal the differences between the various parts of the network, as well as changes of the traffic according to time, these are however very often the way for its practical calculation.

Knowing the costs and costing procedures are usually necessary for two reasons:

- For the determination of the transport prices; for which specific costs are needed, while fees in connection with internal and external costs should be differentiated.
- For the evaluation of the various transport system measures; in case of cost-efficiency evaluation the knowledge of total costs is needed in respect of the solution alternatives.

Efforts for a Detailed Cost Evaluation Approach in Hungary

The disharmony between transportation supply and demand – from the viewpoint of transportation policy and planning – can be moderated with several measures on the basis of a detailed analysis of the current situation. When dealing with transportation problems it is expedient to highlight the approach of **transportation system management**, which includes dealing with transportation needs, infrastructure, facilities institutions and transport processes in such a way that economical, environmental and social impacts are also considered, and the requirements of financial feasibility also gain more and more attention.

In the recent years due to the increase of social environmental sensibility and the decrease of financial sources in Hungary the targets and approach of transport planning as well as the modes of problem solving have changed in several aspects.

Thus the main aim of the recently completed Development Plan of the Budapest Transportation System - instead of the previous approach of trying to satisfy the transport needs above all - is to ensure the functioning of the city, to stop the down-grade of the urban living conditions and to improve the harmony of supply and demand as well as the quality and economy of transportation.

That means the transport policy targets should be achieved through **the appropriate harmonising of the demand and supply factors and the minimising of real (internal and external) social costs of transport.** The extra investment and operational costs of the realisation can be justified by the positive social effects on transport.

Modelling tools in Hungary

These goals – even without the explicit and exact knowledge of external costs – can be approximated to make a measure that points to the right direction mitigating the impacts of transport. This is the broad practice of urban transport planning and development, which is made possible in the region of Budapest by e.g. the TRANSURS (**Trans**port in **Ur**ban and Regional **S**ystems) model system. Among the possible system measures/interventions **the traffic organising/regulating, the financial regulating** and **the infrastructure development** measures enable the improvement of the transport system. To be able to select the optimal among different alternative transport modelling solutions an assessment framework is needed which allows the quantification of different impacts (See Fig. A3-2)

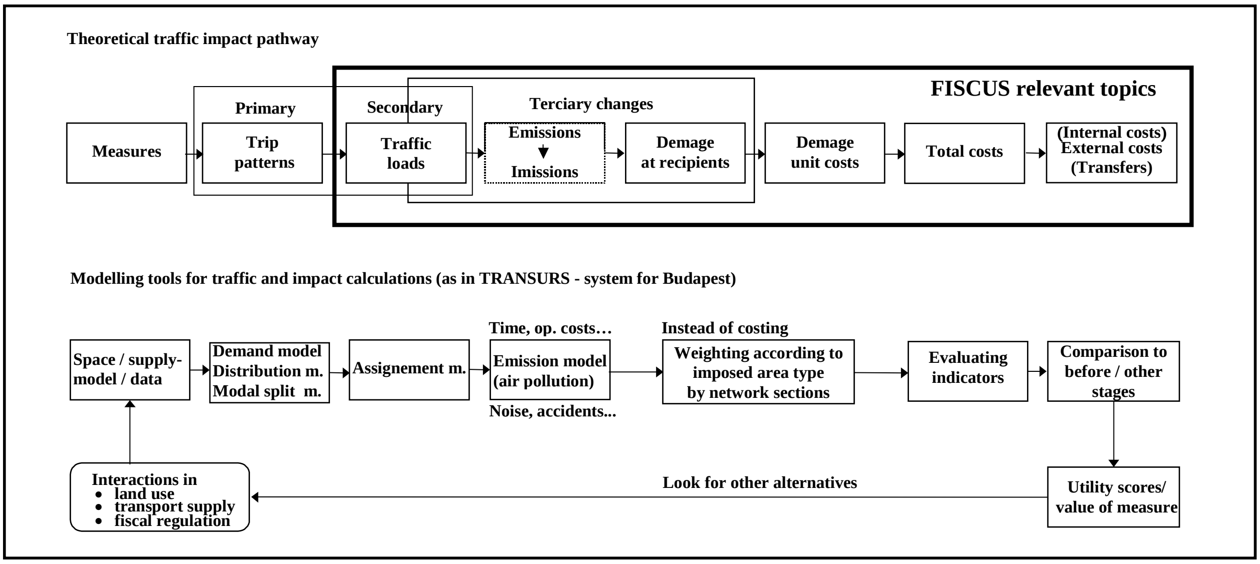


Figure A3-2: Theoretic Transport Impact Pathway and Modelling Capability in Hungary

It can be seen that the detailed impact pathway for costing has been substituted by simpler quantifying-evaluating steps. This does not mean that certain impacts are not expressed in monetary terms but it will be shown that the relative impact evaluation of a certain measure or package-measure is possible without using monetary terms.

As regards transport system development and intervention, impacts appear on three levels:

– The transport and area development measures on the transport system - through changes in journey time, costs and other conditions as ‘regulating elements’ - **primarily** affect the conditions, amount, distribution (according to regions, daily time, modes and network/roads) of traffic (these changes can be estimated by traffic models).

– Changes in traffic bring about a number of **secondary changes**. The most important ones of these are the changes in time inputs, costs, air pollution, noise, accidents, etc., which:

  - involve the transport users inside the **transport system** on one hand, (the time spent with travelling, fuel consumption and other costs), and partly the accident losses.
  - and the ‘outputs’ of transport on the other hand, which appear **outside transport**, e.g. exhaust, noise, accident losses partly (these changes can be estimated by several impact models).

– **Tertiary changes** resulting from the ‘outputs’ and possibilities of transport and the ‘meeting’ of the involved parties (stakeholders) outside transport, e.g. health, nature, and other areas of socio-economic life.

It is clear from the above that the impact is the difference between two states that can be felt on the impact bearers’ side through the quantitative changes of the different impact factors.

The principles explained above – reaching beyond the scope of FISCUS – can be implemented only with a ‘dynamic’ approach requiring appropriate traffic and impact models (e.g.: air pollution, noise, accidents) like the TRANSURS model system in case of Budapest.

The opportunities and the framework of the practical determination of transport impacts and costs regarding Budapest are summarised in the table below. This shows the measured and already available transport data, which can serve as a basis for a static and restricted ‘cost-snapshot’ as well as a dynamic transport demand and traffic impact modelling process.

Items	***Determination of basic quantities*** by measuring/(statistics)	 by modelling (TRANSURS)	***Determination of unit costs***
Traffic volumes, performances	Traffic flow surveys (house-holds, cordons) every 8-10 years; Cross sectional counts roads: annually at 30 sites, public transport: annually network wide	Trip generation – distribution modal split (logit); Traffic assignment road network: equilibrium public transport network:	
Transport times	Travel time measurements (annually on a set of roads combined with fuel consumption measurements)	Speed/delay times by links; Time consumption (including congestion) by traffic load volumes	Value of time estimation by means of revealed preference analysis for choice – GDP for economic evaluation
Fuel consumption	In-traffic measurements, simulation measurements in laboratory	Speed/delay-dependent fuel consumption by traffic load volumes and vehicle categories	Fuel prices for petrol and diesel (HUF/litre)
Air pollution	Permanent emission measurement on the network for the CO, CH, SO_2 and NO_x components	Speed/delay-dependent emission calculation by unit emission values and traffic volumes by vehicle categories; Replacing the monetary values the calculated volumes are weighted by imposed area type	No Hungarian values yet (NO_x equivalent values by component standards)
Noise	Occasional road side noise measurements	Speed/delay-depended noise (dBA) calculation above the standard values by traffic volumes and composition; Replacing the monetary values the calculated volumes are weighted by imposed area type	No Hungarian values yet
Accidents	Statistics of the police and insurance companies (problems with localisation of accidents inside settlements)	Accident hazard scores using relative hazard-values by section/intersection parameters, traffic volumes and composition	Specific accident losses by fatal, serious and light accident events and injured persons derived from interurban statistics considering the age skill and loss in GDP
Road vehicle operating costs	Occasional data collection from automobile club, and companies	Cost calculation using unit costs and traffic volume by vehicle categories	Unit costs by vehicle categories (HUF/km, HUF/h, Replaceable by fuel costs?)
Public transport operating costs	Company cost accounts containing personal, vehicle operation and maintenance, depreciation and overheads (in top-down approach)	Cost calculation by unit costs of transport modes and traffic performance	Unit costs (HUF/place km) by vehicle types/makes
Road operating costs	Infrastructure provider cost statistics about maintenance and operation	Cost calculation by unit costs of road categories	Yearly unit costs by road categories and age (not realistic costs because of budget constrains)
Infrastructure investment	Investors' calculation in the public transport and the road sector	Calculated total values by new network elements	Unit prices (HUF/km, HUF/m^2 etc.)
Public transport vehicle investment	Purchase data by vehicle type/make	Calculated total values by development actions	Purchase unit prices (HUF/vehicle)

Table A3-1: Transport Volume and Cost/Impact Calculation Framework in Budapest

Speed dependency of costs/impacts

Transport costs and impacts highly depend on traffic volumes and conditions. This holds especially for urban transport where traffic is concentrated and steady flows are interrupted by congestion and node waiting times resulting in significant extra time, fuel consumption, air pollution and noise. With regards to the fact that these circumstances depend highly on the technical conditions and travelling speed of the vehicles it is important how the resistance (also influenced by these vehicles) to be overcome is calculated. In this regard it is expedient to distinguish:

– Road traffic, which is characterised by occasional congestion and in which vehicles travel with different speeds in a less bound state;
– Public transport process, in which vehicles are operated according to a given timetable with fixed frequency and sometimes segregated infrastructure. Travel speed is usually influenced by the technical features of the vehicle.

Considering the above, within the framework of the TRANSURS model system two main indicator groups can be calculated for the different impact fields and impact bearer groups. Traffic-dependent impact indicators; Inter-area relational impact indicators. These indicator groups which represent “costs” are briefly discussed in the following.

Quantification of traffic dependent impacts

In terms of external transport impacts it is worth to view road traffic resistance, which consists of two parts:

– On sections the travel time depends on speed depending again on traffic volume (capacity ratio).
– At nodes traffic becomes slower because vehicles arrive from usually four directions and cannot continue the journey uninterrupted. The average waiting time (T) depend on the node control system, the lane pattern and the traffic volumes (see figure on different section and node resistance).

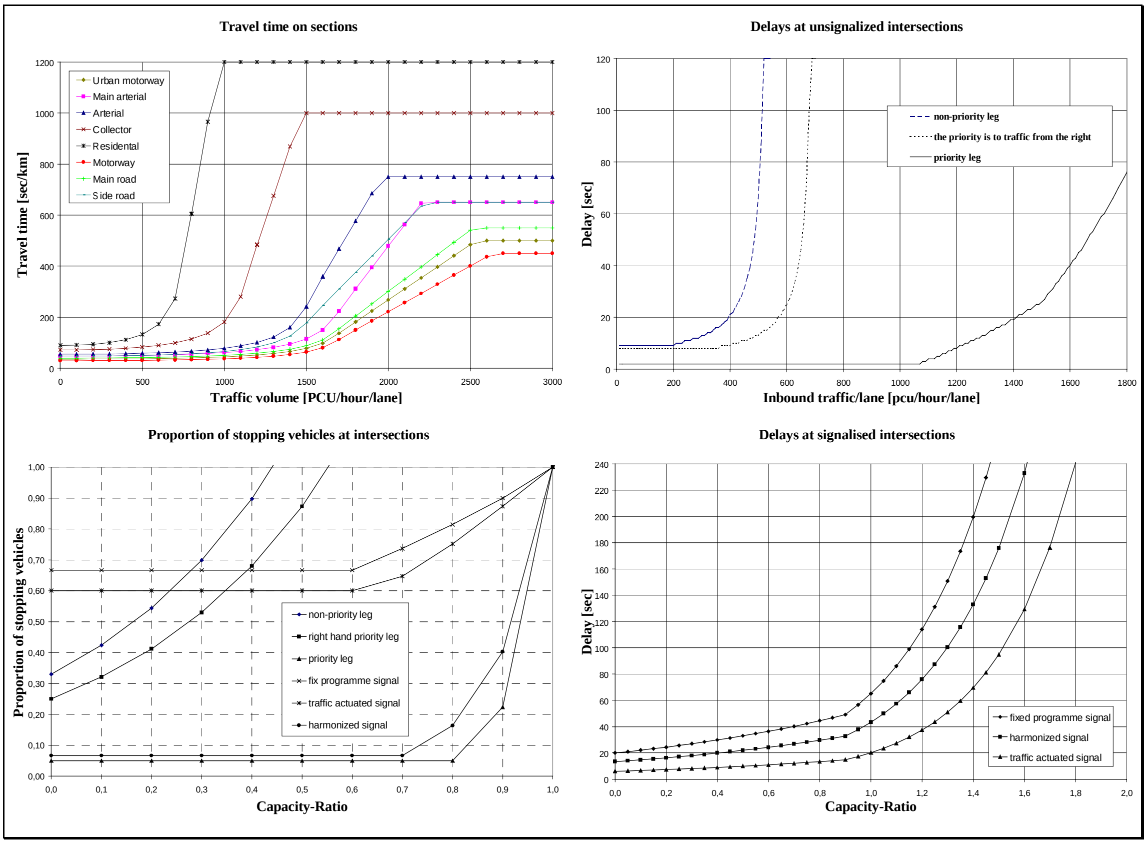


Figure A3-3: Travel Time and Delay Functions (used in the TRANSURS model-system)

The traffic congesting around the node will react to the speed conditions of the section leading to the node so the section-node relations should be handled together. This can be achieved through detailed simulation (e.g.: as in SATURN) or simplifying assumptions. Within the TRANSURS model system a combined capacity utilisation factor is considered relating to the previous section and the corresponding leg of the following node.

Distribution of impacts/costs over time

Besides the speed dependency of traffic processes it is important to deal with traffic and its impacts as processes in time because in different periods of the day (peak hours, off-peak hours, night hours) vitality is different and therefore traffic loads, speeds, impacts and costs are also different. This has significance from two aspects:

– summing up different impacts and costs can be carried out with regard to the annual traffic distribution curve (8760-hours);
– cost components in the different time periods can give a solid basis for setting transport fees.

Figure A3-4 shows it well that speed (V), and different indicators as unit time consumption (T), fuel consumption (F), air pollution (P) etc. will change as a function of link loads (number of vehicles – M) or capacity ratio/utilisation (CU).

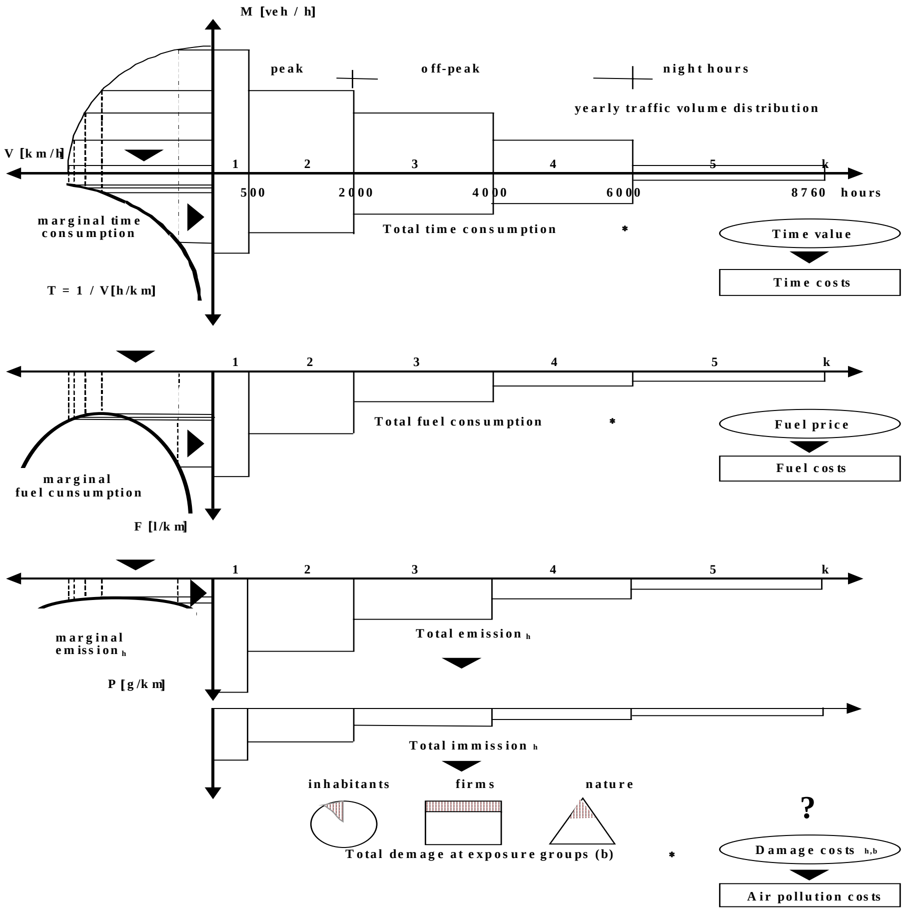


Figure A3-4: Principles of the Model Calculation of Different Internal and External Impacts/Costs of Road Traffic over a Year

That means that a number of indicators, which can be, calculated for the individual network elements (links and nodes) in strong correlation with the traffic conditions and average hourly speeds. The main traffic dependent impact-indicators are the following:

– *Time consumption of the transport users;*

The hourly (annual) volume of time spent on travelling by the vehicle and their occupants is calculated for following layers: weekday passenger traffic, weekday truck traffic. Time is strongly related to travelling speed and is inevitably derived from that. To quantify this in monetary terms value-of-time (VOT) data for economic evaluation can be derived from income or GDP figures. VOT for choice modelling is different: it expresses individual or group values and can be estimated based on household survey and revealed preference survey results.

– *Transport operating costs;*

Operating costs are generally substituted by fuel consumption as far as road traffic is concerned. In the calculation method several factors are distinguished such as acceleration/steady speed/deceleration and fuel consumption is calculated separately for petrol and diesel engines. Fuel consumption – travel speed correlation is demonstrated by the following figure. Unit public transport cost data are obtained from the operators.

– *Air pollution of vehicles;*

This indicator is calculated for each vehicle type (car, truck, bus) and for each component (CO, NO_X, CH, SO_2, Lead, CO_2) in CO or NO_X equivalent units. It is obvious that these indicators are strongly fuel consumption dependent and therefore are calculated in close relation to fuel consumption. The correlations between emissions and travel speed are demonstrated by the figures A3-3 and A3-4, that are results of measuring from the Institute of Transport Sciences. There don't exist national monetary values yet.

– *Noise emission of vehicles;*

The effect of noise caused by traffic is calculated in scores, based on the product of the link length and the difference between the actual and permitted (see table below) noise levels (with the latter being fixed in dB in the corresponding standard). In course of the calculation the distance of the built-in area, the height of the buildings and network characteristics are also considered. There is no monetarisation yet.

Area type	**Permitted noise level in dB**							
	Area without road traffic		**Residential area with low traffic**		**Feeding roads with medium traffic**		**High traffic roads, railway lines**	
	day	**night**	**day**	**night**	**Day**	**night**	**day**	**night**
Sparse recreation	45	35	50	40	55	45	60	50
Sparse residential	50	40	55	45	60	50	65	55
Dense structure	55	45	60	50	65	55	65	55
Industrial area	60	50	65	55	65	55	65	55

Table 2: Permitted Noise Levels

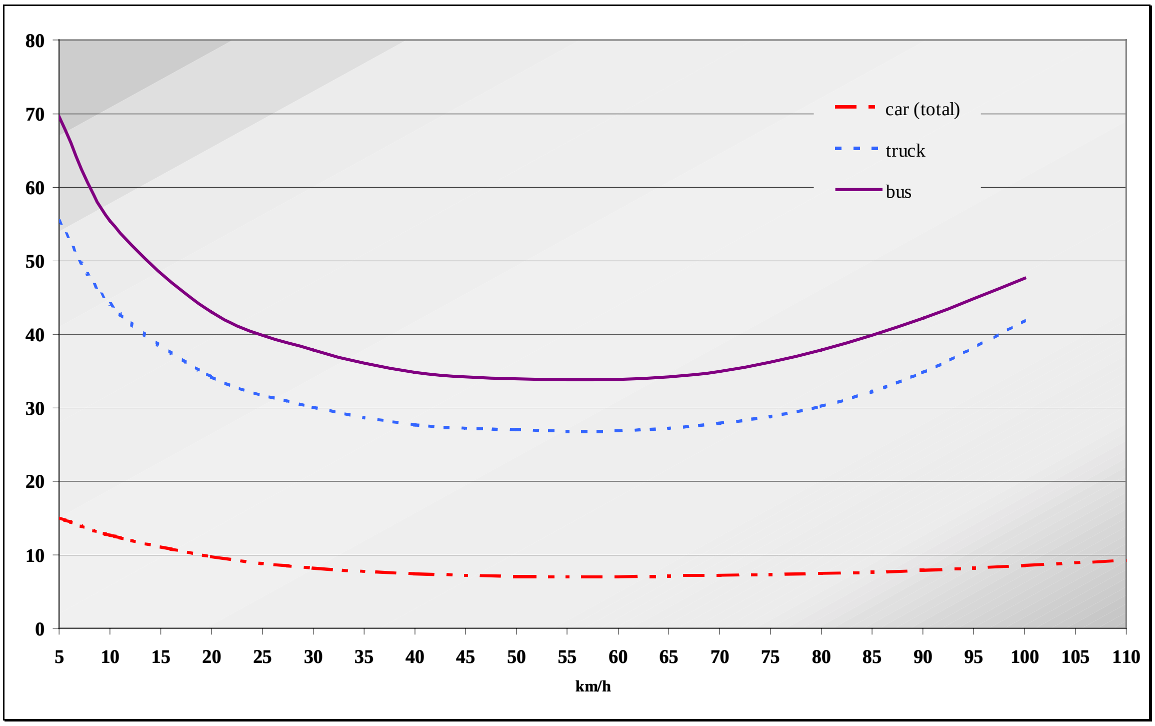


Figure A3-5 Fuel Consumption by Vehicle Categories

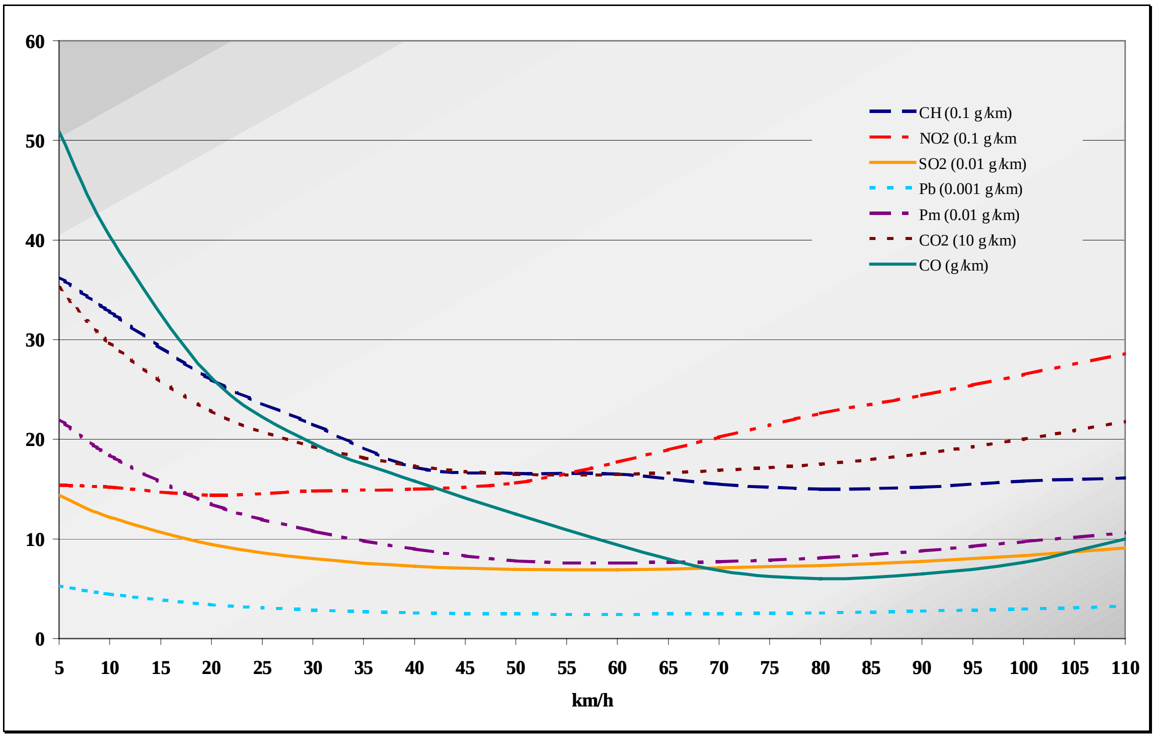


Figure A3-6: Emission Values by Vehicle Categories

- *Accident damage and risk;*
  Accident statistics per road type, traffic volume and composition are available for interurban roads only. Accident rates by type are available from the Institute of Transport Sciences. The estimated social loss for someone killed is HUF 17.3 million, for a serious injury 1.2 million and for a light injury 0.27 million. For urban area a so called risk calculation method has been developed to substitute statistics. This method is based on calculating a risk index for each link and node based on geometric layout and traffic characteristics. The hazard factors are based on a survey, which has ranked the different characteristics of the sections and nodes. This subjective method is only useable for relative evaluation of alternative development scenarios.

Relational Indicators of Accessibility

Within the inter-area or interurban relations 'travelling opportunities' can be best characterised by travel time-like indicators as general indicators of development potentials. They are calculated as a function of travel times weighted by average peak hour traffic flow magnitudes of the selected routes. The whole of the network can be characterised by a single 'accessibility' figure, which is the sum of all the travel times described above.

Assessment Techniques used in Hungary

The main goal of evaluation is to make a decision based on a set of indicators representing approximately the costs (internal and external) and benefits of a given transport measure. In course of the evaluation these indicator sets are compared and the scenario best meeting the requirements will be selected. The different computed indicators of different alternatives for Budapest as an example is shown in. Fig. A3-7.

The **common impact evaluation** can be carried out by the following methods:
Cost-benefit analysis: impacts that can be expressed in money (time, fuel, accidents, investments) are considered in this process and the benefit and cost elements relation of can be interpreted as economic efficiency indicators will be.
Use value analysis:
This kind of analysis is usually used for evaluation factors that are difficult or impossible to express in monetary terms. Indicators are usually rated according to 'utility scales' the minimum and maximum values being the edges of the scale. The aggregation of different indicators is done by weighting. This allows to consider the preferences of different stakeholders: different sets of weighting factors represent different preferences (see Fig. A3-8).
Other quality methods (verbal evaluation by ranking the features considered)
In this form only the 'relative efficiency' of the scenarios can be shown (either relative to a do-nothing or base case or relative to each other). An 'absolute efficiency' could be calculated if all indicators could be expressed in monetary terms (e.g. air pollution, noise damages too).

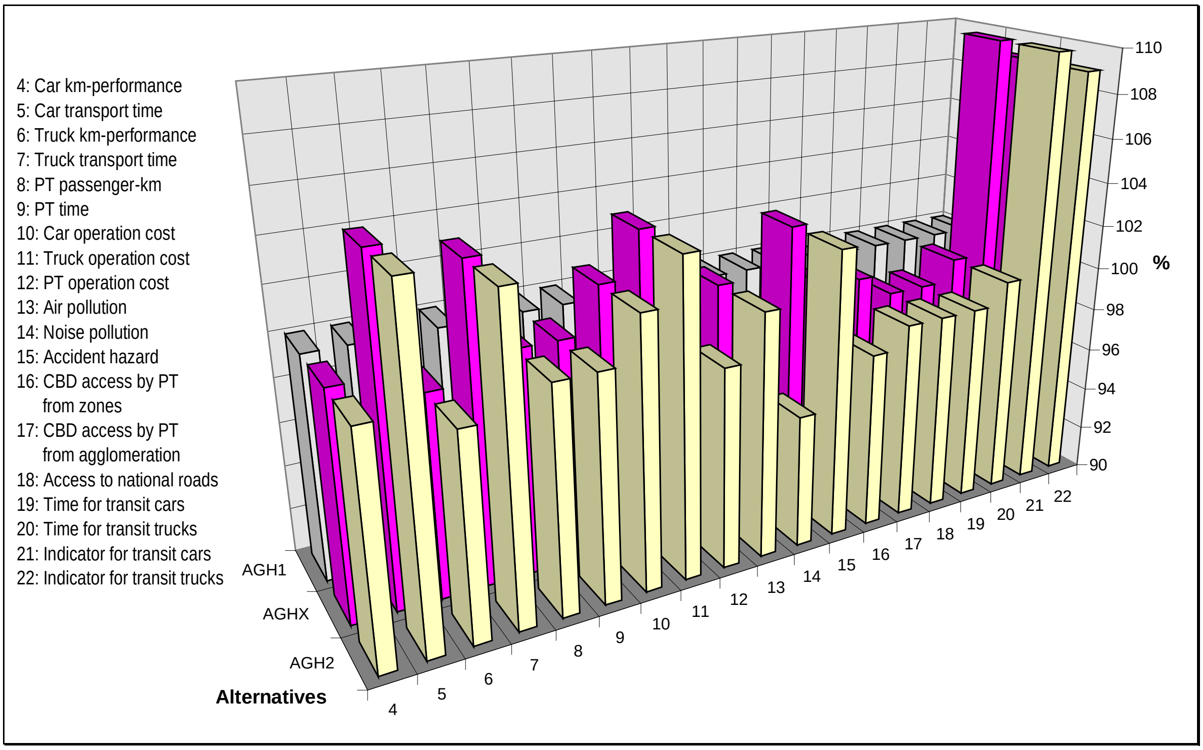
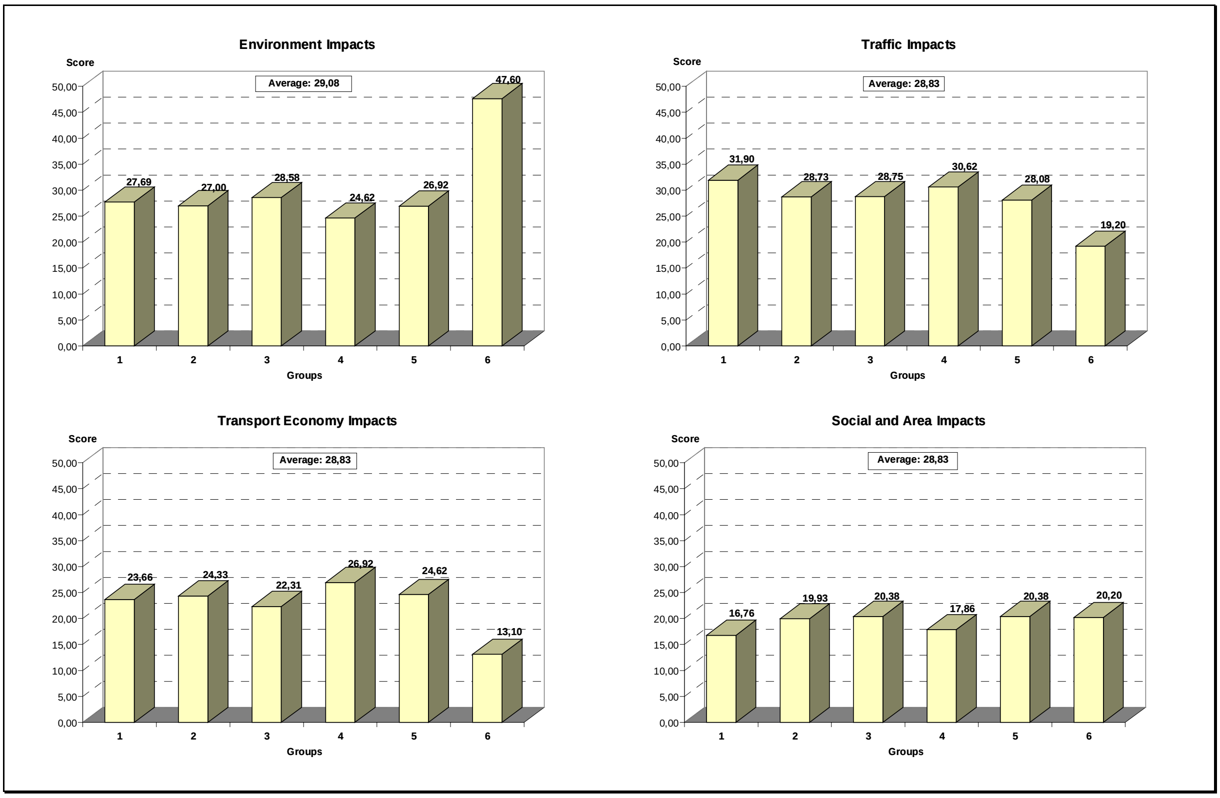


Figure A3-7: Indicators for Multicriteria Evaluation of Options



Note: Groups are as follows: 1 = Municipal authorities, 2 = Ministries, 3 = Research and education institutes, 4 = Transport suppliers, 5 = Other transport organisations, 6 = Press, NGOs

Figure A3-8: The Significance of Development Impacts by Different Stakeholders

Chances for monetarisation of impacts in Hungary

The generated outputs/emissions (emissions, e.g.: air pollution, noise, etc.) as a result of the transport processes change the external environment. Besides the degree of changes in the concerned environment (population, nature, etc.) the value loss/damage of the given units/groups should also be identified, which is still a challenging task in many cases and disputed in professional circles.

Amongst the methods for the costing of the external impacts the method of ‘impact-pathway-procedure’ can be highlighted – shown in Fig. A3-9.

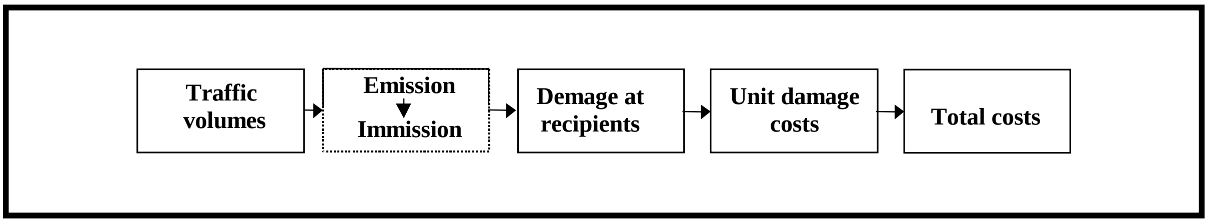


Figure A3-9: Theoretical ‘impact-pathway’ for the definition of costs

The **steps of impact path-way** are as follows (similar to FISCUS):

1. Identification of the outputs of the traffic quantities and impacts
   (speed → time consumption, fuel consumption, emission of harmful materials, noise, number of accidents, etc.)

   Methods: traffic count/statistics → output measurements
   (traffic model → impact models)

   Results: traffic quantities by types of vehicles/use of capacity
   traffic – output – correlations

2. Identification of impact dispersion in the concerned area (immission).

   Methods: emission and immission measurements
   (dispersion models)

   Results: emission – immission - functions

3. The assessment of the degree of damage in the concerned area

   Methods: observing the involved elements (health, nature, etc.) /statistics

   Results: immission – degree of damage - correlations

4. Costing of impacts/damages

Methods:	on the basis of cost calculations of precautions of preventive measures (e.g.: in case of noise damage assessment)
	determination of the intention of paying (e.g.: air, noise)
	fee differences of the fees of real estate value/rent as a basis (hedonic fee) (e.g.: air, noise)
	contingent assessment (e.g.: air, noise, accident)
	assessment of damages by the court (e.g.: damages of accidents)
	assessment of loss of national production (e.g.: in case of calculation of accident losses)
	definition of value of time (time)
Results:	average costs
	marginal costs

The methods listed as examples are often disputed due to their subjectivity and because the basis of most of them is the method of 'stated' preferences, in the course of which the definition of the value/damage of the analysed phenomenon is carried out through a selection from the variances of a given phenomenon, if characteristics of price are also applied. Different figures can be retrieved according to the various income groups. It has to be mentioned here that the private time value (e.g.: in case of mode choice) can differ from the community time value (in case of economical assessment).

The omission of any of the steps of the impact-path-way will result in more aggregated, thus rougher results ('second best practice').

If adequately detailed traffic quantity and impact data for the same period are not available, the setting up of the marginal cost correlation will not be possible, in these cases substitutive average costs can be retrieved.

In this respect attention should be paid to the differences between and possibilities of the two methods of data collection/retrieval and correlation analyses:

- methods based on traffic surveys/statistics and impact assessments; in this case the measured traffic quantities and outputs of the existing network (air pollution, noise, etc.) can mean **static** limitation in respect of issues demanding forecasting,
- methods based on traffic models and impact models; after the adequate models have been set up and calibrated there is a possibility for the **dynamic** estimation of the traffic and impact quantities of the not yet existing situations; more and more big cities have realised the importance of this and the TRANSURS model system in Budapest has been created with this aim, as mentioned already

previously.

Costing is a unique and important step of the impact-path-way, which results in local (country- and city-wide) cost assessment in certain cases. The various national figures are difficult to compare or to transfer to one country to another. If this happens, it can be done on the basis of e.g.: purchase parity power, which demands serious circumspection.

In the international literature the costs of external impacts are often expressed in aggregated form of percentages of the GDP, when the difficulties of detailed calculations are ironed out with the help of approximate estimations. At the same time, the impressiveness of the results increases their convincing force.

In the given domestic conditions analyses have only been carried out as regards to accident losses and determination of time value, data on cost/values are only available in this respect. Domestic surveys on the costing of air pollution and noise are almost completely non-existent.

The role and place of these indicators in the impact pathway and their significance in impact evaluation is well demonstrated by the following figure.

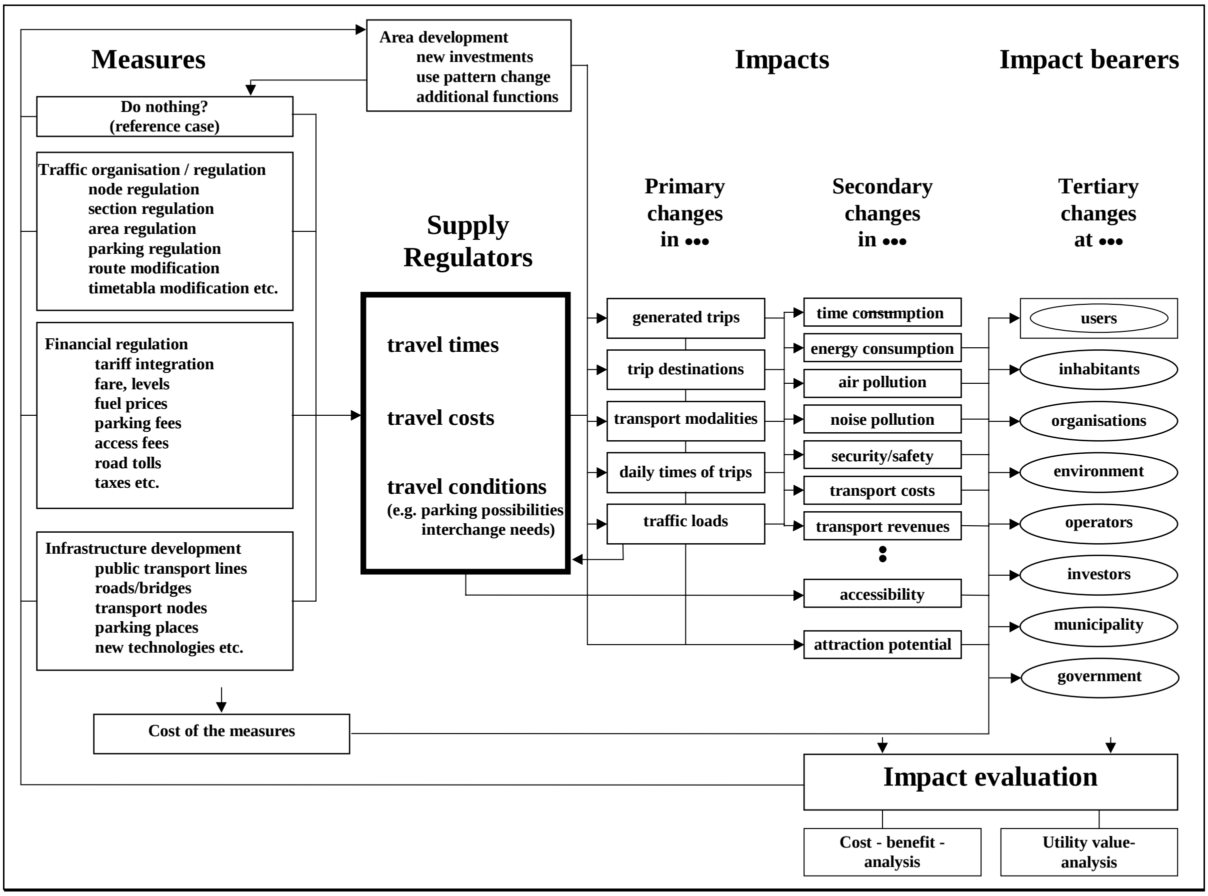


Figure A3-10: Transport Impact Mechanism and Possibilities of Evaluation

Pricing issues in Hungary

In connection with external impacts the touchiest political question is the **pricing (internalisation)** and collection of charges, which can be the following:

– **taxes:** central or local payments that are paid by the taxpayers without getting any definite compensation, and are imposed as general or aim-specific community coverage assets,

– **fees:** particular charges to be paid as the compensation of used performances and values

– **contributions:** amounts imposed for potential advantages or possibilities, in case of which the use of the service is not necessary although the possibility of use is already enough for the liability of contribution

– **penalties:** charges to be paid for the contravention of the given regulations and limit values.

Amongst these elements – in our consideration – taxes and (particular) charges are important, while attention should be paid to the basic principle that with general taxes influence is very difficult to attain.

In respect of charging and the practical execution of it following the principles of ‘causer’ and ‘lesser harmful’ emerging from the approach of total transport are expedient to follow.

Therefore **the aim of charging** is the payment of external transport costs but it also serves other aims: influencing transport processes and consequences (costs) and enforcing the considerations of social ‘re-distribution’.

However, the allowance of the latter considerations encumbers the application of charges for cost coverage (e.g.: in public transport). The bearer of the uncovered costs is the society (e.g.: in connection with the unpaid external costs of the private car users), which appears in the decaying state of the infrastructure and in the depletion of our natural values, etc.; in case of public transport users the society/budget pays the uncovered costs of the services in the form of subsidy/compensation (if this does not happen the deficit generated each year is usually paid by the community sooner or later in the course of reconstruction).

The following **types of charges** are applied in the course of charging also in Hungary:

– **flat fare:** charge independent from the degree of the used service or caused cost (e.g.: price of the single tickets of the local public transport)

– **charges proportional to performance:** the charge is proportional to the used service or the caused cost (e.g.: tolled motorways, with close system public transport charges limited to zones, etc.)

– **charges of multiple parts:** the charge contains a ‘basic part’ dependant on the permanent costs and the other part is proportional to the use of the service (e.g.: taxi charges, or rail charges, where the fee is proportionally higher in the zone of the first 10 km than in the subsequent zones; the taxes related to cars can be seen as two part charges: yearly weight tax as fix part and fuel tax as performance depending part)

– **charge proportional to time:** charges dependant on the duration of the service use, entry fees (e.g.: parking fees, entry fees to the Castle District in Budapest)

– **charge adjusted to marginal costs:** marginal cost is an additional cost caused by a new element in transport (vehicle, passenger), which is a variable relative cost and its degree depends on the extent of the traffic and use of capacity at which the user joins the network.

The characteristics of the charges is that they are valid for the given service or only for a given part of it and they uniformly apply to everybody within the given user group. The reactions to the charges of the certain users (degree of acceptance) are varied: some accept them, others change their previous transport habits due to the changes of the fees (e.g.: they travel less frequently, do not travel where they are used to, travel at another time, or use another route). Before the introduction of the fees the expected reaction of the users can be assessed with the help of the method of stated preferences again, as it is usually done so in case of the implementation of toll motorways.

The cost coverage ability of the charges – as it could be seen – is varied, the incoming revenues usually do not cover even the internal costs in public transport. In case of unit charges and the ones proportional to performance there is a chance for applying charges that are adjusted to the average costs of a previous period (HUF/boarding or HUF/passenger km) thus the total cost can be covered. In case of charges proportional to the marginal costs where instead of cost coverage, the ‘fair’ influencing of charge application is the main aim, this could happen only accidentally. However, this type of charge is to be followed, as this is socially more righteous (the charge is higher at that point and at that time where the costs are also higher) and its impact force in the intended direction is more advantageous.

The question of charging emerges in connection with road transport mostly due to two reasons:

– compensation for the costs of road building,
– compensation for the additional external congestion costs.

Charging of congestion and its consequences is one of the most important tasks in fact, the foundation of which can be based on the correlation emerging from the 'theory of welfare'.

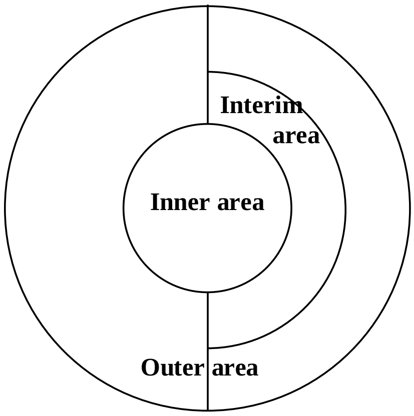
Congestion happens in certain elements of the transport network (lines, conjunctions) if the intensity of the traffic (number of units, e.g.: cars participating in the traffic) gets close to the boundary of capacity and traffic slows down as a result of vehicles hindering one another, the flow of the traffic becomes abrupt compared to the 'ideal' situation assuring uninterrupted traffic flow. As a consequence of this the nature of congestion costs is different from that of the other cost types. Thus: the consequences of congestion are additional costs compared to the costs of a more advantageous situation.

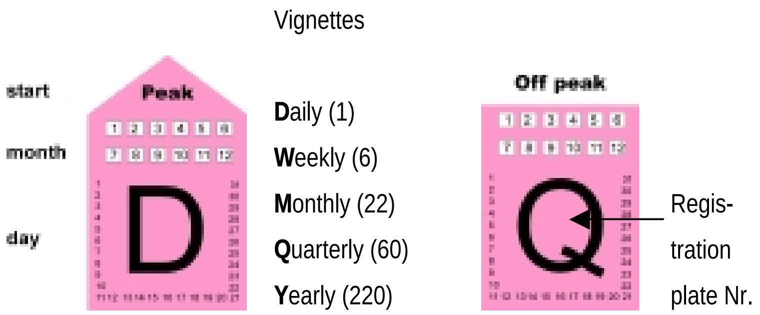
The question of the types of additional costs caused by congestion is still disputed; some regard them as additional time-costs, although it is obvious that beyond the time loss caused to the other user groups congestion's also result in air pollution, noise, etc.

The technique of charge collection is also a closely related issue beside pricing, as the application of differentiated price levels is still very often hindered by the missing technical conditions today.

The determination and collection of fees adjusted to the variable conditions are very difficult, as it would only be possible with the help of a completely controlled electronic system. These system are still non-existent. The fee of a service has to be determined in advance so, it cannot be incalculable and dependant on the conditions; instead differentiated fees according to times of the day and regions could be applicable, which are proportional to the marginal costs. The collection of these fees can happen without stopping in urban conditions or electronically (with a chip card) or with a sticker bought beforehand.

Bearing in mind that in the inner districts with dense population and in peak hours the external costs (congestion, air pollution, noise, etc.) caused by the traffic load are higher, in the sticker system of the theoretical city shown in Fig. A3- 10 fees are the highest in the central areas and in the peak hours and are proportionally lower in the outer districts and off-peak periods (inhabitants of these areas are entitled for using the service free of charge in the off-peak periods through compensation). The control of the stickers bought for different periods and effective from the day of 'self'-validation can be done at the traffic light junctions or in stationary position.





Area of validity	Daily Time	Validity period	Vignette		Reimbursement by area of registration		
			form & colour	unit/piece	inner area	interim area	other area
Inner area	Peak	06-10 15-19	☗	10	6	2	-
	Off peak	10-15	■	6	6	2	-
Interim area	Peak	06-10 15-19	☖	4	-	2	-
	Off peak	10-15	□	2	-	2	-
Outer area	Peak	06-10 15-19	-	-	-	-	-
	Off peak	10-15	-	-	-	-	-

Table A3-3: Theoretic Marginal Cost Proportional Road Pricing Scheme by Area and Daily Time Period Using Paper Vignettes with Self Validation

1) The vignette permits are ranked:
   - the vignettes for the inner area are valid also in the other areas
   - the vignettes for the peak hours are valid for the whole day for the area of validity
2) The price (unit) proportions are the same for the different vignette types. Discount rates depend on the time period of validity (daily, weekly, monthly, quarterly, yearly)
3) Vehicle owners get the off peak permission free of charge for their area of residence or this sum can be considered in the price of higher ranked vignette.

The question often arises if just the variable external costs dependant on the density of the traffic should be paid or the transport users should also pay for the permanent costs (e.g.: infrastructure). This – as opposed to the congestion costs – means the determination of long-term fees connected to the building and expansion of the infrastructure.

If toll is introduced with the aim of financing the building of a new infrastructure, the toll to be paid will be adjusted to the reimburse of the invested capital and the revenues generated from the fees can be higher than the costs of the investment and capital (extra profit). In case of private companies the capital-costs can be more apparent for the user than in case of a company with State interference, where the whole society bear these costs through the budget. As regards to the use of private cars in an urban environment parking fees (e.g.: in Budapest), entry fees (e.g.: in the Castle District in Budapest) and certain road tolls abroad are the most often applied financial regulating tools.

The price and the level of pricing to be applied depends mostly on politics, especially in case of public transport. If the level of prices is adjusted to the solvency of the better-off user groups, additional revenues can be generated from those user groups whose demand is relatively fixed, e.g.: in case of those who use transport for going to work, but the decrease of the demand or non-paying passengers (dead-heads) should also be expected.

Example: application of access fees and its consequences in the inner districts of Budapest (inside the Big Ring). Within the framework of EUROPRICE project various charging experiments and modelling calculations have been executed in London, Dublin, Athens and Budapest. In case of Budapest with the application of the sensitive demand-models (traffic dispersion and distribution) and loading methods derived from the TRANSURS model system based on the data of the 1994 household survey, the model analysis of various charging options have been made possible. The results of one of the options are shown in Fig. A3-11.

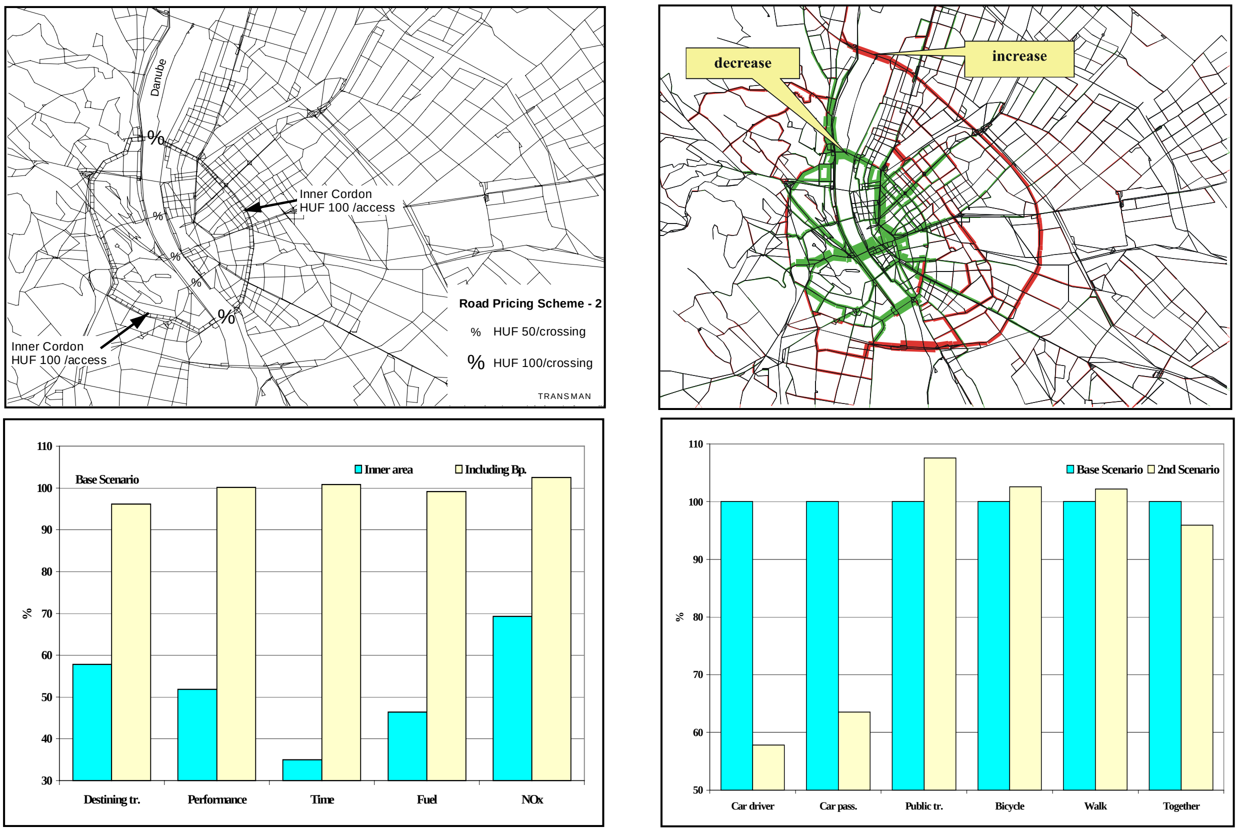


Figure A3-11: Scheme and results of road pricing modelling in Budapest

The not applied, but assumed cordon fee is relatively high, it equals to 4 public transport tickets (price in 1995: HUF 25/ticket), in case of bridge tolls on the Danube bridges in the inner districts of Budapest a fee of an additional 2 units has been assumed.

On the basis of the generalised transport costs (time, fuel, service conditions + entry fee) the results of the logit-based calculations for destination and mode choice in respect of the over 70 passenger groups and groups of reasons for motion are shown in the graphs and the difference figure. According to these

- the departing and destination traffic in the direction of the inner areas would decrease by approximately 4% all in all
  (in the calculations the differentiation between the inhabitants of these areas and the other passengers was not possible)
- the proportion of the transport modes would change as follows:
  private cars –40%, public transport +8%, bicycles +3%, pedestrians +2%
- compared to the basic option the different modes in the inner districts of Budapest as well as in the whole city would change as follows: destination traffic of private cars (-42/-4%) traffic performance (-48/0%), time spent in the traffic (-65/+1%), used fuel (-54/-1%) emitted nitrogen-oxide (NO_x) (-31/+3%) – decrease (-), increase (+).
- the traffic loads of the network in the inner areas and on the bridges would considerably decrease; part of the ‘edged off’ excess traffic would appear on Lágymányosi bridge and Árpád bridge, where this traffic would still cause less additional external costs than in the inner districts
- the annual farebox revenue – which is not an unimportant aspect – would be HUF 7 billion/year (in case of 1995 prices).

In the course of theoretical modelling we did not deal with the technology of fee collection, investment demands and operational costs. Savings would decrease in case of the beneficence of the inhabitants of the given area but the consideration of this was not possible due.