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Socio-Economic
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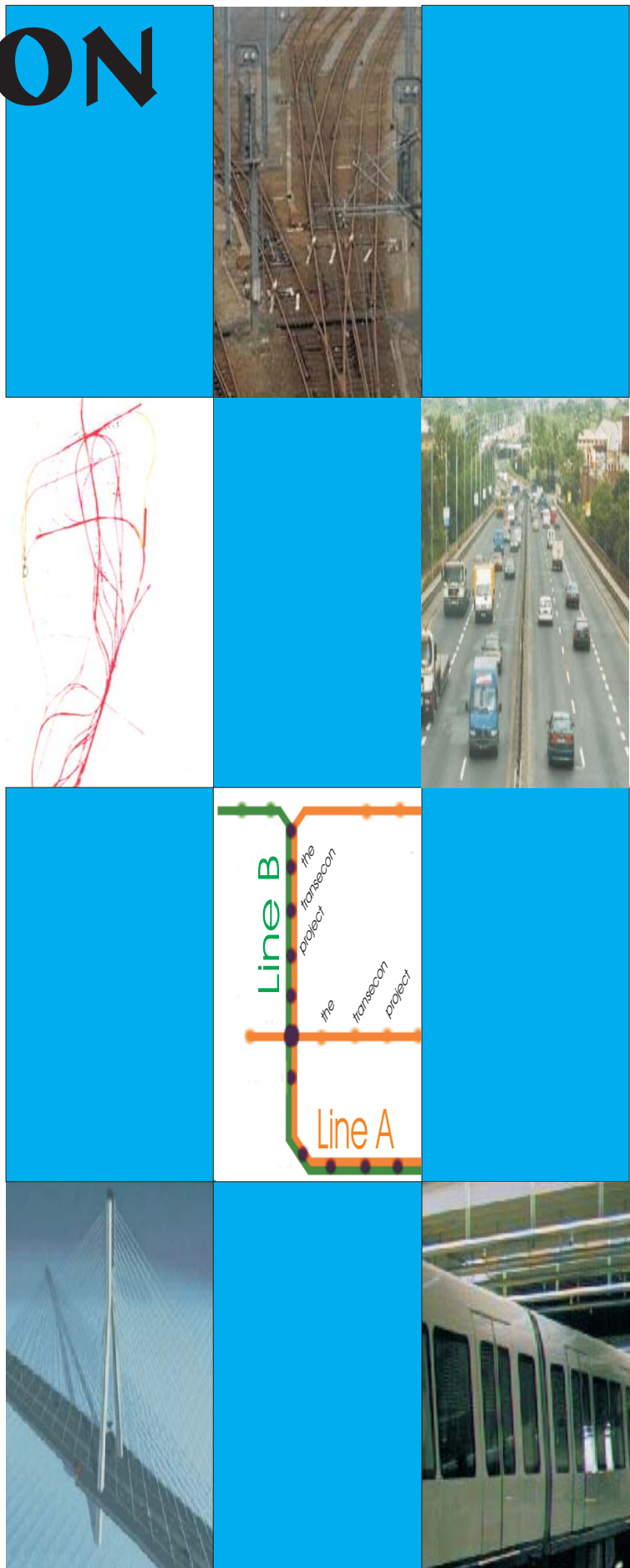
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Transecon - Final Report

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1 EXECUTIVE SUMMARY

Urban transport policies and infrastructure investments have a wide socio-economic impact, not only along the corridor or within the areas they are designed to serve, but throughout the urban-region and through time. The **TranSEcon** research project was carried out within the fifth framework programme of the European Commission under the key action Sustainable Mobility and Intermodality. The **TranSEcon** research project aims to provide qualitative and quantitative evidence regarding the existence of the direct and indirect effects and impacts of transport infrastructure investments in 13 European cities. The long term effects of implemented large scale infrastructure investments of all types of mode are to be analysed using existing data-bases together with stakeholder interviews in the 13 European case studies. The selected case studies cover a good range of city and intervention types (in terms of geographical distribution, city size, transport policies and investments). The research partnership involves 18 organisations (6 universities, 2 research centres, 9 consultancies) in 9 EU member states, an EEA country and an Accession country.

The methodology is driven from a multi-disciplinary perspective requiring expertise in related fields such as: urban and regional land use planning and sustainable development planning, urban re-generation and renewal design, implementation and management, sociology, macro-economics, development economics, labour economics, political science, decision making process analysis, organisation science and institutional development.

The result of the analysis of the 13 case studies provides a good overview of the so called indirect network effects and third party effects: The **regional economic effects** have a multiplier of about 2 to 2.5 of the investment costs; the additional employment effect has a range of about 30 persons per year per Mio. Euro (€) investment. This could be a useful policy instrument, if unemployment rate is a relevant topic in the region. Transportation investments can cause strong **changes in land use** patterns. Central area projects, such as metro lines, may lead to an increase of business, but at the same time a slight decrease of growth rate per capita due to out-migration of inhabitants to suburbs and commuting. In the case of outer city projects, such as an S-Bahn (suburban train), the spatial diffusion or sprawling of activities of population and workplaces towards the suburban belts seems to be enhanced. The latter is higher in the adjacent attractive parts of the metropolitan landscape. Large-scale transport infrastructure can stimulate **urban regeneration** development if the appropriate pre-conditions are given. Areas close to metro or S-Bahn stations that have suffered of industrial decline or still vacant suburban sites have a large development potential, if the general economic climate supports investment in real estate. Inner city areas along metro lines undergo more gradual changes, as the urban fabric may be in good shape and the changes may merely concern the use of already available space.

Concluding, transport infrastructure investments offer great potential for **socio-economic effects**. Not all of these effects are positive. The spatial development of the settlement from the point of view of sustainable mobility and land development requires special attention: depending on the investment project and the changes of accessibility it causes, both desired and undesired concentrations and/or urban

sprawl can result. Therefore, “everything is possible” in principle, it all depends on the framework conditions.

Policy makers can have a positive impact on the performance of public transport projects when supporting tramway or bus feeder systems to the metro or S-Bahn networks and when organizing the services within the frame of a regional transport authority. Policy makers can, however, reduce the benefits and economic returns of public transport investment, if at the same time the road network and the parking supply are improved. The scope of transport investment is too often somewhat narrow in that there is no active policy to develop sites in the areas with improved accessibility. Upgrading of deteriorated urban sites and the development of new areas depends largely on fruitful interaction between investors, business circles and public authorities.

2 INTRODUCTION

2.1 Background

The *TranSEcon* project addresses the “task 2.1.2/4 cluster on socio-economic impacts of transport investments and policies and network effects” -frame of studies in the key action of “sustainable mobility and intermodality” and in particular “subtask 3: urban transport and local socio-economic development” (accompanying measures project). Urban transport policies and investments are implemented on the basis of urban transport planning and management and therefore their evaluation usually is linked to performance in terms of transport operations (e.g. travel-speed, time-savings, travel-safety, investments and operation costs) and environmental aspects. However, urban transport policies and investments may have wider socio-economic impacts and effects not only along the corridor or within the areas that are designed to serve, but throughout the city-region and through time. Therefore it is necessary to carry out research in evaluating these socio-economic impacts and effects stemming from urban transport policies and investments which are not covered by a traditional cost-benefit analysis.

The main expected technical achievements of this research was to provide evidence regarding the social and economic impacts and effects of urban transport investments and policies (so called “indirect effects and impacts” as indirect network effects), in order to inform city authorities in their transport and related policy development and infrastructure planning, as well as to support relevant EU policies, with the emphasis put on long term effects.

2.2 Project Objective

The *TranSEcon* research project aimed to provide qualitative and quantitative evidence regarding the existence of the direct and indirect effects and impacts of transport infrastructure investments in 13 European cities.

The long term effects of implemented large scale infrastructure investments of all types of mode were analysed using existing data-bases together with stakeholder interviews in the 13 European case studies. The selected case studies cover a good range of city and intervention types (in terms of geographical distribution, city size, transport policies and investments). The research partnership involves 18 organisations (6 universities, 2 research centres, 9 consultancies) in 9 EU member states, an EFTA country and an Accession country.

The methodology was driven from a multi-disciplinary perspective requiring expertise in related fields such as: urban and regional land use planning and sustainable development planning, urban re-generation and renewal design, implementation and management, sociology, macro-economics, development economics, labour economics, political science, decision making process, organisation science and institutional development. Thus the project approach is not to concentrate on the normal transport-related direct socio-economic impacts (e.g. modal split changes, accessibility improvements, time savings, vehicle operating cost changes, environmental and safety benefits, revenues and financial concerns).

3 SETTING THE SCENE

3.1 Analytical Framework

Categorisation of effects and impacts of transport infrastructure investments

Given the diversity of case studies, it is necessary first to define an analytical framework to ensure comparability of the case studies in the different countries. In this context the first step of the research work is to describe, characterise and categorise “socio-economic effects” as such. All effects caused by infrastructure investments can be distinguished in direct and indirect effects as well as direct and indirect network effects where:

- Direct effects are related to transport users, operators, neighbours, who are directly affected by transport investments and policies.
- Direct network effects occur within the transport system. These effects are related to not directly affected transport users, operators or other concerned people. These persons are affected by the behavioural changes of directly affected transport users, etc.

Both types of these effects occur as changes in the transport behaviour (route-choice, travel-time, destination-choice, travel costs, etc.), but also as changes in operation costs, investment costs, emissions, noise, etc. These effects are not covered by a traditional cost-benefit analysis

The special focus of this project is to investigate the indirect effects and indirect network effects defined as:

- Indirect effects (known as third-party effects or socio-economic effects): These effects are long term effects which occur in markets other than the transport system. They are caused by the changes in accessibility and other effects transmitted throughout the transport network and lead to changes in the labour market (employment effects), product market, health and environmental situation, urban regeneration, economic development etc.
- The indirect network effects are caused by the changes in indirect or third party effects and occur in the transport system. Changes in the labour market, product market and attractiveness of the city are influencing the transport demand again. This transport demand produces changes in the traffic flows, which are generated through these other markets.

The *TranSEcon* project concentrates on socio-economic effects, and thus only the indirect effects are analysed in the further steps.

Definition of socio economic effects

At the start of the project, it became clear that a definition of socio-economic effects is needed. As mentioned above, socio-economic effects are a type of indirect effect or third party effect which can be classified as follows:

Economic effects can be:

- Broadening the access of employers to a pool of qualified labour,
- The extension of market areas for goods and services,
- The attraction of foot-loose inward investment,

- Bolstering the image of an area,
- Unlocking suitable development sites and
- Spending or employment effects.

Meanwhile social effects can be:

- Improved access to mobility for disadvantaged people,
- Better accessibility of basic services,
- Achievements in terms of safety in traffic and security in public spaces, but also;
- Reducing the burden of traffic nuisance in urban or suburban areas and thus improving health conditions.

The term “socio-economic effects” may therefore refer to a conglomerate of such economic and social effects. In addition it may include some environmental impacts. In *TranSEcon*, this wide interpretation has been chosen, as the socio-economic effects of transport policy identifies the project’s contribution to sustainable urban development. In particular following socio-economic effects are analysed in detail:

- Economic effects during construction (section 4),
- Direct impacts on the transport system (so called direct effects and network effects) (section 5),
- Urban re-generation effect and changes in land use (section 6),
- Economic and spatial development of the area accessed (section 7),

A special emphasis is put on the supporting and organizational and legal framework, which influences the intensity of the above mentioned effects and impacts (section 8 and 9)

Time related influence

The life-cycle of a transport infrastructure investment can be classified in the following phases:

- The planning and evaluation phase; during which the political decision is made,
- The design phase,
- The construction phase,
- The operation phase.

As the *TranSEcon* project is focused on the investigation of socio-economic effects, the influence of the different phases on these effects must be particularly considered. For example, transport policy measures such as infrastructure investments can have an effect on real estate development at different phases of the infrastructure investment life cycle. Decisions for private investments can occur long before a political decision is taken on infrastructure investment, during construction or after start of operation. The reasons for such anticipating, stepwise, or after the event private reaction to infrastructure investment may be that not all real estate developers assess investment risks in the same way, and that local or general economic contexts of private investment show certain cycles as well. It is common knowledge that infrastructure investment cycles and private investment cycles often do not have the same rhythm. Monitoring of socio-economic effects of transport infrastructure must take account of such interference (Figure 3-1).

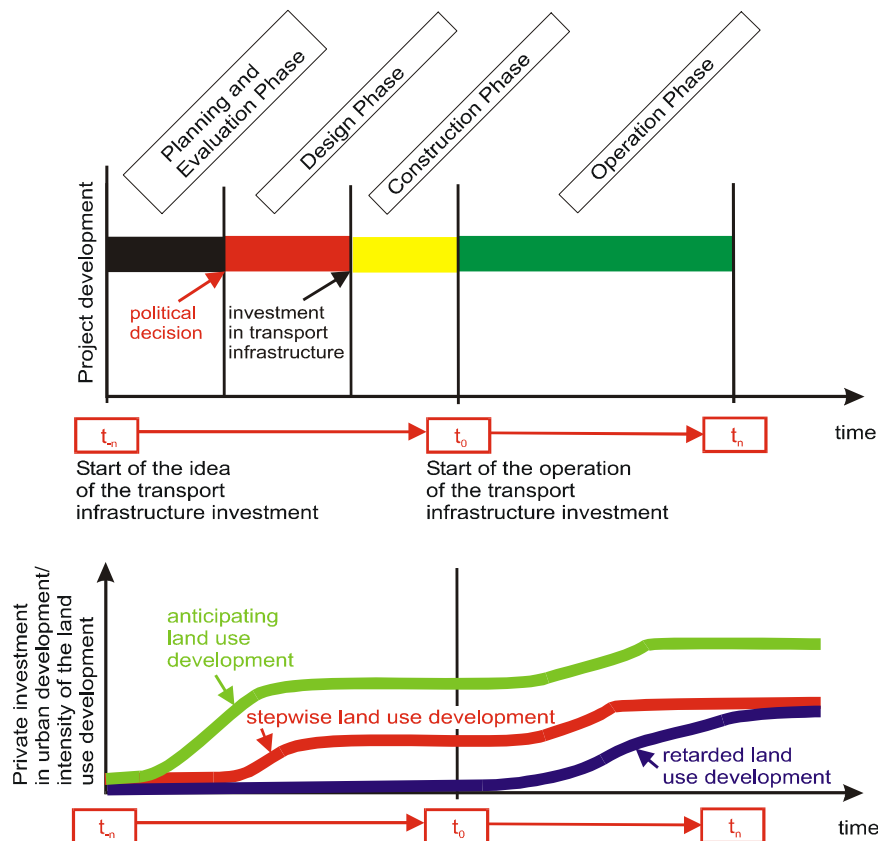


Figure 3-1 Infrastructure investment development and land use development

System elements in relationship to infrastructure investments

Beside the transport infrastructure investment itself three other system elements have to be considered when measuring these socio-economic effects (Figure 3-3) which can be summarized as the project environment and framework:

- (1) The local socio-economic potential. What is the inherent attractiveness of the location (landscape, cultural setting, noise levels etc.)? Who is already there (type of inhabitants, businesses, service facilities)? What is the level of land prices and local taxes? What is the possible function of the area in relation to the entire city? Is there a potential for further economic development that can be better used if only accessibility is improved?
- (2) The general economic situation at the time of the development and realisation of the investment. The economic context, especially the general investment climate, defines the demand for land use development.
- (3) The role of local actor involvement and pertinent political and institutional determinants. For example, are there any formulated strategies and development scenarios that are implemented by means of urban governance? Also, what is the role of public authorities, decision-makers, business circles and other interest groups in developing land along traffic corridors? Positive spatial effects may rely on early co-ordination between different policies such as spatial planning, traffic, environment, finances, and social policy. They may also need co-operation between different governmental and non-governmental actors. In this context, important determinants are the personal and institutional capacities to act,

available resources (know-how, capital) and the will to overcome barriers, including those that can exist between different territorial units.

3.2 Overview of Case Study Cities

The *TranSEcon* case studies represent a range of different public transport systems, including one bicycle network system (Delft). In most cases the investments were made at least 10 years ago. Some are, however, of more recent origin (for instance the Athens metro); their performance and impacts are thus not yet visible in real life but are modelled. The public transport systems distinguish themselves primarily by a wide range of technical system types, the spatial extension, the type of region, type of service, etc. There are two proper S-Bahn systems (Stuttgart and Zurich), six proper metro systems (Athens, Brussels, Helsinki, Lyon, Madrid and Vienna), two types in between (Tyne & Wear and Manchester) as well as two surface transport systems (Bratislava and Valencia). Within the overall evaluation, Tyne & Wear will be considered as a metro system, and Manchester as a tram system. Figure 3-2 allocates these different types graphically.

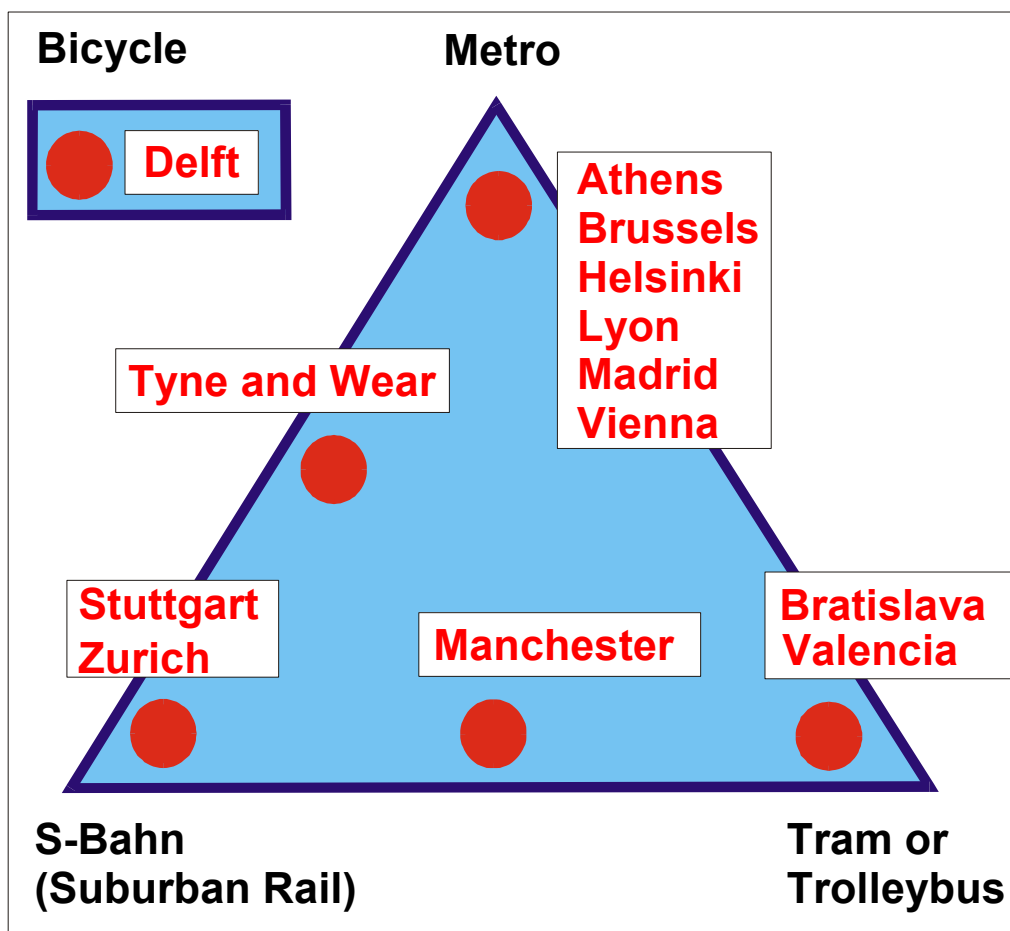


Figure 3-2 Classification of Case studies in *TranSEcon*

Project environment and Framework

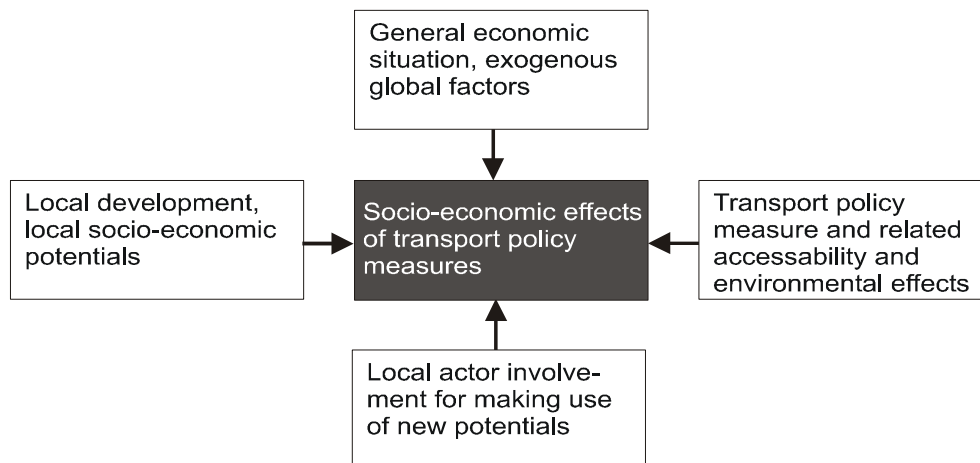


Figure 3-3 Systems analysis of relevance of transport policy measures for socio-economic development

Opportunity of infrastructure investment

Some principle considerations have to be done concerning the opportunity; where, when or in which sector of the market an infrastructure investment should be done. The *TranSEcon* project is focused on the transport sector. This means *TranSEcon* is investigating, which socio-economic effects and impacts occur where (spatial), when (temporal), how intensive and under which framework conditions. These effects are measured as the difference between two situations: the real situation with the implemented transport infrastructure investment and the hypothetical situation, if the transport infrastructure investment had not been implemented. *TranSEcon* does not investigate the effects and impacts of any hypothetical situation (scenario), if the investment had been realised in any other sectors (e. g. health sector) or if the transport infrastructure investment had been implemented in any other area, at any other time or in a different way.

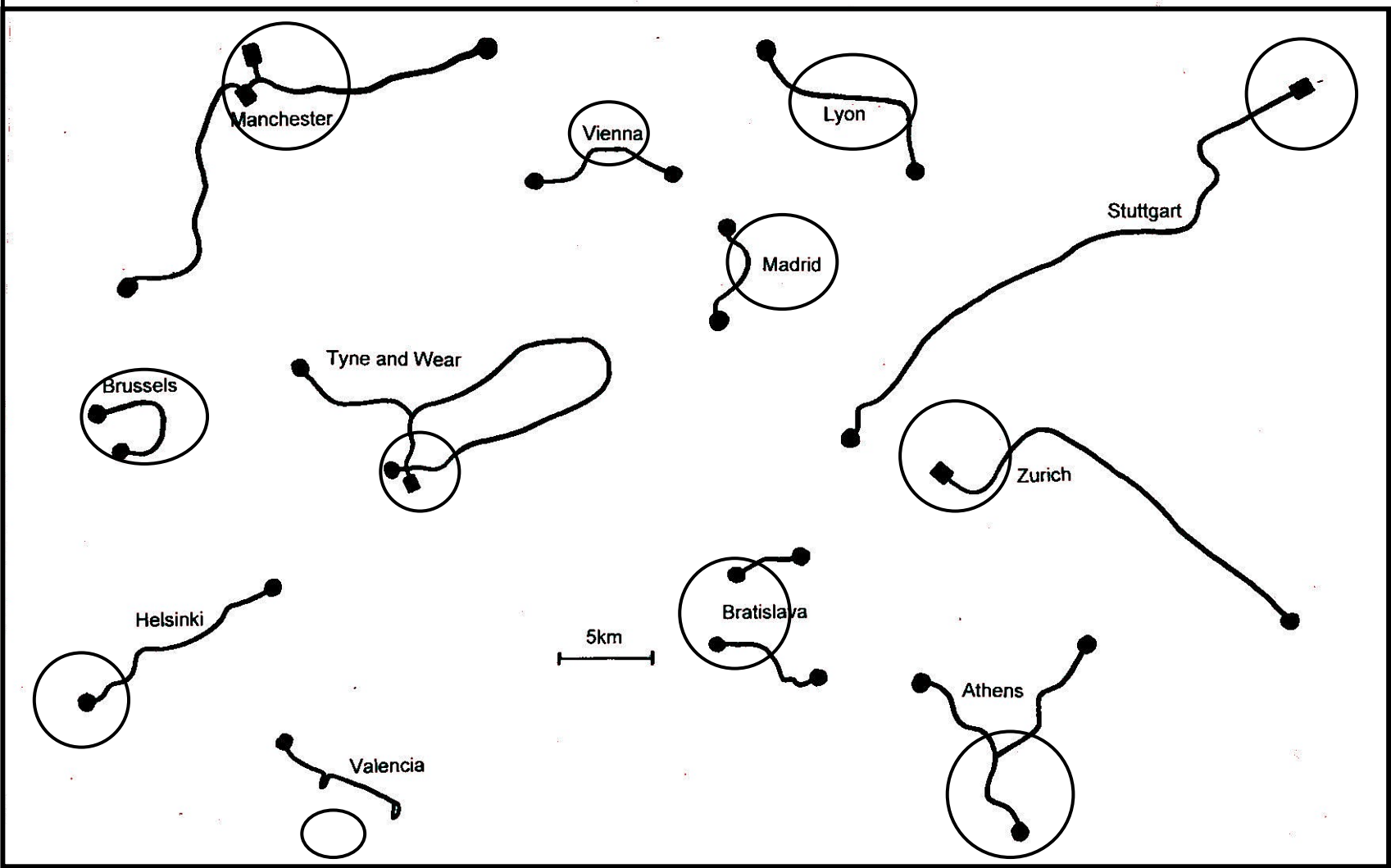
In addition, and also of major importance, the cases distinguish themselves by the geographical orientation of the lines: radial or circle (ring-like). The Brussels and Madrid cases concern inner urban ring lines, although in Brussels the ring is not yet completed as only three quarters of it is in operation with the rest planned. Ring lines have a high capability to distribute traffic from one radial axis to another, and they link important urban functions that are not directly located in the city centre. In Valencia, the new tramway line considered here passes right outside the city centre in a tangential direction, thus offering similar possibilities to enter the city from different sides and linking – such as Madrid – for example, large university campuses. All other systems that have been considered are of radial orientation.

Another distinction between the case studies is their spatial scale. This varies considerably, and the schematic representations are shown in Figure 3-4, where the scale of Stuttgart is large, at one extreme, as compared to Brussels at the other end of the scale. A distinction between the location of the infrastructure investment within the case study city offers another distinction to consider. A number of the case studies refer to investments in the centre of the conurbation which have been

labelled Central Area projects (Athens, Brussels, Vienna, Madrid, Valencia, Lyon and Delft). The remaining case study cities relate to investment in the public transport system between the suburbs and the city centre (Zurich, Stuttgart, Helsinki, Tyne and Wear, Manchester and Bratislava) and are referred to as Other Urban projects.

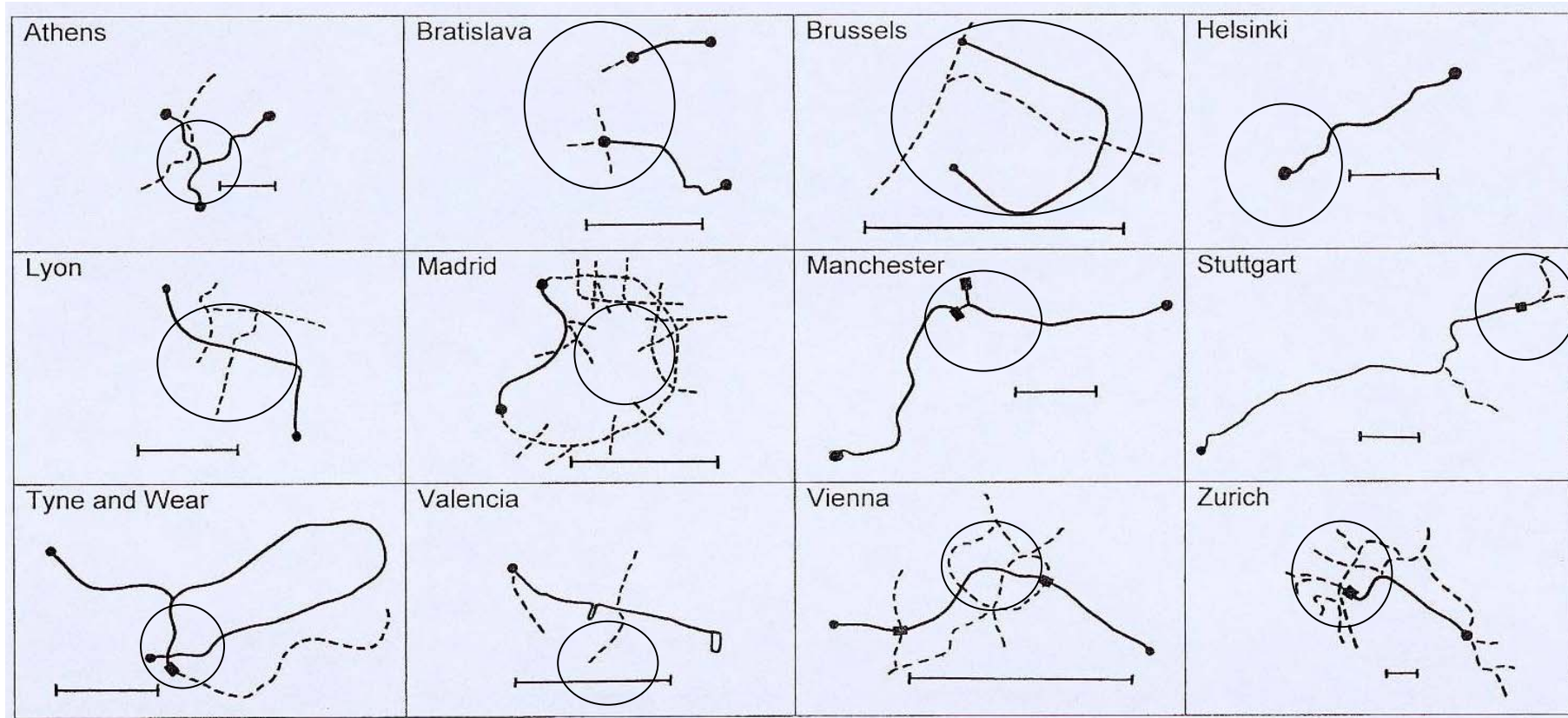
Another distinction can be made with regard to the function of the investment within the whole network (Figure 3-5). In Zurich, the investment considered is for the new through-station (instead of a terminus) and one new tunnel which has opened capacities for inserting S-Bahn services on all other railway lines in the metropolitan region. In Manchester, the metro link between two previous railway stations has opened the path for a through system also. In Madrid, the investment concerns the completion of the metro ring. In Athens, Helsinki, Lyon, Tyne and Wear and Vienna new or additional metro lines have been considered. The Bratislava case involved an extension to an existing tram and bus line. The investments in Delft were directed to upgrading the municipal bicycle network.

The interviews and further analysis carried out during the project have obviously brought further differentiations. For instance, the degree of competition faced by these systems from the private car, the share of tunnel construction or the possibility of revitalising old infrastructure mean that the unit investment costs varied greatly. Whilst discussing performance and impacts, one should thus keep in mind these different characteristics of the projects. Table 3-1 below summarises these characteristics.



(Circle represents location of city centre, Delft is not shown as being too complex a network to represent in this format)

Figure 3-4: Schematic representation of Case study measures and geographic relation to the city centre, same spatial scale



Schematic representation of case studies.

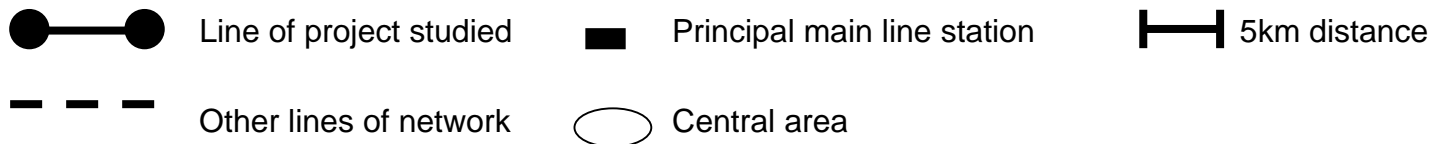


Figure 3-5: Schematic representation of Case study measures and geographic relation to the existing public transport network, different spatial scales (Delft is not shown as being too complex a network to represent in this format)

Table 3-1: Summary of case study characteristics

City	ATH	BRA		BRU	DELFT	HEL	LYON	MAD	MAN	STU	T&W	VAL	VI	ZCH	
Project	Metro	Tram-link	Trolley-bus	Metro	Bicycle network	Metro	Metro	Metro	Metro / tram	S-Bahn	Metro / S-Bahn	Tram	Metro	S-Bahn	
Areas concerned.	city	city	city	city	city	city and suburbs	city	city	city and suburbs	city and suburbs	city and suburbs	city and suburbs	city	city and suburbs	
Length (Km.)	18.0	2.0	6.0	8.2	24.0	11.0	15.0	7.0	31.0	16.0	55.5	9.7	8.2	12.0	
Total network length (Km.)	51.0	243.0	216.0	29.5	236.5	17.0	27.5	171.4	36.6	110.2	59.0	133.2	61.6	365.0	
% new project/ total network	35.3%	0.8%	2.8%	27.8%	10.1%	64.7%	54.5%	4.1%	84.7%	14.5%	94.1%	7.3%	13.3%	3.3%	
Total investment (M euro of 2002)	2190.0	15.0		1300.2	19.0	626.0	524.4	283.0	270.0	30.0/ 352.0 ¹⁾	1233.0	124.2	2487.0	750.0	
Investment/km. (M euro/km.)	121.7	1.9		344.4	0.8	56.9	35.0	40.4	8.7	1.88	22.2	12.8	303.3	62.5	
Operation since	2000	1989	1990	1988	1986	1982	1992	1995	1992	1992	1984	1994	1991	1990	
Evaluation scenarios (With and RS)	2004	2000	2000	1991/ 1994	1995/ 1996	1992/ 1995	1999	2000	2000	2000	1992/02	2001	2002	1999/ 2002	
Years since operation	4	11/12	10/12	3/6	10	10/13	7	5	8	8	8/18	7	11	9/12	
Project area	Area (km²)	32.5	2.0	4.5	16.7	26.3	43.0	8.6	8.9	n.a.	153.5	55.5	10.2	16.9	10.6
	Population	996 566	420	29 500	183 480	96 600	170 567	96 157	190 070	53 088	160 533	249 750	143 834	172 172	34 033
catchment area	Area (km²)	603.7	367.5		433 203	26.3	899.0	487.2	8 029.0	n.a.	2 066.2	53 701	1 230.7	415.0	265.3
	Population	1 796 616	448 292		2 840 600	96 600	855 514	1 167 086	5 205 408	2 440 726	1 376 078	1 095 152	1 502 342	1 562 482	466 922

¹⁾ including highway investment in the same corridor

3.3 Methodological approach

Investigated scenarios

In the framework of the *TranSEcon* project, the *ex post* analysis of transport investments consists of comparing a “with” and a “without” (the infrastructure investment) case. The “without” case is called “reference scenario” (Figure 3-6). This reference scenario is, in the *TranSEcon* project is defined in two different ways: In some cities, the impacts of the project have been modelled in the “with” and the “without” (or reference) case in one and the same area (example: Vienna). In other cities, the impacts in the area where the project has been implemented are measured and compared with the socio-economic performance of an area in which no such project has been implemented (example: Zurich).

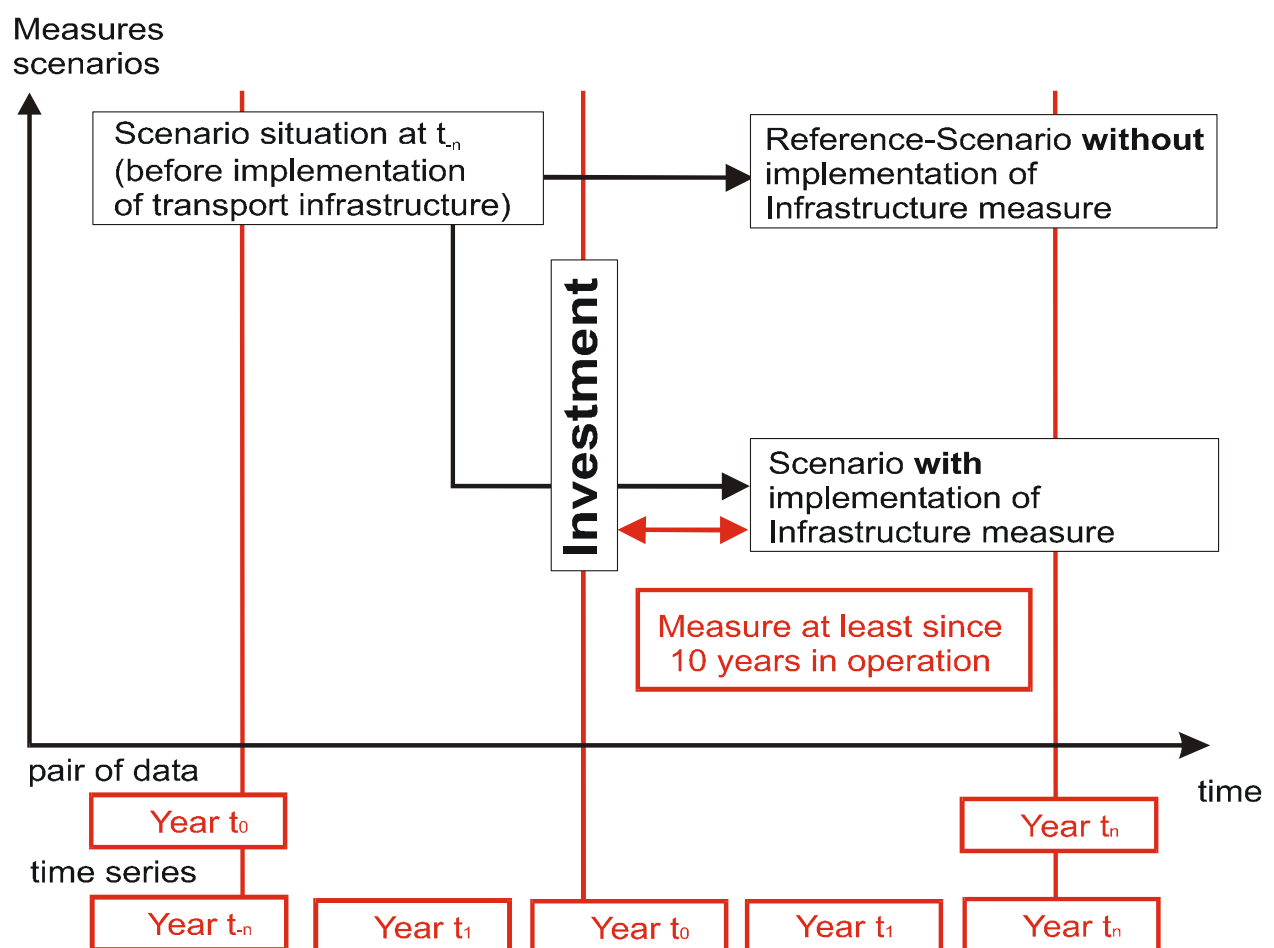


Figure 3-6 Investigated scenarios and the time relationship of the transport infrastructure investment.

Transport definition of the different phases of the investigated effects and impacts

Generally, data describing the socio-demographic structure of an area, such as population characteristics or number of work places, are related to one specific day

or year, whereas data describing e. g. travel demand or costs are related to a time period (e. g. one year). Three classes of **time-horizons** are defined:

- $t=0$, time when the infrastructure investment starts operation,
- $t>0$, time period that the infrastructure investment has been in operation,
- $t<0$, time period before the infrastructure investment starts operation at a future time (construction-, planning-, design-phase or earlier).

Figure 3-7 shows the definition of the relevant phases for the implementation of an infrastructure measure, the so-called investment life cycle, which is classified in four time periods:

- (1) **Planning and Evaluation phase**
Alternatives of possible investments are discussed in order to select one alternative at the end of this phase.
- (2) **Design phase**
The infrastructure investment will be developed in detail. At the end of this phase all planning details are fixed, including all permissions that are a pre-condition for starting the construction phase.
- (3) **Construction phase**
The infrastructure investment is under construction. At the end of this phase the infrastructure measure starts operation.
- (4) **Operation phase**
The infrastructure investment is opened to the public, i.e. users are able to increase their utility.

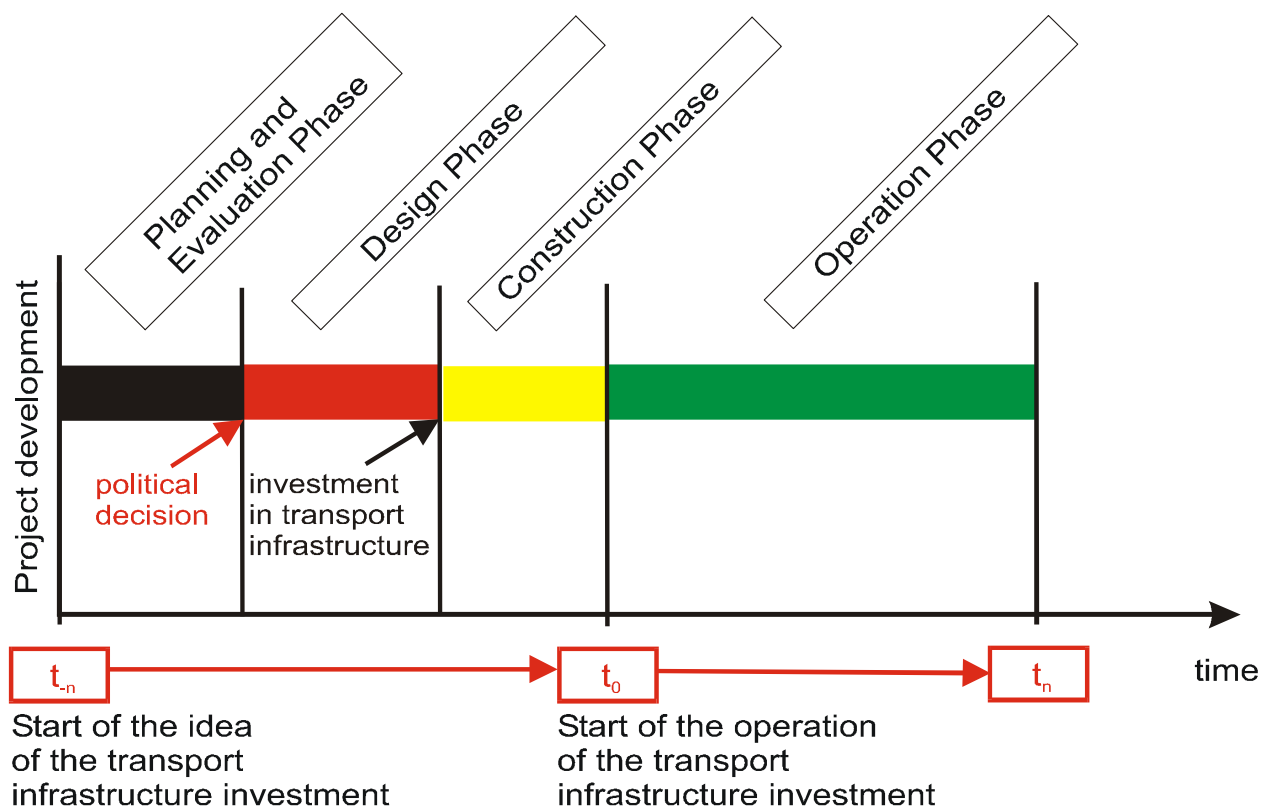


Figure 3-7 Investigated life cycle of the transport infrastructure investment

Spatial definition of the differently influenced zones

A number of the case studies refer to investments in the centre of the conurbation which have been labelled Central Area projects (Athens, Brussels, Vienna, Madrid, Valencia, Lyon and Delft) The remaining case study cities relate to investment in the public transport system between the suburbs and the city centre (Zurich, Stuttgart, Helsinki, Tyne and Wear, Manchester and Bratislava) and are referred to as Outer Urban projects.

This locational distinction underpins the process of zoning that was used in data collection for the detection of socio-economic similarities and differences between the case studies whereby each case study is divided into three zones but the spatial relationship of these zones depend on the location of the infrastructure. The three zones utilised in all studies are Z_{project}, which relates to the direct project catchment area defined as a small corridor along the transport investment, the central area zone Z₁, and zone Z₂ which represents the remaining outer areas of the study area. The differences in zonal configuration between central area projects and outer urban projects are shown in Figure 3-8 below.

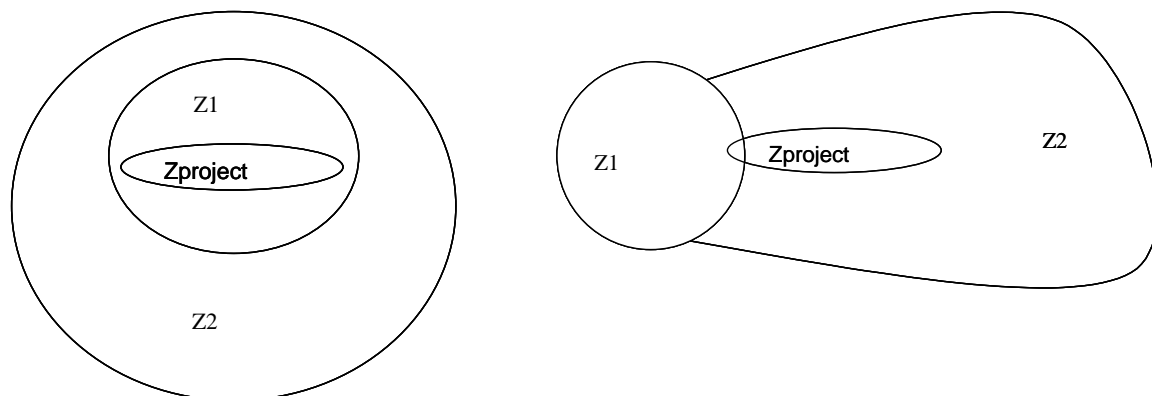


Figure 3-8: Definition of the spatially distribution of the integrated zones of the transport infrastructure investments

Quantitative and qualitative approaches

During the *TranSEcon* project life-time different socio-economic effects were analysed using different analysis tools. The main group of methods were (1) quantitative approaches, such as analysing existing data-bases, modelling of data, recording of data or quantifying a cluster of qualitative indicators and (2) qualitative approaches such as interviews with key actors and qualitative descriptions of effects by a project partner. There are limits, of course, for assessing project performance and impacts by means of statistical or other quantitative data alone. Several key aspects have been treated by a more qualitative approach on the basis of interviews and these complement the quantitative analysis.

It has to be emphasised that the *TranSEcon* consortium was aware, that some investigated effects overlapped. The main goal of the analysis was to identify all

effects which could occur. For some effects different approaches were used to receive the best possible picture of the impacts. It is clear that it is important to take into account this fact for the overall evaluation of the case study cities to avoid any double counting of effects.

Overall socio-economic evaluation

Once each individual effect is measured, all these values were aggregated in final comparative values with the help of a multi-criteria analysis (MCA) addressing the comprehensive objective of a sustainable development of the area influenced by the transport infrastructure investment, in order to evaluate simultaneously the number of objectives – economic benefits, social benefits and environmental improvements – that need to be aggregated. Each objective is measured by one or more specific representative criteria, which receives in turn a value through one corresponding targeted indicator. Some of the criteria are quantitative but in other cases they are qualitative by nature. The problem of double counting of effects is taken into account by the selection of the indicators and by the definition of the value function used.

It is important to highlight that the values describing the effect produced for all the case studies will be related to one evaluation year, not to the project's whole life time. The approach developed of the multi-criteria analysis addressing the sustainable development caused by transport infrastructure investments is a first step for the development of a new type of the evaluation analysis, which can be called "sustainable development analysis" (SDA).

4 REGIONAL ECONOMIC EFFECT DURING CONSTRUCTION

4.1 Methodology

To analyse these indirect effects of each infrastructure project on employment, GDP and regional income, an econometric model is used which simulates 16 different sectors of the regional economy. A number of exogenous variables describing global and national economic conditions and demographic factors, together with the project-specific data on investment are used. These case study specific inputs consisted of capital investment in various economic sectors (e. g. construction, mechanical and electrical engineering, metals) during each year of the project planning and construction phases. The model focuses on key economic variables such as production, investment, employment and income, and estimates net production value, employment and wages for each of the 16 economic sectors considered, for the region in which the investment takes place. Since *TranSEcon* covers a wide range of project types, with widely varying construction costs and investments a standardized categorisation of the different systems is used to look at the effects of each type of investment.

4.2 Results

The value added effect, which is shown by the additional regional GDP, the additional regional income and the additional regional employment generated, has been calculated for all the case study cities' infrastructure investments. The results from the simulation model are shown in two different ways:

- The average value added effect per year, over the investment period (Table 4-1),
- The average value added effect standardized per one Million Euro investments (Table 4-2).

The value added effect of the infrastructure investments per year

In Table 4-1 a comparison of the absolute value added effects, averaged over the duration of the investment for the infrastructure of the 13 case study cities is shown. The table groups the cities according to the four different types of transport infrastructure investment discussed in the previous section. For the six cities which undertook the construction of a new metro-line, Athens has the highest additional value added effects, measured by additional regional GDP of 480 Million EUR, 6,000 extra jobs and an additional regional income of 305 Million EUR (all values averaged over the investment period). Athens is followed by Vienna with 275 Million EUR additional regional GDP, 3441 additional jobs and 175 Million EUR additional regional income. The lowest value added effect was found in Madrid with 40 Million EUR additional regional GDP, 509 additional jobs and 26 Million EUR additional regional income. For the group of heavy trams and Suburban (S-Bahn) rail investments, the highest additional value added effects occur in Tyne and Wear with 259 Million EUR additional regional GDP, 3,246 additional jobs and 165 Million EUR

additional regional income. This is followed by Zurich with 116 Million EUR additional regional GDP, 1454 additional employed people and 73 Million EUR additional regional income. For tramways, Valencia is ranked top with an additional regional income of 22.8 Million EUR GDP, 285 additional jobs and 15 Million EUR additional regional income. Overall, the lowest value added effect was in Delft where the bicycle network only generated 2 Million EUR additional regional GDP, 29 additional jobs and 2 Million EUR additional regional income are generated. Part of the reasons for this vast difference lies in the enormous range of absolute amount of investment where larger investments have a tendency to produce large added values. This can be clearly seen in Figure 4-1 for added value to GDP, Figure 4-2 for the additional employment rankings and in Figure 4-3 for the additional regional income.

Table 4-1: Economic Effect during construction phase per year

City	Period	Investment sum (Mio. €) price basis: 2002	Type of infrastructure	Average value added effect (average per year over the investment period)		
				Regional GDP mio.€ per year	Employment persons per year	Income mio.€ per year
1. Athens	1992-2001	2190.0	Metro (M)	480.08	6.006	305.51
2. Brussels	1983-1990	1300.2	Metro (M)	92.80	1.161	59.06
3. Helsinki	1969-1982	626.0	Metro (M)	75.63	946	48.13
4. Lyon	1979-1991	524.4	Metro (M) - driverless	90.05	1.126	57.31
5. Madrid	1981-1996	283.0	Metro (M)	40.73	509	25.92
6. Vienna	1981-1995	2487.0	Metro (M)	275.04	3.441	175.03
7. Manchester	1986-1992	270.0	Metro link + heavy tram (T)	57.751	735	37.39
8. Tyne & Wear	1972-1986	1233.0	Metro + Suburban-train (S)	259.47	3.246	165.12
9. Stuttgart	1985-1992	30.0	Suburban-train (S)	8.76	110	5.58
10. Zurich	1982-1990	750.0	Suburban-train (S)	92.10	1.152	58.61
11. Bratislava	1984-1989	15.0	Tramway + Trolley-bus (T)	7.15	89	4.55
12. Valencia	1991-2000	124.2	Tramway (T)	22.80	285	14.51
13. Delft	1979-1991	19.0	Bicycle network (B)	2.31	29	1.47

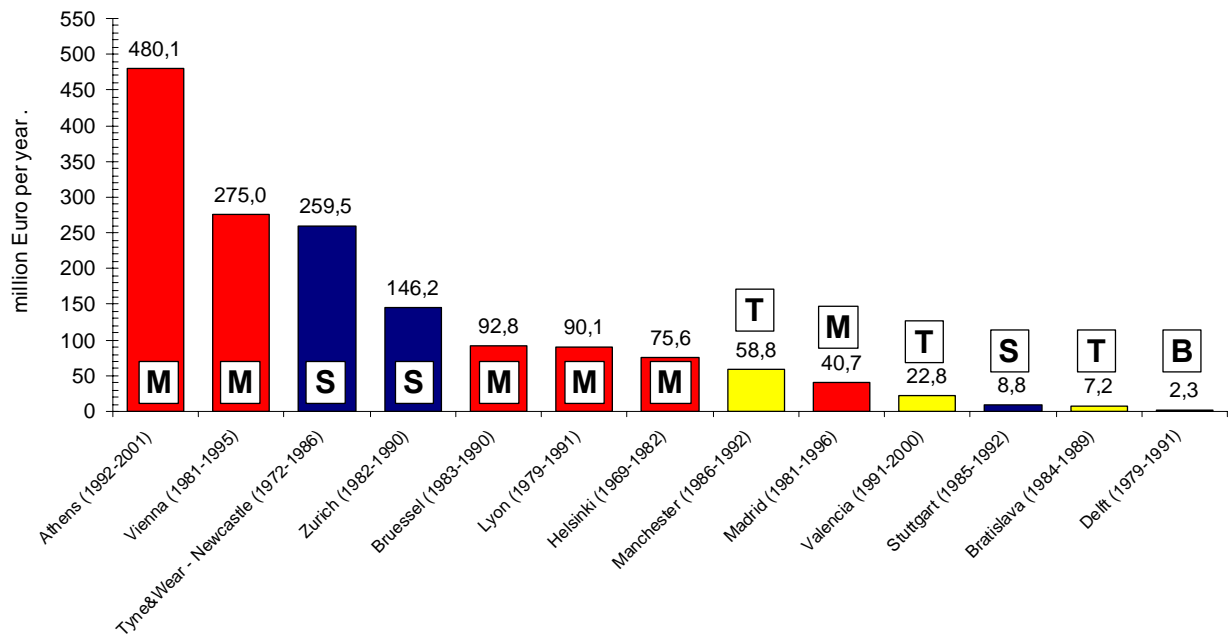


Figure 4-1: Additional regional Gross Domestic Product, average per year of construction phase (2002), M=Metro, T=Tram, S=S-Bahn, B=Bicycle

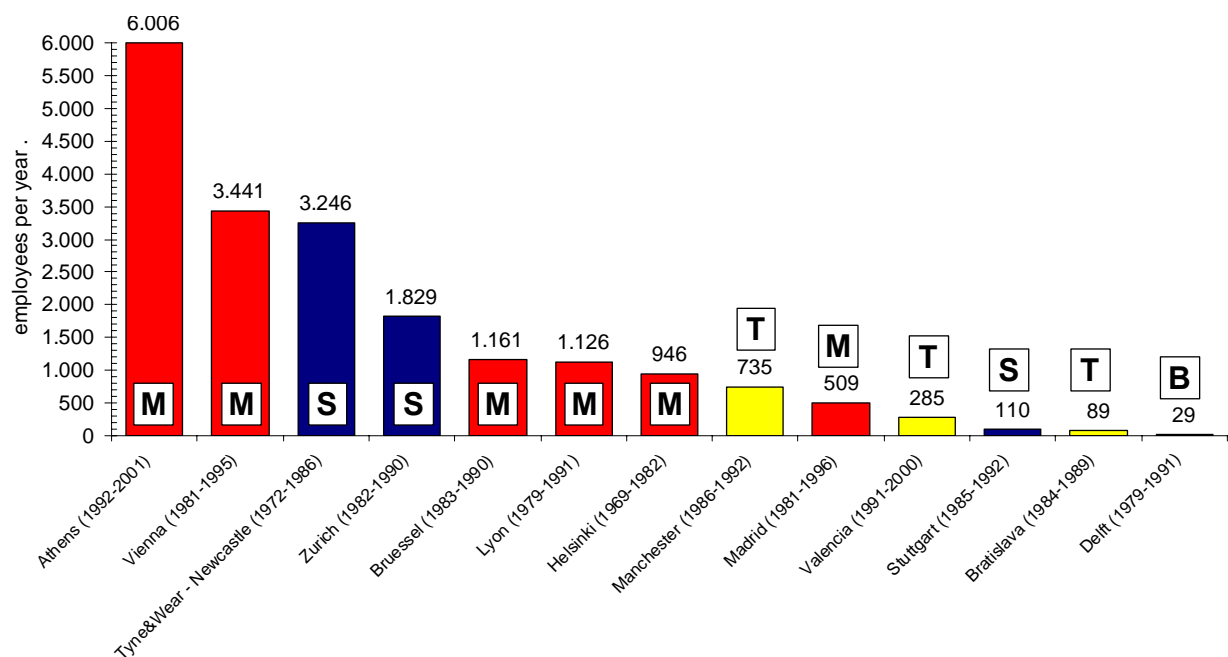


Figure 4-2: Additional regional employment (employees) per year of construction phase, M=Metro, T=Tram, S=S-Bahn, B=Bicycle

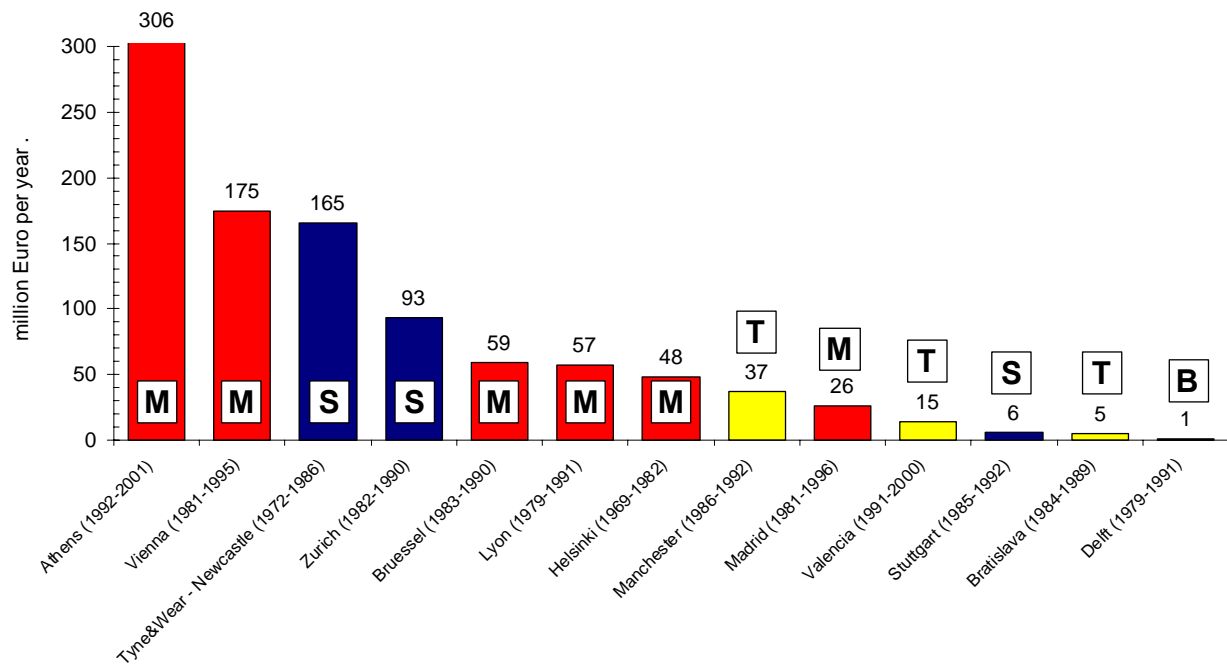


Figure 4-3: Additional regional income per year of construction phase (cost basis 2002), M=Metro, T=Tram, S=S-Bahn, B=Bicycle

The value added effect of the infrastructure investments per one Million Euro investment

In Table 4-2, a standardized comparison for value added effects is given by normalising the average value added effects by the Million € investment. Figure 4-4 clearly shows that differences between the 13 case study cities still exist but these are by no means as large as in the case of the absolute comparison. These differences are caused by the national and regional differences of productivity of labour and the different type of investments. Madrid has the highest additional average value added GDP, normalised per Million € with 2.52 Million €, followed by Athens with 2.51 Million € with the lowest being Zurich at 1.97 million € and Brussels 2.08 Million €. In Zurich the project consists mainly of the construction of a tunnel, which forced the usage of fully automated mechanical aid instead of labour resources. The result reveals that each invested million of Euros translates into an increase of the Gross Domestic Product in the order of € 2.0 to 2.5 million. This corresponds to a multiplier effect of between 2.0 and 2.5. Interestingly, a difference between the individual investment categories is not noticeable.

Table 4-2: Economic Effect during construction, normalized per Mio. € investment

City	Period	Investment sum (Mio. €) price basis: 2002	Type of infrastructure	Value added effect (normalized per mio. € investment); average over the investment period		
				Regional GDP mio.€ per mio. €	Employment persons per mio. €	Income mio.€ per mio. €
1. Athens	1992-2001	2190.0	Metro (M)	2.51	31	1.59
2. Brussels	1983-1990	1300.2	Metro (M)	2.08	26	1.32
3. Helsinki	1969-1982	626.0	Metro (M)	2.48	31	1,58
4. Lyon	1979-1991	524.4	Metro (M) - driverless	2.23	28	1.42
5. Madrid	1981-1996	283.0	Metro (M)	2.52	32	1.61
6. Vienna	1981-1995	2487.0	Metro (M)	2.13	27	1.36
7. Manchester	1986-1992	270.0	Metro link + heavy tram (T)	2.27	29	1.45
8. Tyne & Wear	1972-1986	1233.0	Metro + Suburban-train (S)	2.35	29	1.50
9. Stuttgart	1985-1992	30.0	Suburban-train (S)	2.32	29	1.48
10. Zurich	1982-1990	750.0	Suburban-train (S)	1.97	25	1.25
11. Bratislava	1984-1989	15.0	Tramway + Trolley-bus (T)	2.48	31	1.58
12. Valencia	1991-2000	124.2	Tramway (T)	2.45	30	1.56
13. Delft	1979-1991	19.0	Bicycle network (B)	2.27	29	1.44

Figure 4-5 shows the employment effect of transport infrastructure investments. For each invested EUR million, 25 to 32 jobs are created per year. There is no clear-cut difference for the individual project categories according to the means of transport. The additional employment, normalised by Million EUR investment, is again highest in Madrid with 32 additional employed persons per Million EUR investment, followed by Athens and Bratislava with 31 employed persons per Million EUR, and again, the lowest is Zurich with 25 persons per Million EUR.

The additional regional income, normalised by one Million EUR investment, is highest again in Madrid with 1.61 Million EUR followed by Athens with 1.59. The lowest is again Zurich with 1.25 Million EUR. The results in Figure 4-6 clearly show, that normalising makes the results of the value added effects between the cities much more similar and gives a more balanced picture than simply using absolute averaged effects.

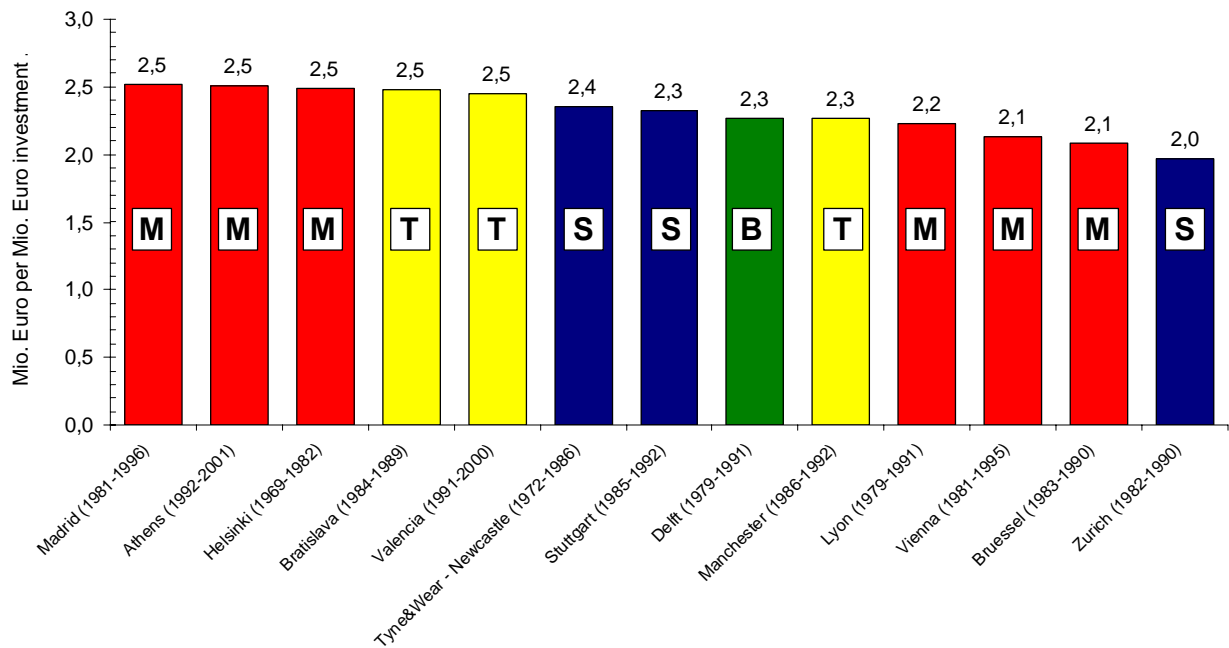


Figure 4-4: Additional regional Gross Domestic Product per million Euro investment (cost basis 2002), M=Metro, T=Tram, S=S-Bahn, B=Bicycle

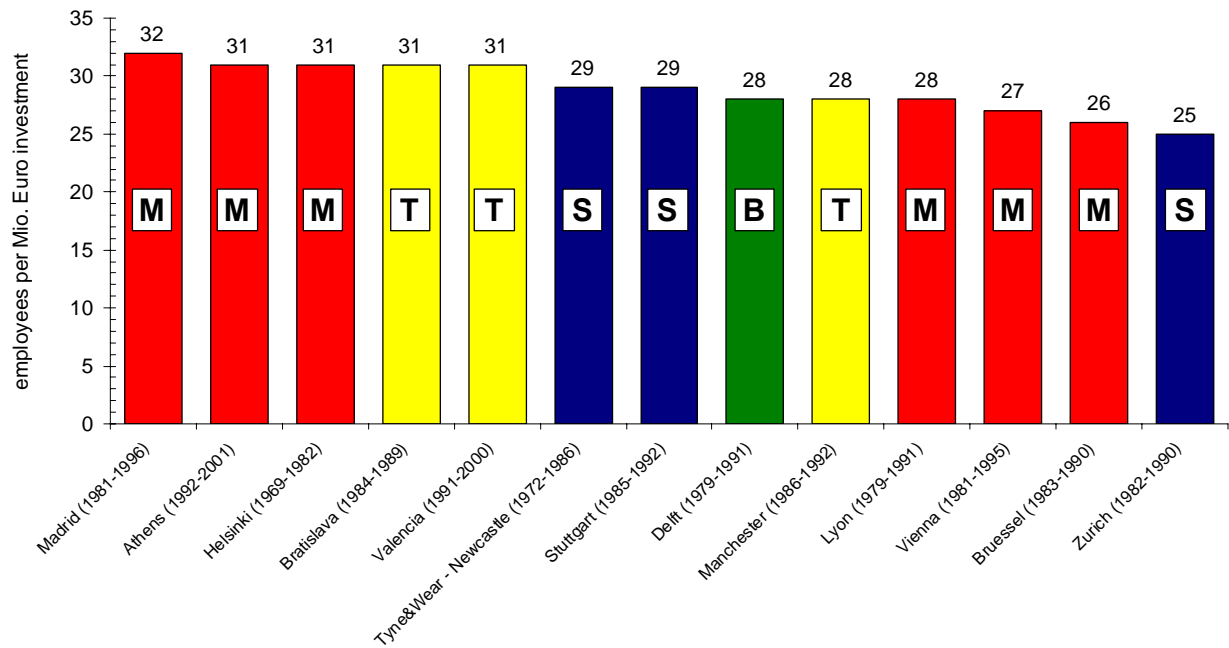


Figure 4-5: Additional regional employment (employees) per million Euro investment, M=Metro, T=Tram, S=S-Bahn, B=Bicycle

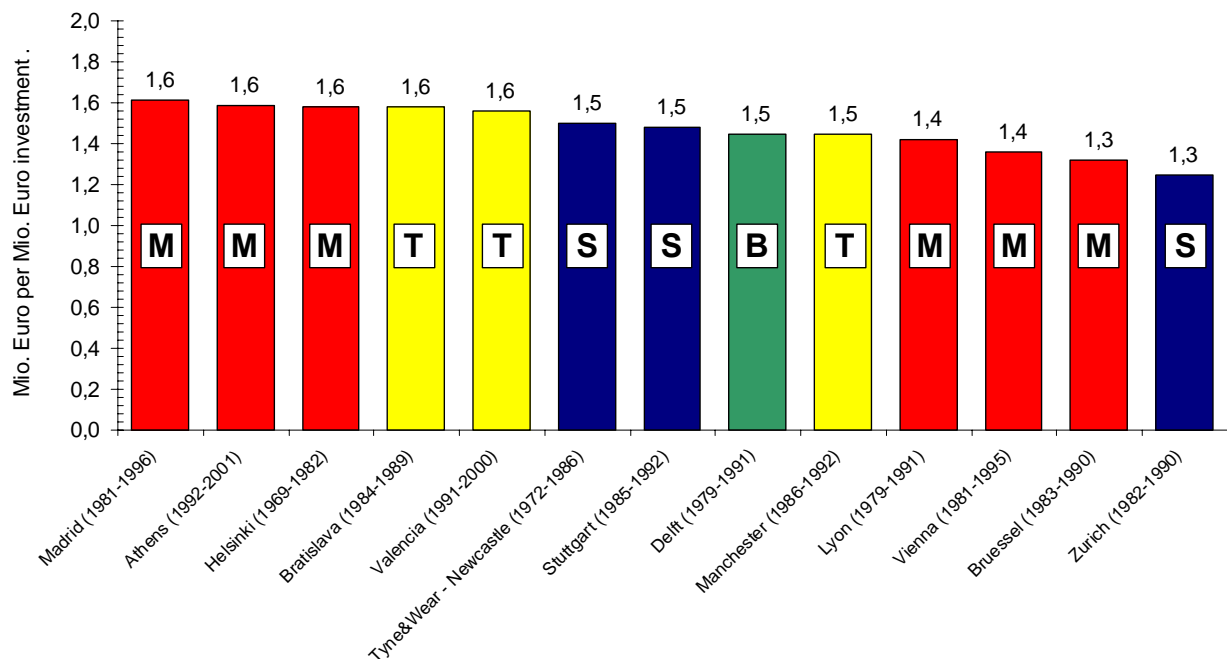


Figure 4-6: Additional regional income per million Euro investment (cost basis 2002), M=Metro, T=Tram, S=S-Bahn, B=Bicycle

Limitations in the methodology and data analysis

The methodological difficulties in undertaking this comparison are listed below and must be taken into account for a critical interpretation of the results:

- (1) Time span: Some projects started construction at the end of '60s, e.g. Helsinki 1969 and ended at the beginning of the '80s (1982). Others, like Athens started construction in 1992 and ended in 2002. The consequence is an investigation period from 1969 to 2002; in which the economic framework was changing strongly.
- (2) Length of investment period: This ranges from 8 years (Brussels) to 16 years (Madrid).
- (3) The total sum of investment vastly differs. The highest investment sum for metro was in Vienna with 2487 Mio. €, compared to the metro in Madrid, with only 283 Mio. €.
- (4) The investment costs (Mio. Euro) per kilometre are different for the 13 cities, too; e. g. Vienna 290,2 Mio. Euro/km and Bratislava 1,9 mio. Euro/km.
- (5) The investment characteristics are different, too; e. g. Vienna metro line, Zurich suburban train, Valencia tramway and Delft bicycle network.

5 CHANGES WITHIN THE TRANSPORT SYSTEM

5.1 Methodology

This section deals with the direct effects and direct network effects and considers the following effects and impacts: changes in the demand and supply, revenues, travel time, environmental effects. The determination of these is carried out by a survey of performance data or by a modelling exercise (see section 3.3).

For assessing the infrastructure effect, the methodology used is based on defined zones and the comparison before implementation, after implementation and without implementation (reference scenario) of each measure.

The calculation of the effects of the investment of the case studies are defined by the differences between the scenario with investment and the reference scenario. For one indicator, the impact of the project corresponds to the difference between the value of the indicators for scenario with the project and the value of the same indicator for reference scenario. With this calculation the absolute variation is defined as follows:

Absolute variation = (Data "with" – Data "RS"), where:

Data "with": data for the scenario with the project;

Data "RS": data for the reference scenario.

From this absolute variation, it is possible to calculate the relative variation of the indicator with the following formula:

Relative variation = ((Data "with" – Data "RS") / Data "RS").

For the comparative analysis, it is necessary to deal with the fact that time horizons are not always the same between case studies. For simplicity and lack of knowledge concerning the development within this time period a linear development in the effects is assumed.

5.2 Results

The following results are related to the definition of three zones, Z_{project} is the catchment area of the implemented project, Z₁ is located in the city centre and Z₂ in the suburban area (see section 3.3)

Urban transport system and public transport supply

Even if the investment is quite important for some conurbations (Figure 5-1), the increase in public transport supply expressed in number of seat-kilometres is quite limited if compared to the supply at the level of the whole conurbation except in the case of Tyne and Wear (Figure 5-1). The projects can be listed in relation with the increase of supply:

- Low increase: Athens, Bratislava, Brussels, Valencia and Vienna;
- Medium increase: Helsinki, Lyon, Madrid, Manchester and Stuttgart;
- High increase: Tyne and Wear.

At the level of the project area, the increase is very strong for Helsinki and Tyne and Wear.

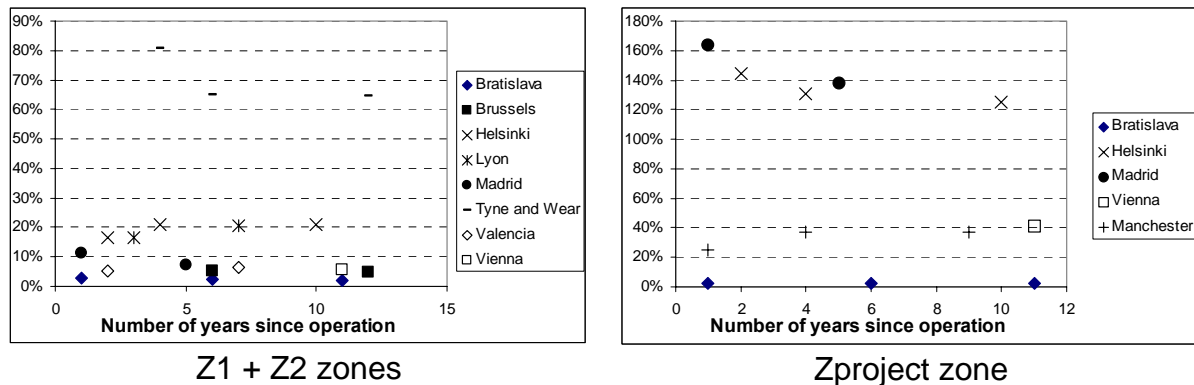


Figure 5-1 Development of the public transport capacity in number of standing and seating places km, compared to the reference scenario

The impacts of the public transport investments on financial public transport indicators are very limited for all case studies (Figure 5-2). At the level of the conurbation, the evolution is always smaller than the evolution of supply. For most case studies the development is so limited that they are inside the interval of confidence of the results.

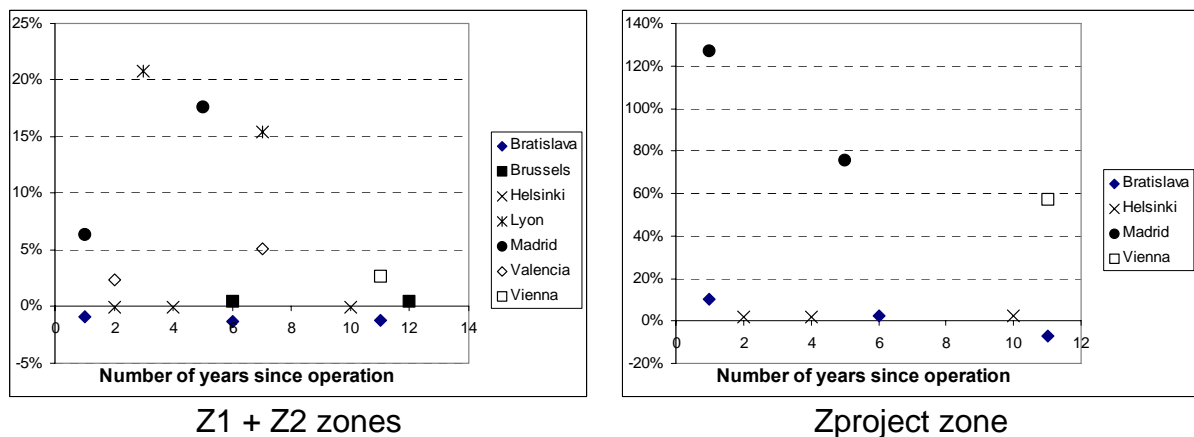


Figure 5-2 Development of the public transport yearly fare revenues, compared to the reference scenario

A greater increase can only be observed at the level of the Zproject area. However the information is available only for Bratislava, Helsinki, Madrid and Vienna. In these cities (except for Bratislava) there is a clear increase in revenue for the Zproject zone and also for trips inside the zones which are directly affected by the investment. At the same time the cost increase is more limited or there is even a decrease such as in Helsinki, which leads to a reduction of the public transport deficit. Even an increase in profit can be observed in the case of Madrid. In all case studies, the

projects have small consequences on the contribution of the public authority to public transport finance.

Private transport system

Logically the public transport investments have no or very little effect on car ownership in these case studies since they do not include any important car use restriction policy. Furthermore the determinants of car ownership are not only related to urban car policy but also to the transport policy conducted at the national level and also of course to household revenues.

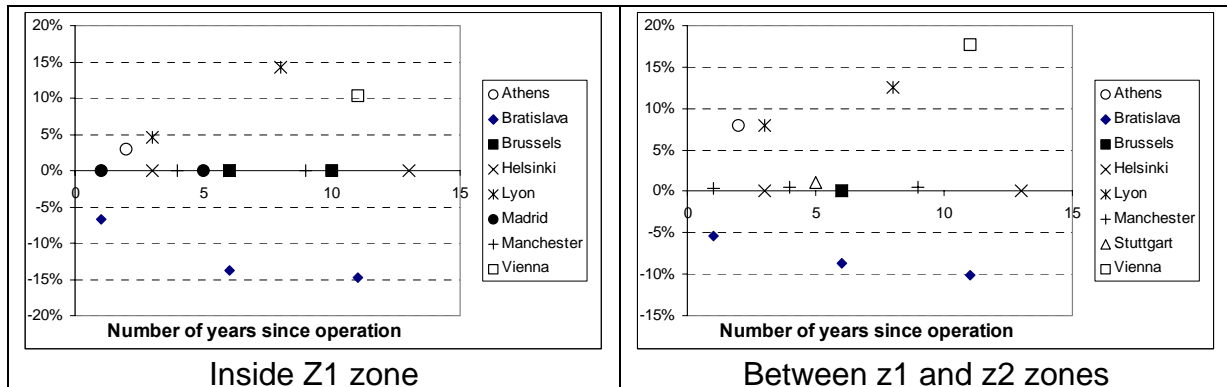


Figure 5-3 Development of the average speed of trips by car (peak period), compared to the reference scenario

But if car ownership remains unchanged, this is not the case for car speed (Figure 5-3) in four case studies (Athens, Bratislava, Lyon and Vienna). In the case of Athens, Lyon and Vienna which are metro projects, an increase in car speed is observed. This would mean that a metro project may have a more favourable impact on car speed than a light rail project. In the case of underground rail, the road infrastructure remains very often quite stable or even increases with less buses (in the Lyon case) or light rail (in the case of Vienna) in the traffic. Furthermore modal shift reduces car traffic at least in the short term (because in the longer term induced traffic can limit the reduction). On the contrary with light rail projects a part of the road infrastructure is suppressed for car traffic. But the modal shift from car to public transport compensates for the car space decrease which produce in general a stable car speed or even a decrease in this speed such as in Bratislava. In the case of Zurich, bottlenecks in the access roads to the core city of the region have so far not been eliminated. The S-Bahn investment has thus brought a strong increase of passengers in the first years of operation and a continuous yet less enhanced increase later on.

Number of trips

Even if there are differences between case studies partially related to the definition of the zones, the directions of the variations are consistent, which can be reasonably expected (Figure 5-4):

- There is an increase effect in the number of public transport trips for all case studies;
- At the level of the city (Z1) or conurbation area (Z2) effects are mostly low, except for Tyne and Wear and Stuttgart: in both cases the project is a significant investment at the urban area level;

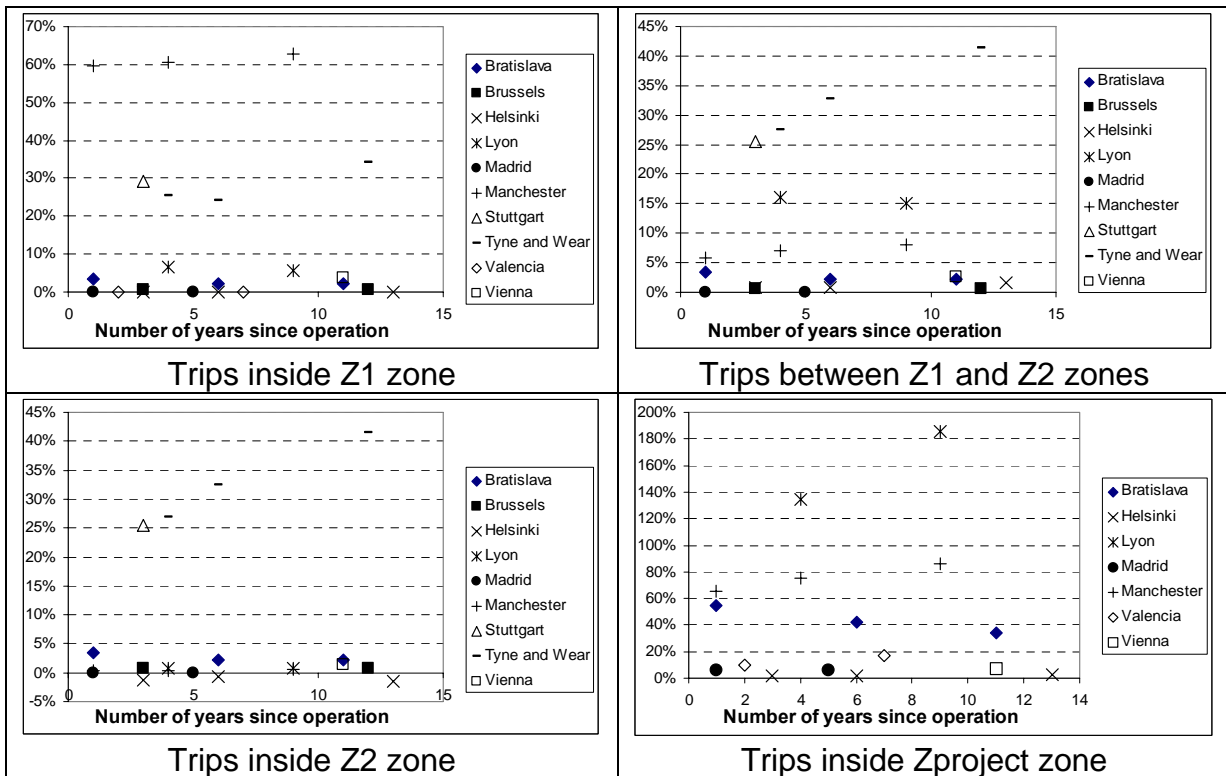


Figure 5-4 Development of the number of public transport trips, compared to the reference scenario

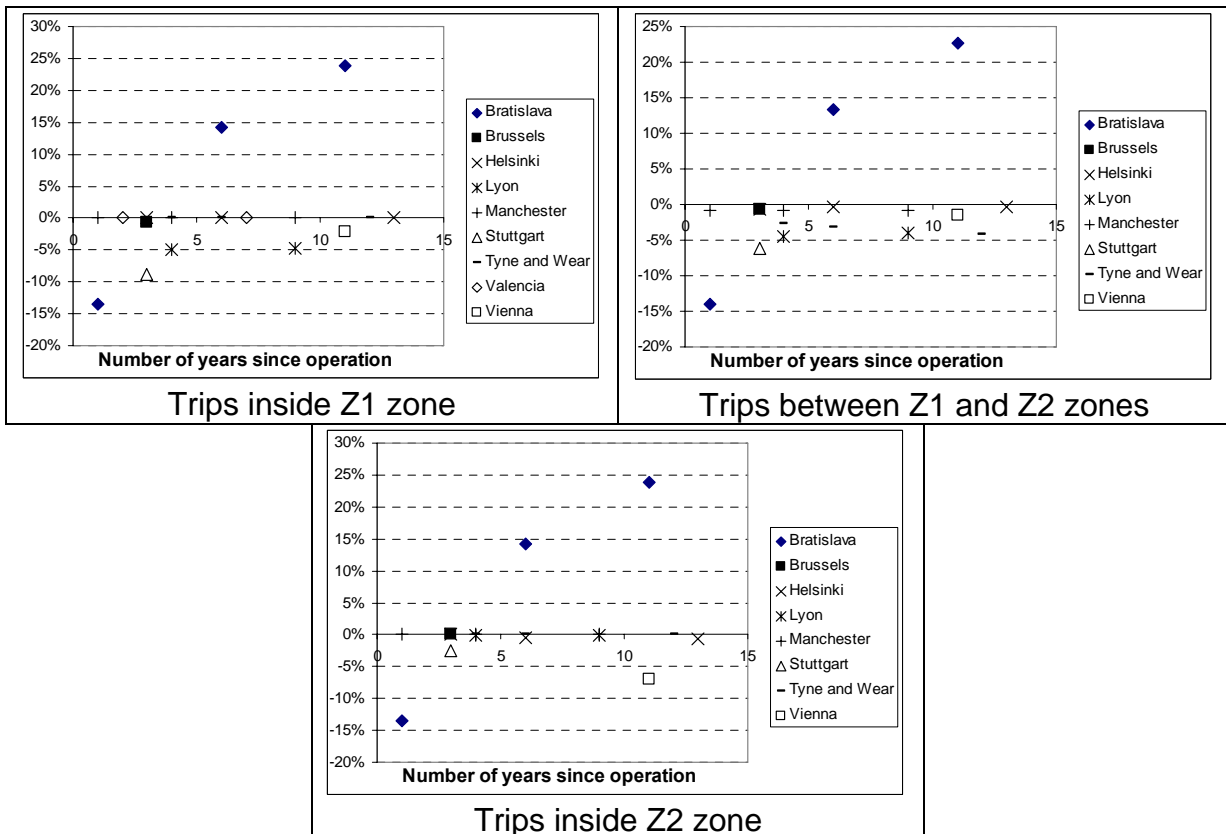


Figure 5-5 Development of the number of car trips, compared to the reference scenario

- When data are available more specifically for the project the effects are sometimes quite important in the long term: +180% for trips in Lyon, +60% for trips and pass-km in Manchester, +40% in Bratislava, +20% in Valencia;
- The impact is always strongly decreasing over the time horizon which indicates that the impact on public transport use is mainly a short term impact. After this short term impact, the impact of the project is no more identifiable and mixed with the general trend of public transport use;
- There is generally a decreased effect on car trips and car-km for all case studies or absence of effect. However if present this effect is systematically very low, except in Bratislava - decrease of 14% in short term (Figure 5-5).

Time savings

Figure 5-6 shows the time savings indicators for each case study. The effect is not very strong at the level of the conurbation, but becomes more significant at the level of the project for some conurbations (Athens – 55%; Lyon and Brussels – 30%; Vienna – 20%). For the conurbations where several observation dates are available, the effect appears quite stable over time. The effect on car trip duration is even smaller than for public transport trips, except for Athens, Lyon and at a lower degree Vienna where travel time also decreases for car. All these three conurbations have developed metro systems which did not reduce car infrastructure and therefore could permit this decrease in travel time. For the other conurbations there cannot be observed any impact on travel time by car. In Zurich, for instance, time savings by train are accompanied by densification of the schedule and more express trains due to increased capacity of the core parts of the S-Bahn network. At the same time, car traffic is faced with increasing congestion and thus time losses.

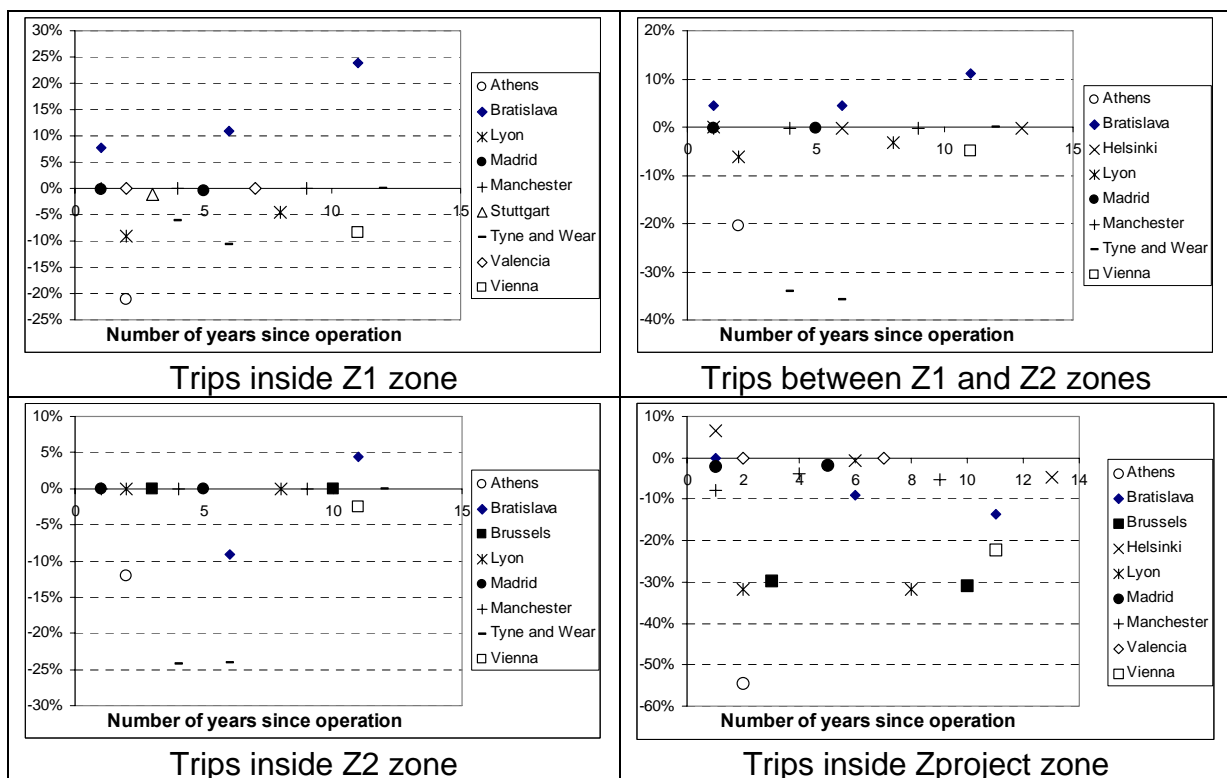


Figure 5-6 Development of the average travel time on the public transport network, compared to the reference scenario

Environmental pollution

In all the case studies, the environmental impact of transport infrastructure is positive or null if we consider the objective of decreasing pollution. In all case studies this reduction of effluent emissions is related to a decrease in car use. But except for the case of Bratislava, Helsinki and Vienna, it should be noted that the evolution is very small and probably not very significant. For these three conurbations there is an important decrease in emissions for all effluents (around 15% of CO, NOx and PM10 for example in Helsinki; 10 to 30% of the same pollutants in Bratislava; about 5% of CO, VOC and PM10 in Vienna, but the impact is much less important for CO₂ (3 to 5% in the three conurbations).

Efficiency of the projects

Huge difference of project efficiency are shown in Figure 5-7, which means that more careful evaluation and decision procedures are recommended (e. g. with the help of a standardised evaluation approach). In general are more efficient:

- public transport on the surface vs. underground systems,
- tram or light rail transit vs. heavy rail system,
- improvement of existing line vs. total new line,
- network completion and enlargement vs. single line,
- non-motorised transport investments.

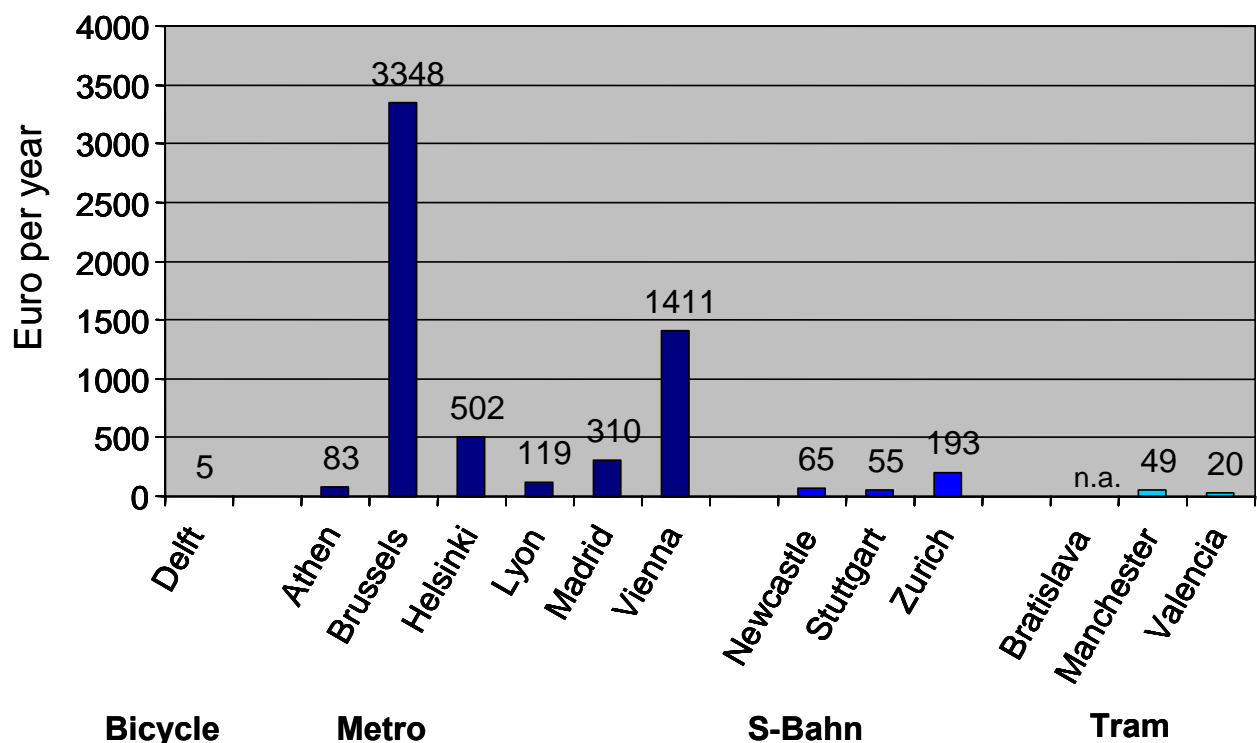


Figure 5-7 Efficiency indicator: Average Investment per additional bicycle or public transport trip per year

Limitations in the methodology and data analysis

The data situation was the most limiting factor in this section of analysis, especially the:

- Problem of data availability for some zones,
- Accuracy of data, for some case studies only samples could be drawn and were analysed (especially if no transport model was available),
- Problem to separate the data related to the pre-defined zones,
- The separation of effects caused by the project and the effects caused by other influences.

6 URBAN REGENERATION

6.1 Methodology

The question addressed in this section is the effect of the infrastructure projects on processes of urban development or redevelopment in the areas benefiting from better accessibility. These processes are regarded as being represented by a broad spectrum of effects, including local economic and land-use effects, but also taking into account more subjective appreciations of people involved. To this end, a mixed methodology was developed, based on quantitative and qualitative analysis. To compare effects on the local economy between case studies, a series of 'hard' indicators were investigated, such as house prices, commercial rents, land-use figures and investment in new construction, rebuilding and public amenities. To capture more perceptual aspects of urban regeneration, 'soft' data were collected as part of a semi-structured interview. In this, respondents were asked about a series of aspects of urban regeneration, some of these being rated on a five-point scale to provide indicators of, for example, each zones attractiveness. Since this highly focussed analysis cannot be employed at every point affected by every infrastructure project, representative zones were selected for each case study for specific analysis. These are a central area, an outer area greatly affected by the project, an outer area near the project but less affected and a control area not served by the project. Using this form of comparative analysis, it can be inferred which types of project and which accompanying measures are perceived as being most successful in the regeneration of urban areas, under a variety of conditions.

6.2 Results

Following the analysis of each case study city, a comparative analysis of all case studies faces problems such as the variation in availability and quality of hard data and the different means of measuring the same hard indicators. Therefore, a systematic analysis of the sample as a whole is not easy to achieve on the basis of tables with commonly measured hard indicators. This fact highlights the advantage of combining 'hard' and 'soft' data; where diversity of project contexts makes direct quantitative comparison or urban regeneration effects difficult, both types of data may still support usefully comparisons at a qualitative level. Therefore, there is still adequate common ground for examining the sample of 13 cities as a whole and evaluating results.

Land Use

In six out of twelve cases, land use patterns before and after the realisation of the project remained almost untouched; these are Athens, Delft, Lyon, Madrid, Manchester and Vienna. In these cases, corridor areas were already developed and there were neither many green fields nor many declined brown fields. Thus, the new transport infrastructure reinforced existing trends in land uses or stabilised the land use for residential purpose in the inner city area like Delft. In the other six cases of the sample (Bratislava, Brussels, Helsinki, Stuttgart, Tyne and Wear, Valencia and Zurich), land use patterns have at some extent shifted. This shift involves the

following: In cases where the new transport project was realised in declined areas with old building fabric or/and derelict brown fields (e.g. old and underused industrial installations mixed with residence in Valencia, old residential buildings not well maintained in Brussels and Bratislava or declining industries in Tyne and Wear and central Zurich), the land use pattern shifted towards high quality building complexes accommodating residences and mainly services. In cases that the new transport infrastructure was realised in areas with building fabric in good condition or/and available green fields (e.g. Stuttgart, peripheral Zurich, Helsinki), the shift of land use patterns concerns further development of residence and the growth of services and light new technology industries (example, see Figure 6-1).

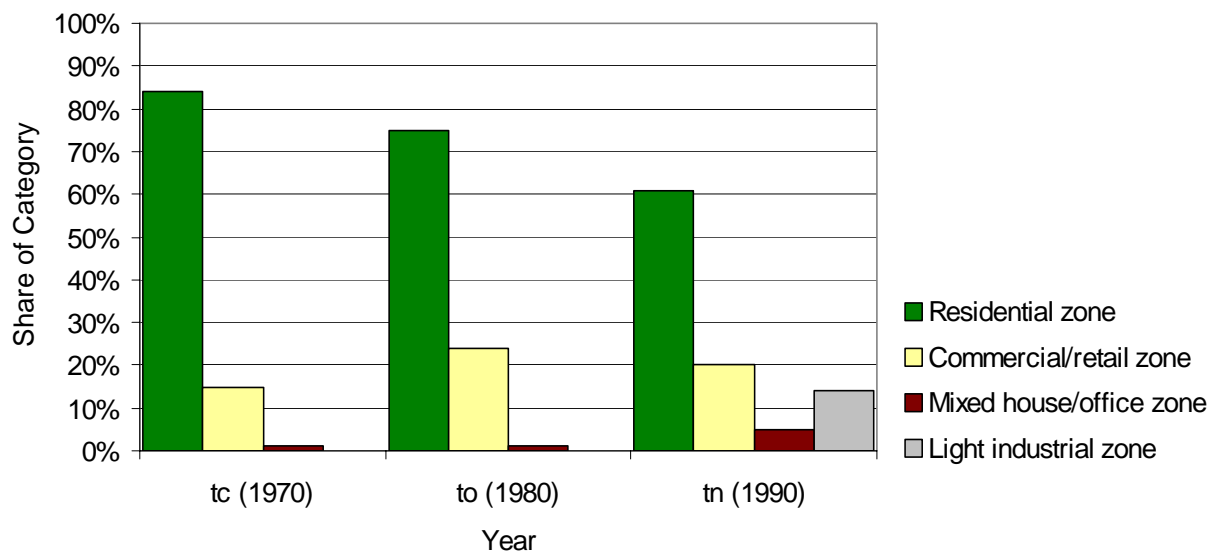


Figure 6-1 Development of the land use of an area accessed by the new infrastructure investment (example Helsinki, Myllypuro/Kvarnbäcken, area in the catchment area of the new infrastructure investment)

But also a project related factor is to mention: the increase of access for the catchment area of the transport investment is very relevant. A small change of access can only cause small changes or stabilize an existing land use development, whereas a stronger change has a potential for a more intensive influence for land-use developments. It has been stated that not all land use changes influenced by transport infrastructure projects can be evaluated well in the sense of a sustainable development. Especially regional public transport projects which connects inner city areas in the surroundings of the conurbation can cause a move of residential population from high density areas towards outside the city.

Real Estate Prices and Rents

In all cases of the sample, the real estate prices and rents increased higher after the realisation of the project related to investigated areas with no transport investment (example see Figure 6-2). Percentages of increase vary and they are controlled mainly by factors not associated to the project itself. These are rents and uses determined by laws for the tenants protection (e.g. in Brussels and Helsinki), market pressures for new space (e.g. for office space in Brussels), the degree to which a

formerly declined area has improved the quality of its spaces (e.g. Valencia), major changes in economy (e.g. Bratislava), the lack of a reliable, rapid and convenient public transport system beforehand (e.g. Athens), the degree to which the accessibility of the area has been improved (Manchester, Tyne and Wear, Lyon, Stuttgart, Vienna, Zurich, Madrid).

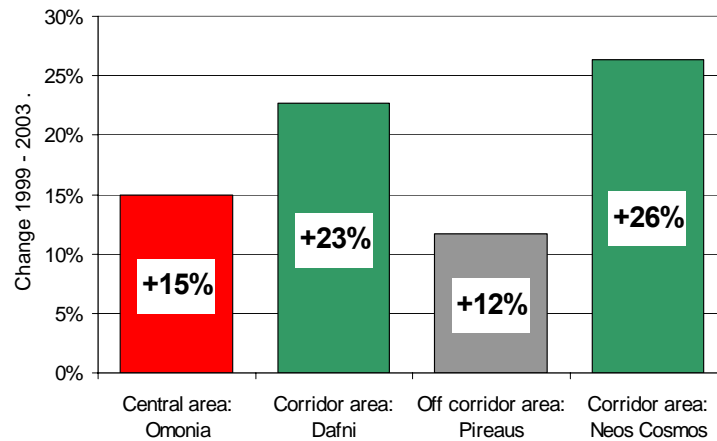


Figure 6-2 Development of the housing rents in the centre, within and outside of the corridor accessed by the new infrastructure investment, year 1999 to 2003 (example Athens)

Investments in development, redevelopment and renewal of urban fabric

In all cases, the construction and operation phases of the project have been accompanied by investments in urban development, redevelopment, renewal and renovation of space (example, see Figure 6-3). The amount of investments vary according to factors such as the development potential of the areas as related to the availability of green fields (e.g. Stuttgart, Zurich, Helsinki), the needs for redevelopment due to the presence of brown fields or/and derelict sites (e.g. Valencia, Brussels), the market pressures for the accommodation of new uses and the replacement of housing by offices and commercial/retail shops (e.g. Brussels), major changes in the state economy (Bratislava). In the hierarchy of investments, Athens appears at the top with a great difference over the second city Valencia. This seems to be related to the special development and redevelopment potential of Athens in the last 5 years. The 2004 Olympic Games have been working as a catalyst for improving the image of the city in all areas, especially in the city centre. It should be mentioned also, that the European Commission is supporting financially the urban regeneration process in this area. Among the 4 study areas of Athens, area A (Omonia) is located in the heart of the city centre and therefore, research has recorded investments in urban redevelopment and renewal that were extraordinarily high. However only some of these may be attributed to the Attico Metro.

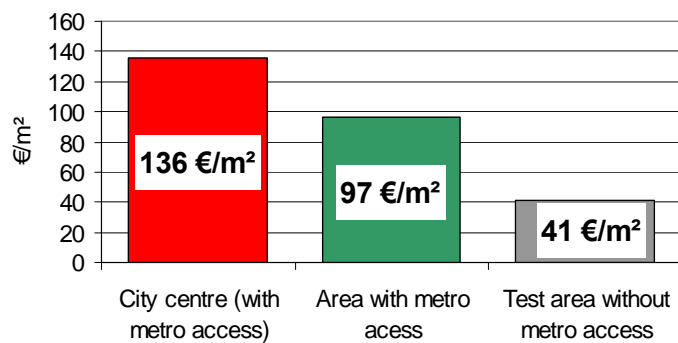


Figure 6-3 Investments in new buildings and in redevelopment of buildings, example Vienna since the opening of a new metro line (period 1991 till 2001)

Cross site comparison

Finally to develop a comparable figure, a so called urban regeneration indicator was developed (Figure 6-4). It could be pointed out, given the varied and disparate type of data from the different case studies, that the results obtained come from an estimated value. Those values were calculated by using one type of indicator - investment in new constructions, for five case study cities, and land use changes, for four cities- which was then moderated by other hard data and the qualitative information obtained from questionnaire replies. This leads to some very tentative averages per mode. Comparing the case study cities (Table 6-1), the impact of S-Bahn/suburban train investments is higher than metro, tram and bicycle.

Table 6-1 Average Urban Regeneration Indicator per transport mode

Transport mode	Urban regeneration indicator
S-Bahn	4.0
Metro	3.5
Tram or trolleybus	3.0
Bicycle	2.0

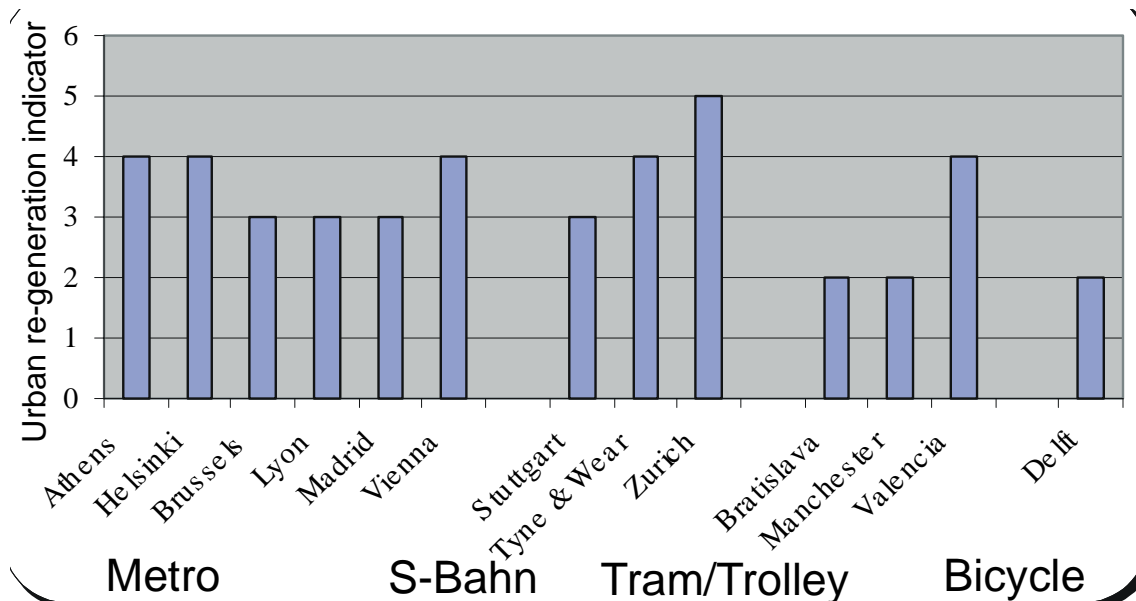


Figure 6-4 Overall urban regeneration indicator, all case studies (scale definition: 0= no effect, 6= strong effect)

Conclusions

The main conclusions of the analysis are:

- Transport infrastructure can have a catalytic effect on re-urbanisation development, but there are a lot of other influencing factors which can make the re-urbanisation development to a successful or unsuccessful story.
- A main influence is the type of the transport investment. Projects with a big increase of the accessibility and travel demand in the catchments area have a big potential in development of sub-urbanisation. The starting point of the accessibility of the catchment area is also an influencing factor. A lack of access in comparison with competing areas of the city enables a potential for a bigger increase of the accessibility.
- Whether the potential for re-urbanisation is used in a successful way is dependent on a number of factors not associated directly with the transport investment itself. These factors are:
 - The condition of the area concerned, declined areas, so called “brown fields”, have a big potential of re-urbanisation, which is strongly supported by the transport investments. Investments in well developed areas have a lower effect on re-urbanisation.
 - The willingness of the city authorities to invest in the public space of the catchment area in addition to the transport investment itself.
 - The local market demand for new space in offices, housing etc. and the local economic situation.
 - The local institutional and political framework, which can promote a climate of redevelopment and private follow up investments. It is evident, that dominant projects as the Olympic Games in Athens can play a catalytic role for redevelopment and re-urbanisation.

Limitations in the methodology and data analysis

The methodology adopted in the chapter required time-series hard data for many parameters such as land uses, investments in construction and reconstruction of buildings, investments in construction and reconstruction of public open spaces, real estate prices and rents for residential space, office space, industrial space, etc. Collection of data was by definition a time consuming and difficult task. A main problem arises, that some data are not available in many cases and when available, measurements were different. Similar problems involve investments in construction and reconstruction of buildings. Therefore, there were serious limitations in the task of comparative analysis of all case study cities. Another problem, which occurs for every statistical analysis is, that time series data are describing a phenomenological development which is caused by a big number of factors. These factors are influenced more or less by the project under investigation as well. It is very difficult to identify the main influencing factors caused by the infrastructure project. Therefore the interpretation of the following results must take into account this circumstance.

7 ECONOMIC AND SPATIAL DEVELOPMENT

7.1 Methodology

The principal problem under consideration in this analysis is the study of regional and zonal development tendencies and the possible influence of the projects studied on these. For each case study a so called shift-share analysis was carried out, which is based on a time series of data of a number of variables, at a highly disaggregated level. The basic variables required were population and employment (at place of residence), but others such as workplace jobs, income per capita, gross wage payments, gross regional product, housing rents, office rents and land prices were supplied where available. These were given in spatial units generally equivalent or similar to NUTS 5 zones. For each variable, a series of growth factors were estimated which characterised the tendency of each. Firstly, a global growth rate was estimated for the whole study area. Secondly, zonal deviations were estimated from this global growth rate, according to zonal characteristics, including distance from the project. To these growth factors, a smoothing process was applied to remove 'noise' effects from the raw data, and a standardisation process was used to give compatibility between growth rates for different case studies. The impact of each infrastructure project could be inferred from the zonal deviations from the global growth rate, since the zoning system was differentiated according to proximity to the project. In this respect, some measure of local interpretation was necessary, as the growth rates on their own were not necessarily sufficient to prove a causal link between the infrastructure investment and zonal development.

7.2 Results

Traffic infrastructure investments that change the structure of the area in terms of accessibility and therefore greatly affect the traffic demand, can cause a perceptible change in terms of spatial and economic development as well. Depending on the area type, these changes can have the desired effect, but they can also have an undesired effect. In other words, both opportunities and risks are stimulated by such measures. The following effects were identified:

- Traffic projects connecting the town centre with the surrounding areas improve the accessibility in the surrounding regions and cause a migration away from the town. The main driving forces of this change are rural ("green") surroundings, better environmental conditions, cheaper housing or house-building prices and the improved accessibility of the town (Figure 7-1). In the town centres, the improved accessibility leads to a concentration of services, in particular in the catchment area of attractive public transport stops.
- Motorways at the edge of the town, both radial motorway systems and ring roads, strongly attract car-oriented services in the catchment areas of the connecting points; they cause a pronounced migration to such installations, away from densely built zones as well.
- Provided that they perceptibly improve the accessibility, inner city public transport lines will markedly influence the land use pattern: in the catchment area of stops

located near the town centre, service installations accumulate and oust the residential population.

- The intensity and speed of the change of the land use pattern and of the sub-regional development depend on the framework conditions of the local economy and its strengths, on the availability of building land, on the demand for multi-storey surfaces for services and on the competitiveness compared with other development areas.
- Investments in the bicycle infrastructure close to the city centre have the desired effect, namely that of keeping the residential population in the area, and in this way they are capable of preserving the structure of the area.

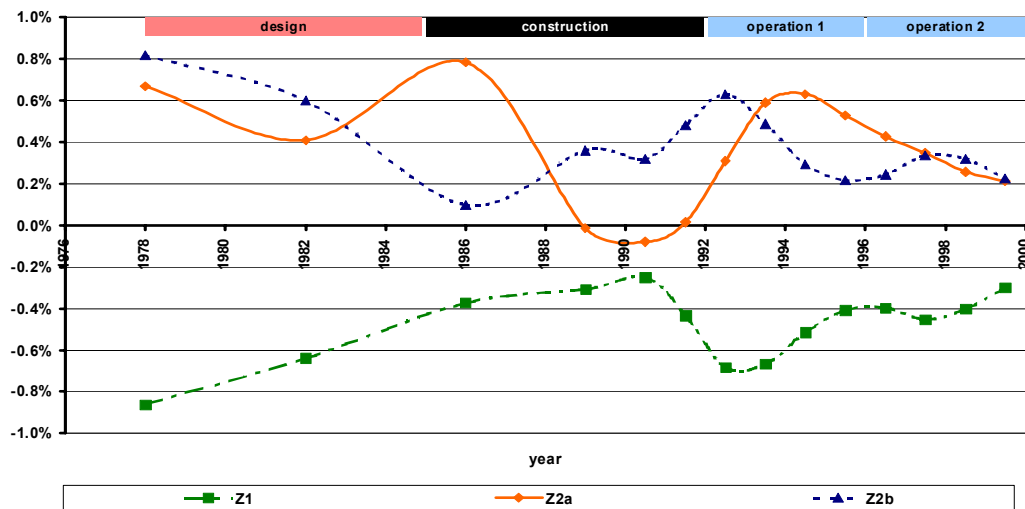


Figure 7-1 Result of the shift-analysis, case study Stuttgart: deviation of the average yearly growth rate of residents

Comparing the impact of the projects a distinction between central area projects and outer urban projects (radial lines) was useful.

Central area Projects

From the infrastructure investment in the central area projects of Athens, Brussels, Vienna, Madrid, Valencia, Lyon and Delft, only the results of the case studies of Vienna and Lyon are considered as sufficiently confirmed by statistical indicators. However, the other case studies of Athens, Brussels, Madrid and Valencia give some evidence that the observed results of Vienna and Lyon can be generalised. The outcome with respect to socio-economic developments effects are listed in Table 7-1. In the case of central urban projects a significant but rather moderate positive socio-economic development effect can be stated on the basis of the shift-share analysis. Investments in public transport projects in the central areas of the conurbation strengthen the position of the central areas and thus diminish sprawl.

Table 7-1: Socio-economic development effects (EDE) for central area projects
 (++) strong positive effect, + positive effect, 0 no effect, - negative effect,
 -- strong negative effect, results in brackets () are uncertain

Case study	socio-economic variable (available data points)	significance	remarks	evaluation EDE
Athens	population (5) workplaces (5) employees registered at the place of home (5) Income per capita (5)	not sig. not sig. not sig. not sig.	only three data points of the statistical data source (until 2001) two forecasted data points	(0)
Brussels	population (4) total labour force (4)	not sig. not sig.	only 3 growth rates	(-)
Delft	population (6) employees (4) income per inhabitant (8)	not sig. not sig. not sig.	income variables only available for the whole case study area	(0)
Lyon	population (7) workplaces (5) income per capita (3) land price (5) prices of new and former flats (5) prices of new / former offices (5)	sig. sig. not sig. sig. sig. sig.	only Z1 and Z2 are under consideration because the statistical data of Z2a and Z1 are the same	+
Madrid	population (5) employees registered at the place of home (5) income per capita (4)	sig. sig. not sig.	only three/four data points	(0)
Valencia	population (3) land price (3)	not sig. not sig.	only two data points	(+)
Vienna	population (21) employed persons registered at the place of work (4) employed persons registered at the place of home (5) income per capita (6) gross wage payment (6) purchase prices of used flats (7) land prices (11) rents of housing, offices and shops (15)	sig. not sig. sig. sig. sig. sig. sig. sig.	it is impossible to interpret development effects with only two/three growth rates (workplaces and employees/work) first data points only available 5 years after implementation of the metro (employees/work, gross wage, income, prices of used flats)	+

Outer Urban Projects

Outer urban projects with investments in public transport systems (radial lines) which increase the accessibility of the city centre are listed in Table 7-2.

Table 7-2: Socio-economic development effects (EDE) for outer urban projects (++) strong positive effect, + positive effect, 0 no effect, - negative effect, -- strong negative effect, results in brackets () are uncertain)

Case study	socio-economic variable (available data points)	significance	remarks	evaluation EDE
Bratislava	population (6) workplaces (6) employees registered at the place of home (6) income per capita (6) rents of housing (6) rents of offices (6) land price (6)	not sig. not sig. not sig. not sig. not sig. not sig. not sig.	economy in transition, untypical development	(0)
Helsinki	population (6) employed persons registered at the place of home and work (6) income per capita (6) gross wage payment (5) prices of old housings (6)	sig. sig. sig. sig. sig.	significant results	+
Manchester	population (6) total labour force (4)	sig. not sig.	population of the years 1986, 1991 and 1996 for Bury and Trafford are calculated breakdown by the data source	(+)
Stuttgart	population (15) employees registered at the place of work (7) number of apartments and residential buildings (7) income per capita of the employees in the mining and manufacturing companies (7)	sig. sig. sig. sig.	significant results, strong competition of different modes (motorway A81 and S-Bahn S1); superposition of effects	++
Tyne and Wear	population (5) employees registered at the place of home (5)	sig. sig.	restructuring of the local economy from heavy industry to service sector	(+)
Zurich	population (7) workplaces (4) land price (7) public and/or private investments for construction (7)	sig. not sig. sig. sig.	significant results, competition of different modes (street network and S-Bahn); superposition of effects	++

For Helsinki and Stuttgart clear socio-economic development effects can be seen. In the case of Helsinki the concentration of population in the city centre is still continuing and the growth rates have increased steadily in districts along the metro line which may be attributed to a higher attractiveness of the locations induced – at least partially - by the new metro. In the case of Stuttgart a positive effect must also be assigned to the investment in the S-Bahn system, since the S1 leads to a relief of the motorway A81 in combination with the 6 park-and-ride facilities located along the corridor. The indicators of population, employment, residential buildings and apartments) clearly demonstrate that the socio-economic development effects in

those communities close to the transport corridor (motorway A81 and S-Bahn S1) are in parts much stronger than in the city of Stuttgart. However, a sub-urbanisation process must be noted, which is mainly related to the motorway A81. Therefore the positive socio-economic development effects of the investment in the suburban rail S1 dominate. For the other case studies, despite the mentioned limitations (Table 7-2) small positive socio-economic development effects can be stated.

Conclusions

The main conclusions of the analysis are:

- There is a confirmation of expected third party effect by shift-share analysis.
- The shift-share analysis shows a development, which is of a merely phenomenological nature; the identification of specific detailed causes is difficult.
- The capable transport infrastructure investments stimulates socio-economic development in areas of improved accessibility:
 - in central areas: mainly shops and offices
 - in periphery areas: mainly residential population.
- A capable transport infrastructure linking city centre and the region stimulates decentralized housing (spatial diffusion).
- The private investment shows concentration in the areas of improved accessibility primarily in the region.
- The strength of the socio-economic development of the infrastructure corridor is dependent on the potential of land development (re-urbanisation or new development).
- The socio-economic development of the infrastructure corridor is also dependent on the local economic framework (local economic power, competition of other areas, etc.).
- (Public) transport investments are stimulating third party investments.

Limitations in the methodology and data analysis

The identification of socio-economic development effects based on the improved shift-share analysis requires time-series data of an appropriate length (10 to 20 years with at least 5 data points) and spatial disaggregation. However, not all case studies were able to provide an appropriate data base for the analysis of socio-economic effects.

Because of the superposition of effects it is very difficult to separate the impacts of the different measures only by considering the spatial-temporal variations of variables such as population and workplaces. For example, investments into different transport projects (e.g. a new metro line) in the same conurbation area could interfere. In addition, the cyclical coupling between causes and effects creates a chicken-egg problem. In such cases it is quite difficult to say whether the investment into a particular infrastructure created a certain additional growth or not.

8 POLICY IMPACTS

8.1 Methodology

The interview approach of the **TranSEcon** project allows an in-depth analysis of the history of the measures or projects and the contexts under which they have been developed and have had their impacts. Of special interest is the role of actors. In this way the difficult question of causality can be tackled in more detail and can be used as a supporting tool for the quantitative analysis.

In each case study city approximately 15 key persons and representatives of the following categories have been interviewed:

- Local, provincial authorities,
- Railway companies, other transport operators, regional public transport associations,
- Real estate dealers, developers, private investors (for homes and/or the commercial, retail and industrial sectors),
- Businesses, private enterprise,
- Interest groups, representatives of political parties,
- Others (Users, residents, other experts).

This comes to an average of two or three interviewees per category. Persons of different geographical areas, such as urban and suburban development and regeneration areas are involved in this analysis. The results of the individual interviews were finally discussed in one or two focus groups where possible, to allow cross-checking of the received answers.

The interviews were designed to be semi-structured so that each of the interviewees did not have to give in-depth answers to all questions. A transport operator, for instance, knows more about the traffic impacts than about regional development impacts. A real estate dealer is more knowledgeable regarding land-prices and land development issues than an environmentalist. Therefore the interviewer shifted the weight of the questions to those matters where he could expect qualified answers. Each interview took between one and two hours. The interviews were completed by the members of the **TranSEcon** consortium in order to guarantee a proper understanding of subject matter and of the overall approach taken by the project.

8.2 Results

Firstly, this section reviews the three most important questions of the semi structured interviews. The results show a significant degree of interlinking between the areas.

Should the promotion of public transport and pertinent heavy investment be accompanied by car restraint measures in order to achieve a better modal split (push and pull policy)? Or should public transport be conceived as a means to absorb excessive travel demand from the road network in order to provide the remaining road traffic with more fluidity?

Zurich is probably the case where the former policy is adopted with most consequence. Parking policies, traffic calming and tram/bus priority on the road network are seen as essential components of a policy that aims at sustainable mobility. In cities like Vienna or Athens, however, the concept of underground public transport involves, in the eyes of interviewees, the potential to free the surface road network from disturbing bus and tram traffic. In Valencia and Brussels, both policies are followed in parallel – the promotion of both public transport and of car traffic – and this was blamed by most of the interviewees as giving contradictory messages. Positive environmental impacts were seen to be successful by public invention only if push and pull measures are implemented.

Should public transport be subsidised as such?

The answer can probably not simply be yes or no. The interviews show functional and economic problems with the partial deregulation in the UK, in the sense of submitting buses to the free market and subsidising a metro system based on heavy investment. The market is distorted and working inefficiently. In most cities the operational efficiency of public transport is hampered by the competition from the car. Only Zurich is an example where subsidies to public transport is gradually – and substantially - reduced due to a relatively clear push and pull policy and due to measures of rationalisation of the public transport system.

Should transport operators conceive their business as a mere service industry, or should they actively get involved in developing sites that have reached gains in accessibility? Should urban or regional authorities engage in such an active urban stimulation or regeneration policy?

The question is twofold and can be answered in several ways. In all cities, site development in the vicinity of the S-Bahn or metro projects was primarily a matter of free market development. The transport operators remained in that sense inactive, and mostly they were not in a pertinent position as were land owners. There are, however, differing forms of real estate development. In Helsinki the land in the metro corridor belonged mostly to the municipality; it was to a large degree developed for social housing and such dense housing projects fit well with the function of public transport. In Zurich, railway stations had, in the 19th century, been the focal points of industrialisation. Today that land is to be converted into business and residential parks, both at much higher densities: the S-Bahn is serving the most important of these re-conversion sites and these developments fit functionally with public transport too. The developers and the municipality have formed common task forces to induce changes in zoning and to restrict at the same time parking numbers. In Brussels, Madrid, Valencia and Vienna the areas close to metro or light rail stations converted gradually to higher value land uses on the free market. The conclusion may be that a more active role of local government and even the transport operator to co-operate with real estate developers for density and thus demand raising near S-Bahn or metro stations is a valid means to improve the return on investment in public transport.

Key features of successful schemes:

- A strong regional authority with the ability to push forward a public transport investment, co-ordinate transport and land-use planning and co-operate with private interests to foster development favourable to public transport.
- A national legislative framework which permits co-operation or competition to maximise transport system efficiency and promote public transport as a single, attractive product, whether it be under public or private ownership
- Broad public and political consensus about the benefits of the project, especially if it is part of a package of measures which includes restraint on car use.
- Optimisation of the efficiency of the transport infrastructure project during the planning and design phase with respect to the local and regional development. It is important to optimise the network effect of a transport infrastructure investment.

Principal barriers to project success:

- Differing levels of support between different levels of government. This often occurs where, for example, one political party dominates regional government and another the local level, and can cause contradictory policy measures to be implemented or wasteful competition between local and regional transport operations.
- Lack of co-operation between transport authorities and private developers, investors and businesses, to develop areas adjoining the project in a public transport sympathetic way. It is also important that this co-operation can discourage land-use patterns only accessible by car. Lack of coordination with land-use authorities or insufficient planning powers may also aggregate this problem.
- The sacrifice of co-ordination of transport for the sake of competition. Although there may be price benefits to the user of competition between public transport modes, a legislative framework aimed exclusively at mode choice may eliminate the user's option of paying higher fares to gain the system benefits of integrated transport.
- No harmonisation of local and regional transport and land use policy. High investments in public transport or bicycle transport which are not accompanied by a restrictive car policy are less effective and successful than the implementation of a real push and pull transport policy.

One can draw a series of lessons from the qualitative questionnaire approach of *TranSEcon*. In terms of methodology it should be mentioned that the interviews have shed light on many aspects that one cannot easily grasp by means of the statistical analysis (see quantitative approach, chapter 3). Information on project history and project characteristics, for instance, as well as on exogenous and endogenous contextual frameworks of project implementation and operation can help to understand why the performance and impacts of the S-Bahn, metro system or other project types in the case cities differ. In addition the interviews have shown to some degree, "what could be made better" in further efforts to promote public transport in urban regions or to promote the indirect, or so called "third party", effect. Similarly the discussion of the bicycle network approach in Delft has allowed us to draw interesting conclusions with regard to a less capital intensive approach to urban

transport problems in smaller cities. The limits of the qualitative questionnaire approach are obviously that the interviews reflect often a personal view or opinion. The result is thus of a somewhat perceptive "subjective nature". There are, however, two reasons why the interview approach is not merely "impressionistic": First, many of the respondents have supplied empirical findings to back up their answers, the advantage being that the data that were made available have been interpreted. Secondly one may say that a certain level of objectivity is reached if the views expressed by the different respondents coincide, especially if they stem from different types of actors and interest groups. Yet there is also something to learn from differing views of the stakeholders.

9 PROJECT ENVIRONMENT AND FRAMEWORK

9.1 Methodology

The motive for this part of *TranSEcon* is to analyse the positive and negative aspects of different organisational frameworks, in terms of their facilitation or inhibition of socio-economic benefits of transport infrastructure investments. The methodology used was common to the analysis of Policy Impacts; semi-structured interviews with 10-20 key actors were carried out in each case study using a questionnaire. Also developed under this section was a methodology for selecting interviewees according to common criteria. This involved the compilation of a Generic Effects Matrix, in which key actor categories were linked with different project effects. Broadly speaking, actors were thus chosen for each case study on the basis of their level of association with the different effects, to ensure appropriate coverage in as objective a manner as possible. Questions asked in the interviews for this work package were designed to elicit information on key actor networks, support of the economic and political climate, institutional relationships and supporting policies. Interview results were compiled into a separate report for each case study using a common framework, from which relevant information was drawn for the analysis.

9.2 Results

The analysis of the interview results was conducted around a number of recurring thematic streams, of which those most relevant to this work package were:

The infrastructure investment within the context of local policy

The main outcome of the interviews is that the promotion of public transport in cities and urban regions is without exception considered as an important contribution to sustainable mobility. Yet the overall transport policy of the local and upper level governments does not provide in all cases a framework for efficient and beneficiary operation of public transport:

Measures to restrain car traffic are not in all case cities considered as an important complementary means to the promotion of public transport. In some cases one can identify even an excessive and willingly supported competition between the two policy lines. Yet one may conclude from the public transport projects which have a high return on investment that a push and pull policy (pro public transport, restriction of car traffic) is of great importance.

Also with regard to public transport policy as such, the case cities show considerable differences. The services of the public transport operators are not interlinked and part of an integrated system in all case studies. Through ticketing in an urban or regional context is not in operation everywhere, and the installation of flexible feeder systems to the more capital intensive light railways is not on the agenda of all the administrations. Again one may say that the public transport projects are economically sounder if efficient feeder systems are provided and if the public transport system appears to the user as one integrated system.

Role and structure of local / regional authorities

Many case studies highlighted the importance of a regional authority with sufficient geographical and political scope to create and maintain a regional public transport system, and to co-ordinate it with other transport modes, land-use planners and local economic interests. Particularly significant are those cases where such an authority previously existed and was disbanded (Tyne and Wear) to the detriment of the system, and where no such body was in existence at the inception of the project but was later created, generating benefits (Brussels).

Role of national government

National governments proved to be important actors in two main respects. Firstly, where a measure of the investment is provided from national public funds, central government may have a decisive role in determining the type of project implemented, such as occurred in Vienna. This is not a problem where national policy is responsive to local conditions, such as in Zürich, but may otherwise give a less than ideal type of infrastructure. However, some projects, although local in coverage, may have a national significance, by virtue of being located in the capital (for example Athens or Vienna) or by setting a national precedent (such as the Tyne and Wear Metro); in these cases it may be appropriate that national or European funding is decisive. Secondly, national government determines the legislative framework within which operators must provide services. This was particularly interesting in the two UK case studies, where the deregulation of public transport put in place in the 1980's contributed to the decline in integration, and hence patronage, in Tyne and Wear, and in Manchester led to the creation of a metro system unsupported by feeder buses. Other case studies such as Stuttgart however reported that their regulatory framework permitted integration whilst maintaining a degree of competition.

Relation with other transport operators

The issue of competition versus integration in the public transport network is also highlighted in the contrast between the UK and other case studies. Whilst a publicly supported project may benefit from subsidies, it may have less commercial freedom in charging fares at market prices, as occurs in Tyne and Wear. Both of these factors may cause friction with rival private operators. Other cities such as Zürich perceive efficiency as a system property rather than one of individual companies, thus opting for a high degree of public transport integration with car restraint policies, any operating deficit being covered by public funds.

Co-operation with developers / businesses

Few attempts to maximise project potential by means of collaboration between transport operators and private enterprise were found. One notable exception was in Lyon where the operator co-operated with investors and local authorities to develop a former industrial area. In Zurich, an initiative is being attempted which brings together local businesses and investors to develop poles around S-Bahn stations.

Participation of interest groups

Few projects suffered strong opposition in the planning phase. This was either due to construction being underground (as in Athens and Vienna), to an existing rail alignment being used (as in Tyne and Wear, Manchester, Stuttgart and Valencia) or

to a degree of prior consultation. The latter occurred in Delft, where lessons were learned from a previous experience where motorists had opposed a scheme which reduced space for cars, and consultation was carried out in the design phase. In Zürich, the S-Bahn project had previously been approved by popular vote where a more expensive metro scheme had been rejected. Other case studies have found that in retrospect, similar exercises would have been advantageous. Examples of public consultation over specific issues were identified in some case studies, for example relating to local environmental problems.

Political interests

As many of the systems studied represented relatively high capital investment, and thus are arguably less cost effective than measures such as guided bus, the existence of a political will and consensus to push the project through was frequently identified as important. In some cases, a key politician with a strong vision was an important figure in project promotion. Often, the main impetus came from the left of the political spectrum, requiring much political manoeuvring to placate the opposition of right-wing parties who preferred car-friendly options. This was notable in Helsinki and Tyne and Wear, whereas in Zürich, a more collaborative approach smoothed the way for the project.

Recommendations

Based on the analysis performed, the following recommendations can be made:

- It is important that a regional authority exists, with sufficient financial and executive powers to impulse an infrastructure project of region-wide benefit. This should ideally cover all centres of population which might usefully be served by the project.
- To maximise the economic potential of projects, closer co-operation should be fostered between transport authorities and land-use authorities developers and private businesses and investors. Private businesses may require positive incentives to locate near public transport rather than a cost burden for not doing so.
- Co-operation should be encouraged with other transport (for example bus) operators, whether under public or private ownership. To this end, it is helpful that authorities are not seen as giving preferential treatment to one or the other. National anti-monopolistic legislation may need to recognise the particular advantages of public transport integration.
- Where significant externalities may be involved, early consultation with stakeholders (such as users, motorists, local businesses, residents), preferably in the design phase, could prevent problems in the operation phase. This may also facilitate a broader consensus amongst local political interests which can smooth the way to project approval.
- In the case that a project's importance could be of national scope, by virtue of its setting a positive example for others, or by being located in a key city, national or European funding contributions may be of long-term benefit, even if short-term local returns are not demonstrably great. But it must be stated, that the finding rules should not be limited on any specific technical solution of public transport (e. g. metro). This should be dependent on the level of cost-effectiveness of the project.

10 OVERALL SOCIO-ECONOMIC ASSESSMENT

10.1 Methodological Approach

The evaluation method follows a specific multi-criteria analysis (MCA) approach, in order to evaluate the improvement of the sustainable development focused on the objectives – economic benefits, social benefits and environmental improvements – that need to be aggregated. The application of this assessment technique could be called as “sustainability development analysis” (SDA). Each objective is measured by one or more, specific criteria, which receives in turn a value through one corresponding targeted indicator. Some of the criteria are quantitative but in other cases they are qualitative by nature. The latter must be measured by choosing an appropriate indicator. At the end, the level of achievement of each objective has to be expressed as a numerical value. Therefore it is required from each topic under evaluation to define a procedure to convert the qualitative results into a final score. Once each individual impact is measured, all these values can be aggregated in a final single value. To this end it is necessary to carry out two tasks; firstly, to convert the range of variation in each indicator to a homogeneous one, typically from 0 to 1. This conversion could be linear or non-linear; therefore transformation curves or value functions have to be designed for each indicator. The value function converts the indicator variation among scenarios into a homogeneous value scaled from 0 (no impact) to 1 (maximum impact). On top of these, impacts can be positive or negative, and the correct sign must be applied. These homogeneous values represent the social utility for each criterion. The second step in the aggregation procedure is to assign the homogenised indicators to each criterion to represent its relative importance to the overall objective of sustainability and social welfare. The final impact will be the sum of all indicators weighted by their corresponding criteria. The final formulation of the process will be the following:

$$SDA \text{ Infrastructure impact} = \sum_{i=1}^n w_i \cdot \alpha_i$$

where w_i are the weights and α_i the social utilities to sustainability of each of the n indicators.

It is important to highlight that the effects produced for all the case studies are measured for one year, not for the whole period of the project. This means that the evaluation presented here is totally different from a CBA because the effects are not considered along the whole life of the project. This approach can be argued on the grounds that in the MCA many subjective and initiative influencing factors are involved. A summing up of all effects for the whole operation period of the projects could show an unachievable accuracy.

10.2 Criteria and Indicators

It is necessary to determine a set of criteria in order to measure the three main objectives for the socio-economic evaluation of the transport projects related in terms of sustainable development. The following table shows the criteria defined, classified by each objective:

Table 10-1: Objectives and Criteria for the overall assessment.

Global Objective	Sub-objectives	Nr.	Criteria
SUSTAINABLE DEVELOPMENT	A. Economic Benefits	A.1.	Reduction of travel time
		A.2.	Economic efficiency
		A.3.	Employment generation
		A.4.	Economic growth
	B. Social Benefits	B.1.	Social Equity
		B.2.	Increase in the use of public transport / bicycle transport
		B.3.	Urban regeneration
	C. Environmental Improvements	C.1.	Air Pollution
		C.2.	Noise
		C.3.	Greenhouse effect
		C.4.	Safety improvements

For each group of sub-objectives, a set of criteria has been chosen. In order to measure the **economic benefits** achieved due to the new infrastructure, it is necessary to measure the benefits to:

- The **users**: these will be measured by the reduction of travel time, because the more savings in travel time the more operating costs are saved, and also the time saved has a value and could be used in other productive activities.
- Transport **operators**: their benefits are linked to the economic efficiency of their business. Therefore, it is considered how they have gained revenue in relation with the incremented costs due to the project under evaluation.
- The economic benefits for **society** are evaluated through the employment generation, since this creates prosperity in the region, and with the economic growth, because this measures the growth of the regional economy, in terms of increasing income.

The second group is the **social benefit** achieved by the new infrastructure, where it is necessary to take into account the following issues:

- The improvement in accessibility is one of the greater social issues. Not all society has equal access to transport, and provision has to be made for those without access to a car or public transport system, so **social equity** is a criterion for measuring the social benefits in a very relevant way.

- Public transport benefits everybody in a society, so the increase in the **use of public transport** will measure the social benefits achieved to all the citizens (for the Delft case: use of bicycle transport).
- The construction of a modern public / bicycle transport infrastructure in deteriorated areas can produce an **urban regeneration** of the zone in which it has been built; there are also other benefits related to this regeneration, as the reduction of the level of crime, the attraction of new enterprises, the increase in quality of life, etc.

To consider the **environmental improvements** due to the new infrastructure, it is necessary to measure the benefits on the following two aspects:

- **Environmental quality of life** can be measured by two proxies: air quality standards (reduction of pollutant emissions from motorised vehicles) and noise pollution levels (reduction of noise from road traffic).
- The **danger of accidents** associated with transport means is considered, so the safety improvement is the second element to ensure good quality of the environment.

These criteria are measured by a set of indicators. The following table shows the indicators used to measure the criteria:

Table 10-2: Indicators for measuring the criteria.

Nr.	Criteria	Indicators
A.1.	Reduction of travel time	Total travel time saved by the project in both, public and private transport, between the scenarios [h per year]
A.2.	Economic efficiency	Fare revenues-Operation costs [€ per year]
A.3.	Employment generation	Additional Regional Employment [persons per year]
A.4.	Economic growth	Economic Development Effect [-]
B.1.	Social equity	Quantified questionnaire responses [-]
B.2.	Increase in the use of PT	Increase in public transport trips per day [trips per year]
B.3.	Urban regeneration	Urban Regeneration Effect multiplied by affected inhabitants [weighted inhabitants]
C.1.	Air Pollution	Reduction of pollutant emissions (CO, SO ₂ , NO _x , lead, PM) [tons per year]
C.2.	Noise	Number of persons that are less/more affected by noise [disturbed inhabitants per year]
C.3.	Greenhouse effect	Reduction of emission of CO ₂ [tons per year]
C.4.	Safety improvements	Reduction of accident costs per year [€ per year]

Due to the lack of data in some case studies, some indicators have been estimated through indirect procedures.

10.3 Weighting and Normalisation

Weighting

As has been defined before, the next step in the multi-criteria evaluation is to assign to each criterion a weight to represent its relative importance to the overall objective of sustainability and social welfare. In some case studies, weights have been determined through a consultation process where key actors of the different cities and research teams have taken part. In other case studies the weighting procedure has been made by a set of experts within the consortium partner group. The following aspects have thus been scored from 1 to 10, where 10 was the maximum importance with respect to sustainable development. The results were normalized to a weight sum of 100 and are shown in Table 10-3.

Table 10-3: Weighting of Indicators

Objective	Criterion	Median Normalised	
Economic benefits	Reduction of travel time	10.58	33.33
	Economic efficiency	7.56	
	Employment generation	7.63	
	Economic growth	7.57	
Social benefits	Social equity	11.13	33.33
	PT Improvements	12.51	
	Urban regeneration	9.69	
Environmental improvements	Air pollution	8.44	33.33
	Noise	8.44	
	Greenhouse effect	8.44	
	Safety improvement	8.00	
Sum:		100	100

Normalisation of the Investment

As the case studies have very different levels of investment, the indicators are standardised by the investment of every case study. Figure 10-1 explains this process. In order to normalise the socio-economic utility by the investment costs, a value function has been developed which converts the investment (in Million Euro of 2002) into a value between 0 and 1, where 0 has been assigned to a null inversion and 1 to the maximum investment, that is, to Vienna investment (2487 M Euro).

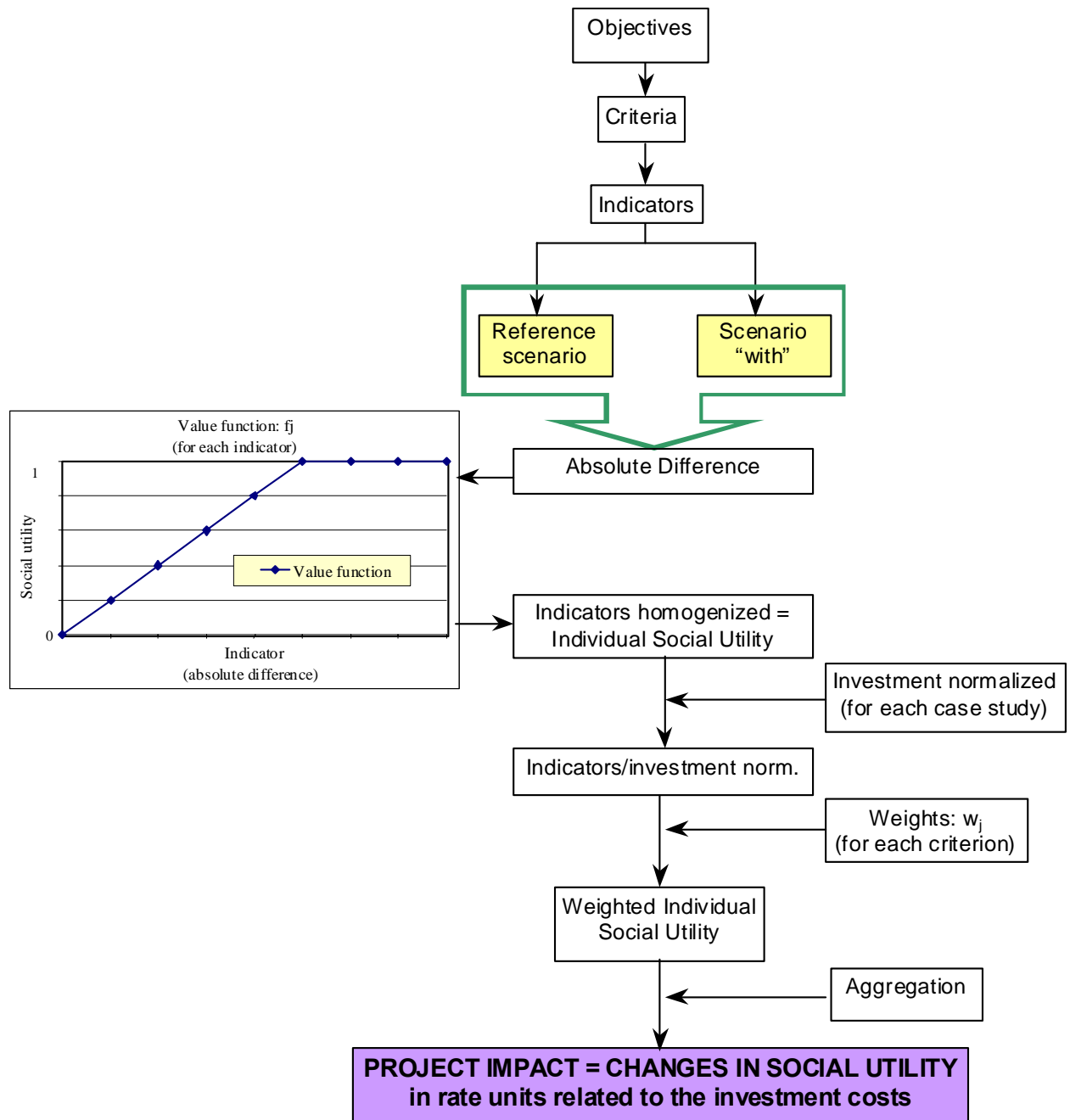


Figure 10-1 Flow-chart of the multi-criteria approach with normalisation by the investment

10.4 Results of the Analysis

The results are shown in Figure 10-2 and can be summarized as follows:

- In general terms, outer city projects have a higher socio-economic utility per unit investment cost than inner ones (except Delft and Madrid). This is logical because building a new metro/tram in the city centre requires bigger construction works and tunnels in most cases.

- ‘Soft’ modes (bicycle network, Delft), which present little investment, have the highest socio-economic utility per unit investment cost, and its social benefit is very high compared to the economic benefit and to lesser extent the environmental impacts. Therefore, it can be said that bicycle infrastructure projects are highly efficient from the environmental point of view and produce very relevant social effects per unit investment. This is due to the re-urbanisation process induced by the project.
- Madrid and Valencia present important time savings, so their economic benefits are the highest. Madrid has also a very significant environmental benefit per unit investment cost due to the reduction in the level of noise.
- Valencia presents the highest social benefit, after Delft, due to the public transport improvements, that is, the important increase in public transport trips between the reference and 'with' scenarios. In Valencia the social benefits are the most important ones, mainly because of public transport improvements and urban regeneration. The city was degraded before the construction of the infrastructure, and without any other high capacity means of transport in the zone. The implementation of the tram has regenerated the city to a significant extent.
- Stuttgart and Helsinki have also a considerable environmental benefit per investment costs; in the case of Stuttgart, it is due to the reduction of inhabitants affected by traffic noise and in Helsinki it is due to the reduction of pollutant emissions.

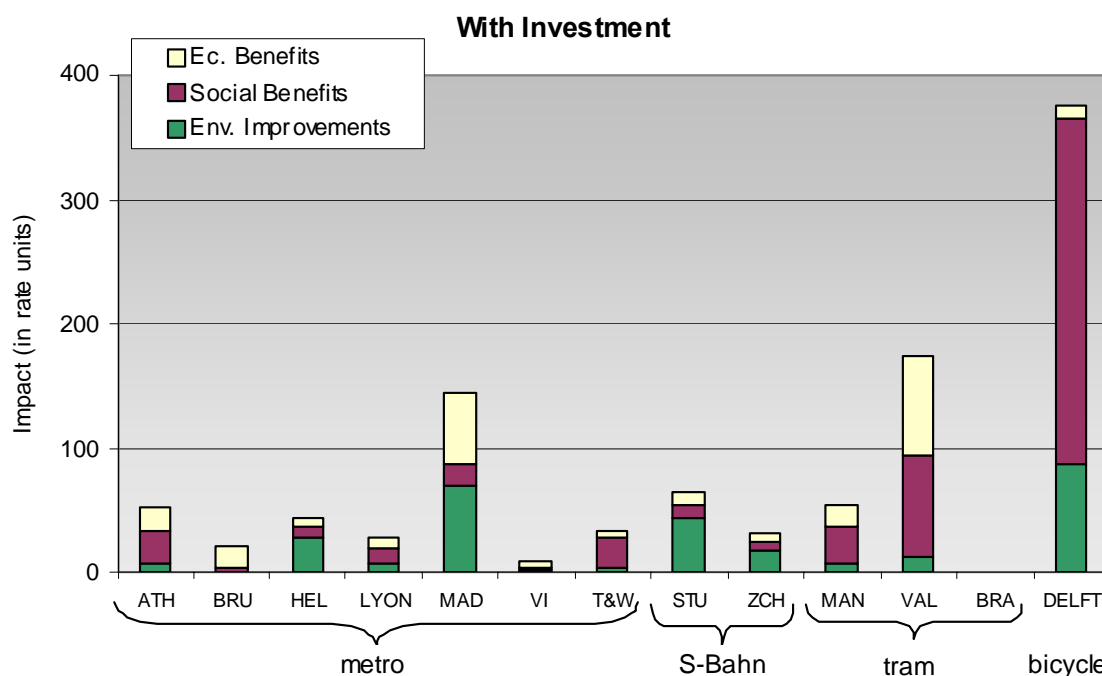


Figure 10-2: Economic, Social and Environmental Benefits of the different case studies under the objective of sustainable development, considering investment.

11 CONCLUSIONS AND RECOMMENDATIONS

In general, the project hypothesis of expected third party effects of large scale infrastructure investments is confirmed as much as there is a clear:

- stimulation of socio-economic development in areas of improved accessibility,
- stimulation of re-urbanisation dependent on the potential development,
- potential of decentralisation of housing (spatial diffusion) and centralisation of shopping.

It can be said that the methodological approach was successful, but there are some limitations of the interpretation as the data availability and data quality was limited.

Efficiency of Transport Infrastructure Projects

The efficiency of the investigated transport infrastructure projects shows great variance, revealing major differences in efficiency depending on the relevant public transport category (underground, suburban railway and tram). The following conclusions can be made in general:

- When decision of traffic policy are taken, greater priority should be given to the efficiency of investments. It is overriding importance that cost/benefit ratio is carefully weighted and that indirect effects are also considered.
- As a general rule, investments in surface public transport with priority route are more efficient than investments in underground public transport.
- Investment in light rail systems are more cost efficient than investments in conventional railways.
- Improvements of existing rail routes, respectively the reuse of existing routes (for instance suburban railways) are more efficient than newly built routes.
- Investments in bicycle traffic with inter-modal interfaces (e. g. bike and ride) are highly efficient.

Regional economic effect

- The direct multiplier effect of transport infrastructure investment costs (public transport and bicycle) for the regional gross domestic product is 2,2 on average (range 1,9 – 2,5), and for the regional income 1,4 on average (range 1,2 – 1,6).
- The multiplier effect of total investment costs (including follow up investments) for the regional gross domestic product is up to 6 for public transport investments.
- The additional employment effect of infrastructure investment per Mio. € is between 25 – 32 persons additionally employed per year.
- The size of additional employment is not influenced by the different project types.

Changes within the Transport System

Factors of success in increasing the demand towards the new project as much as possible are firstly to introduce accompanying measures for public transport infrastructure investments, e.g.

- Park-and-ride,
- Bike-and-ride,
- Information & marketing,
- Integrated fare-, ticket-, service-, timetable-, network system etc.

Secondly to support the public transport infrastructure investment by restrictive car-policy measures: e.g.

- Parking fees,
- Reduction of lane capacity and parking facilities,
- Access restrictions,
- Road or congestion pricing.

Urban Regeneration

Large scale transport infrastructure investments can stimulate re-urbanisation developments. Preconditions for use of potential re-urbanisation development are:

- Substantial increase of accessibility and demand,
- No other sites which are more competitive (in such cases, retarded developments can be observed),
- Availability of land or buildings for new developments (“brown fields”, a public land management policy is needed),
- Willingness and capability of public authorities to invest in public space (organisational and financial framework),
- Local economic situation: demand for new space in offices, housing, etc.,
- Local climate for re-urbanisation which is based on an appropriate institutional and political framework).

Economic and Spatial development

Public transport investment can cause substantial changes of land use patterns (spatial sprawl, re-urbanisation, commercial concentration, etc.) in the catchment area of the station whereas bicycle investments indicate support of residential land use in central areas. The improvement of public transport and car accessibility in outer regions of conurbation stimulates migration from the city centre in the outer city regions (if land is available). The improvement of public transport accessibility in built up areas within a conurbation can stimulate follow up investments in the catchment area of stations. Investment by local commerce and industry are increasing the land prices and support the outward migration of residents. The strength of the socio-economic development caused by public transport infrastructure investment is dependent on the local economic framework and competition of other potential development sites.

Supporting policies (Policy impacts and Organisational Frameworks)

In order to maximise the social-economic benefit of a large scale infrastructure investment, factors of success are:

- Existence of a competent regional authority, which has the vision and power for carrying forward the project (often a person with a strong personality – so-called “project champion”) is the driving force behind a successful project,
- Existence of a comprehensive transport policy, some times stimulated by a huge transport problem or clear and convincing transport objectives to follow,
- Existence of a consistent program of measures: promotion of environmental friendly modes, supporting intermodality (bike-and-ride, park-and-ride), car restrictions, parking management, capacity reduction, traffic calming, marketing, etc.,
- Intensive co-operation between transport authorities, city authorities, land-use authorities, developers, private businesses and developers; an appropriate organisational framework is supporting such co-operation,
- Co-operation with other transport operators (from the users' point of view public transport must be an integrated mobility service system), again an organisational framework can support such co-operation,
- Early and well organized consultation and participation with stakeholders: transport-users, motorists, local businesses, residents, institutional representatives, etc.,
- National and European funding may give long-term benefit in certain cases but should not be limited to a specific type of public transport mode. Funding should be dependent on the efficiency of an investment project.

12 ABBREVIATIONS

SDA Sustainable Development Analysis
MCA Multi Criteria Analysis
CBA Cost Benefit Analysis

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