Final Report

Guide for Strategic Assessment on CTP-Issues

Strategic Assessment Methodology for the Interaction of CTP-Instruments

Public

SAMI

ST-97-SC.1176

Project Coordinator: Technical Research Centre of Finland (VTT), Communities and Infrastructure, FI

Partners:
University College London, GB
Institute for Traffic Planning and Engineering, Technical University of Vienna, AT
Institute for Transport Studies, University of Leeds, GB
Economic and Social Institute, Free University of Amsterdam, NL
CESUR/Instituto Superior Técnico, PT
Marcial Echenique and Partners, Ltd, GB
Warsaw School of Economics, PL
Scientific Centre of Complex Transport Problems, RU

Date: **December 2000**

PROJECT FUNDED BY THE EUROPEAN COMMISSION UNDER THE TRANSPORT RTD PROGRAMME OF THE 4th FRAMEWORK PROGRAMME

CONTENTS

PARTNERSHIP **6**

EXECUTIVE SUMMARY **7**

1. INTRODUCTION **16**

1.1 OVERVIEW OF GUIDE 16
1.2 OBJECTIVES OF THE SAMI PROJECT 17
1.3 CLASSIFICATION OF TRANSPORT ISSUES AND PROBLEMS 17
1.3.1 European Transport Landscape 17
1.3.2 CTP Objectives and Transport Problems 18
1.4 OVERVIEW OF LATER CHAPTERS 20

2. MAIN TRANSPORT TRENDS AND IMPACTS **21**

2.1 CURRENT TRANSPORT TRENDS 22
2.1.1 Economic Activity 22
2.1.2 Car Ownership 22
2.1.3 Transport Infrastructure 22
2.1.4 Passenger Transport 23
2.1.5 Freight Transport 24
2.2 IMPACTS OF TRANSPORT 25
2.2.1 Introduction 25
2.2.2 Direct Impacts on Economic Efficiency 26
2.2.3 Direct Impacts on the Environment and Health 27
2.2.4 Impacts on the Economy and Employment 31
2.2.5 Impacts on Regional Development 32
2.2.6 Indirect Impacts on Environment and Health 35
2.2.7 Equity 35
2.3 TRANSPORT FORECASTS 36
2.3.1 Person Transport 36
2.3.2 Freight Transport 37
2.3.3 STREAMS´ Forecasts 38
2.3.4 Conclusions 39
2.4 TRANSPORT TRENDS AND IMPACTS IN THE CEEC AND CIS 39
2.4.1 Current Trends and Impacts in the CEEC 39
2.4.2 Current Trends and Impacts in the CIS 44

3. DEFINING TRANSPORT POLICY **46**

3.1 HISTORY AND CURRENT STATUS OF EUROPEAN TRANSPORT POLICY 47
3.1.1 Introduction 47
3.1.2 European Transport Policy – Phase 1 to 1992 47
3.1.3 European Transport Policy – Phase 2 from 1992 to 1995 50
3.1.4 European Transport Policy – Phase 3 from 1995 53
3.1.5 Trans European Networks 55
3.1.6 Conclusions 57
3.2 DIRECTION OF TRANSPORT POLICY IN THE CEEC AND CIS 58
3.2.1 Introduction 58
3.2.2 Transport Policy in the CEEC 58
3.2.3 Transport Policy in the CIS 60
3.3 SETTING TARGETS FOR TRANSPORT POLICY 62
3.3.1 Need for Policy Targets 62
3.3.2 SAMI Approach for Setting Targets 64
3.4 SYNERGIES AND CONFLICTS BETWEEN POLICY TARGETS 74
3.4.1 Framework for Assessing Interactions between Targets 74

3.4.2 *The Hierarchy of Targets* ... 77
3.5 PERFORMANCE INDICATORS ... 79
3.5.1 *Developing Policy Indicators* ... 79
3.5.2 *Overall and Operational Indicators* ... 82

4. FORMATION OF STRATEGIES ... 85

4.1 IDENTIFYING POLICY INSTRUMENTS ... 86
4.2 DEVELOPING POLICY PACKAGES ... 88
4.3 SAMI OPTIMISATION METHOD ... 90
4.3.1 *Introduction* ... 90
4.3.2 *Optimisation Algorithms* ... 91
4.3.3 *Demonstration* ... 93

5. PREDICTION OF IMPACTS ... 98

5.1 REQUIREMENTS FOR IMPACT ASSESSMENT ... 99
5.2 POLICY SCENARIOS ... 100
5.2.1 *Need for Scenarios* ... 100
5.2.2 *Scenario Building Process* ... 101
5.2.3 *Images of the Future* ... 103
5.3 TRANSPORT MODELS ... 105
5.3.1 *Basic Characteristics* ... 105
5.3.2 *EURO9 Model* ... 107
5.4 ENVIRONMENTAL MODELS ... 108

6. EVALUATION OF STRATEGIES ... 111

6.1 BACKGROUND FOR EVALUATION ... 112
6.1.1 *Changing Planning Environment* ... 112
6.1.2 *Search for a Balance* ... 113
6.2 PLANNING AND DECISION-MAKING ... 114
6.2.1 *Planning at the Crossroads* ... 114
6.2.2 *Decision Styles* ... 115
6.3 SAMI EVALUATION METHODOLOGY ... 116
6.3.1 *Introduction* ... 116
6.3.2 *Structure* ... 117
6.3.3 *SAMIsoft* ... 119
6.3.4 *Rough Set Analysis* ... 120
6.3.5 *Flag Model* ... 122
6.3.6 *Regime Analysis* ... 124
6.3.7 *Saaty's Method* ... 128
6.3.8 *Illustration on the Use of SAMI Methods* ... 129
6.3.9 *Conclusions* ... 135
6.4 STRATEGIC ENVIRONMENTAL ASSESSMENT ... 135

7. CONCLUSIONS ... 137

7.1 SAMI´S OBJECTIVES AND ACCOMPLISHMENTS ... 137
7.1.1 *Targets* ... 137
7.1.2 *Scenarios and Instruments* ... 137
7.1.3 *Evaluation of Strategies* ... 137
7.1.4 *CTP Implementation on the European Level* ... 138
7.2 NEED FOR GUIDANCE ... 138
7.3 FROM POLICY TO REALITY ... 139

GLOSSARY ... 140

ABBREVIATIONS ... 143

TABLES

Table 1. Dispersion of inter-urban transport problems in Europe 18
Table 2. Categories of transport impacts 26
Table 3. EU15 Person kilometres travelled by mode ('000 / day) 38
Table 4. 2020 Freight model results, 1994 and 2020 comparison (1000T pa) 38
Table 5. Economic growth in some CEE countries 1990-1997 40
Table 6. EU imports from the CEEC 40
Table 7. EU exports to the CEEC 40
Table 8. Investment expenditures for land transport infrastructure in some European countries during 1985 – 1995 41
Table 9. Modal share of domestic and international goods transport in 1993 42
Table 10. Car ownership and death rate in Europe 1996 43
Table 11. The share of CO_2 emissions per economic sector in Western Europe and the CEEC during 1990 – 1995 43
Table 12. EIB Financing for Transport and Telecommunications, 1986-1990 (million ECU) 49
Table 13. Investment in the Trans European Network Priority Projects 56
Table 14. Categories of main policy issues and related targets 66
Table 15. Stakeholders and their position to policy orientations 72
Table 16. Forms and types of interactions between transport policy targets 74
Table 17. The forms and types of interactions between Target "Reduce demand for motor vehicle travel" and the other targets 76
Table 18. Hierarchical Class and strength of transport policy targets 78
Table 19. Examples of environmental indicators 81
Table 20. Road sector indicators 84
Table 21. Impacts of transport policy measures 86
Table 22. Examples of policy instruments 87
Table 23. Unconstrained EEFP values 97
Table 24. Constrained CEEFP values 97
Table 25. Comparison of the two Images of the Future. 104
Table 26. The Information Table; classification of the independent variables 122
Table 27. The colours of flags 123
Table 28. Costs and Benefits in monetary terms of the various project alternatives 127
Table 29. Impacts of project alternatives in other than monetary terms 127
Table 30. Standardised impacts 127
Table 31. Results of Regime Analysis (equal weights) 128
Table 32. Semantic scale of Saaty´s method 129
Table 33. The Impact matrix 130
Table 34. The three sets of weights 132
Table 35. Rank order of alternatives using the uniform weight vector 133
Table 36. Rank order of alternatives using the preferences of technical experts 133
Table 37. Set of critical threshold values 134
Table 38. Frequencies of flags 134

FIGURES

Figure 1. Five building blocks for decision-making on the strategic level. ... 16
Figure 2. Persons killed on the road in the EU ... 29
Figure 3. Areas of policy development and related main issues ... 65
Figure 4. Overview of quantitative policy optimisation ... 91
Figure 5. Steps in SAMI evaluation ... 119
Figure 6 The bandwith of the Flag Model ... 123

BOXES

Box 1. Objectives of the Common Transport Policy ... 19
Box 2. Transport for the past and the future ... 21
Box 3. Conditions for economic growth through transport infrastructure investments ... 32
Box 4. The uncertainty of regional development ... 34
Box 5. The complexity and fluctuations of transport policy ... 46
Box 6. Short-term targets for transport policy in Poland ... 59
Box 7. The concept of the transport policy of the Russian Federation ... 61
Box 8. Road safety targets and their effect on policy ... 63
Box 9. The need for packages ... 85
Box 10. The POSSUM process of constructing policy packages ... 89
Box 11. Search for tomorrow ... 98
Box 12. Potential benefits of policy scenarios to decision-making ... 100
Box 13. The scenario building process ... 102
Box 14. STREAMS strategic transport model ... 106
Box 15. Requirements and recommendations for strategic modelling ... 106
Box 16. The ASTRA System Dynamic Model Platform ... 107
Box 17. The COMMUTE software tool ... 110
Box 18. A quote from a letter of Benjamin Franklin to Dr. Priestly in London 19th September 1772 ... 111
Box 19. TENASSESS PAM and TENASSESS Barrier Model ... 116
Box 20. DECODE Method ... 116
Box 21. COMMUTE framework for SEA ... 136

PARTNERSHIP

Company	Abb.	Post address	E-mail contacts
Coordinator:			
Technical Research Centre of Finland	VTT	P.O.Box 1901, FIN-02044 VTT	veli.himanen@vtt.fi heikki.kanner@vtt.fi
Contractors:			
University College London, The Bartlett School of Planning	UCL	22 Gordon Street, WC1H0QB London, United Kingdom	d.banister@ucl.ac.uk d.stead@ucl.ac.uk
The Institute for Traffic Planning and Traffic Engineering	TUV	Gusshausstrasse 30, A-1040 Vienna, Austria	hermann.knoflacher@tuwien.ac.at guenter.emberger @tuwien.ac.at paul.pfaffenpichler@ tuwien.ac.at
The Institute for Transport Studies, University of Leeds	ITS	LS2 9JT Leeds, Great Britain	ptimms@its.leeds.ac.uk , sshepher @its.leeds.ac.uk
Free University of Amsterdam, Department of Spatial Economics	FUA	De Boelelaan 1105, 1081 HV Amsterdam, The Netherlands	pnijkamp@econ.vu.nl rvreeker@econ.vu.nl
CESUR	CESUR	Av.Rovisco Pais 1, P-1096 Lisbon, Portugal	viegas@alfa.ist.utl.pt
Marcial Echenique and Partners Ltd, Transport and Land Use Consultancy	ME&P	49-51 High Street, Trumpington CB2 Cambridge, United Kingdom	sl@meap.co.uk
Associated partners:			
Scientific Centre of Complex Transport Problems	SCCTP	34 W Sofiyskaja nab, RV-113035 Moscow, Russia	ncktp@online.ru
Warsaw School of Economics, Department of International Transport	WSE	Al. Niepodleglosci 162, PL-02554 Warsaw, Poland	habrd@sgh.waw.pl, plesiak@sgh.waw.pl

This report has been edited by Veli Himanen/VTT, Dominic Stead/UCL, and Paul Timms/ITS. Quality control has been accomplished by José Viegas/CESUR.

EXECUTIVE SUMMARY

INTRODUCTION

Purpose

The purpose of this Guide is to present for politicians, planners and other civil servants useful methods and tools for decision-making on strategic transport issues. The need for guidance is emphasised by the current situation facing the decision-maker with various interest groups and bewildering complexity of scenarios, objectives, instruments and models. The material presented is produced in project SAMI, but in addition to that also the available results from other FP4 (The Fourth Framework Programme) projects are highlighted.

Methods and Tools

Major methods and tools developed in project SAMI are as follows:

?? SAMI approach for setting transport policy targets;
?? SAMI framework for assessing synergies and conflicts between targets;
?? SAMI optimisation method for policy packages;
?? EURO9 transport model;
?? SAMI evaluation methodology, including software.

Transport Problems

Transport issues and related problems can be divided into three categories: traditional, modern, and post-modern. **Traditional** transport problem refers to the everyday question for individuals/firms: how to get (or how to move goods) from one place to another? The unforeseen increase in traffic has resulted in environmental problems and accidents, which form a key issue in **modern** transport problem. The **post-modern** transport problem is typical of densely populated societies with congested networks and without much room for further expansion. This makes earlier solutions – increase of transport capacity – difficult to execute and in addition to that also former local environmental problems have been transformed into global sustainability issues.

TRANSPORT TRENDS

European transport trends have changed dramatically since the creation of the European Community a few decades ago. Over the last 25 years, passenger transport has more than doubled, the number of cars has increased by more than one and a half times and the length of motorways has more than trebled. In contrast, the length of the European railway network fell by 9 per cent between 1970 and 1995.

Person Transport

The average distance travelled per person per year almost doubled in Europe between 1970 and 1995. This was primarily due to people travelling further than travelling more frequently. In 1970, the average yearly travel distance was 6,292 kilometres per person and by 1995 it was 12,337 kilometres per person. In 1995, the average annual travel distance of a European was approximately 10,000 kilometres by car, 970 kilometres by bus, 730 kilometres by train and 700 kilometres by air.

Freight Transport

Freight transport volumes in Europe increased by 71 per cent between 1970 and 1995, primarily due to goods being moved further rather than more goods being moved. In 1995, the average yearly freight transport per capita was 2,960 tonne-kilometres by road, 590 tonne-kilometres by rail, 310 tonne-kilometres by inland waterway and 230 tonne-kilometres by pipeline.

IMPACTS OF TRANSPORT

All human activities produce in addition to the impacts aimed for also impacts not at all wanted. This holds true also in transport, when solving the traditional transport problem through large transport networks and huge parks of vehicles, we have got environmental pollution and accidents and in the end also congestion.

Time and Costs

The 413 million Europeans generate roughly a billion trips a day. In doing so, they consume vast amounts of time, energy and money, produce tons of air pollutants and a lot of accidents. In mid-80´s the average daily travel distance per capita varied from 21 to 37 kilometres and average daily travel time from 53 to 71 minutes in 9 European countries. At the same time that economic activity and incomes in Europe have been increasing, the user costs of private transport have been decreasing in real terms. By contrast, public transport costs (and usually fares) have been increasing in most countries.

Direct Impacts on the Environment and Health

Transport produces a number of emissions with different scope of influence. These include global pollutants (such as carbon dioxide 1.8 tonnes per person in 1994), national or regional pollutants (like nitrogen oxides 16.3 kg per person) and local pollutants (such as VOCs 13.6 kg per person). Transport's contribution to environmental pollution in urban areas is particularly large, where transport is by far the most significant contributor of most emissions. The temporal trends in air pollutants from transport are mixed. Some emissions continue to increase, others have started to fall.

Transport is the most pervasive source of noise for many people in Europe. It is estimated that around 80 million people (or 17 per cent of the population) in Europe are exposed to unacceptable noise level.

More than 44,000 people were killed and 1.6 million people were injured on the roads in 1995. The number of deaths on the road has decreased from 1990 to 1995 in almost all Member States. There are significant differences in road safety between European Member States. The proportion of people killed per capita on the roads in most dangerous countries is more than double the proportion of people killed in the safest ones.

Impacts on the Economic Growth

A benefit of a transport investment is usually calculated by multiplying the estimated saving in travel time with assumed time value. In addition to that it is sometimes claimed that transport investments promote economic growth, i.e. there are additional benefits over the time saving. However, it is also argued that transport investments, in modern economies with well-developed transport networks cannot anymore on its own result in economic growth, but it acts in a supporting role when other factors – like economic externalities, investment factors, and political factors - are at work.

TRANSPORT FORECASTS

Transport infrastructures have very long lives. The decisions about them need a foresight. A traditional way to manage this is to make forecasts with the aid of transport models, which are based on observed trends in human behaviour and economic activities. The daily 14 billion person kilometres in 1994 is forecasted to grow into 20 billion in 2020. Major part of increase will happen in air traffic and the rest is shared between car and train. The transported freight will almost double from 13 billion tonnes per day in 1994 into 24 billion in 2020.

TRANSPORT TRENDS IN THE CEEC AND CIS

Transport in the CEEC and CIS reminds partly that of the Member States some decennia ago, but depending on the different starting point it has also special features and own dynamics. Railway transport was a dominant mode in the former communist countries and because of that the density and quality of rail network is relatively good. The situation with road network is different. It can be estimated that one half of the road network in Poland, the Czech Republic, Hungary, Estonia and Slovenia needs as quickly as possible a general overhaul. In Russia vast areas are even lacking of road network. In this situation it is important to notice that infrastructure investments in the CEE countries and Russia are extremely low. On the other hand it is to be noticed that in the EU countries - with advanced transport networks - still a remarkable amount is invested.

HISTORY AND CURRENT STATUS OF EUROPEAN TRANSPORT POLICY

Transport policy at the European level has developed over the last 40 years from the Treaty of Rome, but it is only in the last decennia that the Common Transport Policy (CTP) has been promoted by the EU.

Transport was identified in the 1957 Treaty of Rome as one of the areas for development of a common policy. Since then the progress towards the **Common Transport Policy (CTP)** has been slow. In 1985, the European Parliament asked the European Court of Justice to officially recognise the lack of a European Transport Policy. The Court also declared at the same year that the inland transport of goods and passengers should be open to all Community firms, without discrimination as to nationality or place of establishment. After the following discussions a modest proposal which concentrated available resources on a limited number of projects was accepted in November 1990.

The Maastricht Treaty of the EU states that the Union aims to "*promote a stable and non-inflationary growth which respects the environment*" and it stresses the importance of an integrated approach to economic growth, quality of life, jobs, local development and the environment. As a consequence of this new imperative, the EU changed its approach to transport so that a Transport Policy would be based on *sustainable mobility* and in 1992 the **CTP** was published. Its objectives can be summarised as i) increasing *economic efficiency*, ii) stimulating social cohesion through *regional development*, and iii) *protecting environment.*

In 1995, the Commission launched its *action plan* for 1995-2000. As part of this new initiative, there have been a series of important debates opened up in the transport sector. Although the main aims of the CTP of 1992 have not changed fundamentally, there is a significant change in the focus of transport policy in the EU. The efficiency of the transport system still underlies much of the policy thinking, as this is seen as being essential to the competitiveness of Europe and to growth and employment. But a greater emphasis is being given to the social cohesion objectives, to safety (again), the environment, subsidiarity, and the accession countries.

The concept of the *Trans-European Networks* was developed during the formulation of the Maastricht Treaty of the European Union, which specified a network of transport corridors forming the backbones of the European transport system. At the Council in Essen in December 1994, 14 TEN priority projects were accepted. The priority projects have benefited from substantial amounts of EU financial support, particularly those located in areas eligible for Structural and Cohesion Fund financing. The TEN Transport Budget, (around 1,800 MECU 1995-1999) has had a considerable impact in helping to launch major projects. The European Investment Bank (EIB) is the major source of loan funding for TEN projects, advancing 1,400 MECU to the 14 priority projects in 1997 alone.

DIRECTION OF TRANSPORT POLICY IN THE CEEC AND CIS

The major policy question "*how to finance the development of road network*" cannot be answered in the short term. This makes the management of railways a most important policy issue in order to keep the relatively high share of rail transport. Fast increased car ownership is bringing serious environmental problems in cities and necessitates also improvements in public transport as well as the tightening of traffic control.

Many countries – like Poland and Russia - have published transport policy documents with objectives very much in line with the EU. However, these are not always followed in practice. The current shortage of financial resources leads to short-term solutions aimed on serving daily needs without consideration on safety or long-term ecological issues. In the short-term there exists a lot of practical issues needing harmonisation and coordination in the East-West freight and passenger transport.

SAMI APPROACH FOR SETTING TARGETS

Common transport policy has to be tuned into the actual planning situation and this can be best achieved through the definition of targets providing information about the change aimed in every policy. SAMI approach for setting targets goes through the following conceptual path:

1. define the **issue** , the general associated **targets** and the geographical **scope** (s) at which the policy discussion is relevant;
2. present likely **policy orientations** (lines of action) on the basis of current discussions in multiple institutions;
3. identify and assess the **position of each stakeholder** group (social groups who would support or oppose those policy orientations) with respect to each policy orientation mentioned (present an explicit argument in case of a strongly negative position);

4. evaluate the global level of **acceptability** of each orientation and make a general comment on likely dominant policy orientations.

SAMI FRAMEWORK FOR ASSESSING INTERACTIONS BETWEEN TARGETS

It is obvious that a conflict between economic efficiency and environmental protection/safety objectives forms a fundamental hinder for the execution of transport policy. This originates already from the basic characteristics of transport systems as the pursuing of traditional transport problem has provoked unwanted side-effects. In order to illuminate the interactions between transport policy targets and to provide a tool for addressing them a framework has been developed in SAMI. The framework considers the forms and types of interactions according to six characteristics.

The basic form of an interaction between policy targets is determined by three characteristics: the direction, intensity and precedence. The **direction** tells us if the interaction is synergetic, i.e. pursuing one target will be helpful for improvement on the other or if there exists a conflict as pursuing of one target would worsen situation with respect to the other. The **intensity** describes the power of the interaction. If there is no intensity then there is no interaction between the targets. The **precedence** implies which one of the targets generates a reaction in the other. This is a necessary information because in many cases interactions between targets are not symmetrical, even though also symmetrical cases exist so that either target can generate a reaction on the other.

In addition to the form of interactions also the type characterised by structural, circumstantial and instrumental dimensions is important. A **structural** interaction is considered permanent, independent of the current positions and point of view, as well as of the orientations adopted for action in pursuit of the targets. One of the major factors contributing for a structural interaction is a strong commonality of stakeholders engaged (positively or negatively) in the two targets being considered. A **circumstantial** interaction refers to the situation where a change of position with respect to one of the targets would lead to changes in the direction and intensity of the interaction. An **instrumental** interaction means that the interaction between targets is likely to depend on the instruments or policy orientations adopted for their pursuit.

PERFORMANCE INDICATORS

In practical use targets need to be measured and performance indicators form the way of measurement. These indicators show quantified information, which can help to explain how change is occurring through time. They ought to be able to both i) *measure* the extent to which policies are achieving policy targets and ii) *simplify and communicate* a large amount of data using a smaller amount of representative, meaningful information. Many different types of indicators for a variety of sectors are already available form literature. Some policy objectives are difficult to measure (such as quality of life), which is problematic when trying to identify policy indicators. Indicators therefore have limitations and should not be used in isolation to determine progress towards policy targets. Qualitative information is also required in order to make judgements about whether policies are having the desired effect. In SAMI two types of indicators were used: overall indicators for measurement of progress on the selected target and operational indicators related to progress along the suggested policy orientations.

FORMATION OF STRATEGIES

When the appropriate transport policies have been agreed and related targets defined, the formation of strategies - needed to reach these targets - can start. Then available transport policy instruments will be identified and the most appropriate ones selected. The selected instruments have to be formed to packages, because it is well known that usually one instrument alone is not enough. The formation of packages can be an extremely complicated process, when there are many possible instruments and for any instrument there are many possible variations, e.g. different prices. An optimisation method applicable on the strategic level and developed in project SAMI can alleviate this task.

Identifying Policy Instruments

The first stage in generating transport strategies is compiling a comprehensive list of possible policy instruments that might be used to achieve the desired policy objectives. A number of publications have been produced which provide inventories of the different types of transport policy measures that might be used. For each policy instrument, it is necessary to identify i) the *influence* of each measure on the policy targets; ii) the *timescale* of effect of the policy instruments – whether impacts are likely to be short, medium or long-term; and iii) the potential interaction between policy instruments. The SAMI project formulated a list of policy instruments divided into two main classes: economic and regulatory. The instruments provided relate to the targets developed in SAMI and by that way they are mainly addressing the modern and post-modern transport problems.

SAMI OPTIMISATION METHOD

It is increasingly recognised that individual policy instruments should be combined into comprehensive policy packages. A difficulty arises though when the question is asked "at what level is a particular instrument set - such as road pricing or increase in public transport frequency?". SAMI Optimisation Method provides a quantitative planning approach, which aims to find the levels of implementation of instruments *that maximise some prespecified social objectives.* In such a way optimal packages of transport instruments for road, rail, air and water modes can be formed including, e.g. pricing and capacity instruments for both passenger and freight transport. The demonstration of the SAMI method proved it quite suitable for use on the European level. Probably it could be used as well on the worldwide level.

PREDICTION OF IMPACTS

When the policy packages are chosen, the next step in the planning process is to estimate their possible impacts. This is usually made with the aid of models. The impacts have to be considered inside an appropriate context. Often this will be obtained with the aid of scenarios. Models are then used for estimating the impacts of the instruments, both with regard to economic efficiency (*transport models*) and the environment and safety *(environmental and accident models*).

Scenarios

The dynamic nature of policy objectives, priorities and advice requires a way of identifying policies and proposals that are robust and flexible enough to withstand change. Policy scenarios allow the role and effect of different policies and proposals to be studied across a range of possible futures. A scenario is a tool that describes pictures of the future world within a specific framework and under specified assumptions. The scenario approach includes a description of two or more scenarios, designed to compare and examine alternative futures. There are a number of distinct different traditions and approaches in scenario construction. In the *Swedish approach,* used in SAMI, Images of the Future are constructed without taking account of current trends. The Images of the Future set the framework for identifying policy instruments. They specify different future conditions under which policies are made, including, for example, lifestyles, technological change, and mobility patterns. The Images of the Future also specify the prevailing conditions for future policy-making, such as the level of support for environmental policies in the future, the level of growth in the economy, and the level of global political cooperation.

Images of the Future

Two Images of the Future have been chosen for examination in the SAMI project. They provide two polarised cases of policy-making environments and available policy instruments. The first Image, *Unified Europe*, is one in which there is good coordination and cooperation between national governments on policy-making and strategic policy is coordinated at the EU level. Transport policy is geared to provide efficient transport operation with an extensive network of roads, railways, airways and waterways, including the opportunity of transfer between modes. In contrast, the second Image of the Future, *Cohesive Regions*, reflects more regional and local priorities, in which decision-making is devolved to the national, regional and local levels in line with the principles of subsidiarity. Transport policy is geared to providing greater accessibility through the development of local public transport networks. Regulations and standards take the prime role in this Image of the Future, with pricing having a more supportive position.

Transport Models

Most past model development has been directed at creating urban or regional models. However, particularly as a result of the FP4 there has been great interest recently in creating transnational strategic models like the STREAMS model. In SAMI the **EURO9 model** was developed in order to test the variation of a great number of policy variables within acceptable computation time.

SAMI EVALUATION METHODOLOGY

Different transport policy strategies are defined through sets of policy packages. When the impacts of these packages are known it comes possible to compare the strategies with each other in order to decide which direction the actions will have. In project SAMI a meta-method combining the gains of various other evaluation methods and specially aiming on the strategic level has been developed. The core of the methodology designed by Project SAMI is formed by a qualitative-quantitative Regime analysis, extended with complementary approaches like the Flag Model, Rough Set Analysis and Saaty's hierarchical method.

The aim of **Rough Set Analysis** is to reduce the cumbersome characteristics of fuzzy input in the decision making process. More precisely, Rough Set Analysis is designed to discover possible cause-effect relationships between the data-components, to underline the importance and the strategic role of some data, and to differentiate between irrelevant and relevant data. The intrinsic value of Rough Set Analysis is its ability to manage quantitative as well as qualitative data. The *decision rule* and the *table of information* are the basic elements used to solve multi-attribute choice and ranking problems. The binary preference relations between the decision rules and the description of the objects by means of the condition attributes determine a set of potentially acceptable actions. In order to rank such alternatives, we need to conduct a final binary comparison among the potential actions. This procedure will define the most acceptable action or alternative.

The main purpose of the **Flag Model** is to analyse whether one or more scenarios/policy alternatives can be classified as acceptable or not. It is done so by comparing an impact value with a set of reference values (called *Critical Threshold Values*). The Flag Model has been designed to assess the degree to which alternatives fulfil predefined standards or normative statements in an evaluation process. There are three important components of the model: i) identifying a set of measurable standards or indicators; ii) establishing a set of normative reference values; and iii) developing a practical methodology for assessing alternatives.

The input of the Flag Model is an *impact matrix* formed by the values that the indicators assume for each considered scenario. The Flag Model can operate both as a classification procedure and as a visualising method. In the former case, for example, in combination with Regime Analysis, the Flag Model can determine the acceptable alternatives that then will be ranked by means of the Regime Method. In the latter case, we can utilise the Flag Model in order to visualise better the results obtained for example from the Regime Method or a Rough Set Procedure.

The multi-assessment method used in the SAMI evaluation methodology is the **Regime Analysis**. The strength of Regime Analysis is that it is able to deal with binary, ordinal, categorical and cardinal (ratio and interval data), while it is also possible to use mixed data. This applies to both the effects and the weights in the evaluation of alternatives. The fundamental framework of the method is based upon two kinds of input data: an *evaluation matrix* and a set of (political) *weights*. The evaluation matrix is composed of elements that measure the effect of each considered alternative in relation to each considered criterion. The set of weights gives information concerning the relative importance of the criteria in the evaluation procedure. Regime Analysis is a generalised form of concordance analysis, i.e. the basic idea is to rank a set of alternatives by means of their pair-wise comparisons in relation to the chosen criteria.

The core of the **Saaty´s method** is an ordinal pair-wise comparison of all criteria. Per pair of criteria the decision-maker is asked to which degree a criterion is of more importance than the other is. By means of these comparisons the method defines the relative position of one criterion in relation to all other criteria. In this way quantitative weights are assigned to the criteria. Saaty´s method is based upon three basic components: i) hierarchy articulation of the elements of the decision problem; ii) identification of the priority; and iii) checking of the logic consistency of the priority.

STRATEGIC ENVIRONMENTAL ASSESSMENT

Strategic Environmental Assessment (SEA) is a relatively new process in decision-making on the transport sector. Environmental Impact Assessment was earlier typically only applied to individual transport infrastructure projects rather than wider policies, plans and programmes (PPPs). As a consequence, the consideration of the environmental effects was only concluded at a local level. Recently the widespread nature of transport systems and their consequent environmental effects have been leading to the application of Strategic Environmental Assessment (SEA). The relationships between SEA and general assessment methodologies are still developing. Assessment methodologies have been developed and used in practice for a long time. SEA is a new phenomenon that is still under development. Its final role in the decision process will evolve during the following years. The Flag Model will probably be a useful tool also in SEA, especially when critical threshold values for environment have been or could be defined. By this way also SAMI optimisation procedure could be used in connection to SEA.

1. INTRODUCTION

1.1 Overview of Guide

The purpose of this Guide is to present for politicians, planners and other civil servants useful methods and tools for decision-making on strategic transport issues. The need for guidance is emphasised by the current situation facing the decision-maker with various interest groups and bewildering complexity of scenarios, objectives, instruments and models. The material presented is produced in project SAMI, but in addition to that also the available results from other FP4 (The Fourth Framework Programme) projects are highlighted. Some material is also obtained directly from current scientific literature.

Major methods and tools developed in project SAMI are as follows:

?? SAMI approach for setting transport policy targets;
?? SAMI framework for assessing interactions between targets;
?? SAMI optimisation method for policy packages;
?? EURO9 transport model;
?? SAMI evaluation methodology including software.

Strategic transport issues – in comparison to short term corrective policy actions – can be characterised by attributes like long term, structural change, multimodality and spatial dimensions like European level.

The Guide is constructed according to five interrelated building blocks for decision-making on the strategic level (see Fig. 1). Inside these blocks above mentioned tools and methods will be presented. In addition to trends and policies related to the EU also special transport circumstances in the CEEC and CIS will be clarified. The future enlargement of the Union accentuates the need to understand current transport situation in the CEEC as well as to consider the TEN extensions/links to the CEEC and CIS.

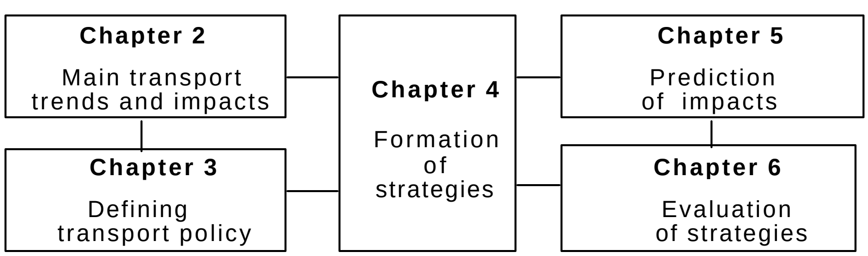


Figure 1. Five building blocks for decision-making on the strategic level.

1.2 Objectives of the SAMI Project

The overall objectives of the SAMI project are:

1. to identify candidate CTP targets and assess possible conflicts and synergies between them in order to define the structure of a target system including hierarchical levels, interactions, and quantifiable indicators;
2. to define scenarios and sets of possible CTP instruments related to selected targets;
3. to refine and test an optimisation methodology - previously developed on an urban level - on the European level;
4. to define and develop a strategic assessment methodology - including necessary software - for system-wide (European) impacts of policy packages; and
5. to clarify the conditions for CTP implementation on the European level when considering also the implications in the CEEC/CIS.

1.3 Classification of Transport Issues and Problems

1.3.1 European Transport Landscape

Transport issues and related problems can be divided into three categories: traditional, modern, and post-modern[1]. **Traditional** transport problem refers to the everyday question for individuals/firms: how to get (or how to move goods) from one place to another? The unforeseen increase in traffic has resulted in environmental problems and accidents, which form a key issue in **modern** transport problem. The **post-modern** transport problem is typical of densely populated societies with congested networks[2] and without much room for further expansion. This makes earlier solutions – increase of transport capacity – difficult to execute and in addition to that also former local environmental problems have been transformed into global sustainability issues.

In recent years the European transport scene has shown significant changes. Mobility has drastically increased and as a consequence congestion has also increased in almost all transport modes (see section 2.3). At the same time the environmental burden of the transport sector exceeds the carrying capacity of our environment and threatens ecological sustainability as advocated amongst others in the Brundtland Report[3] (see also section 2.2). Transport seems to have a double face nowadays. On the one hand, it is increasingly recognised that transport plays a vital role in building up an integrated European network economy and on the other hand there is a growing awareness of the high – sometimes unacceptable – social costs of transport.

It is also noteworthy that in the past years most European countries appear to have developed a common trend towards **devolution** of transport policy (e.g. deregulation, decentralisation, and privatization)[4]. The current trends in the transport geography of Europe can be expressed by two words: **integration and expansion.** The integration issues are well highlighted in the following discussion about European transport policy (see section 3.1). The expansion of the EU will next mean activated (transport) contacts with the CEEC (see section 2.4).

It has to be noticed, however, that Europe is not a homogeneous area regarding transport problems, even inside the EU there are big differences. In addition to the inter-urban problems highlighted in Table 1, we have to remember urban transport problems, which in big European cities have everywhere reached the post-modern state.

Table 1. Dispersion of inter-urban transport problems in Europe

Transport problem	Core countries	Nordic countries	Southern countries	CEEC/CIS
Traditional	Well developed transport networks	Well developed transport networks	A part of road network of low quality	Major part of road network of low quality
Modern	Differences in safety; severe pollution.	Moderate safety; modest pollution.	Poor safety; severe pollution.	Poor safety; local severe pollution.
Post-modern	Severe congestion; not much room for construction.	No severe congestion; room for construction	Some congestion; some room for construction	Some congestion; room for construction

1.3.2 CTP Objec[illegible]sport Problems

The Common Transport Policy (CTP) w[illegible]discussed fully in Section 3.1. However, it is useful at this early stage to examine how the seven objectives of the CTP (see Box 1) are associated with the three types of problems listed above. Actually most of the CTP objectives (1, 2, 3 and 7) are addressing the traditional problem (how to get from one place to another), whilst two of the objectives (4 and 5) are addressing the modern problem (environmental and safety problems). However, none of the objectives is directly addressing the post-modern problem (congestion and restricted room for expansion).

Box 1. Objectives of the Common Transport Policy[5]

1. The continued reinforcement and proper functioning of the internal market facilitating the free movement of goods and persons throughout the Community;
2. The transition from the elimination of the artificial regulatory obstacles towards the adoption of the right balance of policies favouring the development of coherent, integrated transport systems for the Community as a whole using the best available technology;
3. The strengthening of economic and social cohesion by the contribution which the development of transport infrastructure can make to reducing disparities between the regions and linking island, land-locked and peripheral regions with the central regions of the Community;
4. Measures to ensure that the development of transport systems contributes to a sustainable pattern of development by respecting the environment and, in particular, by contributing to the solution of major environmental problems such as the limitation of CO_2;
5. Actions to promote safety;
6. Measures in the social field;
7. The development of appropriate relations with third countries, where necessary giving priority to those for which the transport of goods or persons is important for the Community as a whole.

More recently, the European Commission has examined ways in which transport prices can better reflect the costs to society of pollution, congestion and accidents[6] (see also section 3.1.4). This can be understood as a step to develop transport policies able to cope also with the post-modern transport problem.

Even though the post-modern transport problem has not directly been addressed by CTP objectives, it has influenced Transport Research Programmes, and it has been an origin to various projects aiming for the reduction of traffic. Of course, travel reduction influences also other transport problems, but its main emphasis is in the post-modern problem there the only solution seems to be the reduction of travelling because current situation is felt unsatisfactory and there is no room for the expansion of infrastructure.

In principle it can be stated that travel reduction provides a solution also for modern transport problem (accidents and environmental pollution), but that it is more or less in conflict with the responses for the traditional one. This conflict is the major barrier for the introduction of many travel reduction measures. However, it has to be remembered that congestion poses as well a hindrance to accessibility, which is the major concern when solving the traditional transport problem. The way to assess both conflicts and synergies between objectives is presented in section 3.4.

1.4 Overview of Later Chapters

Chapter 2 aims to give a background for transport policy considerations on the European level. For that reason it describes current transport trends and the resulting direct impacts, also a discussion of indirect impacts is included. It also presents some future views predicted by transport forecasts. In order to obtain a broad European viewpoint the above mentioned transport issues – related mainly to the EU – are then compared with the corresponding information about the CEEC and CIS. Chapter 2 differs from the following chapters since it is providing mainly background information, whilst the latter are providing methods, tools and examples aimed to be directly used in the preparation of material for decision-making.

The first issue in any strategic planning process - after the current situation is analysed - is to define policies (cf. Fig. 1). Chapter 3 deals with this topic by presenting the key issues in the policy-making process. It starts with a retrospective view about the development of CTP since the creation of the European Community, identifying a number of key stages and priorities for transport policy. It also includes a short presentation of TEN-T. Also the specific conditions in the CEEC and CIS when defining policy objectives are illuminated. The chapter then looks more prospectively at how transport policy can be developed in the future by presenting **SAMI approach for setting transport policy targets** and identifying indicators as well as describing **SAMI framework for assessing synergies and conflicts between targets**.

When the targets have been defined, the next step in the planning process is to form the strategies aimed to fulfil these targets. Chapter 4 deals with this phase and presents available transport policy instruments and describes ways to combine them into packages. A powerful tool for this process, **SAMI optimisation method**, which aims to select the best possible combination of instruments, is also presented.

The next task is to predict the impacts of instruments with respect to a number of future scenarios. In Chapter 5 requirements for impact assessment are given and methods to build scenarios are presented. Furthermore, major tools for prediction of direct impacts, transport and environmental models including **EURO9 transport model** developed in the project, are presented.

When the probable level of impacts is known the alternative strategies can be compared with each other. In Chapter 6 a background information for evaluation is given and current issues in planning and decision-making are discussed. Then **SAMI evaluation method** together with developed **software is** presented. In addition to that also the role of strategic environmental assessment (SEA) is discussed.

2. MAIN TRANSPORT TRENDS AND IMPACTS

This chapter aims to give a background for transport policy considerations on the European level. For that reason it describes current transport trends and the resulting impacts. It also presents information on how future transport forecasts have changed over the past decade. In order to obtain a broad European viewpoint the above mentioned transport issues – related mainly to the EU – are then compared with the corresponding information about the CEEC and CIS.

2.1 Current Transport Trends

European transport trends have changed dramatically since the creation of the European Community a few decades ago. Over the last 25 years, passenger transport has more than doubled, the number of cars has increased by more than one and a half times and in the length of motorways has more than trebled. In this section, we take a retrospective view over 25 years (1970-1995) which sets the scene for a prospective view of transport scenarios later in section 5.2.

2.2 Impacts of Transport

All human activities produce in addition to the impacts aimed for also impacts not at all wanted. This holds true also in transport, when solving the traditional transport problem through large transport networks and huge parks of vehicles, we have got environmental pollution and accidents and in the end also congestion. In this section various transport impacts – mainly not-wanted ones - in Europe will be discussed.

2.3 Transport Forecasts

Transport infrastructure has very long life. The decisions about it need a foresight, which is difficult to obtain. A traditional way to manage it is to make forecasts with the aid of transport models, which are based on observed trends in human behaviour and economic activities. In this section various forecasts are referred and the recent development on them is discussed.

2.4 Transport Trends and Impacts in the CEEC and CIS

Transport in the CEEC and CIS reminds partly that of the Member States some decennia ago, but depending on the different starting point it has also special features and own dynamics. In this section these will be highlighted and some comparisons with the EU will be presented.

Box 2. Transport for the past and the future[7]

> The human drive for a larger and larger territory has been served by faster and faster modes of transport developed during the last two centuries…The car has been the speed-provider during our lifetimes and the working of the process is under our eyes. But the process worked the same before, when canals, railways, and paved road vehicles like bicycles were introduced. The next level speed-provider is the aeroplan. *C. Marchett*

2.1 Current Transport Trends

2.1.1 Economic Activity

Economic activity has increased substantially in all European Member States over recent decades. Between 1970 and 1995, the overall GDP per capita of all current European Member States increased by 65 per cent in real terms: an average increase of around 2 per cent per year. The largest increases in GDP per capita were in Luxembourg, Ireland and Portugal, where economic activity more than doubled between 1970 and 1995 (an average increase of around 3 per cent per year). It is noticeable, however, that the rate of increase in economic activity decreased in many European countries between 1990 and 1995.

2.1.2 Car Ownership

Increasing economic activity and changes in transport costs are both stimuli to the growth in car ownership. The total number of cars per capita in Europe increased substantially more rapidly than economic activity between 1970 and 1995[8]. In 1970, average car ownership in all current European Member States was 181 cars per thousand persons and by 1995 the corresponding figure was 428: an increase of 137 per cent over 25 years. It is noticeable that there are some signs that the increase in car ownership is slowing in some countries, which may well be connected with changes in economic activity. The effect of increased car ownership on travel patterns is not just the substitution of journeys made by other modes but the increase in the journey distances[9]. These impacts of increasing car ownership on travel patterns have important implications for the environmental impacts of transport (discussed in section 2.2).

2.1.3 Transport Infrastructure

In 1970, there were 15,935 kilometres of motorway in the 15 current Member States. By 1995, this figure had trebled to 49,024 kilometres[10]. The length of the motorway network increased in all Member States but the largest increases took place in Luxembourg and Spain, where the length of motorway increased more than tenfold. Spain and Luxembourg now have most motorway per capita than any other Member State, whilst Ireland and Greece have the least. Investment in transport infrastructure, has been supported by European transport policy (Trans European Networks – TENs) and European Structural Funds, particularly in the peripheral regions of Europe (see also section 3.1.5).

According to the OECD, road-building in many northern European countries has been scaled down and/or implemented much slower over recent years due to factors such as:

?? the reluctance of governments to spend money on roads, especially new construction, in line with general cuts in public expenditure (which has encouraged some highway authorities to explore alternative sources of funding, including greater involvement of the private sector);

?? the increased cost of road-building as land, engineering and labour costs have grown, particularly in urban areas, where more complicated construction techniques are sometimes necessary;

?? increasing political concerns about the adverse social and environmental impacts of road building, which have resulted in the introduction of wider public consultation procedures: some schemes have been abandoned as a result of strong opposition from businesses and/or residents[11].

In contrast, the length of the European railway network decreased in almost all Member States between 1970 and 1995[12]. The length of railway track in Europe fell by 9 per cent between 1970 and 1995, from 170,541 kilometres to 155,836 kilometres. Sweden and Finland have most railway track per capita than any other Member State, whilst Greece, Italy, Portugal and the UK have the least.

2.1.4 Passenger Transport

The average distance travelled per person per year almost doubled in Europe between 1970 and 1995[13]. This was primarily due to people travelling further than travelling more frequently. In 1970, the average yearly travel distance was 6,292 kilometres per person and by 1995 it was 12,337 kilometres per person. In 1995, the average annual travel distance of a European was approximately 10,000 kilometres by car, 970 kilometres by bus, 730 kilometres by train and 700 kilometres by air.

The use of the car is growing rapidly and reliance on the car is increasing[14]. Travel by car more than doubled between 1970 and 1995 and around 80 per cent of passenger-kilometres were by car in 1995 (compared to 76 per cent in 1970). The reliance on the car varies across European Member States. In Greece, 88 per cent of travel distance is by car, whereas in Austria, only 71 per cent of travel distance is by car. The use of air transport is a small but rapidly growing proportion of passenger transport. Travel by air increased more than six-fold between 1970 and 1995 and now accounts for more than 6 per cent of passenger-kilometres. Travel by bus and rail increased at a much slower rate than by car or air and now accounts for around 14 per cent of passenger-kilometres. Bus and coach travel increased by 39 per cent between 1970 and 1995 in Europe (most of this increase occurred between 1970 and 1980). Travel by rail increased by 25 per cent, with most of this increase taking place between 1970 and 1990. The UK was the only country in Europe to experience a decline in travel by bus or rail over this period: travel by bus fell by 28 per cent in the UK and travel by rail fell by 4 per cent.

In 1995, the average annual travel distance by car was highest in France, Denmark and Ireland (more than 15 per cent above the European average) and lowest in Spain, Austria and Belgium (more than 10 per cent lower than the European average)[15].

The average annual travel distance by bus was highest in Austria and Denmark (more than 70 per cent above the European average) and lowest in Greece (more than 40 per cent lower than the European average). The average annual travel distance by train was highest in Austria (more than 65 per cent above the European average) and lowest in Ireland (half of the European average).

2.1.5 Freight Transport

Freight transport volumes in Europe increased by 71 per cent between 1970 and 1995, primarily due to goods being moved further rather than more goods being moved[16]. In 1995, the average yearly freight transport per capita was 2,960 tonne-kilometres by road, 590 tonne-kilometres by rail, 310 tonne-kilometres by inland waterway and 230 tonne-kilometres by pipeline[17]. Increases in freight transport were the highest in Italy and Spain, where freight transport increased by more than 150 per cent, and lowest in Luxembourg, where total freight transport increased by just 8 per cent between 1970 and 1995. In 1995, Finland had the highest freight transport volume per capita in Europe (more than 50 per cent above the European average), whilst Greece, Ireland and Portugal had the lowest volume of freight per capita (less than half the European average).

The reliance on roads for transporting goods is increasing. In 1995, almost three-quarters of freight transport were moved on roads, compared to less than half in 1970[18]. Freight transport by road increased by more than 150 per cent in Europe between 1970 and 1995. The reliance on road freight transport varies across European Member States. In Greece, 98 per cent of freight transport is moved on roads, whereas in Austria, the figure is only 41 per cent of all freight transport. The use of air transport is a small but rapidly growing proportion of freight transport. Freight traffic increased by more than 8 per cent at the major European airports in the space of a year between 1994 and 1995. Freight transport by inland waterways and pipeline increased at a much slower rate than by road or air and now accounts for around 14 per cent of freight tonne-kilometres. Freight transport by inland waterways increased by 6 per cent in Europe between 1970 and 1995, although there were bigger increases in Germany. Freight transport by pipeline increased at the same period by 29 per cent across Europe. Goods movement by pipeline increased more than fourfold in Denmark, Spain and the UK between 1970 and 1995. Meanwhile, freight transport by rail fell between 1970 and 1995, accounting for only 14 per cent of freight transport in 1995, compared to almost 32 per cent 1970. The biggest decreases were in Greece and the UK, where freight transport by rail fell by more than half. In Sweden and Finland, however, freight transport by rail increased over this period. Rail freight still forms a major mode for the movement of goods in both these countries (accounting for 39 and 36 per cent of freight-tonne kilometres in Sweden and Finland respectively).

In 1995, per capita freight transport by road was highest in Belgium, Finland and Spain (more than 40 per cent above the European average) and lowest in Luxembourg and Portugal (less than half the European average)[19]. Per capita freight transport by rail was highest in Finland and Sweden (more than three times the European average) and lowest in Greece (less than one twentieth of the European average). Per capita freight transport by inland waterways was highest in the Netherlands (more than seven times higher than the European average). Very few goods were moved by inland waterways in a number of countries (such as Denmark, Greece, Ireland, Portugal, Spain and Sweden). Per capita freight transport by pipeline was highest in Austria and Denmark (more than double the European average). Very few goods were moved by pipeline in Finland, Greece, Ireland, Luxembourg, Portugal and Sweden.

2.2 Impacts of Transport

2.2.1 Introduction

The fundamental purpose of providing transport facilities is to decrease the travel time and the direct costs when travelling from one place to another, thus leading to an improvement in accessibility. In terms given in Chapter 1, the decrease of time and cost is the solution to the "traditional" problem of transport. In this sense, transport plays a crucial role in industrial and commercial organisation, in the economic prosperity of countries and regions, and in allowing people to develop their own lifestyles. For many people, the availability of high quality transport allows them to improve their economic situation and quality of life. For others, the lack of transport or an inability to use it remains a constraint on their activities. Transport also allows firms to compete in the national and international markets. Although transport is not a major component of total production costs (in most industries), it allows flexibility in production and distribution, and in conjunction with new logistics has permitted the supply chains of firms to be reorganised more efficiently.

All the impacts in the paragraph above can be categorised as "economic efficiency impacts". However, as pointed out in the "modern" problems defined in Chapter 1 the provision of transport facilities also leads to a wide range of negative direct impacts on the environment and health. Congestion, which is a paramount impact according to the post-modern transport problem, has an influence in journey time and can thus be categorised as an economic efficiency impact. Hence two dimensions of impacts can be defined[20]:

1. Economic efficiency
2. Environment and health

Furthermore the impacts can be divided into direct and indirect ones. Both types of impacts can be classified as to whether they are economic efficiency or environment/health impacts. Examples of the former type of indirect impacts are those on employment and regional development. Thus a matrix of impacts can be formed as in Table 2.

Table 2. Categories of transport impacts

Impact type	Economic efficiency	Environment/health
Direct	Journey time Travel cost	Pollutant emissions Noise and vibration Accidents Solid waste Built environment Energy and mineral resources Land resources Water resources
Indirect	Economic growth Employment Regional development	Air quality Quality of life Biodiversity Global warming

Finally, there are equity implications related to all of the impacts in Table 2 reflecting how positive and negative impacts are distributed to different (socio-economic) groups.

This section discusses some of the main impacts and examines how these impacts have changed over time. As a general conclusion it can be stated that in the sense of the traditional transport problem (cp. Chapter 1) a huge improvement has occurred. However, as a logical consequence the modern transport problem has accentuated and also in the core area of the EU the post-modern transport problem has appeared. Congestion in the core area of the EU has resulted from:

- high density population and a high concentration of economic activities in those regions;
- North-south traffic crosses through this area and it is concentrated in a limited number of congested corridors;
- rapid and recent development of east-west flows related to the political and economic changes in central and Eastern Europe.

2.2.2 Direct Impacts on Economic Efficiency

Travel Time

The 413 million Europeans generate roughly a billion trips a day. In doing so, they consume vast amounts of time, energy and money, produce tons of air pollutants and a lot of accidents. Nevertheless, as individuals and as societies, they are willing to do that, in order to get to work, shopping or to leisure activities, and to support the productive and consumptive life-styles they lead. Travelling to work may take approximately the same time as it did in the past, but the distance has increased tremendously. This opened new horizons for professional specialisation, as well as opportunities to reside in a location fulfilling personal preferences.[21]

In mid-80´s the average daily travel distances per capita were from 21 to 37 kilometres and average daily travel times from 53 to 71 minutes in 9 European countries[22]. As an example of the changes during last decennia it can be mentioned that in Finland during 1974-1992 average daily travel time has been about 70 minutes, but average daily travel speed has increased from 30 to 46 km/h and consequently daily kilometrage from 31 to 48.[23]

The Costs of Travel

At the same time that economic activity and incomes in Europe have been increasing, the user costs of private transport have been decreasing in real terms. By contrast, public transport costs (and usually fares) have been increasing in most countries[24]. In the UK, the real cost of bus and rail fares increased by 55 and 71 per cent respectively between 1974 and 1994: both higher than the 51 per cent real increase in disposable income. Meanwhile, the cost of motoring, which includes costs such as insurance, servicing, repairs, road tax, fuel and oil, decreased by almost two per cent and the real price of fuel and oil decreased by nearly 8 per cent between 1974 and 1994[25].

The costs of fuel for transport vary substantially across EU Member States, as do vehicle costs. Fuel costs are to some extent related to GDP: countries with a lower than average GDP per capita tend to have lower than average fuel costs. The highest petrol price in the EU in 1995 was in the Netherlands. Between 1990 and 1995, the price of petrol increased most in Finland. In Ireland and Italy the price of unleaded petrol decreased.

2.2.3 Direct Impacts on the Environment and Health

Pollutant Emissions

Transport produces a number of emissions with different scope of influence. These include global pollutants (such as carbon dioxide which contributes to global warming), national or regional pollutants (nitrogen oxides which produces acidification or 'acid rain' for example) and local pollutants (such as particulates which contribute to respiratory problems including the increased susceptibility to asthma). Transport's contribution to environmental pollution in urban areas is particularly large, where transport is by far the most significant contributor of most emissions. The temporal trends in air pollutants from transport are mixed. Some emissions continue to increase, others have started to fall. However, some of the emissions that are decreasing may be a problem in the future if the growth in transport increases faster than improvements in technology[26].

Transport currently accounts for more than one fifth of Europe's carbon dioxide emissions – the most important greenhouse gas, which is responsible for global warming and climate change. In 1994, 1.8 tonnes of CO_2 were produced in the transport sector for every person in Europe[27]. The transport sector is now the largest generator of CO_2 emissions in some European Member States (such as Austria and France). In 1994, transport-related CO_2 emissions were lowest in Portugal (1.15 tonnes per capita) and highest in Luxembourg (2.83 tonnes per capita). If the trends in CO_2 emissions from transport continue, a 40 per cent increase in carbon dioxide emissions from transport might be expected between 1995 and 2010[28]. Although the total CO_2 emissions per capita in Europe have decreased over the last two decades due to reductions in energy consumption in other sectors (such as domestic and industrial energy consumption), the rapidly increasing emissions from the transport sector may reverse the trend (for forecasts see section 2.3 and for policies section 3.1).

Nitrogen oxides cause national and transnational pollution, contributing to acid deposition and the formation of secondary pollutants, which give rise to photochemical smog and poor air quality. Almost half of all emissions of nitrogen oxides in Europe now originate from road transport[29]. Emissions of nitrogen oxides in many European countries decreased between 1980 and 1995 as a consequence of the introduction of catalytic converters. They are likely to continue decreasing in most countries for several years but could then begin increasing again if increasing levels of traffic outweigh the emission reductions achieved by catalytic converters.

The transport sector is now the largest generator of NO_X emissions in almost all European Member States. In 1994, an average of 16.3 kilograms of NO_X per person was emitted from transport in Europe[30]. Transport-related NO_X emissions were lowest in Austria (12.0 kilograms per capita) and highest in Finland (26.5 kilograms per capita). Although the total NO_X emissions per capita have decreased in most European countries over the last two decades, there have been increases in total NO_X emissions in a few Member States (such as Ireland and Portugal).

Volatile organic compounds (VOCs) contribute to the formation of secondary pollutants, which give rise to photochemical smog and poor air quality. Almost one third of all emissions of VOCs in Europe now originate from road transport[31]. Emissions of VOCs in many European countries decreased between 1980 and 1995 as a consequence of the introduction of catalytic converters. Emissions are likely to continue decreasing for several years but could then begin increasing again if increasing levels of traffic outweigh the emission reductions achieved by catalytic converters.

The transport sector is also one of the largest generators of VOCs in many European Member States. In 1994, an average of 13.6 kilograms of VOCs per capita was emitted from transport in Europe[32]. Transport-related VOCs emissions were lowest in Germany (8.30 kilograms per capita) and highest in Luxembourg (22.44 kilograms per capita). Although the total VOCs emissions per capita have decreased in most European countries over the last two decades, there have been increases in total VOCs emissions in a few Member States (such as France and Portugal).

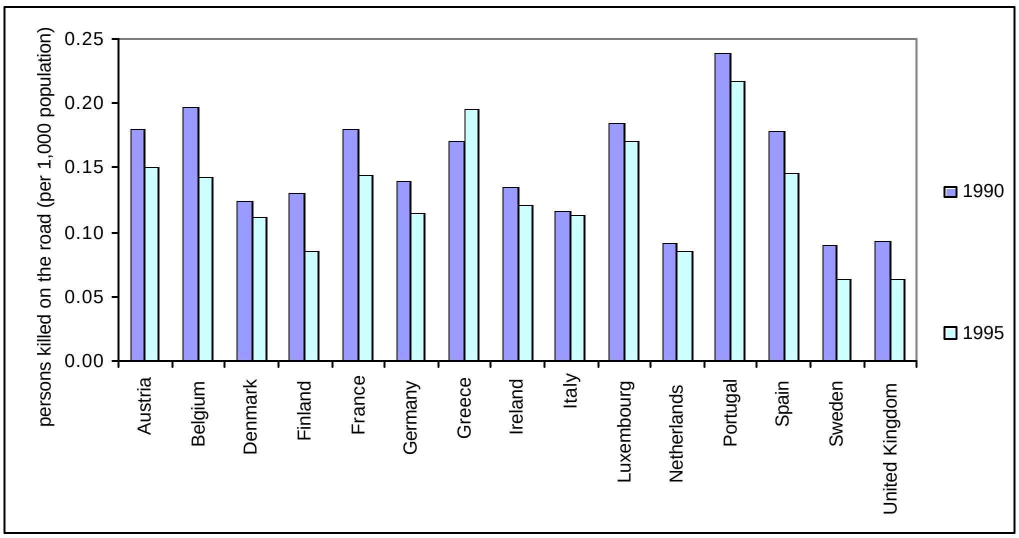
Noise and Vibration

Transport is the most pervasive source of noise for many people in Europe. It is estimated that around 80 million people (or 17 per cent of the population) in Europe are exposed to noise levels above 65 dB(A), which the OECD define as an unacceptable noise level. The exposure to noise varies by country: from around 4 per cent of the population in the Netherlands to 23 in Spain[33]. The most common sources of transport noise (in order of importance) are road traffic, aircraft and trains. Road traffic is generally considered to be more of a nuisance than most other sources of noise. Conclusive evidence of the health effects of noise is limited to cases of hearing loss and tinnitus caused by long periods of exposure to high noise levels – more than 75-80 dB(A)[34]. It is unlikely that most people are exposed to traffic noise at these levels over a sufficiently long period to cause these health effects, although traffic noise may aggravate or contribute to stress-related health problems such as raised blood pressure and minor psychiatric illness[35]. Sleep is also disturbed by transport noise for a number of people[36]. Transport movement also causes vibration, which may be another contributory factor to stress-related diseases[37]. Excessive noise from traffic may also discourage social interaction in streets and reduce the attractiveness of walking or cycling.

Accidents

More than 44,000 people were killed and 1.6 million people were injured on the roads in 1995. In other words, more than five people were killed every hour and more than three people injured per minute on Europe's roads. The costs of road casualties are thought to amount to between 2.0 and 2.5 per cent of Europe's GDP[38]. The number of deaths on the road has decreased from 1990 to 1995 in all other Member States except Greece. There are significant differences in road safety statistics between European Member States. The proportion of people killed per capita on the roads in Portugal is more than double the proportion of people killed in the Netherlands, Sweden or the United Kingdom (see Fig. 2).

Figure 2. Persons killed on the road in the EU



Solid Waste

Transport accounts for a significant proportion of solid waste due to the high rate of vehicle scrappage. Millions of road vehicles are scrapped annually, resulting in millions of tonnes of waste material requiring recycling, reclamation and disposal. Vehicle residues for disposal are rapidly increasing as the proportion of steel used in vehicles declines. Plastics are increasingly being used in vehicle manufacture but few of these are recycled at present. Waste tyres present another major solid waste problem: millions of tyres are scrapped each year.

Built Environment

Transport's impact on the built environment includes the damage to property as a result of accidents, structural damage to transport infrastructure (such as road surfaces and bridges) and damage to property and monuments as a consequence of corrosive local pollutants. Road damage is dependent on factors such as climate, the road surface and the axle weight of vehicles using the road. Because road damage is related exponentially with axle weight, heavy vehicles with few axles cause most of the damage.

Energy and Mineral Resources

In 1970, the average amount of energy used in the transport sector was 0.40 tonnes of oil equivalent (TOE) per capita in Europe. By 1995, this figure had almost doubled to 0.77 TOE per capita. In 1970, the transport sector accounted for 14 per cent of Europe's energy consumption. By 1995, it was responsible for more than 21 per cent. Energy equivalent to 285 million tonnes of oil was consumed by the transport sector in 1995[39]. The transport sector is now the largest and fastest increasing consumer of energy due mainly to the growth in road and air transport. The last decade saw large increases in the use of energy intensive modes such as cars and aircraft for the movement of passengers and freight. Over the same period there was a decrease in the use of energy efficient modes such as walking and cycling. Passenger vehicles became more fuel efficient but factors such as catalytic converters, higher safety standards, air conditioning and higher vehicle performance tended to counter the fuel efficiency gains from improved engine design.

As an example for the impacts of road maintenance and construction it can be mentioned that in 1995, 78 million tonnes of roadstone were quarried in the United Kingdom, almost one-third more than the tonnage quarried in 1985[40]. According to the Royal Commission on Environmental Pollution the construction of one kilometre of a three-lane motorway requires around 120,000 tonnes of aggregates[41]. The extraction of aggregates and roadstone can damage natural habitats, scar the landscape and can also create noise and disturbance from quarrying and the transport of materials.

Land Resources

Transport occupies substantial areas of land and for example in the UK the amount of land taken for transport infrastructure currently probably amounts to over 20,000 hectares per year(approximately equivalent in area to a square whose sides measure 14 kilometres). Roads occupy approximately one-fifth of the urban surface area and railways take up around a further four per cent of the surface of large cities[42]. Every kilometre of three-lane motorway requires 4.2 hectares of land[43]. In addition to the land consumed for roads, significant amounts are also used for the storage of vehicles. The effects of this land loss include the loss of productive agricultural areas, the loss of biodiversity and the fragmentation and severance of local communities (see below).

Water Resources

In northern countries salt is used in road maintenance in order to prevent skidding. This may have impact on water resources[44].

Transport of oil by big tankers can lead into oil spills in coastal and marine waters. The oil spill from the Sea Empress in February 1996 off the coast of Milford Haven is a recent example of a major water pollution incident with serious impacts on biodiversity, recreation and tourism. 72,000 tonnes of crude oil were released into the sea, of which between 3,000 and 5,000 tonnes reached the shore, affecting 200 kilometres of shor eline in the United Kingdom alone[45].

2.2.4 Impacts on the Economy and Employment

A benefit of a transport investment is usually calculated by multiplying the estimated saving in travel time with assumed time value. In addition to that it is sometimes claimed that transport investments promote **economic growth**, i.e. there are additional benefits over the time saving. However, it is also argued that transport investments, in modern economies with well-developed transport networks cannot anymore on its own result in economic growth, but it acts in a supporting role when other factors are at work (see Box 3).

Transport infrastructure investment can have direct, indirect and derived effects on **employment**:

- ?? direct effects arise from the planning and construction of the facilities;
- ?? indirect effects are induced by the above mentioned economic growth;
- ?? derived effects refer to the operation, maintenance and repair of the constructed facilities.

The first and last effects are natural consequences of the investment action, but the second one depends on the realisation of the economic growth, which may or may not happen as discussed above.

For the time being there is no consensus about the magnitude, causality, and assessment methods for indirect effects, like economic growth and employment. In the FP5 there is one task (2.1.2/4) addressing these issues.

Box 3. Conditions for economic growth through transport infrastructure investments[46]

> 1. In developed countries where there is already a well-connected transport infrastructure network of a high quality, further investment in that infrastructure will not on its own result in economic growth.
>
> 2. Transport infrastructure investment acts as a complement to other more important underlying conditions, which must also be met if further economic development is to take place. Additional transport investment is not a necessary condition, but acts in a supporting role when other factors are at work.
>
> *Three sets of necessary conditions need to be at work:*
>
> - The first, and most important of these conditions is the presence of underlying positive *economic externalities*, such as agglomeration and labour market economies, the availability of a good quality (well trained and highly skilled) labour force, and underlying dynamics in the local economy. This is a fundamental condition, as it is only when these factors are all positive and the local economy is buoyant that new transport investment will, in conjunction with other necessary conditions, have an economic development impact.
> - Secondly, there are *investment factors* which relate to the availability of funds for the investment, the scale of the investment and its location, the network effects (e.g. are there missing links in the network), and the actual timing of the investment. Transport infrastructure investment decisions are not made in isolation, so the nature of the investment, including its "place" in the network, is also one of the necessary conditions that need to be considered. These factors on their own are again not sufficient.
> - The third set constitutes *political factors*, that are related to the broader policy environment within which transport decisions must be taken. To achieve economic development, complementary decisions and a facilitating environment must be in place; otherwise the impacts may be counterproductive. Included in this group of factors are the sources of finance, the level of investment (local, regional or national), the supporting legal, organisational and institutional policies and processes, and any necessary complementary policy actions (e.g. grants, tax breaks and training programs). Again, on its own, even a favourable political environment will not result in economic growth, unless the other necessary conditions are also present.

2.2.5 Impacts on Regional Development

The regional dimension is important as investment in infrastructure is often justified on the basis of improvements in accessibility and an increase in economic performance[47]. The arguments, particularly on causality, have never been clear[48], and the fundamental process of regional economic development leading to convergence or divergence is still intensely debated[49].

Recent arguments have stressed the importance of space and the existence of increasing returns as the basis for understanding the spatial economy. The rationale here is that increasing returns explains the separation of production and the spatial concentration of industry. However, the assumptions used in these models have also been questioned as they are based on perfect competition assumptions of free entry and common levels of technology. In particular, the importance allocated to transport costs in these models seems to be too great. Transport costs are usually only a small part of total production costs, yet they do seem to have been given a disproportionately large role in explaining competitive advantage and location decisions of firms. With the advent of a high technology service based society, with flexible labour markets and high levels of skills, the influence of transport costs must still be decreasing.

The "new growth economics" emphasises economic growth as endogenous to an economic system, rather than as the result of outside forces. It is the factors of production, including the skills and knowledge of the labour force, which are internal to the economic system that explains the differential growth. Yet, even here it is difficult to draw tight boundaries around systems as much of the development takes place within a national, international or global context. Regional boundaries are not any more geographically based.

The magnitude of the impact of transport infrastructure on regional development depends very much on its ability to create economic growth. As was discussed above in section 2.2.4 this is not at all a short-cut issue. When considering regional development a key issue is where the economic growth will happen. This complex issue has been discussed in the EUNET/SASI[50] project of the FP4 (see Box 4), with the conclusion that the relationship between transport infrastructure and regional development has become more complex than ever. There are successful regions in the European core confirming the theoretical expectation that location matters. However, there are also centrally located regions suffering from industrial decline and high unemployment. On the other side of the spectrum the poorest regions, as theory would predict, are at the periphery, but there are also prosperous peripheral regions such as the Scandinavian countries.

Box 4. The uncertainty of regional development[51]

It is debated whether transport infrastructure contributes to regional polarisation or decentralisation. Some analysts argue that regional development policies based on the creation of infrastructure in lagging regions have not succeeded in reducing regional disparities in Europe, whereas others point out that it has yet to be ascertained that the reduction of barriers between regions has disadvantaged peripheral regions. From a theoretical point of view, both effects can occur. A new motorway or high-speed rail connection between a peripheral and a central region, for instance, makes it easier for producers in the peripheral region to market their products in the large cities, however, it may also expose the region to the competition of more advanced products from the centre and so endanger formerly secure regional monopolies.

While these two effects may partly cancel each other out, one factor unambiguously increases existing differences in accessibility. New transport infrastructure tends to be built not between core and periphery but within and between core regions, because this is where transport demand is highest. It can therefore be assumed that the trans-European networks will largely benefit the core regions of Europe.

These developments have to be seen in the light of changes in the field of transport and communications which will fundamentally change the way transport infrastructure influences spatial development. Several trends combine to reinforce the tendency to reduce the impacts of transport infrastructure on regional development:

- An increased proportion of international freight comprises high-value goods for which transport cost is much less than for low-value bulk products. For modern industries the quality of transport services has replaced transport cost as the most important factor.
- Transport infrastructure improvements which reduce the variability of travel times, increase travel speeds or allow flexibility in scheduling are becoming more important for improving the competitiveness of service and manufacturing industries and are therefore valued more highly in locational decisions than changes resulting only in cost reductions.
- Telecommunications have reduced the need for some goods transports and person trips, however, they may also increase transport by their ability to create new markets.
- With the shift from heavy-industry manufacturing to high-tech industries and services other less tangible location factors have come to the fore and have at least partly displaced traditional ones. These new location factors include factors related to leisure, culture, image and environment, i.e. quality of life, and factors related to access to information and specialised high-level services and to the institutional and political environment.

On the other hand, there are also tendencies that increase the importance of transport infrastructure:

- The introduction of totally new, superior levels of transport such as the high-speed rail system may create new locational advantages, but also disadvantages for regions not served by the new networks.
- Another factor adding to the importance of transport is the general increase in the movement of goods (due to changes in logistics such as just-in-time delivery) and travel (due to growing affluence and leisure time).

2.2.6 Indirect Impacts on Environment and Health

Air Quality

The pollutant emissions discussed above are mixed with air resulting in lowered air quality. Recent research suggests that the deaths of thousands of vulnerable people may be brought forward each year and thousands hospital admissions and re-admissions per annum may arise as a result of short term air pollution containing ozone, sulphur dioxide or particulates[52]. Transport is a major contributor to pollutants that form ozone as a secondary pollutant (such as nitric oxide) and one of the largest sources of particulate matter. The people most likely to be affected by air pollution are likely to belong to vulnerable groups such as pregnant women, the frail or the very ill. Air pollution levels normally experienced in Europe may not have any short-term effects on other groups but the long-term effects are still unknown.

Quality of Life

Heavy traffic disrupts home and community life in a way that also social contacts on the street declines as traffic volumes increase[53]. Behavioural differences such as use of front gardens and front rooms in homes were correlated with traffic volumes. Many families chose to move away from heavily trafficked areas if they could afford to do so. Transport corridors (a motorway or railway line for example) can cause the partition or destruction of neighbourhoods. Social contact and/or walk journeys may be inhibited where corridors are difficult or inconvenient to cross.

Biodiversity

Infrastructure construction and maintenance often leads to losses of vegetation-rich land including hedgerows and verges. Newly planted verges are generally not an adequate replacement. Where new infrastructure cuts across natural or semi-natural habitat, the effects on biodiversity will depend on factors such as the habitat's sensitivity, the siting of the infrastructure and the area of land used for construction. Transport infrastructure such as roads, airports or railways may act as a barrier to the movement of species, which may result in the separation of populations and a decline in numbers. Rarer species may disappear if the population becomes too small.

Global Warming

The impact of transport in global warming is mainly related to the amount of CO_2 (for the emissions see section 2.2.3 and for the forecasts see section 2.3).

2.2.7 Equity

Transport, as with other commodities, will never be available to all people equally, nor will it be distributed equally over space[54]. Agglomeration economies, income and age constraints will mean that not all people will have equal access to facilities and services. Even, if it were available to all equally it would not be ideal as different people (and businesses) have different requirements. Many of these requirements are influenced by the changing patterns of work and leisure, the changes in family structure and the changes in business organisation. In addition to the changes in patterns of demand, there have been significant changes in the distribution of services and facilities. The basic issue here is that of accessibility to facilities, both at the aggregate level and for particular groups of people. Accessibility relates both to the physical distribution of land uses and the availability of transport services, and to the needs of the people to use the services provided. Access is a function of both travel times and the number and quality of nearby destinations, but it has to be noticed also that the value different people place on access to different destinations also varies[55].

A clear distinction between two groups of people – those with a car available and those without - has emerged through the growing car ownership, which have big impact on travel speeds (for car ownership see section 2.1.2). Average daily journey speed of different groups can vary between 8 and 60 km/h[56]. This is one of the major equity issues in transport policies. Also the distribution of negative impacts may differ between groups of people, e.g. air pollution caused by through going traffic.

2.3 Transport Forecasts

Traffic increase in Europe has mainly been caused by the rise in the number of cars, vans and lorries as well as by the rising number of air flights. The higher speeds obtained by new vehicles and new networks have been used for more travelling. Various forecasts still foresee a considerable increase in European traffic. However, the forecasts differ very much from each other. We will first present some forecasts prepared in the end of 80´s and then some more recent ones prepared in the FP4 followed by a general discussion about driving forces.

2.3.1 Person Transport

Forecasts from the 80´s
International Road Federation (IRF)[57] expected a 35 per cent increase in passenger-kilometres in Western Europe from 1988 to the year 2000. If this pace of increase would continue, car traffic would double early next century. This kind of development has also been forecasted in the United Kingdom where 82 (low GDP growth) to 134 (high GDP growth) per cent increase (from 1988 up to the year 2025) was expected in car traffic [58].

In other forecasts somewhat lower expectations were presented. For example, in Finland car traffic was expected to reach a maximum in 2010 and then to decline because of decreasing population. Before that period an increase of 50% from the end of the 1980's was forecasted.[59] A similar increase, 54 per cent, has been foreseen for Sweden, although another study gives somewhat lower estimates, viz. 23 per cent (1984-2010)[60]. Also in the Netherlands forecasts varies when a 70 per cent increase up to the year 2010 in car traffic was found possible compared to a 40 per cent rise indicated by another study.[61]

Theoretical Considerations

Theoretically, the upper limit of car ownership per capita might be reached when almost all adult persons would own a car. However, Californian figures showed that this 'natural' limit could easily be exceeded. Whether such a situation would ever become reality in Western European countries is still an open question. The total number of cars depends naturally on the number of people, but this is apparently not leading to a fixed saturation level. In any case, in countries with an increasing population the increase of car traffic will undoubtedly still continue after the saturation of car ownership has been obtained, however the modest population increase in the Member States will diminish this effect. On the other hand traffic – with saturated car ownership – may still increase because of changing travelling habits [62]

If we assume a saturation level of almost one car per adult person, then in many European countries a saturation of car ownership has approximately already been obtained for males. It can be expected only a minor increase in a situation where almost 85 per cent of adult males own a car – the situation in the year 2000 in most of the EU countries. For females however, car ownership is much lower and a further increase can be expected.

Theoretically, the limits of car traffic might be calculated with the aid of behavioural data. The average daily travel time seems to be very stable over time. The average daily travel distance has increased with higher average journey speeds obtained by increased used of cars and air transport. When we would know demographic features and suppose that female car ownership will probably remain somewhat below male ownership, the maximum traffic might in principle be calculated. It has to be added that the number of average kilometres can be made with different cars (e.g., one for long distances and one for intra-urban traffic), so that the saturation level for car ownership is still difficult to identify.

2.3.2 Freight Transport

Forecasts from the 80´s

The development of freight traffic is influenced amongst others by the number of people and the level of consumption. IRF expected a 30 per cent increase in freight ton-kilometres in Western Europe in the year 2000, compared to the 1988 level. If this increase would continue, the freight traffic would also double early next century. It is evident that the share of road transport is all the time increasing. ECMT[63] supposed that freight transport on rails and inland waterways would not increase at all; the predominant expansion would take place on roads with a 70 per cent increase in ton-kilometres between 1988 and 2010. A similar development has been forecasted in the United Kingdom (1988-2025); heavy lorry traffic will go up by 67 - 141 per cent and light goods traffic by 101 - 215 per.[64] In Finland a more moderate increase is expected, viz. 23 per cent for lorry traffic and 70 per cent for van traffic.[65]

2.3.3 STREAMS´ Forecasts

Person transport

According to a FP4 project STREAMS the overall increase in person kilometres in the EU will be from 13.8 billion per day to 20.5 billion, an increase of approximately 50% (see Table 3). Major increase will happen in air traffic, but also train passenger kilometres will double depending on a supposed expansion of high-speed network. Increase in car use is rather modest. The overall average trip length is predicted to rise from 13 kilometres to 17. This growth is in line with historical trends. Possible breaking of the trends is discussed below. However, when compared to the above references STREAMS´ forecast represents a modest increase in car traffic.

Table 3. EU15 Person kilometres travelled by mode ('000 / day)[66]

Mode	1994 (pkm)	2020 (pkm)	(%) per annum growth
Air	664,444	4,090,654	7.3
Car	10,639,159	12,989,902	0.8
Bus / Coach	1,061,237	1,147,265	0.3
Slow	725,000	684,215	-0.2
Train	781,364	1,584,596	2.8
Total	13,871,204	20,505,632	1.5

Freight transport

According to the STREAMS project international freight transport is increasing at a greater rate than national (see Table 4). Overall the volume of goods moved nearly doubles between 1994 and 2020. Also the volume of goods imported to the EU is much greater than goods exported from the EU to the rest of the world. The total volume of international freight moved increases by a factor of approximately three over the period. However, in terms of volume, national freight movements still form by far the majority of total freight moved. Compared to the national forecasts referred above STREAMS´ freight forecast is quite high.

Table 4. 2020 Freight model results, 1994 and 2020 comparison (1000T pa)[67]

Characteristic	Modelled 1994	Modelled 2020
National Flow	11,261,710	18,520,941
EU15-EU15 International Flow	852,838	1,871,609
Rest of World - EU15 International flows	597,580	2,587,545
EU15 – Rest of World Flows	259,116	707,141
All International Traffic	1,709,534	5,166,295
Total Volume Moved	12,971,244	23,687,235

2.3.4 Conclusions

The traditional forecasting with the aid of transport models (for a description of transport models see section 5.3) as presented above has been successful during last four decennia, because the increase in traffic has been continuous. There are, however, some issues, which may provide disruptions in this continuous development: i) major transport modes are based in old technological inventions and are approaching their saturation levels; ii) environmental concern has started to influence transport policies; and iii) the requirements of the "Information age"[68] can be different from those of the industrial age. To cope with uncertainties a different approach, using possible scenarios instead of fixed forecasts can be advocated (see section 5.2).

As stated above it is air transport, both passenger and freight, which has biggest growth possibilities. This growth is expected to be supported by current liberalisation of air services.

It has to be noticed that the awareness of the limits to growth in mobility - as a result of high social costs involved - has dramatically increased during the 90´s. Environmental and safety considerations have become major determinants in the declining social acceptance of our mobile society. Thus new transport solutions – especially infrastructure - will have to be implemented within increasingly narrower limits imposed by our society and the environments.

2.4 Transport Trends and Impacts in the CEEC and CIS

A general description about transport trends and related impacts are presented next in order to give a background for policy discussions in the next chapter. Thorough macroeconomic and transport data on the CEEC and CIS have been presented by the FP4 project SCENES[69].

2.4.1 Current Trends and Impacts in the CEEC

Economic Activity

After a short but intensive recession in the beginning of the 1990s the economies are growing steadily (see Table 5). In relation to this growth the trade between the EU and CEE countries has also increased (see Tables 6 and 7). Even though the freight measured in tonnes is bigger from the CEEC to the EU, its price per tonne is less and actually the CEE countries are paying more fore the products they buy than they earn from the products they sell to the EU.

Table 5. Economic growth in some CEE countries 1990-1997

	Percentage change of GDP at constant prices over previous year							
Country	1990	1991	1992	1993	1994	1995	1996	1997
Czech Re-public	-1.2	-11.5	-3.3	0.6	2.7	5.9	4.1	1.0
Estonia	-8.1	-7.9	-14.2	-8.5	-1.8	4.3.	4.0	7.0
Hungary	-3.5	-11.9	-3.1	-0.6	2.9	1.5	1.0	3.0
Poland	-11.6	-7.0	2.6	3.8	5.2	7.0	6.0	5.5
Slovenia	-4.7	-8.9	-5.5	2.8	5.3	4.1	3.1	4.0

Source: European Bank for Reconstruction and Development

Table 6. EU imports from the CEEC

Country	**EU15 imports from respective countries (in thousand tonnes)**				
	1990	1992	1994	1995	1996
Poland	27 006	36 473	46 782	43 673	40 235
Czech Rep.	11 204	24 358	22 605	22 279	22 136
Hungary	6 344	6 912	7 382	8 332	8 490
Latvia	n.a.	3 714	6 555	7 702	6 543
Slovak Rep.	incl. in Cz	ind. in Cz	5 743	6 575	5 997
Estonia	n.a.	922	2 376	3 921	4 436
Romania	4 109	2 243	3 738	4 741	4 325
Bulgaria	1 472	1 813	2 440	3 923	3 657
Lithuania	n.a.	3 712	5 926	4 350	3 636
Slovenia	n.a.	1 286	2 397	2 512	2 413
All 10 countries	50 135	81 433	105 944	108 008	101 868

Table 7. EU exports to the CEEC

Country	**EU15 exports to respective countries (in thousand tonnes)**				
	1990	1992	1994	1995	1996
Poland	3 489	9 332	9 813	10 798	14 632
Czech Rep.	1 482	4 508	4 734	5 655	6 885
Hungary	1 604	2 223	3 680	3 538	3 666
Romania	2 443	3 186	2 222	2 776	3 465
Slovenia	n.a.	1 738	3 637	3 404	3 356
Slovak Rep.	incl. in Cz	incl. in Cz	1 137	1 559	2 111
Estonia	n.a.	628	775	1 203	1 537
Latvia	n.d.	602	585	1 179	1 212
Lithuania	n.d.	779	424	576	765
Bulgaria	479	967	1 179	1 053	723
All 10 countries	9 497	23 963	28 186	31 741	38 352

Source: Eurostat

Transport System

Railway transport was a dominant mode in the former communist CEE countries and it was mainly planned for serving the needs of heavy industry. The density and quality of rail network is relatively good e.g. the railways density in Poland (7.5 km per 100 km^2) is higher than the EU average and the same holds true also with the share of electrified lines.

The situation with road network is different. It can be estimated that one half of the road network in Poland, the Czech Republic, Hungary, Estonia and Slovenia needs as quickly as possible a general overhaul. For example, in Poland the length of national roads is 45 700 km, of which 30 % are of bad quality, further 46% of insufficient quality and only 24% of good quality. The main defect being the insufficient bearing capacity. In this situation it is important to notice that investments in the CEE countries are extremely low (see Table 8). On the other hand it is to be noticed that in the EU countries - with advanced transport networks - still a remarkable amount is invested.

Table 8. Investment expenditures for land transport infrastructure in some European countries during 1985 – 1995

Country	Investments in ECU per capita (fixed prises 1995)		
	1985	1990	1995
Germany	181	175	265
France	159	215	205
Spain	65	155	134
UK	100	154	132
Portugal	24	56	94
Greece	n.a.	44	49
Czech Republic	n.a.	n.a.	50
Hungary	n.a.	n.a.	27
Poland	n.a.	n.a.	23

Source: Report prepared by ECMT experts, Paris, April 1998 and MtiGM, 1998.

Transport Modes

The most remarkable changes in the CEEC during the 90´s included a rapid increase in car ownership and the privatisation and liberalisation of road haulage. Car ownership in the most advanced CEE countries is approaching western standards (see Table 10). As a natural consequence the share of public transport is declining both in bus and rail services. On the other hand air transport is increasing in many countries, but in some countries it was still decreasing by the end of 90´s.

It has to be noticed that e.g. in Poland 90% of bus and coach services are operated by state owned companies. They, as well as state owned Polish railways, have to provide services also on unprofitable routes and in addition to that also to grant a lot of free or lower priced tickets. The economic crisis of Polish railways is – in addition to that - deepened by powerful trade unions preventing the reduction of personnel. The access to the profession of road transport operator is strictly regulated and there exists also an act from 1994 requiring the co-ordination of timetables between different operators.

The dominant role of rail in freight transport can be seen in modal shares. Compared to western figures (see section 2.1.5) the share of rail is very high - except in Estonia (see Table 9). In Estonia a major part of rail freight consists of transit into/from Russia. However, the share of rail is decreasing, because of change of economy and because of new competition through road haulage.

Table 9. Modal share of domestic and international goods transport in 1993

Country	Per cent share by mode 1)			
	Road	Inland waterways	Pipelines	Rail
Czech Republic	15	4	-	81
Estonia	78	-	-	22
Hungary	42	6	17	35
Poland	41	-	10	50
Slovenia	45	-	-	55

1)The share is calculated from tonne kilometres. Source UNECE, 1995.

As an example of current situation in road haulage it can be noticed that in Poland privatisation has reached nearly all companies. At the same time domestic freight transport was liberalised so that no licensing was required. As a consequence a large amount of small companies has appeared – in early 90´s their number reached 90 000. International transport is subject to licensing and therefore the number of companies is much less. A relatively easy access of foreign carries to the CEE markets has helped road hauliers from the EU – especially German and Dutch – to dominate.

In general the CEE countries have done a lot to fit EU's standards in transport sector. The screening of legislation, which begun in November 1998, has shown a relative high degree of coherence between most advanced CEE countries and the EU. The policy orientation in all CEE countries is in general the same; the differences depending mostly on the present needs and political and economic circumstances related to GDP levels, and conditions of co-operation with the EU and the Russian Federation.

Impacts of Transport

The quick increase of car ownership in the CEE countries has been followed by an increased number of **accidents**. It has to be remembered that neither the EU is a homogenous area when regarding traffic safety. There are countries with low level of accidents and countries with death rates comparable to the CEE countries (see Table 10 and Fig. 2). In general it can be stated that with rapid increase in car ownership the number of accidents starts to grow until control measures are tightened and traffic culture developed, e.g. in Finland the corresponding figure was over 250 in 1972. The accident rate – measured with the number of persons killed in traffic accidents per one million inhabitants - is not dependent on car ownership rate, but on the implementation of control measures and related traffic culture.

Table 10. Car ownership and death rate in Europe 1996

Country	Persons killed in traffic accidents per one million inhabitants	Number of cars per 1000 inhabitants
Hungary	134	222
Czech Republic	152	306
Poland	165	208
Latvia	222	153
The United Kingdom	61	388
Finland	79	379
Germany	107	500
France	138	436
Greece	197	223

Source Eurostat, CESTAT 1998/4

The political and economic changes launched in early nineties in CEE countries together with the introduction of a market economy resulted among others in profound changes in the field of environmental protection. The process of environmental recovery has begun with reductions in emission of many pollutants. The main achievement is the lowered emission from industrial and power plants due to introduction of cleaner technologies or simply filtering devices. Still the share of energy production and industry of **CO_2 emissions** is higher in the CEEC than in Western countries due to more polluting factories and less voluminous traffic (see Table 11).

Table 11. The share of CO_2 emissions per economic sector in Western Europe and the CEEC during 1990 – 1995

Economic sector	Western Europe		CEEC	
	1990	1995	1990	1995
Energy	33	32	39.5	39
Industry	25.5	25	34	34
Transport	22.5	25	9	8.5
Households	15	14.5	13.5	14.5
Others	4	3.5	4	4

Source: Europe's Environment: The Second Assessment, European Environment Agency, 1998.

The increase in cargo and passenger transport considerably influences the environment in the CEE countries e.g. it is estimated, that 40 % of the whole population in Poland live within the range of burdensome road transport **noise**. The level of exposure is quite similar to that in the EU.

2.4.2 Current Trends and Impacts in the CIS

Economic Activities

This section is mainly based on the information about Russia. The major issue affecting transport development in Russia is **lack of money**. This hinders renewing of vehicles and improvement of infrastructure as well as necessary consideration of safety and environmental protection.

EU imports from the Russian Federation in 1997 were 157 million tonnes, which is 50 per cent over the import from the ten CEE countries (cf. Table 6). EU exports to the Russian Federation were only 11 million tonnes in 1997 and dropped to mere 8 million in 1998 because of the economic crisis. The exports to Russia is thus less than to Poland (cf. Table 7). The unbalance in the trade between the EU and Russia is obvious when considered that in 1997 the EU Member States paid to Russia almost 30 billion ECU from the imports and got only 20 billion for the exports to Russia.

Infrastructure

Poor financial condition has impaired all transport modes. Investments in road and rail infrastructure were in 1995 only 27 ECU per capita – comparable to CEE countries (cf. Table 8).

In the internal waterways as well as in some sea and river ports technical control and service devices have deteriorated. In railways there are long sections with permanent reductions of speed.

Road network in the western parts of Russia reminds that of the CEE countries. The network density is sufficient, but the quality is poor. Many bridges are worn out, carrying capacity of roads is often low and pavements deteriorated. Situation is different in the eastern and northern parts of Russia, where there are large areas totally lacking of road connections. These regions have been earlier served with subventioned railways and airlines. With current prices earlier services cannot be affordable, which has big impact in the economy of these regions.

The runways and other facilities at airports are also deteriorating and technical equipment is insufficient. In the network of oil and gas pipelines there is an ever-increasing need of replacement for pumping facilities and tubes.

Vehicles

In Russia transport companies do not possess money for renewal of technical means. Therefore, rolling stocks are old in all modes. Some 30 per cent of railway locomotives are over 20 years. The main part of aircraft fleet is approaching the end of their specified life, whereas over a third does not comply with modern norms on the noise level and atmospheric emissions, and on navigation and landing aids. Half of sea and inland waterway ships are over 20 years old.

Compared to ships and locomotives trucks used in road haulage are younger – some 20% are over 10 years old and 10% are used less than three years. In contrast to that urban bus and streetcar park is old as well as underground cars and related technical facilities.

Car ownership is Russia is somewhat lower than in the most CEE countries, i. e. 105 cars per 1000 inhabitants in 1996. In Ukraine car ownership is even a bit lower. Vehicle stock originates from foreign (partly imported as used cars) and Russian production.

Besides, it should be noted that a part of trucks, aircrafts, and other machinery produced by Russian plants does not meet modern international standards, although lately some factories are approaching or completely conforming to the international standards.

Also the inferior quality of cheap motor fuel produced in Russia has its impact in pollution.

Safety level in Russia is quite poor – 199 deaths in road accidents per one million people in 1996. In Ukraine it is somewhat better – the corresponding figure was 131 (cp. also Table 10).

The process of introduction of new machinery, fuel, and renewal of the vehicle fleets, as well as reconstruction of the infrastructure is gradual and relatively long. Therefore, for Russia in the short term it is only reasonable to consider how safety and ecology parameters can come nearer to the standards and regulations currently valid in the EU.

Both federal and regional authorities are very interested in the development of transport. However, the main emphasis is in the traditional transport problem (cp. Chapter 1), i.e. in solving day-to-day issues, such as possibilities to carry out haulings and to decrease their costs as well as how to maintain the rolling stock and infrastructure in a serviceable condition.

In the longer term the integration of the Russian economy with the western one will harmonise also the rules and regulations concerning transport.

3. DEFINING TRANSPORT POLICY

In a strategic transport planning process the first forward looking phase is the definition of policies. Of course all policies are influenced by the concern on transport problems (see section 1.3) related to current and forecasted trends and impacts described in Chapter 2. The aim of this chapter is to describe the tools provided by the SAMI project, which can be used in the planning and decision-making processes. In addition to that also European transport policy is discussed and some relevant results from other FP4 projects presented.

3.1 History and Current Status of European Transport Policy
This section gives a background for the selection of transport policies by describing and assessing the various phases through which current European transport policy has evolved.

3.2 Direction of Transport Policy in the CEEC and CIS
Special characteristics of transport policy in the CEEC and CIS are highlighted and the relations to the EU policies discussed.

3.3 Setting Targets for Transport Policy
Common transport policy has to be tuned into the actual planning situation and this can be best achieved through the definition of targets providing information about the change aimed in every policy. In this section the need for targets is discussed, the SAMI approach for setting targets is presented and the targets developed in the SAMI project are described.

3.4 Synergies and Conflicts between Policy Targets
One of the major problems when setting targets is the existence of synergies and conflicts between targets. In this section we present SAMI framework for assessing interactions between targets and a following hierarchy of targets.

3.5 Performance Indicators
Indicators are used for measurement of progress on the selected targets. In this section an approach for setting indicators is described and examples of indicators related to various targets are presented.

Box 5. The complexity and fluctuations of transport policy [70]

> We can observe policy cycles in much the same way as there are product cycles, resulting in the emergence of new policy issues through time and the decline of others. These can lead to modifications in both goals and objectives, and “fashions” for using different measures can also change over time. *F. LeClercq*

3.1 History and Current Status of European Transport Policy

3.1.1 Introduction

As we have seen in Chapter 2, there has been a continuous growth in traffic in Europe, reflecting increased mobility levels, rising incomes levels, increased social and leisure time, and the breaking down of national barriers within Europe. There seems to be at least three basic types of interlinked transport problems (see section 1.3) without any clear-cut solution. If the current trends are to continue the problems are likely to get worse in the future. As we shall see in this Chapter, there seems to be uncertainty over the direction of policy. On the one hand, there is a lack of capacity, and many of the systems are incompatible, both in the technical sense and in an organisational sense. On the other hand, there is a realisation that unlimited mobility is not environmentally desirable. The EU and the national governments have not yet found the way out. This reflects a more general issue – still not solved– how the human kind can attain sustainable development.[71]

Transport policy at the European level has developed over the last 40 years from the Treaty of Rome, but it is only in the most recent past (the last seven years) that the Common Transport Policy (CTP) has been promoted by the European Union (EU). The three main components of that policy are – competitiveness, cohesion and environment. These clear underlying principles, which cut across many other sectors of EU policy, have recently been modified in a further communication from the Commission[72].

The main purpose of this chapter is to provide the background context to the development of the CTP. Three main stages in its development are identified, which correspond with different priorities and objectives for European transport policy. The main focus is at the strategic level and attention is paid to the development of the Trans European Networks for transport. This is where the EU has had most influence in determining future policy on transport in Europe, at least until recently when other policy imperatives, relating to sustainability, pricing, quality and safety have become more important[73].

3.1.2 European Transport Policy – Phase 1 to 1992

Emergency of European Transport Policy

Transport was identified in the 1957 Treaty of Rome as one of the areas for development of a common policy. Since then, progress has been slow towards the Common Transport Policy (CTP). In 1985, the European Parliament asked the European Court of Justice to officially recognise the lack of a European Transport Policy and that this failure was due to the inefficiency of the European Council of Ministers[74]. The Court also declared at the same year that the inland transport of goods and passengers should be open to all Community firms, without discrimination as to nationality or place of establishment. In 1986, the Commission put forward proposals for a medium term plan on transport infrastructure[75]. It described the principal deficiencies of the European transport network; the ways in which the Community could take action to resolve them; the ways in which the Community could declare an interest so that Community action would be possible; and it identified the needs for overall financial investments in infrastructures. The Council of Ministers was reluctant to accept that proposal, and in 1988 the Commission submitted a four year plan extending to 1992 which coincided with the introduction of the Single Market. Again, there was resistance from the Council and the Commission presented more modest proposals which concentrated available resources on a limited number of projects regarded as the most important. This proposal was accepted in November 1990.

Many international initiatives concerning transport have not come from the EU but from the transport industry itself. For example, the proposal for an international network of high-speed trains has come from the Community of European Railways. The role of the EU has been of secondary importance and restricted to issuing directives such as those on the environment, standards for road freight, cabotage, and reductions in custom's formalities. The 1991 Maastricht Treaty expanded transport's role to include common rules on international transport and improvements in transport safety.

Investments in Infrastructure

The EU budget for transport infrastructure investment has always been limited and any increase in that budget has been resisted by Ministers due to a conflict with national interests and the notions of subsidiarity. Contributions have been made to specific projects, often under the European Regional Development Fund (ERDF) and European cohesion programs. The ERDF allocated 43 percent of its expenditure between 1983 and 1987 to infrastructure projects of Community interest[76]. However, only 40 percent of EU territory are eligible for ERDF financing. In Greece, 24 percent of ERDF funding investment is for transport infrastructure, and the corresponding figures for Portugal, Spain, Italy and Ireland are 18, 47, 10, and 39 percent respectively[77]. It is only in the air and telecommunications markets that the private sector has been fully involved, and it is here that most of the new investment has taken place. The possibilities for an enhanced role for the private sector, either on its own or through joint ventures with the public sector, have not yet been fully explored for a wider range of infrastructure projects including road and rail[78].

The other main agency has been the European Investment Bank (EIB), which co-finances projects (up to a maximum 50-percent contribution) designed to modernise Europe's economy. Between the date of its establishment (December 31, 1982) and 1985, the EIB allocated just over 20 percent of all its financing operations within the Community to transport. Between 1986 and 1990, the EIB further increased its support to 15 billion ECU's (37 percent of its total budget) for transport and telecommunications infrastructure and equipment (Table 12). The assessments of projects are based on financial criteria related to the potential profitability of the project.

Table 12. EIB Financing for Transport and Telecommunications, 1986-1990 (million ECU)

Country	Overland Transport	Air Transport	Shipping	Tele-comms[a]	TOTAL
Belgium	-	6.0	-	-	6.0
Denmark	476.1	241.2	5.6	188.5	991.4
Germany	252.3	30.1	1.2	-	283.5
Greece	208.0	7.4	0.9	-	216.3
Spain	594.7	652.1	40.3	1,203.8	2,490.8
France	2,448.5	45.1	15.8	85.3	2,594.6
Ireland	150.7	144.9	-	135.3	430.9
Italy	1,294.1	414.4	302.0	2,311.5	4,322.0
Luxembourg	-	-	1.6	-	1.6
Netherlands	-	367.3	-	-	376.3
Portugal	639.0	53.6	57.7	176.7	927.0
United Kingdom	640.3	731.0	77.4	44.4	1,892.2
Article 18	-	-	-	660.8	660.8
TOTAL	6,703.7	2,693.1	502.5	5,205.4	15,104.0

Source: European Investment Bank (1991)

Note: [a] Telecomms includes telecommunications and telecommunications satellites; Article 18 projects are located outside the EU (such as submarine cables and satellites). Austria, Finland and Sweden were not members of the EU. This is the EU12 rather than the EU15.

The total allocation of the EIB to transport and telecommunications has increased as follows:

1986	1,945 Million ECU
1987	1,661 Million ECU
1988	2,980 Million ECU
1989	4,001 Million ECU
1990	4,518 Million ECU

To enhance European integration, the EIB has given priority to projects which:

?? Help to develop regions in difficulties;

?? Achieve energy savings or other energy-related investment so to reduce the EC's dependence on oil;

?? Assist in European economic integration or towards the achievement of Community objectives such as protection of the environment;

?? Modernise and promote sectors with high innovation potential including advanced technology[79].

EIB loans are generally repayable over 8 to 20 years, and loans can be backed by financial guarantees or by the assets represented in the project itself.

The Edinburgh Council (in December 1992) recognised the problem by setting up a new European Investment Fund to help fill the *missing links* in European infrastructure and also extended the lending facility of the European Investment Bank. It will now be easier for financial markets to back large infrastructure projects for Trans-European networks, including transport, telecommunications and energy. The EIB will contribute 40 percent of the fund's capital of 2 billion ECU's with the remainder coming from the Community (30 percent) and the private and public sectors (30 percent). It is estimated that the Fund could support investment projects worth up to 20 billion ECU. The crucial assumption here is the expectation that the limited capital in the new Fund will generate this level of borrowing – a gearing ratio of 10 to 1 is very high. Nevertheless, this is an important step forward in EU thinking, as it is the first time that a new financial instrument has been set up in this area. Previously, the Council had confined itself to laying down the objectives of an infrastructure policy and identifying the principal criteria for establishing whether that project is of Community interest. The EU has approved 14 priority infrastructure projects. The new European Investment Fund has been approved and this means that action can now take place on the major new infrastructure projects.

However, across the EU there is still no infrastructure policy. The long-term loans provided by the EIB support individual projects submitted separately by public and private promoters in each EU country. Although it is recognised that international travel is only a small part of overall travel, some corridors are already at capacity, there are many missing links in the European network, and transport demand may still increase as a result of the Single Market. Some strategy seems to be essential, particularly when transport policy is set against competition policy, regional development policy and environmental policy within the EU.

3.1.3 European Transport Policy – Phase 2 from 1992 to 1995

Birth of Sustainable Mobility

The Maastricht Treaty of the EU states that the Union aims to *"promote a stable and non-inflationary growth which respects the environment"* and it stresses the importance of an integrated approach to economic growth, quality of life, jobs, local development and the environment. The European Commission's interpretation of sustainable development is contained in the Fifth Action Plan for the Environment. As part of the required action, it calls for the integration of the principles of sustainable development into all of the EC's policies[80]. This includes the regulations governing the Structural Funds programme, which supports a large number of transport projects (approximately one fifth of Structural Funds are used to support transport projects). As a consequence of this new imperative, the EU changed its approach to transport so that a Transport Policy would be based on *sustainable mobility*[81]. The new framework sets out strict environmental standards for all modes of transport, for quality standards on pollution, for encouraging environment-friendly modes, and for the promotion of guidelines for infrastructure and the development of urban transport. These guidelines for the development and assessment of Community infrastructure projects would:

"discourage unnecessary transport demand and encourage where appropriate the development of alternatives to road transport, such as railway, inland waterways and combined transport. Guidelines for the conversion and upgrading of relinquished infrastructure, particularly for the purpose of "soft" transport, would be implemented"[82].

The common strategy of sustainable mobility should:
"contain the impact of transport on the environment, while allowing transport to continue to fulfil its economic and social functions, particularly in the context of the Single Market, and thus ensure the long term development of transport in the Community. It should also contribute to social and economic cohesion in the Community and to the creation of new opportunities for the peripheral regions" [83].

Common Transport Policy
In the EU White Paper on a Common Transport Policy (CTP), one of the main themes has been Trans-European networks. Incompatibilities between national transport systems have been highlighted, including inadequate interconnections, missing links and bottlenecks, and obstacles to inter-operations. All of these lead to inefficiencies. The EU has had only a limited policy role mainly through the Committee on Transport Infrastructure (set up in 1978), but with the principal financial contributions coming from the structural funds and instruments that have been mentioned previously:

- ERDF credits (1975-1991) for transport infrastructure of 16 billion ECU,
- EIB loans (1982-1991) for transport infrastructure of 14 billion ECU,
- European Coal and Steel Community loans (1987-1991) to TGV track in France and Spain and to canals 1.2 billion ECU.

The EU now proposes to establish and develop a:
"Trans-European transport network, within a framework of a system of open and competitive markets, through the promotion of interconnections and inter-operability of national networks and access thereto. It must take particular account of the need to link island, landlocked and peripheral regions with the central regions of the Community"[84].

The goal is to improve the integration of the Community transport system and not the improvement of the transport infrastructure in general. It is likely that much of the funding will continue to be allocated to the geographically isolated regions. On the crucial question of financing, the White Paper is pessimistic. The general level of investment in transport infrastructure has been stagnant at about 1 percent of GDP. The volume of investment required for the period between 1990 and 2010 is nearly 1,500 billion ECU, or 1.5 percent of GDP[85]. This level is far in excess of the resources available to the EU even if its mandate would permit such intervention. Its role is limited to financing feasibility studies, loan guarantees, and interest rate subsidies. In addition, the EU may have a major dilemma. On the one hand, it sees under-investment in transport infrastructure, but on the other hand it is arguing for sustainable mobility and protection of the environment (for the basic policy objectives see Box 1 and for the conflicts between objectives section 3.4).

The EU policies on infrastructure now extend beyond the Community members, and there is a specific provision for cooperation with third countries. The Prague Declaration adopted by the Pan European Transport Conference in 1991 emphasised the necessity of developing transport networks on a truly European scale and of integrating the greater European transport market. Measures have already been taken with the

European Economic Area agreement and transit agreements with Switzerland and Austria. Trade between East and West Europe will increase movements in both directions (see section 2.4), which in turn will place considerable pressure on the links where little investment has taken place for the past 40 years.

It should be acknowledged, however, that the EU policy is more of a stimulating and initiating nature, while the final responsibility for implementation and enforcement rests with the individual Member States. At the same time, the CTP has become increasingly important, due to several 'package deals'[86]. First, as a result of the internal market objective, transport markets were liberalised and the Trans European Networks became a pre-requisite for the functioning of the internal market. Second from 1987 onwards more financial support (such as for the financing of transport infrastructure) was granted in order to compensate peripheral regions for the negative impacts of the internal market. Third, these funds became larger in 1992 in order to compensate these regions for economic disadvantages of the monetary EMS and EMU criteria.

In order to focus the policy assessment aspects of the CTP, the above mentioned objectives can be summarised as follows (see also section 3.1.4):

?? *Efficiency*: subsidies should be reduced and market principles should be increased in the operation of the transport system and by assessing new investments; in this way the transport system should contribute to economic efficiency of society and to an improvement of the competitive position of the economy.
?? *Regional Development*: the transport system is a means to stimulate economic development in more peripheral regions (especially CEE-countries and Southern Europe) and is used to stimulate the social cohesion within Europe.
?? *Environment*: the transport system has to reduce its external (environmental) impacts, so that the system favours a sustainable (environmental) development.

Although most of the CTP has been focussed on infrastructure, this transition phase (1992-1995) also brought about other important changes in regulations, particularly on safety and the environment[87]. European regulation aims at reducing air pollution by road vehicles by setting emission reduction targets per vehicle, by reducing traffic congestion and by reducing mobility growth. The first has been relatively successfully applied over the recent past in Europe, which reduced emissions of several gases up to 50%[88]. However, the simultaneous rise in mobility has meant that the net energy consumption and emissions of CO_2 by transport have increased. The reduction of CO_2 emissions is seen as a major environmental challenge, and the stabilisation target was agreed at Rio (reducing CO_2 emissions to 1990 levels by 2000). More recently (in 1997) the EU has taken the lead from Kyoto to set a target level of reducing CO_2 emissions by 8% between 1990 and 2010.

The existence of and the quality of infrastructure are both prerequisites for using any mode. In the past, a large road infrastructure network has been constructed in Europe, which has induced a steep growth in the number of vehicle kilometres and thereby in personal mobility. At present the road network is relatively dense in comparison to rail or air networks. The CTP is now aiming to close the gaps in the European (trans-national) network ("missing links", "missing networks" and "Trans-European networks") for both road and rail infrastructure. The main justification for this are economic reasons, as building new infrastructure is promoted as a generator of economic growth and regional economic development (see also sections 2.2.4 and 2.2.5). However, this is only one element of the CTP.

3.1.4 European Transport Policy – Phase 3 from 1995

Broader Scope

In 1995, the Commission launched its action plan (CTAP) for 1995-2000[89]. As part of this new initiative, there have been a series of important debates opened up in the transport sector. Although the main aims of the CTP of 1992 have not changed fundamentally, there is a significant change in the focus of transport policy in the EU. The efficiency of the transport system still underlies much of the policy thinking, as this is seen as being essential to the competitiveness of Europe and to growth and employment. But a greater emphasis is being given to the social cohesion objectives, to safety (again), the environment, subsidiarity, and the accession countries.

Improving efficiency and competitiveness of the transport system is not only concerned with new infrastructure and the completion of the TENs, but with four other main policy initiatives:

?? liberalising market access (particularly as it relates to railways, air and ports);

?? ensuring integrated transport systems across Europe (continuation of the TEN-Transport priority projects, but with public private partnerships for financing and operating these systems);

?? ensuring fair and efficient pricing within and between transport modes, in particular applying the principles of marginal social cost pricing;

?? enhancing the social dimension so that more balanced and sustainable development can be implemented across all the EU.

Improving quality in response to the needs of EU citizens means that priority is given to the following three areas of policy:

?? safety is a permanent concern of the EU in all forms of transport, particularly in the air, maritime and roads sectors;

?? the development of sustainable forms of transport to limit the impact of transport activity on climate change. This work includes the development of accurate indicators of transport and the environment, and the strengthening of the environmental impact assessments of policy initiatives. Links are being made here with air transport noise and emissions, with waste reception in maritime transport, with the problem of heavy lorries in the roads sector, and with the emissions work of the Auto/Oil I and II programmes;

?? protecting consumers and improving the quality of transport services through participation and representation of organisations in the development of the CTP. The two main sectors concerned here are in aviation and local public transport. In the latter, a Citizens Network has been set up to establish best practice, including the integration and benchmarking of services.

Improving external effectiveness covers the links with the accession countries and the globalisation of the world economy. Agreements have been negotiated with some of the accession countries so that markets can become more open during the transition period to the membership of the EU. This will facilitate the enlargement with minimum disruption. The globalisation issues relate to trading and market conditions as they relate to external countries.

New Approaches

As can be seen from the discussion above, the CTP has evolved substantially from 1992 to a much broader-based and more coherent approach[90]. The primary concerns of policy within the EU along the three original dimensions of competitiveness, cohesion and the environment are still present. They form the first two of the new priorities (efficiency and competitiveness, and improving quality), but the two new dimensions relating to the accession countries and the role of the EU in global markets have substantially enhanced the scope of the CTP.

Secondly, the original concerns were primarily with the network and the means to provide a European infrastructure to link all the EU countries together, and to link with the countries of Eastern Europe (CEEC) and the Soviet Union (CIS). This has also changed with a new emphasis on bringing down the barriers to free trade (and using pricing tools more effectively), making the systems compatible (interoperability), getting the best out of the different modes of transport (intermodality), making good use of the network (interconnectivity), promoting best practice in organisational structures (including logistics and technology), and in ensuring the responsible use of resources in transport. Strong links are now being drawn between the transport policy perspective and the new European Spatial Development Perspective (ESDP), as the combination of these two policy areas is necessary to achieve sustainable mobility and a balanced territorial development.

Recent priority areas for EU transport policy are also reflected in the content of a succession of European policy papers. The 1995 Green Paper on fulfilling the potential of passenger transport in Europe, 'The Citizens' Network', identifies how public transport may be made more attractive and usable, and looks at all levels of policy-making (local, national and European) that might achieve this goal[91]. The 1995 Green Paper on policy options for internalising the external costs of transport, 'Towards Fair and Efficient Pricing', explores economic policy options for internalising some of the external costs of transport such as air pollution, congestion, accidents and noise[92]. Promoting rail modernisation, integration and use is addressed in the 1996 White Paper on a strategy for revitalising the Community's railways[93]. It recommends Community action in five main areas: finance; market forces; public services; integration of national systems; and social aspects. The 1997 Communication on intermodal transport (Intermodality and Intermodal Freight Transport in the European Union) sets out a framework for the integration of transport modes to provide seamless and efficient door-to-door services[94].

The action plan sets out the initiatives it intends to take to ensure "sustainable mobility" within the European Union, which it interprets as encouraging 'efficient and environmentally friendly transport systems that are safe and socially acceptable'. The document states that the efficiency of transport systems remains a fundamental objective for the competitiveness of Europe and for growth and employment, whilst at the same time promoting "sustainable mobility".

However, there may still be inconsistencies in EU transport policy, particularly as it relates to the environment and the achievement of the challenging Kyoto targets for CO_2 reduction. As it states in the recent Communication on the CTP:
"it will be necessary to assess more globally to what extent existing policy measures will bring the transport sector in line with environmental objectives and what further well-focussed and complementary measures may be needed. Particular attention will need to be given to measures designed to reduce the dependence of economic growth on increases in transport activity and any such increases on energy consumption, as well as the development of less environmentally damaging energy alternatives for transport"[95].

These are the new challenges of the Common Transport Policy for the next 5 to 10 years. According to the Commission much progress has been achieved, but to sustain economic progress, social structures and a clean environment, significant further agreement at the EU level is required[96].

3.1.5 Trans European Networks

The concept of the Trans-European Networks was developed during the formulation of the Maastricht Treaty of the European Union, which specified a network of transport corridors forming the backbones of the European transport system. At the Council in Essen in December 1994, 14 TEN priority projects were accepted (Table 13). Special emphasis was placed on the improvement of those European axes.

The timetables submitted by the Member States suggest that there will be a very substantial increase in expenditure on the 14 priority projects during the period 2000-2006, with many of the larger projects moving into the full construction phase. At present, three of the 14 projects are close to completion (Malpensa airport – opened in 1998, the Øresund fixed link opened in 2000 and the Greek Motorways), all are under construction or at an advanced state of preparation and most are likely to be completed by around 2005.

Table 13. Investment in the Trans European Network Priority Projects

Trans European Network Project	Investment pre-1998 (MECU)	Investment 1998-1999 (MECU)	Investment 2000+ (MECU)	Total Investment (MECU)
High Speed Train/Combined Transport North-South	2,505	1,325	11,245	15,075
High Speed Train (Paris-Brussels-Koln -Amsterdam-London: PBKAL)	3,728	4,118	9,386	17,232
High Speed Train South	240	1,375	11,757	13,372
High Speed Train Paris-eastern France -southern Germany (including Metz-Luxembourg branch)	59	170	3,086	3,315
Conventional rail/combined transport Betuwe line	360	870	2,864	4,094
High Speed Train/Combined Transport France -Italy (Lyon-Turin-Milan-Venice -Trieste)	368	943	16,949	18,260
Greek Motorways PATHE and Via Egnatia	2,175	2,351	4,716	9,242
Multimodal Link Portugal-Spain-Central Europe	not available	not available	not available	6,212
Conventional Rail Link Cork-Dublin-Belfast-Larne-Stranraer	328	29	0	357
Malpensa Airport, Northern Italy	473	406	168	1,047
Fixed rail/road link between Denmark and Sweden-Øresund Fixed Link	2,505	1,377	276	4,158
Nordic Triangle	0	1,260	3,320	4,580
Ireland-United Kingdom-Benelux road link	1,670	247	1,710	3,627
West Coast Main Line (UK) High Speed Train/Combined Transport North-South	287	532	2,180	2,999
Total for all 14 projects	14,698	15,003	67,657	103,570

The priority projects have benefited from substantial amounts of EU financial support, particularly those located in areas eligible for Structural and Cohesion Fund financing. The TEN Transport Budget, (around 1,800 MECU 1995-1999) has had a considerable impact in helping to launch major projects. The European Investment Bank (EIB) is the major source of loan funding for TEN projects, advancing 1,400 MECU to the 14 priority projects in 1997 alone.

The Community budget will continue to play a crucial role in getting projects off the ground and maintaining momentum. In a number of cases the Community contribution will be a determining factor in the financial viability of the project. The estimates of financial requirements (5,000 MECU for the period between 2000 and 2006) which the Commission put forward with the proposal to revise the TEN Financial Regulation reflects the forecast increase in activity, and the need to continue to recognise the strong Trans-European element in the projects concerned. However, the role of the Commission in the TEN programme has also been considered to be much more comprehensive than could theoretically be justified[97].

The 14 projects are not necessarily the most critical ones, but they are symbolic of the wider European ideal. Most of the projects outlined above improve the infrastructure between two or more EU countries, all countries are represented, and most funding is for rail schemes (usually high-speed rail). In terms of sustainable mobility, it is necessary to make use of the most efficient forms of transport.

High-speed rail seems to be in an anomalous position, as it uses more energy than conventional rail, but less than air and car, but its overall efficiency is dependent upon high occupancy factors. In energy terms, high-speed rail can be extremely efficient, provided that passengers have switched from car or air and provided that the trains are full[98]. However, if new long distance travel is encouraged and spare capacity is realised for more air travel (as more slots become available as a result of new high speed rail investment), then the energy arguments in favour of high speed rail are far less clear.

3.1.6 Conclusions

Three different cycles in the development of the CTP have been described in sections 3.1.2-3.1.4 and a discussion on the related concept of TEN is presented in section 3.1.5. The success of the CTP is difficult to assess, but some basic considerations can be made with the aid of transport problems (defined in Chapter 1), stated objectives and their interactions.

The solutions for the **traditional transport problem** have produced increasing travel speeds and decreasing travel costs. This kind of trend is historically very long and facilitated mainly by introduction of new technology like locomotives and steam ships in the 19th century or bicycles, cars, vans, trucks and aeroplanes during the 20th century. The production of new vehicles has been accompanied by the construction of new infrastructure like railway lines and stations, ports, road networks and airports.

In the Member States well-developed transport systems already exist and a further expansion can provide only limited gains. This probably holds true also for the promotion of regional development, which has been considered important for the cohesion objectives.

The **modern transport problem –** pollution and accidents is a direct consequence from the solutions of the traditional one. The use of catalytic converters has somewhat diminished local air pollution in the Member States. However, there still exists serious concern on the effects of current emissions. There are still big differences in the accident risks between the Member States and the total toll of the accidents is horrible.

The **post-modern transport problem** is related to congestion, lack of room for infrastructure expansion and sustainability issues. The tackling of it is very difficult because the major progress is made through the decrease of traffic, which is in contrast of the solutions for the traditional transport problem. In addition to that sustainable development is an ill-defined concept without clear demands for the actions or with the demands which are in strict conflict with short-term economic development.

3.2 Direction of Transport Policy in the CEEC and CIS

3.2.1 Introduction

As stated in section 2.4 railways have traditionally been the backbone of transport system in most of the CEE and CIS countries. Now it is losing both passengers and freight to road transport. However, road network is in a poor state and not capable of receiving increasing traffic. In general public transport is loosing passengers and at the same time it is unable to solve financial problems. Poor control of regulations is together with increasing traffic causing accidents and environmental damages.

Transport policy in the CEEC is discussed in the following mainly according to the Polish experience and the presentation of CIS transport policy is based on the Russian conditions.

3.2.2 Transport Policy in the CEEC

The major policy question "how to finance the development of road network" cannot be answered in the short term. This makes the management of railways most important policy issue in order to keep the relatively high share of rail transport. Fast increased car ownership is bringing serious environmental problems in cities and necessitates also improvements in public transport as well as the tightening of traffic control.

Environmental problems have lately received attention in the CEEC. As a concrete example a new document "*National Strategy for Sustainable Growth – 2025*" in Poland can be mentioned. It is based on a parliamentary resolution and it includes also targets for the development of transport system. What is especially important is a short-term target to re-organise the Polish National Railways in order to solve current financial crises mentioned in section 2.4.1 (for the targets see Box 6).

Box 6. Short-term targets for transport policy in Poland

- ?? To privatise partly the Polish National Railways i.e. to privatise all activities and assets which are not directly connected to the operation and infrastructure;
- ?? to conduct the planned re-organisation of the Polish National Railways, to repay its debts and to implement stable instruments of governmental aid, which would enable the company to compromise between the state controlled tariffs and its earning capacity;
- ?? to continue privatisation and to develop competitiveness in inter-urban public coach transport;
- ?? to conduct a strategic environmental assessment of the impacts of the new transport policy as well as to verify the latest experience in the environmental assessment on motorways;
- ?? to elaborate executive procedures for national transport policy covering:
  - ?? promotion of modes alternative to the road transport;
  - ?? development of urban transport;
  - ?? environmental quality of transport means and fuels, and utilisation of alternative fuels in particular;
  - ?? safety of hazardous transport;
  - ?? safety and organisation of road traffic (traffic and technical control, improving driving skills, etc.);
  - ?? reduction of negative impacts of air transport;
- ?? to increase the number of road and rail border crossings and to improve their infrastructure (increase of capacities and free flow of traffic, radical improvement of services available for drivers, etc.);
- ?? to introduce EU standards regarding drivers' working-time;
- ?? to include environmental effects in the drivers' training.

In the middle term the above mentioned document includes e.g. targets to improve transport network and a target to meet international targets for transport means and fuels. In the long-term, up to the year 2025, transport volumes are aimed to be kept within 150% of the present level.

It can be noticed that in the short term harmonisation of all transport-related regulations and practices is neither possible, nor desirable. In the current situation Eastern operators can offer lower transport prices for western industry, because of lower salaries being paid to employees in the CEE countries.

In a practical level it can be noticed following short-term issues needing harmonisation and co-ordination in the East-West freight and passenger transport:

- **Conditions for access to the profession of transport operator**. While in the EU three basic qualitative conditions - professional competence, financial aptitude and personal reliability - are to be fulfilled, this holds true in the CEEC only for international road operators. The regulations of access to the profession for road freight operators on the domestic markets are totally missing.
- **Conditions for access to the market**. East-West goods transport is regulated by bi- and/or multilateral agreements and licensing requirements. In such agreements quotas are being permitted at a lower level than needed by one of the contracting parties - the limited number of permits does not cover the real needs. Besides that, many taxes and fees on transit have arbitrary or discriminatory character and are being applied in non-transparent way - both in the EU (e.g. *Solidaritätszuschlag* in Germany) and the CEEC. To eliminate these negative phenomena progressive liberalisation and harmonisation of access conditions to the international (further also domestic) transport market is needed.
- A further barrier to the East-West transport is **visa** obligations for professional drivers. A solution could provide professional drivers with annual multi-entry visas for countries with visa requirements.
- Harmonisation of **technical standards** in international road and rail transport would ensure the interoperability and minimise the environmental risks (especially with regard to dangerous goods transport). Domestic legislation in the CEE countries could simultaneously be adjusted step by step to international regulations.
- Increase in the number of trained **control forces** (especially police forces) with more authority is needed in order to control the abeyance of laws and regulations in the CEE countries.
- A stronger role of the associations for **stakeholders** – both transport operators and users - in the CEE countries would enable them to act in the interests of their members.

3.2.3 Transport Policy in the CIS

Also a major question in the CIS – like in the CEEC - is how to finance the improvement of road network. When considering the size of the area, this is a world-scale issue. There is no reason to expect a fast solution. That is why also in the CIS countries the management of railways is most important in order to keep the relatively high share of rail transport. Also the improvement of public transport as well as the tightening of traffic control in the cities is necessary.

Russian Federation government has approved already in *1997 the Concept of the State Transport Policy of the Russian Federation*. This Concept presents the basic objectives for the development of transport (see Box 7).

Box 7. The concept of the transport policy of the Russian Federation

- ?? The aim is to provide safe and efficient transport services for passengers and freight when considering also social and environmental requirements;
- ?? this will be otained through
  - ?? enhanced state control over natural monopolies;
  - ?? decreased transport costs;
  - ?? established reasonable tariffs;
  - ?? increased competition between transport companies;
- ?? adaptation of Russian transport system in line of the international standards on the international routes including a staged opening of inland waterways for the passage of foreign ships;
- ?? improvement of transport services in remote regions especially in the north.

A program is to be developed about separate measures aimed at improving safety and ecological impacts of all modes. Also large transport projects are planned to undergo an assessment of environmental impacts. The ecological issues in the transport sector ought to be solved according to the law *"On Environmental Protection"*. In addition to the above mentioned Concept and Law there is a vast array of legal and normative documents and resolutions of Russian authorities aimed to cover various aspects of transport activities.

Even though the transport policy objectives are very much in line with the EU´s ones the practice differs. The current shortage of financial resources leads to short-term solutions aimed on serving daily needs without consideration on safety or long-term ecological issues.

3.3 Setting Targets for Transport Policy

3.3.1 Need for Policy Targets

"Targets can give policy a clearer sense of direction; they can add to the pace of policy implementation and development; and they can make explicit those aspects of policy that might otherwise remain opaque"[99]

Targets are becoming increasingly important in the development and implementation of transport policy, particularly since the introduction of the concept of sustainable development into policy-making, which has been one of the main driving forces behind the development of policy targets. As such, most of the literature on developing policy targets relates to environmental concerns. For this reason, this section focuses mainly on environmental targets and how they can be developed for transport policy. However, the discussion also has relevance for social or economic policy targets.

Targets are likely to become increasingly important for the development and implementation of transport policy in the future. In the context of transport policy, environmental targets generally represent points of reference or 'staging points', as opposed to specific end-points. Environmental targets may relate to environmental levels established by scientific investigation (such as the dose-response characteristics of pollutants and health), attitudinal surveys (such as the quality of landscape), or a combination of the two (such as acceptable levels of noise). Thus, environmental targets represent a qualitative or quantitative statement of aspirations about the state of the environment and the quality of life.

The nature of existing targets varies considerably. Some are fixed, aimed at clearly specified objectives, whilst others are 'rolling'. The sanctions behind targets also vary; some have legal status and are backed by penalties; some form part of international obligations or agreements (such as national CO_2 targets), whilst others are more indicative. Agreement of the 1992 Rio Declaration on Environment and Development commits all European countries to the concept of sustainable development in all areas of policy. The concept of sustainable development has led to a prominent role for environmental targets in several stages of the development and implementation of policy. Environmental targets have a key role in the identification of policy options as well as assessment and review.

The Royal Commission on Environmental Pollution recommends establishing environmental targets to provide a framework for the environmental appraisal of transport policies[100]. The value of targets in policy implementation is discussed in the EU Expert Group on the Urban Environment's European Sustainable Cities Report. The report argues that two important functions of targets in the implementation of policy are securing commitment to a direction of change and helping to achieve policy goals. The report states that the effective implementation of policy depends on establishing the direction and rate of change, using indicators and targets. The Group argues that targets are an integral part of policy assessment and review, providing 'staging points' against which policy performance can be measured[101].

Research into road safety targets suggests that more ambitious targets are associated with more successful achievement of objectives, by securing more commitment and/or resources for the achievement of the objectives (see Box 6).

Box 8. Road safety targets and their effect on policy[102]

National road safety targets have been adopted in various countries in recent years. These include Denmark, Finland, France, Great Britain, the Netherlands, Norway and Sweden. Targets have also been adopted at a local level in some of these countries. In Norway, road safety targets have been set by a number of county authorities.

In the study targets were classified into three categories according to their type and ambitiousness: highly ambitious quantitative; less ambitious quantitative; and qualitative targets. It appeared that the counties, which set quantified targets, were more successful in reducing the road accident rate than counties, which set qualitative targets. Of the counties setting quantitative targets, the ones with highly ambitious targets achieved a larger reduction in road accidents. The study shows that road safety is associated with the type of target, the ambitiousness of the target, and the level of road safety spending in the county (a link between these three factors seems likely).

The study suggests that the adoption of ambitious targets can assist the policy-implementation process by enabling priorities to be set more effectively, and enabling schemes to be implemented more successfully.

The process of developing and deriving environmental targets is at least as political as it is scientific:

"limits are not always absolute or objectively 'discoverable'. The environment's capacities are not always fixed, and they cannot always be scientifically defined. Science can provide useful (if uncertain) information, particularly on factors such as 'sustainable' extraction rates for renewable resources or the 'critical loads' of pollutants at which serious damage to ecosystems is caused. But scientific evidence does not by itself make a judgement on society's goals. Ultimately environmental capacities depend on what society believes to be tolerable, for itself and future generations"[103].

Thus, environmental targets should be developed in a systematic way, based on sound environmental data, and determined by participation and consultation on public aspirations about the state of the environment and quality of life. In some cases (but not all) it may be possible to base local targets on existing national environmental targets or environmental standards (such as EU 'guide values' and 'limit values' of air pollutants). Setting targets requires striking the balance between too ambitious and too undemanding levels. There is little point in setting targets that would be achieved in their absence, or in setting excessive, unrealistic targets that may discourage progress towards achieving them. Target setting requires reliable baseline data and a system for monitoring progress towards the target. At the local level, authorities may wish to adopt target levels set by national or international organisations (such as the European Union, World Health Organisation or national government) or adapt them to reflect local conditions. A number of European environmental targets already exist. These include CO_2 emissions, NO_X emissions, dioxins, volatile organic compounds (VOCs), noise and biodiversity[104]. Environmental targets may not always be complementary, and the interrelation between targets should be carefully examined before they are adopted (see section 3.4). A hierarchy or priority list of targets may be useful for assessing and comparing the contribution of different measures towards meeting a range of targets[105].

3.3.2 SAMI Approach for Setting Targets

Introduction

The presence of conflicting interests in society, interrelations among issues, and imperfect knowledge all bring the setting of transport policy targets deep into the political arena. Here we are presenting an approach how the targets can be defined. The examples given have been created during the SAMI project. They are presented in order to illustrate the approach - not as examples of real political process.

SAMI approach for setting targets goes through the following conceptual path:

a) define the **issue**, the general associated **targets** and the geographical **scope(s)** at which the policy discussion is relevant;
b) present likely **policy orientations** (lines of action) on the basis of current discussions in multiple institutions;
c) identify and assess the **position of each stakeholder** (social groups who would support or oppose those policy orientations) group with respect to each policy orientation mentioned (present an explicit argument in case of a strongly negative position);
d) evaluate the global level of **acceptability** of each orientation and make a general comment on likely dominant policy orientations.

The four steps of the path are presented in the following sub-sections. The steps are necessary because the political support for a policy target is based on the positions of stakeholders, and these in turn will depend on the policy orientations and instruments selected to tackle them.

Along this path it may become clear that the issue being treated is not independent of other issues in the list, as one or more of the orientations adopted for intervention in one domain may have (positive or negative) consequences on the other one. The interrelations between targets – synergies and conflicts – will be discussed in detail in section 3.4.

The role of indicators – necessary when targets are formulated in quantifiable terms - are presented in section 3.5.

Definition of Issues, Targets and Scope

The definition of main policy issues starts from the areas of policy development – originating from the objectives of the CTP (see section 3.1). For the three areas of policy development the most relevant issues are then identified (see Fig. 3). It requires a comprehensive approach as each issue should not be considered in an isolated way and some of them simultaneously have a global and local scope. Common definitions of geographical scope include global, European, national, regional and local aspects.

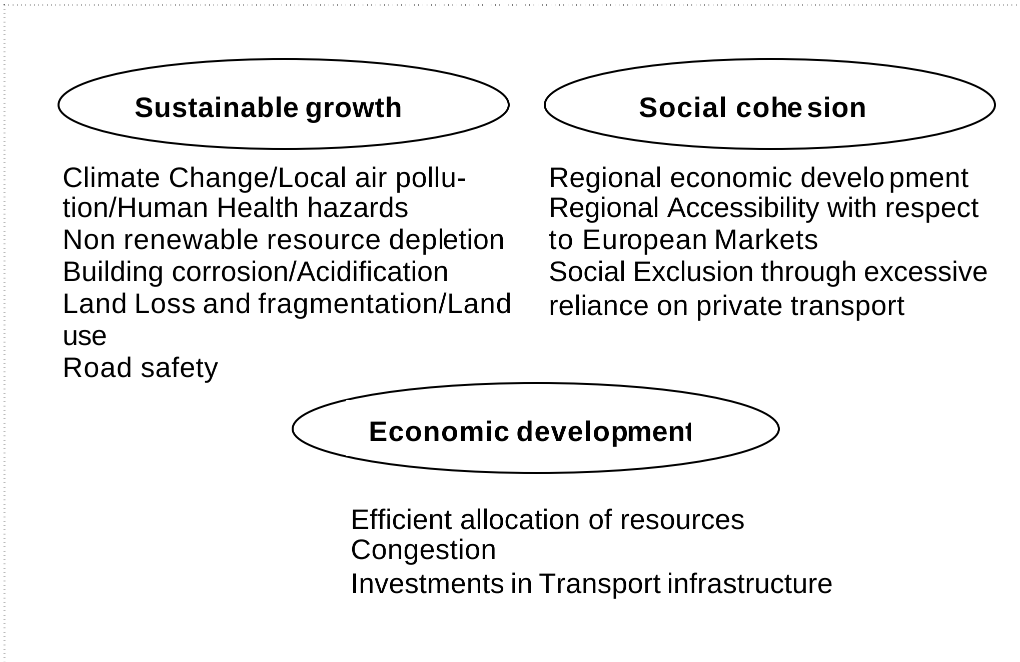


Figure 3. Areas of policy development and related main issues

In this section numerical values for the targets are not specified, then targets are interpreted as *directions of progress*. This is because the level of progress achieved in each of them will depend on the balance of power established in society between the forces in favour of that progress and resisting it, as well as on the interactions between targets. These aspects will be highlighted hereunder. In the case that the numerical values of the targets are set sophisticated models can be used for the formation of strategies (see section 4.3 for SAMI optimisation method).

For each of the policy issues (see Fig. 3) some specific targets have been identified in the SAMI project. In addition to the targets also the categories of the policy issues have been presented in Table 14. A category includes the definition of geographical scope and the area of policy development.

Table 14. Categories of main policy issues and related targets

Category	Policy Issues and Targets
Global Environment	1. Climate change/local air pollution/water pollution/human health hazards ?? Reduce the demand for motor vehicle travel ?? Drastic reduction of CO_2 emission by vehicles ?? Drastic reduction of toxic emissions by vehicles
Global Environment/ Local Environment	2. Non-renewable resource depletion ?? Drastic reduction of fossil fuel consumption per unit of transport performed ?? Increase recycling of vehicle construction materials
Local Environment	3. Building corrosion/acidification ?? Reduce acid components and particles (soot) in exhaust gases ?? Reduce pollution impact from traffic streams on valuable buildings
Local Environment	4. Land loss and fragmentation / land use ?? Reduce land loss and separation effects of building new infrastructure network
Safety	5. Road safety ?? Drastic reduction of road traffic fatalities ?? Especially drastic reduction of road traffic fatalities among more vulnerable road users
Economic Efficiency	6. Efficient allocation of resources ?? Promote fair allocation of costs to those who generate them ?? Promote competitive markets where state intervention is not essential ?? Increase competitive pressure (through transparency and comparability of costs) on companies operating in markets protected from competition
Economic Efficiency	7. Congestion ?? Drastic reduction of congestion, especially as a recurring event
Economic Efficiency	8. Investments in transport infrastructure ?? Avoid excessive spending of public money in infrastructure ?? Avoid self-defeating traffic induction through construction of expansionist infrastructure
Regional Development	9. Regional economic development ?? Avoid excessive differences of accessibility among different regions ?? Stimulate, for each region, location of economic activities whose mobility needs match the accessibility profile and comparative advantages of the region
Regional development	10. Regional accessibility with respect to European markets ?? Avoid excessive differences among regions concerning their level and calendar of integration in TENs, even for those with low traffic volumes (possibly recurring to intermodal solutions)
Social Cohesion	11. Social exclusion through excessive reliance on private transport ?? Promote good access to all basic urban functions without recourse to a private car ?? Avoid exclusion of citizens of very low income to public transport (through direct subsidisation)

Each of above discussed issues is seen in different ways by each group of stakeholders. Some of them have a positive/negative impact on the pursuit of certain goals, while others will be more independent with respect to the interests of those stakeholders. In the latter case, those stakeholders and their standings do not have to be considered for the decision-making process. Before going into the identification of stakeholders the two types of goals are presented, because stakeholders´ attitude has different flavour according to the type of a goal.

Two Types of Goals

It is possible to distinguish two types of goals:

a) *expansive* goals – where our aims are for an ever increasing level of availability of something considered to be good;
b) *defensive* goals – where we wish to reach or maintain our position with respect to some variable in a range considered satisfactory (in most cases corresponding to the preservation or recovery of previously known states of balance);

Expansive goals are normally formulated in terms of maximisation or minimisation, whereas for defensive goals normally translated in what mathematically is seen as a constraint, like 'not more than $\underline{x}$', or 'at least $\underline{y}$'. In most cases, stakeholders will be more open to accept compromise over expansive goals (for example, short delays in action, reductions of speed of progress, etc.) than over defensive goals (where present positions are considered entitlements and any movement may be perceived as withdrawal). This difference is easily observable in many policy domains, not just in transport.

Quite often, because there is not enough precision in the information available about the limits of tolerance of the states of balance (both in biological and in social systems), the thresholds are ill defined and expressed only in adjective (or 'fuzzy') terms. We are then working with 'soft constraints'.

We have seen above that some goals (the expansive ones) are formulated as the core of optimisation problems, whereas other goals (the defensive ones) are formulated as the core of sufficiency or threshold problems.

This is important not only for their mathematical translation, but also for their policy implications: while expansive goals correspond to aspirations of a better future, defensive goals correspond to the preservation of entitlements, and it is always easier to accept slower progress towards that better future than being deprived, even if only lightly, of some previously available right.

Thus it is no wonder that usually all policies are announced in terms of their expansive sides, not on the defensive implications, even if they are generally considered to make society move in the sense of greater equity. Loss of privilege by some groups without strong protest only occurs when it is an unexpected (indirect) consequence of some apparently unrelated policy, and even then, only when the losers are not close enough in space, time or lifestyle to get quickly organised as they start perceiving the threat.

Defining numerical targets is much easier as an aspiration for expansive goals than as a level of retreat for defensive goals. In either case, it must be realised that fixing a target in a policy is not only announcing what level we want to reach (for a specified indicator), but also when we want to reach it. It is well known that most policy actions do not have immediate effects, and the time element gives an important message about the level of determination in the pursuit of that policy.

Some of the recent international discussions about policies for containment of global environmental aggression make this point very clear, as efforts are made to fix target levels for CO_2 emissions in some future year. The targets for reductions agreed at the Kyoto conference (defensive goal), not only would have been impossible to estimate on a pure optimisation exercise, but also were accompanied by a set of measures destined to minimise pain in the translation from global goal to operational goals and measures.

There are several examples of policy targets that, given their high moral value, would seem to be subscribed by all members of society, the most striking example being the severe reduction of traffic related fatalities (issue above: road safety). If we address the problem at the global level, this goal inevitably scores very high in the hierarchy, because it seems to face no opposition from any group of stakeholders.

But when we make the translation into policy orientations and operational goals (thus having to think about the measures that have to be taken to move towards that target), it becomes visible that some of those measures have negative implications on some defensive goals of some stakeholders. This does not restrict the announcement of that goal as a very important one, but limits the intensity and boldness of the actions that are socially acceptable. This can be translated for the purpose of our work as a constraint on the political strength of the targets defined, even of highest merit.

In reality, politicians will avoid as much as possible making reference to detailed operational actions and easily measurable targets for specified indicators, not only for fear that they might fail to reach them, but especially because being so clear would make them face the risk that it would be realised that this would imply sacrificing a significant amount of a defensive goal of some important group.

Identification of Stakeholders

In general, for any system under analysis, the field of stakeholders can be organised along five main areas:

a) agents in the system, i.e. those who are active in its planning, provision and control;
b) users or clients of the system;
c) non-users of the system directly affected by it (positively or negatively);
d) policy makers, representing the interests of those not directly involved with it;
e) citizens' pressure groups, representing highly focused values and goals.

The pressure groups have strong feelings about some issues and act mostly on the basis of defence of moral values, not on their material interest on those issues.

Through their activism and militancy, they have been capable of becoming a parallel force to elected political officials in the representation of the general interests of society. Because they do not have to be elected by the population at large, they can be highly focused on a narrow set of defensive goals and will mobilise on the discussion of any issue that may be felt potentially threatening to those goals.

In most systems, this general formulation is rather sufficient and effective. However, in the transport sector things become more complicated because almost everybody may be considered a user, but at the same time does not feel directly involved with some parts of the system, i.e. those that he or she does not use or is affected by.

This aspect must be recognised but can be quickly dismissed if we remember that this is only an analytical tool and no person is required to actually register in one and only one of the categories above. The fact is that the reaction of any of us towards the transport system is very different when we are using it and when we are being disturbed by some of its harmful effects, e.g. noise, fumes, etc. Thus, when considering the positions of any group of stakeholders, we are thinking of personal roles rather than of physical persons.

When dealing with **agents** of the system, it may be convenient to consider separately the agents representing the government at any of its levels (national, regional, local), and the private parties like companies who earn their livelihood on the corresponding business. In the specific case of providers of transport services, the special conditions of the workers in this sector give them a particular negotiating power, which leads to their recognition as a stakeholder in this process.

In the area of **users** of the transport system, it is convenient to start by dividing into self-serving users like individual transport in the case of passengers, own-account transport in the case of goods, and users through an intermediary provider of services. It is also useful to distinguish, in either of those groups, between systematic users of a certain part of the transport system, and occasional users of that same part, as their requirements will probably be different.

The third group, related to directly affected **non-users** mainly includes people located at the borders of the transport system. On the negative side of impacts we have to consider all the usually referred externalities of transport like noise, particles, vibrations, odours, etc., but there are also significant interests on the side of positive effects from shopkeepers and tourism industry.

In the area of **policy makers**, more than a division of the group, we have to consider the interests they are thought to represent. These include both agents and users as well as the citizens. The agents and users are frequently organised so that policy makers are directly made aware of their interests. The citizens in general want to preserve (or not deteriorate further) their tranquillity and environmental quality, the taxpayers may feel that too much subsidy is being given away for some parts of the transport systems, and some geographical communities in special circumstances, like small islands for example, have their own special interests.

For the representation of the goals at the policy making level we will not be repeating those relative to the agents and users, since their organisation and power have led us to consider them as first order stakeholders and their goals as directly intervening in the formation of policy (as an example of possible stakeholders in transport see Table 15 below).

Balance of Power

Policy orientations are the results of a complex and continuous process, where interest groups present their views, arguments are discussed in public and in private, and eventually moral positions are defined, in the sense that dominant views emerge about what is good and what is bad for society as a whole.

In societies like ours, living with mature market economies, the pursuit of private interests and gains is considered legitimate within the boundaries imposed by the avoidance of excessive damage to others in particular or to society as a whole. So, in the gradual process of formation of policy goals, the dominant forces are:

?? *Economic Power*, normally resulting from some previous advantage in the market, and partially invested in adequate representation of its own interests at the (formal and informal) policy making institutions;

?? *Power of opinion* and its effective dissemination, through which general concepts and specific cases of justice and equity are talked about and spread in the public opinion, giving rise to gradual changes in the system of (moral) values.

In the permanent dialogue between these two types of power, a hierarchy of goals is formed, based on their combination of rankings as an expansive goal for some groups, and as a defensive goal to other groups. The more easily retained goals will be those that have some stakeholders (not necessarily many) strongly interested - expansive goal – and few or no stakeholders negatively affected by the corresponding actions – defensive goal.

This is a game where the results of cost-benefit analysis do not apply because gains and losses are not felt symmetrically, losers are rarely compensated, and also because any initial loss is always feared to represent the beginning of a downward spiral. So, the policies that might correspond to the maximum benefit / cost ratio may not get through, if they have too many beneficiaries with nothing substantial to gain and just a few losers who place their whole strength against that policy.

The implication of this for our work is that for any candidate policy orientation, identification must be made of the groups that will be strongly or weakly in favour or against, and those who will be approximately neutral. For those that are weakly against, there might be corrective (compensatory) measures that soothe them into becoming neutral or even weakly positive.

In the SAMI project the list of issues presented above has been sequentially addressed, trying for each of them to identify the expectable policy orientations, then identifying the most relevant stakeholders and their positions with respect to each of the alternative orientations on that issue. Then, for each of the policy orientations defined, a balance check of the intensity of support or rejection of that orientation by the various stakeholders has been developed, through which a first appraisal of the acceptability of each of those positions can be made.[106]

The reactions of stakeholders can be described in simple terms, ranging from the 'strong support' (++), through 'moderate support' (+) and 'indifference' (=), to 'moderate rejection' (-) and finally to 'strong rejection' (--). The assessment of acceptability of each orientation by society can be made based on the balance of pluses and minuses, taking in consideration the relative political strengths of the supporters and of the rejecters.

Examples of stakeholders´ reactions into possible policy orientations related to targets (issues and targets are defined in Table 14 above) of policy issue 1 "Climate change/Local Air Pollution/Water pollution/Human Health Hazards" are presented in Table 15. In this case possible policy orientations are considered to be:

a) raise vehicle purchase and registration fees;
b) stimulate use of public transport, ridesharing and telecommuting;
c) integrate land-use planning with transport services and infrastructure development;
d) economic incentives to car industry towards low-emission vehicles;
e) differentiate fuel taxes according to level of CO_2 generation / local air pollution.

In order to aid the reading of Table 15 the following clarification is given:
a policy orientation "Raise vehicle purchase and registration fees" against which we state that Road Vehicles Manufacturers will have a moderate negative reaction. This is because prices paid by consumers must rise without any incorporation of additional value, thus contributing to lower demand for their product. On the other hand we state that they will show a strong support for a policy orientation towards creation of "Economic incentives to car industry towards low-emission vehicles, as they will be able to improve their products (thus helping long-term sustainability of their business) and have governments share their costs and risks in the process.

Table 15. Stakeholders and their position to policy orientations

STAKEHOLDERS	Position with regard to				
Agents	a)	b)	c)	d)	e)
Direct Production & Sales					
Road Vehicle Manufacturers	-	=	=	++	-
Infrastructure (officials + contractors)	-	=	=	=	=
Fuels, components, other consumables	- -	-	=	=	- -
Transport operators (road)	- -	++	+	++	-
Transport operators (other modes)	+	++	=	-	=
Transport workers & trade unions	=	++	=	=	=
Managers & Supervisors					
Traffic Management Officials & agencies	+	++	++	+	=
Traffic Police	+	+	+	=	=
Other Providers					
Information Technology Providers	+	+	=	++	=
Banks & financial institutions	+	-	=	=	=
Hospitals and similar	+	+	+	+	+
Users					
Private drivers	- -	+	=	=	-
Public Transport passengers	+	++	++	-	+
Goods carriers	-	=	+	++	-
Third-Party (directly affected)					
Pedestrians & cyclists	=	+	++	=	=
Neighbours to busy traffic	=	+	+	+	=
Roadside shopkeepers	-	=	-	+	-
Policy Makers					
Repres. Taxpayers	+	-	+	-	+
Repres. Civil rights	=	=	=	=	=
Repres. Cohesion values	=	+	+	+	+
Pressure Groups					
Ecologists (inc. built heritage)	++	++	++	++	++
Industrial Associations	-	+	=	+	=
Scores:					
- -	3	0	0	0	1
-	5	3	1	3	5
=	5	5	10	8	11
+	8	8	7	6	4
++	1	6	4	5	1

'strong support' (++), 'moderate support' (+) and 'indifference' (=), 'moderate rejection' (-), and 'strong rejection' (--).

When regarding Table 15 it can be noticed that:

- ?? orientation a) faces some strong opposition;
- ?? orientation b) raises a lot of support but may have a difficult start because of lack of effective organisations in support and huge difficulties in implementing dispersed measures;
- ?? orientation c) has also major support and no strong opposition, but may have relatively low effectiveness in the short term;
- ?? orientation d) is already being implemented, level of success is connected to uncertainty of science and technological fields;
- ?? orientation e) will face some opposition namely by the oil industry that may not be interested in losing their profits.

As a conclusion about policy orientations it can be stated that a dominant orientation could be a mix of d), b) and c), and slowly developing into e).

About the above targets it can be concluded that they seem to be feasible and could be effectively pursued, albeit with great difficulties on the reduction of demand for motorised travel. The difficulties arise from the dependency of our societies on road transport, the image of the private car as a provider of freedom and status, and the progressive adaptation of the built environment to accommodate its needs.

This relative strength of supporters and rejecters of a certain policy orientation is not the same all over Europe, and even for a certain region it may well change over time. Many conditions will influence this **balance of power**, the main factors probably being:

a) the current level of endowment of the region (in transport provision on the most relevant modes for its lifestyle) with respect to competing and neighbouring regions;

b) the relevance for the economy of the region of the traffic flows that are being considered on a particular issue;

c) the intensity of direct aggression by transport flows to the quality of life and to the environment of the region.

So, for most issues, it will be impossible to dictate a policy orientation that would be generically preferred all over the EU.

The fact that one particular policy orientation on an issue has a strong acceptability does not imply that it will form the basis of policy on that issue: quite often, it is on the operational specifications and their details that oppositions are created, and this may imply adjustments which may be wider than expected. On other occasions, a strong acceptability tarnished by one remaining strong rejection may lead to the redefinition of the initial orientation in the direction of making it less performing for those in favour but also less harmful for those opposing it, thus increasing its global acceptability.

Both these cases will be addressed by explicitly listing the defensive goals of stakeholders' groups when describing their negative reaction to a policy orientation on a specific issue.

Because of this possible 'barrier', in some issues there will be more than one position that could form the basis of policy, the definition of the latter being only possible by adequate treatment of operational details. In some cases, the consequence may be that a policy is defined on the basis of two initially separate positions that are combined for greater support, even if that implies some loss of consistency.

3.4 Synergies and Conflicts between Policy Targets

3.4.1 Framework for Assessing Interactions between Targets

As discussed in section 3.1 the obvious conflict between economic efficiency and environmental protection/safety objectives forms a fundamental hinder for the execution of transport policy. This originates already from the basic characteristics of transport systems, where as stated in Chapter 1 the pursuing of traditional transport problem has provoked unwanted side effects. The issue of conflicts and synergies has big impact also on the selection of policy instruments (see Chapter 4).

In order to illuminate the interactions between transport policy targets and to provide a tool for addressing them a framework has been developed in SAMI. The framework considers the forms and types of interactions according to six characteristics (see Table 16).

Table 16. Forms and types of interactions between transport policy targets

Form of interaction			Type of interaction		
Direction	Intensity	Precedence	Structural	Circumstantial	Instrumental
Synergy (+); conflict (-)	Weak (+) or (-); strong (++) or (--)	? , ? or ?	Permanent (S)	Depends on actual circumstances (C)	Depends on selected instruments (I)

The basic form of an interaction between policy targets is determined by three characteristics: the direction, intensity and precedence. The **direction** tells us if the interaction is synergetic, i.e. pursuing one target will be helpful for improvement on the other or if there exists a conflict, as pursuing of one target would worsen situation with respect to the other. The **intensity** describes the power of the interaction. If there is no intensity then there is no interaction between the targets. The **precedence** implies which one of the targets generates a reaction in the other. This is a necessary information because in many cases interactions between targets are not symmetrical, even though also symmetrical cases exist so that either target can generate a reaction on the other. The target towards which the arrow points precedes the other (see also Table 17).

In addition to the form of interactions also the type characterised by structural, circumstantial and instrumental dimensions are important. A **structural** interaction is considered permanent, independent of the current positions and point of view, as well as of the orientations adopted for action in pursuit of those targets. One of the major factors contributing for a structural interaction is a strong commonality of stakeholders engaged (positively or negatively) in the two targets being considered. A **circumstantial** interaction refers to the situation where a change of position in one of the targets would lead to changes in the direction and intensity of the interaction. An **instrumental** interaction means that the interaction between targets is likely to depend on the instruments or policy orientations adopted for their pursuit.

An Example on the Interactions between Targets

In order to illustrate the interactions between targets an example is given in Table 17 about the interactions, which target 1 "Reduce demand for motor vehicle travel" has with other targets defined in Table 14 above.[107] Only those targets, which have interactions between each other, are included.

When looking at the table, it becomes clear that interactions between targets are a major element to be taken into consideration in policy-making. Ignoring these interactions would certainly lead to ineffective actions, and special efforts must be developed to take into account the web of relationships illustrated in the table.

Table 17. The forms and types of interactions between Target "Reduce demand for motor vehicle travel" and the other targets

Target	Form	Type	Our Description
4 – Drastic reduction of fossil fuel consumption per unit of transport performed	- ?	S	Lower consumption by vehicles will induce more travel
9 – Drastic reduction of road traffic fatalities	++ ?	S	Less motorised travel will reduce traffic fatalities
10 – Especially drastic reduction of fatalities among more vulnerable road users	++ ?	S	Less motorised travel will reduce conflict between vehicles and vulnerable road users
13 - Promote fair allocation of costs to those who generate them	+ ?	C	A fair allocation of costs will probably increase costs of motorised travel and thus reduce it
14 - Drastic reduction of congestion, especially as a recurring event	++ ?	S	Less motorised travel will reduce the direct cause of congestion
16 - Avoid self-defeating traffic induction through construction of expansionist infrastructure	++ ?	S	Avoiding construction of new infrastructure will reduce induction of additional motorised travel
17 - Avoid excessive differences of accessibility to fundamental social functions among citizens of different regions	-- ?	C	Raising the levels of transport services in regions less served today will induce additional travel in them
18 - Stimulate, for each region, location of economic activities whose mobility needs match the accessibility profile of the region	+ ?	C	A more balanced set of accessibilities and mobility needs will help contain growth of motorised travel
19 - Avoid excessive differences among regions concerning their level and calendar of integration in TEN's, even for those with low traffic volumes (possibly recurring to intermodal solutions)	- ?	C	Good long-distance accessibility will induce additional travel in more peripheral regions (although starting from a very low basis)
20 - Promote good access to all basic urban functions without recourse to a private car	+ ?	S	With good access to most places without a car, demand for motorised travel will be reduced

A description of "Form" and "Type" is given in Table 16 and in the text after it.

3.4.2 The Hierarchy of Targets

When analysing the interactions between targets, it becomes obvious that there exists a hierarchy between targets. A set of 8 classes of targets has been identified in SAMI. A higher rank here does not mean that the target is necessarily more important, only that it is less dependent on actions intended at other targets. This means also that the actions aimed on higher ranked targets are in principle easier to execute. The 8 hierarchical classes of targets are presented below in Table 18, with comments on their potential for effective pursuit in the near future. For every target also the probable strength is marked, using classes A (strongest) to C (weakest). This classification is based on the analysis made in SAMI considering the list and relative power of stakeholders in favour and against pursuit of those targets.[108]

Targets 4, 11, 12, and 20 in Class 1 have no others affecting their success. They are relatively easy to pursue, do not raise strong opposition and so it should be no surprise that to some extent they are in the EU and national agendas.

Targets 2 and 3 in Class 2 are almost direct consequences of target 4 (reduce unit consumption), and receive also high public acceptance, as the fears of global warming and air pollution seem to be widely spread. Target 18 corresponds to common sense and has even already been transcribed into a law in the Netherlands (the so-called ABC rule relating transport and land-use). All of these targets seem uncontroversial for political support.

Targets 13 and 16 in Class 3 are positively influenced by advances in their preceding targets. However, they correspond to more difficult policy actions, caused to a rather large extent by technical difficulties in demonstrating the real extension of costs (target 13) and in showing that a certain piece of infrastructure is expansionist (target 16). This latter target is also especially vulnerable to opposition from several powerful groups, and thus demands a much stronger political will, which could be hard to gather in times of unemployment.

Targets 5, 6, and 8 in Class 4 have precedence only from targets 4 and 13, and would by this effect present no significant problems. Indeed, targets 5 and 6 are already well advanced in European or national policies. Target 8 is much more dependent on a local scale, where general principles of policy meet material interests of powerful persons and groups, and is much more difficult to pursue, especially because clear and strict guidelines are difficult or impossible to formulate.

Table 18. Hierarchical Class and strength of transport policy targets

Target No.	Description	Strength	Class
4	Drastic reduction of fossil fuel consumption per unit of transport performed	A	1
11	Increase comparability of costs among companies operating in markets protected from competition	A	1
12	Promote competitive markets	B	1
20	Promote good access to all basic urban functions without recourse to a private car	B	1
2	Drastic reduction of CO_2 emission by vehicles	B	2
3	Drastic reduction of toxic emissions by vehicles	A	2
18	Stimulate, for each region, location of economic activities whose mobility needs match the accessibility profile of the region	B	2
13	Promote fair allocation of costs to those who generate them	B	3
16	Avoid self-defeating traffic induction through construction of expansionist infrastructure	C	3
5	Increase recycling of vehicle construction materials	A	4
6	Reduce acid components and particles (soot) in exhaust gases	A	4
8	Reduce land loss and separation effects of building new infrastructure network	C	4
7	Reduce pollution impact from traffic streams on valuable buildings	B	5
15	Avoid excessive spending of public money in infrastructure	B	5
17	Avoid excessive differences of accessibility to fundamental social functions among citizens of different regions	A	6
19	Avoid excessive differences among regions concerning their level and calendar of integration in TEN's, even for those with low traffic volumes (possibly recurring to intermodal solutions)	B	6
21	Avoid exclusion of citizens of very low income to public transport (through direct subsidisation)	A	6
1	Reduce demand for motor vehicle travel	C	7
9	Drastic reduction of road traffic fatalities	B	8
10	Especially drastic reduction of fatalities among more vulnerable road users	A	8
14	Drastic reduction of congestion, especially as a recurring event	C	8

For target 7 in Class 5, only positive influences from preceding targets have been identified. Similar to target 8 in Class 4, the main problem is the dependence on local implementation conditions, but for target 7 it should be possible to apply some general rules. For target 15, the only preceding target with negative interaction is target 8 (reduce land loss and separation) because considerations of those effects raise the direct financial cost of infrastructures. But proper consideration of the costs of land loss and separation can certainly in most cases lead to a wise decision on the adequate level of spending. The greatest difficulties in this respect correspond to the need of breaking with the traditional ease of spending large amounts of public investment in infrastructure.

All targets 17, 19 and 21 in Class 6 fall in the domain of regional or local development. In all cases, there are no fundamental oppositions as long as the funds are used with acceptable efficiency. The difficulty is always to balance the (almost undisputed) long-term willingness to contribute to regional development with the short-term limitations of the contributing regions, especially in times of fiscal discipline and high unemployment. It would be possible to say that the principles are not being questioned but the speed of progress is limited through the funding capabilities.

Target 1 is the only one in Class 7. This target has a very wide geographical scope and has a lot of interactions with other targets, as motorised mobility is such a strong feature of modern life. Motorised mobility also represents a powerful symbol of social status for those who only recently have had access to it. Some of these interactions are structural and with a negative impact on the progress of other targets, e.g. targets related with regional development

Targets 9, 10 and 14 in Class 8 are the most complex targets, as they are affected by progress in so many others. All three targets are related to the level of road traffic, particularly in individual transport. For all of them the large part of the efforts made so far have been on the technological and regulatory side, since there has been little willingness to adapt / impose changes in behaviour. There seems to be a higher social acceptance towards measures for special protection of the more vulnerable road users. For the other two targets, all solutions pointed at reduction of traffic volumes seem to be ill received in most countries.

3.5 Performance Indicators

3.5.1 Developing Policy Indicators

Policy indicators ought to show quantified information, which can help to explain how change is occurring through time. Their economic counterparts are better known and more established, and include indicators such as gross domestic product (GDP), the level of employment, the rate of inflation, and the balance of payments and have been used for many years to judge the state of the economy. They do not explain why particular trends are happening, and they do not necessarily reflect the situation in a particular economic sector or geographical area, but overall they provide policy makers and the public with indicators about changes in the economy. Economic indicators can assist economic policy decision making and allow the public to judge how well the economy is performing overall. Policy indicators can be used in the same way as economic indicators. They can assist policy decision making by providing information about the effects of policy changes.

In order to make better decisions about policies, reliable information about the transport sector, and the factors which impact upon it, is needed. Policy indicators provide a summary of this information. The challenge in developing these indicators is to strike the balance between too many indicators resulting in information overload, and too few indicators resulting in the oversimplification of issues. Thus, policy indicators must be able to both:

?? measure the extent to which policies are achieving policy objectives;
?? simplify and communicate a large amount of data using a smaller amount of representative, meaningful information.

The selection of policy indicators involves the following stages:

?? identifying the users of the indicators;
?? defining of the purpose of the indicators;
?? deciding on the process of generating and updating potential indicators;
?? determining the suitability of potential indicators.

Although policy indicators are more likely to be used by practitioners to evaluate the effects of policy on a number of issues, indicators may also be used for other specific user groups, e.g. politicians or the public. The type of user will determine indicator selection. Practitioners may require more aggregated scientific data whereas the public may be more interested in less complex, more 'resonant' indicators. Practitioners may demand both global and local indicators whilst the public are generally more likely to want to know about indicators relating to local issues that directly affect their quality of life. Being at the interface between government practitioners and the public, politicians may wish to know about the indicators used by both practitioners and the public.

Furthermore, the selection of potential indicators is also influenced by their intended purpose:

?? policy development;
?? policy appraisal;
?? policy assessment/review;
?? environmental auditing;
?? public information.

There are a variety of ways to generate potential indicators. The list below is by no means comprehensive, and the options are not mutually exclusive:

?? technical devices coupled with sampling programmes;
?? administrative data (statistics);
?? public opinion surveys;
?? public fora;
?? literature review;
?? Delphi technique using expert groups; and/or
?? expert workshops/seminars.

A policy indicator should ideally have the following qualities:

?? representative of one or more impacts;
?? measurable or calculable;
?? simple and easy to interpret;
?? demonstrate trends over time;
?? give early warnings about trends in the 'wrong' direction;
?? sensitive to policy changes;
?? have a relationship to other indicators;
?? based on readily and cheaply available data;
?? significant;
?? have or lead to a target or guideline against which to compare it.

In practice, rarely all these criteria are met in a single indicator. For example, an indicator, which is simple and easy to interpret, may not be sensitive to changes over time. There is an increasing level of interest and activity in the use of indicators for policy analysis and decision-making. Many different types of indicators for a variety of sectors are being investigated and used. There is already a body of literature on indicators – especially environmental ones - for the transport sector[109] (see Table 19).

Table 19. Examples of environmental indicators

Type of Indicator:
1. Resource Consumption:
?? energy consumed by transport
?? energy consumption by mode
2. Pollution
?? global pollutants (CO_2, NO_X) from transport
?? local pollutants (CO, VOCs, particulates) from transport
?? waste from transport sector
?? population affected by transport noise
3. Land:
?? land lost through infrastructure construction
4. Minerals:
?? aggregates production for transport infrastructure
?? oil production for transport
5. Air:
?? levels of local pollutants in air
6. Health:
?? transport injuries and deaths
?? ambient noise levels from transport

While indicators may help policy makers to focus on key issues and highlight some significant trends, they do not provide a complete picture. They are by their nature simplifications of a more complex picture. They might not, unless disaggregated, show trends in different sectors or different geographical areas. Some policy objectives are difficult to measure (such as quality of life), which is problematic when trying to identify policy indicators. Indicators therefore have limitations and should not be used in isolation to determine progress towards policy targets. To do so could easily lead to misrepresentations or distortions of priorities. Qualitative information is also required in order to make judgements about whether policies are having the desired effect. Indicators are nevertheless useful tools in helping to inform and stimulate thinking about policy impacts.

3.5.2 Overall and Operational Indicators

In SAMI two types of indicators were used: overall indicators for measurement of progress on the selected target and operational indicators related to progress along the suggested policy orientations. In order to illuminate this approach an example is given about the **policy issue** 1 "Climate change/local air pollution/water pollution/human health hazards", which includes three **targets**:

?? reduce the demand for motor vehicle travel;
?? drastic reduction of CO_2 emission by vehicles;
?? drastic reduction of toxic emissions by vehicles.

For them following **overall indicators** can be defined:

?? global evolution of CO_2 emissions related to transport activities;
?? local level of air pollution related to transport activities.

The targets are connected into five **policy orientations**:

a) raise vehicle purchase and registration fees;
b) stimulate use of public transport, ridesharing and telecommuting;
c) integrate land-use planning with transport services and infrastructure development;
d) economic incentives to car industry towards low-emission vehicles;
e) differentiate fuel taxes according to level of CO_2 generation / local air pollution.

Policy orientations can then be transformed into **operational goals**, which combine the targets and policy orientations on the practical level:

a) reduce growth of car ownership;
b) reduce market share of individual transport;
c) reduce need to travel long distances for normal activities;
d) +e) reduce average emissions of CO_2 and air pollutants by vehicles.

Operational indicators can then be attached to these operational goals in a way that the progress along the suggested policy orientations can be measured:

a) rate of growth of car ownership;
b) average number of trips by private car per unit of GDP;
c) average mobility (number of person-kilometres) per unit of GDP;
d) + e) average emission (per km travelled) of CO_2 and of local air pollutants.

When selecting the indicators, it has to be remembered that indicators must be:

- ?? *appropriate,* i.e. measure progress along the intended direction;
- ?? *efficient,* i.e. do it with a data gathering cost that is no more than necessary, and desirably represents a small fraction of the benefits we hope to derive by moving towards that target.

This is frequently difficult in the transport system, and not only in its relations to the environment. The disperse nature of transport activities in space and in time make many of its variables possible to be read only by sampling, and frequently with relatively high costs. Moreover, it frequently happens that, when we are dealing with complex phenomena, only indirect measurements are possible and thus an additional margin for error comes into play.

Elsewhere in the FP4, the MAESTRO project has defined a large number of indicators for all transport sectors, as an example indicators related to impacts on road sector are given in Table 20.

Table 20. Road sector indicators[110]

Impacts	Name of indicator	Description of indicator	Unit of measure	Type of measure (scale)	Method of obtaining measure	Data sources
Changes in regional economic performance	Economic output	Measure of economic performance of primary, secondary and tertiary industries	EURO	Quantitative	Collected	Public statistics
Changes in proportion of freight use of roads	Tonnage	Estimate of value of goods transported on roads	Tonne	Quantitative	Collected	Survey
Changes in accident rates for drivers	Accident rate	Measure of injury producing accidents	Per vehicle kilometre	Quantitative	Collected	Official records
Changes in accident rates for other road users	Accident rate	Measure of injury producing accidents	Per head of population	Quantitative	Collected	Official records
Changes in detection rates for alcohol and drugs	Detection rate	Detection against set criteria for consumption level	BAC or similar	Quantitative	Collected	Police records
Changes to levels of loss or damage to freight	Value of freight	Value of freight reported to authorities	EURO	Quantitative	Collected	Insurance and police records
Changes in energy consumption	Fuel consumption	Measure of consumption level for all road traffic	Litre	Quantitative	Derived	Counting
Changes in emissions of noxious gases	Emission levels	Measure of gas emissions from vehicle stock CO,VOC,SO_2,NOX,	Ton/a	Quantitative	Derived	Survey
Changes in noise levels	Noise levels	Measure of peak and mean noise	dB	Quantitative	Derived	Survey
Changed occupancy rates for vehicles	Occupancy rate	Occupancy rate for passenger vehicles		Quantitative	Derived	Survey
Changed demand for public transport	Occupancy rate	Occupancy rate for public vehicles		Quantitative	Derived	Survey
Changed number of mixed mode journeys	Mixed mode journeys	Number or proportion of journeys including car and other transport mode		Quantitative	Derived	Survey

4. FORMATION OF STRATEGIES

When the appropriate transport policies have been agreed and related targets defined (for setting targets see section 3.3), the formation of strategies - needed to obtain these targets - can start. Then available transport policy instruments will be identified and the most appropriate ones selected. The selected instruments have to be formed to packages, because it is well known that usually one instrument alone is not enough. The formation of packages can be an extremely complicated process, when there are many possible instruments and for any instrument there are many possible variations, e.g. different prices. An optimisation method applicable on the strategic level and developed in project SAMI can alleviate this task.

4.1 Identifying Policy Instruments
A discussion of necessary information related to policy instruments and a list of possible instruments and their impacts (for current transport impacts see section 2.2) is given first. Then a classification of policy instruments and a set of instruments used in the SAMI project are presented.

4.2 Developing Policy Packages
The need for packages is discussed and an example is given on how the packages can be formulated with the aid of experts. Then follows a discussion about the approaches for developing policy packages.

4.3 SAMI Optimisation Method
An optimisation method – aiming to find an optimum way to combine the instruments according to the specified targets - developed in SAMI is presented. After a general presentation the different steps of the approach are described and the results from a demonstration highlighted.

Box 9. The need for packages[111]

In any complex system, attack – however apparently intelligent – on a single element or symptom generally leads to a deterioration of the system as a whole. *Forrester´s first law*

4.1 Identifying policy instruments

The first stage in generating transport strategies is compiling a comprehensive list of possible policy instruments that might be used to achieve the desired policy targets (for setting targets see section 3.3). A number of publications have been produced which provide inventories of the different types of transport policy measures that might be used[112]. For each policy instrument, it is then necessary to identify:

?? the influence of each measure on the policy targets (e.g. probable impacts (see also section 2.2 and Chapter 5) compared to the indicators related to the targets);

?? the timescale of effect of the policy instruments – whether impacts are likely to be short, medium or long-term; and

?? the potential interaction between policy instruments (see also sections 3.4 and 4.2).

An example of fifteen transport policy instruments and their probable impacts on carbon dioxide emissions, kilometres driven by car and equity are given in Table 21 below.

Table 21. Impacts of transport policy measures[113]

Policy	CO_2 emissions	Kilometres by car	Equity issues
Fuel taxes	Reduction	Reduce total	Problems in rural areas
Variable car excise taxes	Reduction	No direct impact	Improvements
Scrappage bounties	Reduction	Small reduction	Improvements
Road congestion pricing	Reduction	Reduction in priced area, may increase elsewhere	Ambiguous
Vehicle use restrictions	Reduction	Reduction	Ambiguous
Parking charges	Reduction unless diversion a problem	Reduction in priced area, but ambiguous in total	Ambiguous
Parking controls	Reduction unless diversion a problem	Reduction in controlled area, but may increase elsewhere	Ambiguous
Land use planning	Reduction if policy successful	Reduction if policy successful	Possible long term improvement
Traffic calming	Possible increase in total	Reduction in residential areas	Improvements possible
Public transport subsidies	Small increase	Reduce total, especially urban	Improvements
Road construction	Increase	Increase	Could be negative

The SAMI project formulated the list of policy instruments given in Table 22. It can be seen that instruments are divided into two main classes: economic and regulatory.

The instruments provided relate to the targets developed in SAMI and by that way they are mainly addressing the modern and post-modern transport problems (for the categories of transport problems see section 1.3).

Table 22. Examples of policy instruments

ECONOMIC INSTRUMENTS	REGULATORY INSTRUMENTS
?? Business incentives for telecommuting; ?? Differentiated fuel costs according to emissions; ?? Differentiated fuel costs according to fuel type; ?? Differentiated new car costs according to level of recyclability; ?? Differentiated vehicle costs according to safety features; ?? Funding for pedestrian and cycle networks; ?? Funding for the segregation of different road users/ speeds of vehicles; ?? Funding of intermodal/interoperable transport in areas with low accessibility; ?? Incentives for public transport provision; ?? Funding of education programmes for drivers; ?? Funding of infrastructure; ?? Increase fuel costs; ?? Increased funding for traffic policing; ?? Road pricing; ?? Tax car parking spaces; ?? Taxes on the use of private transport; ?? Research and Development incentives to industry; ?? Regional taxation; ?? Road tolls on TENs.	?? Casualty reduction targets; ?? Driver information systems; ?? High Occupancy Vehicle lanes; ?? Increased fines for dangerous driving; ?? Introduce lower speed limits; ?? Land use planning guidance; ?? Location policy (e.g. Dutch ABC locations); ?? Park and Ride facilities / parking restrictions in the City Centre; ?? Public service contracts; ?? Reduction of roadspace; ?? Regular checks on driving ability; ?? Regulate against cross-subsidy of services; ?? Regulations for cost transparency, EU benchmarking of service provision; ?? Regulations on Environmental Impact Assessment and Strategic Environmental Assessment; ?? Regulations on social appraisal; ?? Requirements for intermodal ticketing; ?? Restrict roadspace and car parking; ?? Business transport plans; ?? Restrict traffic in conservation areas; ?? Standards for the content of fuel; ?? Standards for the recyclability of cars; ?? Standards for the segregation of different road users/ speeds of vehicles; ?? Standards for vehicle design; ?? Traffic calming; ?? Travel information systems; ?? Traffic targets.

4.2 Developing Policy Packages

It is increasingly recognised that individual policy instruments should be combined into comprehensive policy packages. There are two main reasons for this development:

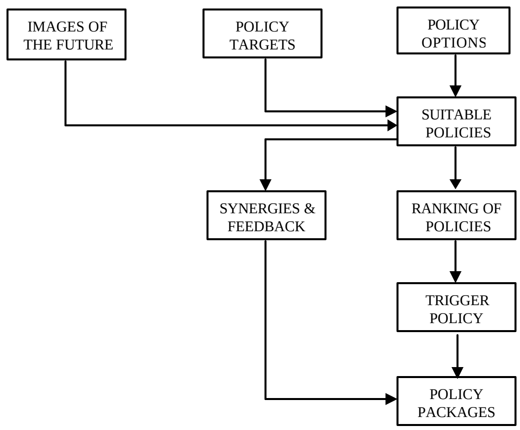
1. There might well be natural synergies between individual instruments which makes their combination efficient (see also section 3.4).
2. For reasons of public acceptability it is important to balance a potentially unpopular instrument (such as road pricing) with a popular instrument (such as improved public transport).

Following these two comments and knowledge of the instruments available, packages of instruments can be created by planners in a relatively straightforward manner. The POSSUM project of the FP4 provides an example how this can be done in a creative process (see Box 10).

A difficulty arises though when the question is asked "at what level is a particular instrument set - such as road pricing or increase in public transport frequency?". It is a well known fact that if left to the market, the socio-economically optimal outcome will not be realised, because of market failure caused by the negative externalities existing in the transport sector. In the SAMI project a quantitative planning approach has been developed which aims to find the levels of implementation of instruments that maximise some prespecified social objectives (see section 4.3 below).

Box 10. The POSSUM process of constructing policy packages[114]

Suitable policies are first selected from an inventory of policy options which contribute to one or more policy targets. Synergies between policies and feedback mechanisms between policies can be identified using expert groups. Suitable policies are ranked to indicate their likely impact on each of the policy targets. From the higher-ranking policies, a trigger policy is selected – a policy which contributes significantly to the policy targets but which presents few major obstacles to implement. The trigger policy forms the basis for the construction of the policy package.



Having identified the trigger policy, the process follows a series of similar stages where complementary policies are identified. In the first stage, one or more policies that are most complementary to the trigger policy are identified. For each of the complementary policies identified in Stage 1, one or more policies that are most complementary to them are identified in Stage 2 of the process.

4.3 SAMI Optimisation Method

4.3.1 Introduction

As stated in section 4.2, a quantitative policy optimisation procedure is useful for creating a package of policy instruments where each instrument can be implemented at a number of different levels. Optimisation is a means of performing an *intelligent search* using predictive models and quantitative assessment methods to produce an *optimal* combination of policy instruments with a limited effort. The procedure is summarised in Figure 4.

The major benefit of an optimisation procedure is that it makes full use of the quantitative information stored in any predictive model and assessment method being used in policy formulation. The optimisation procedure simply finds the set of policy instruments that are optimal with respect to the model and assessment method. The results of the optimisation will be useful if the model and assessment method are accurate and comprehensive. If they are not so, the optimisation method, however sophisticated computationally, will be unable to hide the fact.

Due to the quantitative nature of the optimisation procedure, it is of limited value in taking into account qualitative impacts, which cannot in any sense be expressed quantitatively. Thus, an optimal set of policy instruments should also be scrutinised with respect to qualitative impacts where appropriate. However, this is not an issue of optimisation per se but rather an issue of quantitative assessment in general.

An interesting question arises with respect to how the optimisation procedure handles equity issues. As with qualitative assessment, the essential difficulty with handling equity concerns the assessment method rather than the optimisation procedure. However, the computational power of the latter can be used to help ameliorate the problem if not actually solve it. The mechanism for doing so is to define a distinct assessment formulation for each stakeholder group of interest, and then to find the optimal package of transport instruments with respect to each of these groups. The impacts of these group-specific optimal instruments could then be formed into a structured information table which would feed an appropriate evaluation method (cf. Fig. 5). Although this procedure was not used in the SAMI demonstration (see section 4.3.3 below) it could be a subject of future research.

The main aim of the SAMI work on optimisation was to **develop an optimisation method** able to find optimal transport strategies for Europe with respect to politically defined transport targets. Such strategies are typically made up of packages of transport instruments for road, rail, air and water modes, and involve, e.g. pricing and capacity instruments for both passenger and freight transport.[115]

The SAMI optimisation approach uses, with respect to the steps in Figure 4:

1. Possible CTP instruments and their possible levels of implementation (see section 4.1).
2. Alternative future scenarios (see section 5.2).
3. Predictive models (see sections 5.3 and 5.4).
4. Agreed policy targets (see 3.3), related indicators (see section 3.5), and a quantitative evaluation method (see Chapter 6) for making judgements on policy. These ingredients are combined to create an *objective function* which measures how well the CTP instruments are reaching the agreed targets.
5. Optimisation algorithms (described in section 4.3.2 below).

The optimisation algorithms are presented next in section 4.3.2 and then a demonstration of the SAMI Optimisation Method is described in section 4.3.3.

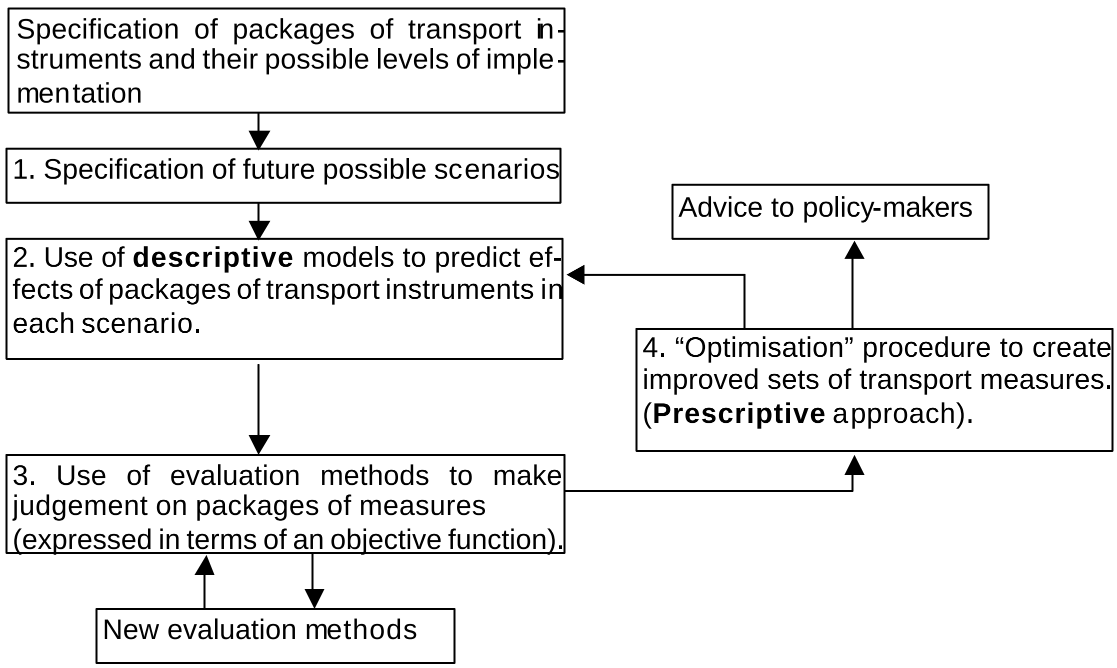


Figure 4. Overview of quantitative policy optimisation

4.3.2 Optimisation Algorithms

Optimisation algorithms were developed in SAMI in order to maximise the values of the objective functions created in Step 4 in Figure 4. Since algorithms are generally defined in terms of the *minimisation* of objective functions, the SAMI algorithms will follow this terminology (i.e. they will be defined in terms of minimising the negative of the objective functions created in Step 4). All the SAMI optimisation algorithms were variations upon a *core optimisation algorithm*, involving combinations of *centralised* and *decentralised sub-algorithms*. The details of these variations are described below in section 4.3.3 since they were specific to the SAMI demonstration. The current section describes the core algorithm and gives the principles behind centralised and decentralised sub-algorithms.

Core Optimisation Algorithm

The core optimisation algorithm applied within SAMI is based on the downhill simplex method in multidimensions[116].. It solves a multidimensional minimisation, i.e. finding the minimum of a function of more than one independent variable. A simplex is the geometrical figure consisting, in N dimensions, of N+1 points (or vertices) and all their interconnecting line segments, polygonal faces etc. In two dimensions, a simplex is a triangle. In three dimensions it is a tetrahedron, not necessarily the regular tetrahedron.

The method requires an initial starting point, that is, an N-vector of independent variables. The algorithm is then supposed to make its own way downhill through the N-dimensional topography, until it encounters a (at least local) minimum. The downhill simplex method must be started not just with a single point, but with N+1 points, defining an initial simplex. If one of these points is taken to be the initial starting point $\mathbf{P}_0$, then the other N points can be expressed as:

$$\mathbf{P_i} \ ? \ \mathbf{P_0} \ ? \ ?_i \mathbf{e_i} \qquad \textbf{(1)}$$

where the $\mathbf{e}_i$'s are N unit vectors, and where $?_i$ is a constant which is a guess at the problem's characteristic length or scale ($?_i$ could be different for each vector direction).

The downhill simplex method takes a series of steps, most steps just moving the point of the simplex where the function is largest ("highest point") through the opposite face of the simplex to a lower point. These steps are called reflections, and they are constructed to conserve the volume of the simplex. When it can do so, the method expands the simplex in one or another direction to take larger steps. When it reaches a "valley floor", the method contracts itself in the transverse direction and tries to ooze down the valley. If there is a situation where the simplex is trying to "pass through the eye of a needle", it contracts itself in all directions, pulling itself in around its lowest (best) point. The routine name AMOEBA is intended to be descriptive of this kind of behaviour[117]. An appropriate sequence of steps will always converge to a minimum of the function (though not necessarily a global minimum).

For each new point the procedure simply requires an evaluation of the function to be minimised. The method can handle hard constraints or discontinuities within the objective function.

Centralised and decentralised applications of core algorithm

The *core* algorithm described above can be applied in a centralised or a decentralised approach. In the centralised approach, all policy measures are optimised simultaneously to find the minimum of the objective function. This simultaneous optimisation is analogous to centralised traffic signal control whereby all signal settings in a network are optimised simultaneously within a central computer.

One of the problems with the use of a centralised approach may be that there is a restriction on the number of measures which can be considered without causing problems in the N dimensional topography or search space. It may be that as the number of measures increases then the changes in the objective function become more difficult to relate to changes in the N measures.

A possible solution to this problem is to break the problem down into sub-problems of the same type, and to apply the core algorithm to each sub-problem independently. This application of the algorithm is a *decentralised* approach and again it has analogies in the traffic signal control field whereby some systems treat junctions as individual optimisation problems with constraints from neighbouring junctions.

Inevitably, a decentralised approach involves more actual optimisations than a centralised approach. However, since each sub-problem consists of fewer variables, these optimisations will certainly have fewer iterations. Thus the total number of iterations required for convergence of the whole problem may be less than in the centralised approach.

Prior Belief and the Restart Option

As mentioned above, it is possible for the optimisation process to find a local rather than a global optimum. In addition the algorithm may be fooled by a single anomalous step that, for one reason or another, failed to get anywhere. Therefore, it is frequently a good idea to *restart* a multidimensional minimisation routine at a point where it claims to have found a minimum. This restart is achieved by reinitialising N of the N+1 vertices of the simplex in a fashion similar to equation (1) where P_0 is one of the vertices of the claimed minimum or *current best* solution. The *prior belief* of the decision-maker can be used as a basis for the other N points during the restart option.

Using this method to assign the restart simplex has a dual purpose: i) it provides an independent restart option; and ii) it incorporates the prior belief of the decision maker within the search process thus bringing in expert knowledge and allaying fears of automated processes. The use of a restart option is not expensive in terms of computation effort as the simplex has already a converged solution as one of the vertices and if this were a true minimum then the process will converge back to this point in a small number of iterations.

4.3.3 Demonstration

The methods described above are generic and can be used in a large variety of applications. This section describes a particular use of the optimisation procedure, to optimise European transport policy actions, and can be thought of as a case study of the generic methods. In this case study the optimisation procedure was used to find "optimal" zone-based transport policy measures for the Unified Europe and Cohesive

Regions scenarios (see section 5.2.3), for both *unconstrained* and *constrained* objective functions (see below).

Requirements for the Instruments

The screening of instruments (see Table 22 above) to be included in the demonstration considered that:

- ?? instruments must be distinguished by four main modes (road, rail, air and water);
- ?? instruments can be applied in any subset of 9 (internal) zones of Europe;
- ?? instruments can be either freight-oriented or passenger-oriented or both;
- ?? instruments are essentially price-based or capacity-based.

Furthermore, it should be possible to represent the implementation of these instruments (where appropriate) at any level within a given range, thus creating a *transport instrument space*

Objective Function

The SAMI optimisation approach uses an objective function created with the aid of evaluation methods, where the value of the objective function signifies whether one policy package is better or worse than another is.

The objective function used was adapted from previous work in the FATIMA project at the urban level. This objective function represents an extended form of traditional cost benefit analysis to take into account externalities due to pollution, noise and accidents.[118] This function uses quantitative indicators and gives them monetary values; it has been adopted by the AFFORD project of the FP4, where it is used to represent marginal social cost pricing at the urban level[119]. It is one of a range of possible objective functions that could have been used. Chapter 6 describes SAMI Evaluation Methodology, which deals with both qualitative and quantitative indicators. One of these methods, the Flag Method, has been incorporated into the SAMI objective function in order to represent hard targets on the reduction of CO_2 emissions. These targets, which vary for different parts of Europe, are represented in the optimisation procedure as hard constraints, leading to high penalties being added to the values of the objective functions if the targets are overrun[120].

The results of the unconstrained optimisation are taken to represent policy measures which reflect the goal of maximising social welfare, as the objective function EEFP (Economic Efficiency Function with externalities) is taken to represent marginal social cost pricing including local externalities. The results of the constrained optimisation (CEEFP) are taken to represent the same general objective or goal but further constrained by the specific CO_2 targets as specified in the Kyoto agreement.

Scenarios

The demonstration was based on two Images of Future (see section 5.2.3). In summary, the first image, **Unified Europe**, is one in which there is good co-ordination and co-operation between national governments on policy-making and strategic policy is co-ordinated at the EU level. In contrast, the second image of the future, **Cohesive Regions**, reflects more regional and local priorities, in which decision-making is devolved to the national, regional and local levels in line with the principles of subsidiarity.

When using the Unified Europe scenario – with common targets for all Member States - both EEFP and CEEFP are optimised for Europe as a whole. In the Cohesive Regions scenario, optimisations are carried out on a zone by zone basis, which allows zones to have conflicting objectives. Each zonal optimum takes into account the zonal optima calculated for other zones.

Analogous to traffic assignment methods, a Unified Europe optimum is comparable to a *system optimum*, whilst a Cohesive Regions optimum is comparable to a *user equilibrium*. If each zone has the same objectives, the user equilibrium is *deterministic*; if zones have different objectives the user equilibrium is *stochastic*.

Policy Packages

As mentioned above, a critical issue with regard to the effectiveness of optimisation algorithms concerns whether they can handle a large number of policy measures. In order to make useful comparisons between different algorithms, optimisation tests were conducted in the SAMI case study with different sets of policy measures, each set with a different size:

- 18 Measures: Passenger road prices (9 measures) and freight road prices (9 measures);
- 36 Measures: As 18 plus train passenger prices (9 measures) and train freight prices (9 measures);
- 72 Measures: As 36 plus road capacity (9 measures), train passenger capacity (9 measures), train freight capacity (9 measures) and air prices (9 measures);
- 113 Measures: As 72 plus air passenger capacity (9 measures), water freight prices (9 measures), water freight capacity (9 measures), passenger ferry prices (7 measures) and passenger ferry capacity (7 measures).

Definition of Algorithms

Section 4.3.2 described centralised and decentralised approaches to applying the core algorithm. In the centralised approach, all variables are optimised with respect to the objective function simultaneously. On the other hand, the decentralised approach breaks the problem into smaller sub-problems. In this case study, this is accomplished by breaking the problem down into zonal sub-problems.

The optimisation problem under a Cohesive Regions scenario must inevitably be solved by a decentralised approach, due simply to the definition of the scenario. However, whilst the final step of optimisation under a Unified Europe scenario needs to be centralised, there is some flexibility on whether a centralised or decentralised approach is used before the final step. As mentioned in section 4.3.2, a centralised approach might be unsuccessful for an optimisation problem involving a large number of variables.

The methods constructed for the Unified Europe scenario in the SAMI case study vary as to how far they use decentralised sub-algorithms before the final step. An algorithm named *Method 1* has no decentralised sub-algorithm; however algorithms named *Method 2* and *Method 3* do have decentralised sub-algorithms. Essentially, the difference between Methods 2 and 3 is that the latter has more decentralised iterations. Method 3, which can be termed a *decentralised - iterative* method, was applied to the problem for 113 measures only due to the relatively large number of transport model runs it requires.

If one method leads to significantly greater optimal values than another method for either EEFP or CEEFP, then this shows that the latter method is finding only a local optimum rather than a global optimum.

Thus SAMI has formulated three methods of implementing the same *core* optimisation algorithm to be applied to the Unified Europe scenario.

For the Cohesive Regions scenario, *Method 4* was devised which involved a pure decentralised algorithm. This algorithm had the same decentralised steps as Method 3 (for the Unified Europe scenario) but did not have the latter's centralised final iteration.

Results from testing algorithms

The objective function was used firstly without constraints to find the unconstrained optimal prices and capacity changes. An analogous constrained optimisation was then carried out which ensures that the solution meets the policy-makers' targets on CO_2 emissions (CEEFP).[121]

The optimal values of EEFP and CEEFP for the three methods for the Unified Europe scenario are shown in Tables 23 and 24. The absolute values in these tables hold no interest; rather it is the relative sizes that are significant. In general, these tables show that sensible results were obtained as follows:

- with one exception (Method 1 for CEEFP), increasing numbers of measures provided better values of both EEFP and CEEFP for both Methods 1 and 2;
- final values of EEFP and CEEFP were higher than initial values for both Methods 1 and 2;
- the optimal values of CEEFP are always lower than the optimal values of EEFP (to be expected since the latter has no hard constraints).

In terms of making a comparison between methods:

- Method 2 gave higher (or the same) optimal values of both EEFP and CEEFP when compared with the optimal values provided by Method 1. The superiority of the former method can be seen to increase as the number of measures being tackled increases.
- Method 3 gave higher optimal values than Method 2 of both EEFP and CEEFP for the 113 measure set on which it was tested.

The simple conclusion from these results is that algorithms for complex measure sets in the Unified Europe scenario should contain decentralised sub-algorithms.

Only one method (Method 4) was tested for the Cohesive Regions scenario and so there are no equivalent meaningful tables for it like Tables 23 and 24. The main aim in testing Method 4 was to examine its robustness in the face of differing objective functions by zone. The conclusion was that it was extremely robust.[122].

Table 23. Unconstrained EEFP values

	Unified Europe Unconstrained EEFP Values (*10^{12} Euro)				
Number of measures	METHOD 1 Centralised		METHOD 2 Decentralised - Centralised restart		METHOD 3 Decentralised Iterative with centralised restart
	Initial	Final	Initial	Final	Final
18	5.33	5.52	5.39	5.59	
36	5.58	5.61	6.50	6.53	
72	7.17	7.40	10.08	10.26	
113	6.94	7.70	10.30	10.44	11.37

Table 24. Constrained CEEFP values

	Unified Europe Constrained CEEFP Values (*10^{12} Euro)				
Number of measures	METHOD 1 Centralised		METHOD 2 Decentralised - Centralised restart		METHOD 3 Decentralised Iterative with centralised restart
	Initial	Final	Initial	Final	Final
18	2.99	4.83	4.72	4.83	
36	3.93	4.16	5.12	5.39	
72	4.23	6.06	9.75	9.83	
113	4.03	7.19	9.81	9.91	11.24

The demonstration of the optimisation method indicated that the SAMI approach is suitable for use on the European level. Probably it could be used as well on the word-wide level, and this could be a subject of future research. However, in order to be used in any "real-life" policy evaluation the calibration of EURO 9 transport model has first to be executed.

5. PREDICTION OF IMPACTS

When the policy packages are chosen, the next step in the planning process is to estimate their possible impacts. This is usually made with the aid of models. The requirements for impact assessment depend on the planning and decision-making context, which also influences the following evaluation phase (see Chapter 6). The impacts have usually to be considered in a future situation. Often this will be obtained with the aid of scenarios. Models are then used for estimating the direct impacts (as defined in Chapter 2) of the instruments, both with regard to economic efficiency (*transport models*) and the environment and safety (*environmental models*).

5.1 Requirements for Impact Assessment

Impact analysis aims at estimating all policy-relevant consequences of given policy packages. When analysing a certain policy, one is interested in the assessment of the effects that solely accrue from that policy. In this section distinct levels where impact assessment can be applied are presented and the conditions the assessment methods should fulfil defined.

5.2 Policy Scenarios

In this section the need for scenarios and different approaches in scenario construction are discussed and a scenario building process is described. Also two Images of the Future used in the SAMI project are presented. In addition to that also the research on scenarios in other FP4 projects will be highlighted.

5.3 Transport Models

The basic characteristics of transport models are discussed and an example of a comprehensive model is given. Also the requirements for strategic transport models are presented. The EURO9 model developed in the SAMI project is described, too.

5.4 Environmental Models

After the presentation of the environmental part of the EURO9 model the basic features of a major environmental model developed in a FP4 project are given.

Box 11. Search for tomorrow[123]

We must no longer wait for tomorrow, it has to be invented. *Gaston Berger*

5.1 Requirements for Impact Assessment

The assessment of impacts (see also section 2.2) forms the basis for following evaluation phase. In principle, one may distinguish four distinct levels at which impact assessment of policy packages may be applied:

1. an assessment (usually qualitative) of the **contribution** of policy measures towards the solution to a given policy problem;
2. a consideration of the **appropriateness** of the package of policy instruments in the light of either changed economic circumstances of the contentions of economic theory;
3. the measurement (as far as possible) of the range of **benefits** accruing from the package of relevant policy measures;
4. the measurement of both the **costs and benefits** of the policy and the cost effectiveness of individual policy instruments.

When analysing a certain policy (e.g., transportation policy, regional policy), one is interested in the assessment of the effects that solely accrue from that policy. Impact analysis thus aims at estimating all policy-relevant consequences (direct and indirect, intended and unintended) of (a set of) given policy measures. Usually, questions that emerge when dealing with impact analysis of a certain policy are the following:

?? What would be the situation if there were no specific policy?

?? What would be the influence of possible other relevant variables besides the specific policy instruments or measures used in this framework?

?? Which are the interrelations between those different variables impacting on the system at hand?

Impact analysis deals typically with 'policy-off' versus 'policy-on' situations. The 'policy-off' situation refers to the zero (initial) situation (assuming away the implementation of policies). The 'policy-on' situation refers to the evaluation of the system after the policy measures have been implemented. Clearly, different policies lead to different 'policy-on' situations, each of which has to be judged on the basis of multiple judgement criteria. Sometimes also a desired alternative is (implicitly or explicitly) taken as a frame of reference. An impact assessment method for transportation (infrastructure) policy should ideally be able to identify both direct and indirect impacts (see section 2.2). In practice this is not always the case. On the strategic level it often happens that data needed as input for transport and environmental models is not complete (for the models see sections 5.3 and 5.4). In addition to that it has to be remembered the theoretical difficulties when assessing possible impacts on economy (see sections 2.2.4 and 2.2.5).

Clearly, impact analysis is a useful and necessary tool in the evaluation of public policies. However, using impact analysis leads also to the necessity to be aware of the great many problems inherent in its implementation. In the context of impact assessment methods for the evaluation of transportation infrastructure planning, one has to take into account the specific characteristics of network infrastructure marked by a complex connectivity structure. Finally, it is clear that the scope of impact analysis may be very broad, covering a multiplicity of policy sectors, spatial entities, time horizons etc. To the same extent there is a wide variety of different impact assessment methods and evaluation methods (see also Chapter 6).

5.2 Policy Scenarios

5.2.1 Need for Scenarios

The dynamic nature of policy objectives, priorities and advice requires a way of identifying policies and proposals that are robust and flexible enough to withstand change. Policy scenarios allow the role and effect of different policies and proposals to be studied across a range of possible futures (for the benefits see Box 12).

Box 12. Potential benefits of policy scenarios to decision-making [124]

1) *providing useful frameworks for decision-making* – scenarios allow decision-making issues to be explored using a range of alternative scenarios, reflecting different assumptions about the future;
2) *identifying dangers and opportunities* – considering a range of alternative futures increases the likelihood of identifying possible problems and opportunities in policy-making;
3) *suggesting a variety of possible approaches* – the use of scenarios may generate a range of approaches to tackle issues or problems whereas the use of forecasts, often based on single theories or simple extrapolations, often leads to the pursuit of singular solutions;
4) *helping to assess alternative policies and actions* – scenarios may for example be used to identify the usefulness of different policies under alternative future conditions; and
5) *increasing creativity and choice in decision-making* – identifying possible future developments and avoiding the acceptance of current trends as inevitable opens up new possibilities for policy development.

A scenario is a tool that describes pictures of the future world within a specific framework and under specified assumptions. The scenario approach includes a description of two or more scenarios, designed to compare and examine alternative futures[125]. Often other scenarios are compared to a reference scenario, which is based on the projection of current trends. Elsewhere in the FP4 the SCENARIOS project has developed a reference scenario for European transport for a 2020 horizon[126].

In the following three different traditions and approaches in scenario construction are presented[127].

In the *American approach*, a distinction is made between context and strategy with the scenarios first being presented as the context within which the system operates and policy making takes place. Various actors are then asked to choose between alternative strategies and to adapt these so that "least regret" strategies can be selected by the user of the scenarios.

In the *French approach*, a comprehensive picture of the future is presented in terms of the current situation, a description of some future alternatives and a description of a number of events, which may connect the present situation with future ones. A particular version of the French approach has been adapted and used mainly in Swedish research so we also make the distinction of a third approach, although it is related to the French approach in many ways.

The *Swedish approach* has certain clearly distinctive characteristics and they have been mainly used for policy analysis[128]. They are normative in their structure and based on desirable futures or choices. They also use a backcasting approach (rather than forecasting) where an Image of the Future is constructed without taking account of current trends. A path is then constructed on how to move from where one is at present to this desirable future position. Experts are used to validate the process at various stages, so that feedback and modification of the scenarios can take place. The intention is not to provide a prescriptive view, but to illustrate possible future policy paths and indicate the nature and scale of actions (together with a timetable) necessary to achieve the scenario targets.

5.2.2 Scenario Building Process

Elsewhere in the FP4 the POSSUM project has distinguished seven main stages in the scenario-building process (see Box 13). Although some stages are reliant on one or more previous stages in the process, the link between each stage does not form a simple sequence. There are interactions and feedback loops between many of the main stages.

Box 13. The scenario building process[129]

1) The first stage in the scenario-building process is the identification of **key issues** facing policy-makers at the moment and emerging issues which could be important to policy-making in the future. Key issues can be identified through questionnaires, discussions with professionals and literature reviews.
2) Having identified the key issues, **trends** are extrapolated into the future to give some indication of future conditions in the absence of policy change. These extrapolations form the basis of the *Reference Case*, against which other scenarios can be compared.
3) **Policy targets** are generated in order to specify desirable points in the future and form the basis for exploring the types of policies that might be used to reach these points. Policy targets need to be challenging but achievable.
4) Scenario-building requires a number of **'Images of the Future'** to provide the basis for policy analysis under a range of alternative futures. Images of the Future specify a variety of assumptions about future conditions for policy-making. They contain assumptions about both 'internal' and 'external' elements.
5) **Policy options** are defined and **policy paths** are developed from the present to the future - this is achieved through a "backcasting" process. Policy options for each of the Images of the Future must be consistent with the internal and external elements and contribute to the achievement of one or more policy targets.
6) Certain combinations of policies may work well together and give rise to synergies, leading to impacts greater than the sum of their individual parts. Other combinations of policies on the other hand may conflict with each other. The generation of **policy packages** is based on maximising potential synergies and minimising potential conflicts.
7) The process of **validation** and **assessment** is crucial to understanding the role of different policy measures and packages in alternative futures. This can be carried out in a number of ways using workshops, interviews and/or questionnaires.

5.2.3 Images of the Future

The Images of the Future set the framework for identifying policy instruments. They specify different future conditions under which policies are made, including, for example, lifestyles, technological change, and mobility patterns. The Images of the Future also specify the prevailing conditions for future policy-making, such as the level of support for environmental policies in the future, the level of growth in the economy, and the level of global political cooperation.

Two Images of the Future have been chosen for examination in the SAMI project[130]. They provide two polarised cases of policy-making environments and available policy instruments. It should be noted that they provide the framework for developing the SAMI methodology but do not reflect the most desirable or probable futures. They merely form a hypothetical basis on which to conduct the later stages of the research. The polarisation of these two Images of the Future provide a way of testing the robustness of the later methods employed in the project – if the methods are able to cope with these extreme situations they are likely to be able to cope with other less extreme situations.

Images of the Future are constructed around different scenarios of prevalent policy instruments and the degree of policy coordination and cooperation between national governments. The Images of the Future also contain assumptions about transport demand, the scale of production and the extent to which transport and the economy are decoupled[131].

The first Image, **Unified Europe**, is one in which there is good coordination and co-operation between national governments on policy-making and strategic policy is coordinated at the EU level (see Table 25). Transport policy is geared to providing efficient transport operation with an extensive network of roads, railways, airways and waterways, including the opportunity of transfer between modes. This view of an integrated Europe is based on market principles (pricing), supported by regulations to promote choice in transport while at the same time maintaining high levels of environmental quality and safety. Further European unification and the development of the single market are central to this Image in both the freight and passenger transport sectors. Travel distances are long, but there is a greater reliance on the use of public transport, particularly on high-speed rail. Economic efficiency is maintained through economies of scale, extensive networks and of the globalisation process.

In contrast, the second Image of the Future, **Cohesive Regions**, reflects more regional and local priorities, in which decision-making is devolved to the national, regional and local levels in line with the principles of subsidiarity (see Table 25). Transport policy is geared to providing greater accessibility through the development of local public transport networks. Regulations and standards take the prime role in this Image of the Future, with pricing having a more supportive position. Individual regions decide about priorities through more local decision-making processes as to whether investment should take place (e.g. inter-regional versus intra-regional networks). There is a greater emphasis on dematerialization[132], and more decoupling. The regional economy, rather than the global economy, becomes more important. In terms of transport demand, travel distances are lower than in the previous Image, and there is a greater reliance on the use of public transport, walking and cycling. Trip lengths and car dependence are both lower than in the previous Image. There is also less need for inter-regional and international air travel, and increased use of telecommunications, replacing both passenger and freight transport.

Table 25. Comparison of the two Images of the Future.

Image of the Future	**Description**	**Implementation of policy**
Unified Europe	Strategic transport policy is coordinated at the EU level, with the emphasis on policies that maximise the benefit to the EU as a whole. Policies mainly reflect pan-European concerns such as competitiveness, efficiency, global environmental quality and safety.	TEN investments are targeted to areas, which help with the development of Europe-wide rail, air, water and road networks. Differential pricing policies are applied according to transport capacity – fuel pricing, carbon taxes and road pricing. Some EU regulations (e.g. emissions, air quality and safety) – all are consistent in each Member State
Cohesive Regions	Decision-making is more devolved to the national and/or regional level, in line with the principles of subsidiarity. Policies reflect issues of regional development, social inclusion, local environmental quality and safety.	Promotion of regional markets through technology and investment. TEN investments are evenly spread across member states in peripheral regions to develop intra regional accessibility. Differential pricing policies are applied according to peripherality and cohesion. EU regulations (e.g. emissions, air quality and safety) apply in all countries but some member states may impose stricter standards for reasons of national interests (e.g. environmental or capacity reasons).

5.3 Transport Models

5.3.1 Basic Characteristics

The term *transport model* often leads to some confusion since there are a large number of possible definitions for it. In this Guide, we define a transport model as being a *strategic network model that can make predictions on flows and other direct economic efficiency parameters for a future target year.* The basic ingredients of such a model are the following:

- A *zoning system* which splits up the area being modelled into zones;
- A "present day" *origin-destination trip matrix* which has information on the number of *interzonal* trips from each origin to each destination;
- An estimate of "present day" *intrazonal* trips within each zone;
- A sub-model for estimating future trip matrices in the target year (including intrazonal trips);
- A *mode choice sub-model* for allocating trips between modes;
- A representation of the physical network in the target year for all modes being considered;
- An *assignment sub-model* for allocating trips to routes.

Such a model is typically embedded in a computer software package. Most past model development has been directed at creating urban or regional models. However, particularly as a result of the 4th Framework programme there has been great interest recently in creating transnational strategic models. A prime example of such a model is the STREAMS model, details of which are given in Box 14 (for STREAMS´ forecasts see section 2.3.3). The SCENARIOS project conducted a review of such models, leading to a list of requirements (see Box 15). In the ASTRA project a transport model is connected to environmental (see also section 5.4) and economic (see sections 2.2.4 and 2.2.5) models in order to create a comprehensive and dynamic model platform (see Box 16).

Box 14. STREAMS strategic transport model[133]

The STREAMS model´s base year is 1994 and the model forecasts to 2020, working at the level of a typical day. The model has comprehensive 'real' networks for all modes and inter-modal connections in the EU and it has independent passenger and freight demand model components, each highly segmented for forecasting purposes. The model includes a special treatment of local trips, and incorporates the STREAMS software development programme designed to make models easier to use.

The STREAMS model uses a zoning system based on the NUTS2, which means the model structure contains approximately 200 internal zones. The model includes all trips, of whatever length, which means that in a model with NUTS2 zoning, a large proportion of trips will be within zones. This in turn implied the need to improve the treatment of intrazonal trips compared to their treatment in most transport models. Both the passenger and freight demand modules are based on the need to understand why travel demand tends to grow over time. For the passenger model this meant a detailed representation of traveller types and trip purposes. For the freight model it meant using a Regional Economic Model to generate freight flows and segmenting these by industry type. In large scale models, transport networks are often represented as corridors. In this case, given the need to represent transport costs accurately, the level of policy interest in understanding travel patterns and also their environmental impacts, this suggested a need to develop a link-based model.

Box 15. Requirements and recommendations for strategic modelling[134]

Strategic modelling should be directed at supporting strategic policy making, which is defined as policy-making of interest to European-scale policy makers, with a tendency towards long term and multisectoral issues. Along with this definition, a number of both general and detailed requirements were given:

?? Strategic models must be able to represent, in sufficient detail, the operation of the specific strategic transport instruments that might be of interest to the policy-maker.
?? They must (collectively) be able to provide required input for assessment methods, concerning e.g. environment and equity impacts of policies.
?? Strategic models should be *complete* (representing different structural dimensions of society, e.g. socio-economic as well as cultural and technological) and *connected* (representing the interdependencies between these structures).
?? In view of the likelihood of EU enlargement, they should be able to represent potential new member states of the EU along with current members.
?? In the long term, it is likely that strategic network models of the whole world will be created, to represent the internal movements of different continents, as well as the flows of passengers and freight travelling between them.

Box 16. The ASTRA System Dynamic Model Platform[135]

> The ASTRA System Dynamics Model Platform (ASP) comprises four sub-modules, which are integrated together within the system dynamic software “ITHINK”. The macroeconomic sub-module (MAC) estimates the economic framework data of the EU respectively the member countries. The results of the MAC key indicators (e.g. GDP, employment) are transferred to the regional economics and land use sub-module (REM). Within the REM basic data for transport demand modelling (e.g. car-ownership) is calculated. This forms the input of the first two steps of the classical 4-stage transport model: trip generation and trip distribution. The resulting transport demand is transferred to the transport sub-module (TRA), which includes the final stages of the transport model: modal split and assignment. The environmental sub-module (ENV) is mainly fed by data from the TRA (e.g. traffic volumes). It includes the vehicle fleet models.

5.3.2 EURO9 Model

The EURO9 transport model was developed within the SAMI project. Its purpose is to manufacture "standard" transport model output to help develop the optimisation algorithms being developed in SAMI. To test the variation of a great number of policy variables within acceptable computation time it is necessary to use a model with a very short run time and the EURO9 model satisfies this requirement. It should be emphasised that it was not a target of the project to create a model of Europe to be used to inform policy-makers in its own right. However the demonstration proved that the EURO9 model could be a useful tool for European-wide impact assessments. Before being used in real-life situations it ought to be thoroughly calibrated. It would be very suitable – because of the short run time – to be used as a *screening tool* to help reduce the number of policy combinations to be tested with more detailed models (such as the above described STREAMS model).

The underlying principles of the EURO9 model are:

?? The model requires as small a number of zones as possible whilst satisfying certain requirements (as given below). This leads to a zoning system to represent the whole of Europe (including CEEC and European CIS) in nine zones.

?? The model considers a future target year of 2015.

?? The total number of interzonal trips in 2015 is assumed fixed, though there is the possibility of redistribution of trips by OD pair in response to changing costs.

?? Intrazonal trips are distinguished by 5 distance classes.

?? All intrazonal trips are considered including short (less than 10 km) pedestrian and cyclist trips.

?? The total number of intrazonal trips in 2015 is assumed fixed; though there is the possibility of redistribution of trips between distance classes in response to changing costs.

It follows immediately that EURO9 does not represent the generation or suppression of numbers of trips. It does however model the effect of transport measures in creating longer or shorter trips, and hence models generation and suppression of trip kilometres.

The requirements of the EURO9 model are to:

1) represent the following policy measure types:
   ?? "small scale" investment in infrastructure;
   ?? legislation, standards and regulations (resulting in changed journey times, and possibly in changed journey costs);
   ?? market-based measures (resulting in changed journey costs);
   ?? European-wide transport policy measures;
   ?? policy measures applied to specific regions of Europe (e.g. peripheral, core, East, West, North, South);
2) distinguish between:
   ?? four modes (rail, air, water and road);
   ?? freight and passenger traffic;
3) create output data that are consistent with the performance indicators listed in section 3.5 above.

Small scale investment in infrastructure could be seen as measures such as: road traffic signal improvements; rail signal improvements; technical measures to reduce waiting time at border crossings and check-in times at airports; reductions in loading and unloading time for freight transport; improvements in interchange facilities for various modes; various telematics measures to improve coordination and information; and general improvements as a result of increased technical interoperability.

It is assumed in the EURO9 model that all the transport measures can be represented as combinations of:

?? increases/decreases in capacity (equivalent to decreases/increases in average travel time) by mode, purpose and zone;

?? changes in monetary costs of making a trip, by mode, purpose and zone.

Whilst this is clearly a simplification, it is adequate for the demonstration of optimisation procedure in SAMI.

5.4 Environmental Models

Environmental models are required to predict the environmental impacts presented in Chapter 2. Usually transport models provide information about transport volumes, which then are translated into emissions by environmental models. The SAMI EURO9 model (discussed in section 5.3 above) is able to predict also levels of CO_2 emissions and energy consumption.

CO_2 emissions and energy consumption are calculated using functions which depend upon speed and vehicle kilometres. The equations (2) for fuel consumption and CO_2

emissions are designed in a quadratic form with different factors a_n for each purpose and mode.

$$e_k \; ? \; a_{2k} * V^2 \; ? \; a_{1k} * V \; ? \; a_{0k} \qquad (2)$$

where*:*

e_k	Fuel consumption or emission per Vh-km
a_n	factors
V	Average Speed [km/h]

Elsewhere in the FP4, the COMMUTE project created a strategic tool for predicting environmental impacts. This tool is described in Box 16.

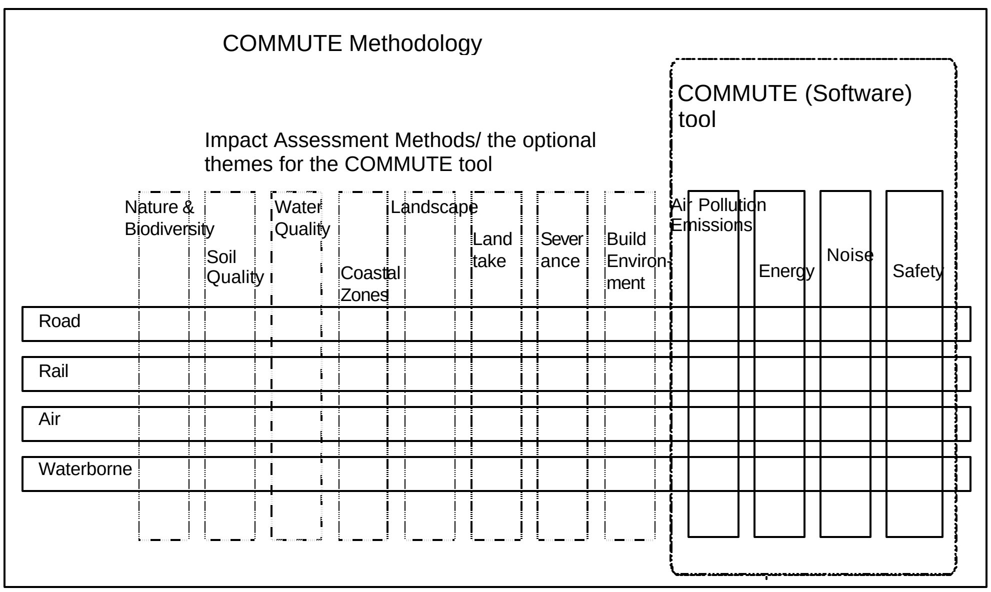
Box 17. The COMMUTE software tool[136]

The COMMUTE software tool embodies the impact assessment methods for the primary pollutant emissions, energy consumption, noise and safety across the transport modes road, rail, air and waterborne transport, but it is also designed for future expansion to cover other important land use and ecological impacts (see Figure below).

The COMMUTE tool is based on relatively large scale spatial resolutions. The tool focuses on assessing the environmental impacts of Programmes, Policies and Plans (PPPs) at:

?? European level (i.e. assessing impacts of PPPs for the whole of the EU)
?? National level (i.e. assessing impacts of PPPs for individual countries)
?? Regional level (i.e. assessing impacts of PPPs for large administrative regions (e.g. NUTS 2) or for regional scale corridors)

The tool is network oriented, using links and nodes. The impacts are calculated on a link-by-link and node-by node basis and then added together for assessments of networks or corridors comprising a number of links and nodes. In this context urban areas, harbours and airports are represented as nodes in the network. These nodes could then each have traffic flow data associated with them within the tool that would cover the whole area (e.g. vehicle-km figures and an average speed for a whole city in the case of road transport). This approach does not include explicit representation of the urban transport network within each urban area. It therefore allows assessment of policies that have an impact in urban areas (e.g. policies that encourage modal shift for urban travel) but would not be suitable for assessment of urban infrastructure programmes.



Environmental themes in COMMUTE Methodology and tool.

6. EVALUATION OF STRATEGIES

Different transport policy strategies are defined through sets of policy packages (see Chapter 4). When the impacts (see section 2.2 and Chapter 5) of these packages are known it comes possible to compare the strategies with each other in order to decide which one to choose. There are various evaluation methods available. In addition to traditional cost-benefit and multicriteria methods also – a method stressing environmental issues – has been emerging. In project SAMI a meta-method combining the gains of various other evaluation methods and specially aiming on the strategic level has been developed.

6.1 Background for Evaluation

Changing planning environment and the search for a balanced transport policy cause the need for new approaches in evaluation on the strategic level.

6.2 Planning and Decision-Making

Traffic planning in the Information age is positioned at the crossroads of various economic, political, social, spatial and technological developments. In this complex environment there exist also quite different decision-making styles.

6.3 SAMI Evaluation Methodology

The core of the methodology designed by Project SAMI is formed by a qualitative-quantitative Regime analysis, extended with complementary approaches like the Flag Model, Rough Set Analysis and Saaty's hierarchical method.

6.4 Strategic Environmental Assessment

Strategic Environmental Assessment (SEA) is a relatively new process in decision-making on transport sector. The methods developed in the SAMI project can hugely alleviate the application of SEA.

Box 18. A quote from a letter of Benjamin Franklin to Dr. Priestly in London 19th September 1772

> When these difficult Cases occur, they are difficult chiefly because while we have them under Consideration all the Reasons *pro* and *con* are not present to the Mind at the same time; but sometimes one Set present themselves, and at other times another, the first being out of sight. Hence the various Purposes of Inclinations that alternately prevail, and the Uncertainty that perplexes us. To get over this, my Way is, to divide a half a Sheet of Paper by a Line into two Columns, writing over the one *pro* over the other *Con*. Then during three of four Days Consideration I put down under the different Heads short Hints of the different Motives that at different Times occur to me for or against the Measure. When I have thus got them all together in one View, I endeavour to estimate their respective Weights; and where I find two, one on each side, that seem equal. I strike them both out; If I find a Reason *pro* equal to some two Reasons *con*, I strike out the three. If I judge some two Reasons *con* equal to some three Reasons *pro*, I strike out the five; and thus proceeding I find at length where the Balance lies; and if after a Day or two of farther Consideration nothing new that is of Importance occurs on either side, I come to a Determination accordingly.

6.1 Background for evaluation

6.1.1 Changing Planning Environment

Transportation planning used to be an engineering-oriented activity aiming at modelling complex transport systems by means of mathematical routines seeking to maximise the performance of such systems. It was more an operations research activity than a social science driven research challenge. In the past decade the scope, orientation and planning relevance of transportation research has drastically changed. Next to the traditional tasks of transport planning, we observe the need for flexible and sometimes visionary policy strategies and decision aid tools in an uncertain environment. Two major forces have been responsible for this dramatic change in the 'face' of transport planning, viz. the return to market-oriented, competition-based economics (with more free entrepreneurship, less government intervention and more sovereignty of households and citizens) and the growing awareness of the ecological limits to transportation growth, mobility and infrastructure development (with more emphasis on environmentally sustainable modes of transport).

As a consequence, transport planning is increasingly positioned in a complex force field with many conflicting views and decisions. The dilemma between economic-technological performance of a transport system and its environmental social aspects is one example, but there are many others, such as conflicts between mobility and safety or between congestion and accessibility (see also section 1.3). Especially in a European context with its deepening and widening of economic integration we observe a great many conflicting issues which lead to a repositioning of transport planning in Europe (for transport policy development see Chapter 3).

To increase the efficiency and effectiveness of planning in case of multiple goal conflicts, it will be necessary to rationalise and structure complex decision problems, to make them transparent to all actors and stakeholders, and to deploy them as communication tools for tracing and judging the implications of policy choices. Thus, planning has turned into the 'art' of treating in a structured and analytical way conflict and uncertainty surrounding choice possibilities in the transport sector, in particular in regard to economic, social, environmental, spatial and technological objectives, constraints and considerations. Consequently, impact assessment and evaluation are indispensable tools in modern European transportation policy.

6.1.2 Search for a Balance

Most governments in Europe seem to have a 'hate-love' relationship with transport. Transport is a source of economic progress, of accessibility to public facilities, i.e. a solution for the traditional transport problem and – last but not least – of fiscal revenues (which comprise taxes, gasoline taxes, parking fees, toll revenues etc.). But it is also a source of concern from the viewpoint of safety and environmental (modern transport problem) and of congestion (post-modern transport problem). A basic feature with transportation is that the need for spatial mobility or for trade originates from other sources than transport. Transport is largely a 'derived demand' which is the result of production, consumption and investment decisions taken elsewhere in the economy. Any decision to influence transport has therefore implications on a chain of economic and social activities covering many fields of our society. To find a balance between economic and ecological interests in the transport sector is therefore not an easy task. The need for 'sustainable transport' (see section 3.1) seems to be at odds with the prevailing trend in a modern society towards 'nomadic' life styles. This modern nomadism is reflected in increasing mobility rates of people and in a steadily rising volume and action radius of freight transport (see also Chapter 2).

A necessary input for a balanced European transport policy is detailed insight into the benefits and costs (or, in general, into the advantages and disadvantages) of transport operations (including the changes brought about by policy). Such information is necessary to make, for example, a convincing plea for intermodal substitution in both passenger and freight transport, for the adoption of 'user charge' principles in the transport sector or for the harmonisation of international transport networks (e.g. in aviation). Effective and sustainable transport policy in Europe presupposes, therefore, the presence of a customised policy strategy geared towards the interest of multiple actors and stakeholders with the aim to offer mediation tools for conflict resolution. Consequently, evaluation analysis is a sine qua non, not only from a technical or financial perspective, but also with a view to social implications, environmental effects, material resources, and human responses.

In conclusion, the scene of transport policy has witnessed dramatic changes in the past decade (see also Chapter 2). There is undoubtedly a need for taking a fresh look at transportation planning in Europe. The SAMI project aims to contribute to this challenge by offering a new perspective on evaluation analysis in the European transport sector. A concise review of the present scene will be given in the next section.

6.2 Planning and Decision-making

6.2.1 Planning at the Crossroads

Transportation planning in our modern era is positioned at the crossroads of various economic, political, social, demographic, spatial and technological developments. In many EU debates on sustainable mobility and transportation planning we may observe two focal points: (i) issues related to an efficient operation of the transport system (reflected inter alia in transportation modelling, travel demand analysis, optimal route or mode choice, cost-efficiency measures etc.) and (ii) issues related to the context of the transport system (e.g., sustainability strategies, dynamic impacts of ICT on transport behaviour, scenario analysis, the generative effect of new infrastructure etc.). The first set of concerns is more internal to the transport system, while the latter part is mainly addressing external impacts. Especially in the latter category of issues the analysis of non-cost factors and of social equity variables deserves more profound attention.

It is noteworthy that in recent years the potential of transportation (infrastructure) has increasingly received much attention, particularly in the context of a selective land use and transportation planning in which in addition to traffic aspects also economic, environmental and safety aspects play a joint role [137]. This also implies that transport impact analysis and evaluation is fraught with multiple analytical problems, as the assessment of the spatial-economic consequences of (new) transport systems is a far from easy task. A major question, for instance, is whether modern infrastructure generates new benefits for the country as a whole or only – as redistributive impacts – for particular regions (especially those located on nodal points of a network). This important equity question – in combination with the efficiency question – deserves closer attention (see also sections 2.2.4 and 2.2.5). Similar remarks can be made on the sustainable nature of transportation policy (see section 3.1).

Clearly, there is a mutual relationship between transportation infrastructure and sustainable spatial development[138]. On the one hand, urban and regional development influences the growth of infrastructure, for instance, because an increase in regional welfare induces the demand for transport and hence for more infrastructure, while the public expenditures for financing the infrastructure are also generated by the same economic growth (a so-called Keynesian monetary effect). This is a so-called following (passive) infrastructure policy. On the other hand, the availability of appropriate infrastructure has a positive impact on the development of countries, regions and cities. This requires a rather comprehensive mode of thinking.

6.2.2 Decision Styles

The above observations have demonstrated that policy-making in the transport field is not a ‘mechanical’ activity, but requires an open mind from the side of both planners and scientists. In view of the conflicting nature of transportation planning, planners have to avoid two traps: to neglect meaningful and feasible alternatives (e.g., creative transportation plans) to be envisaged and to generate an overwhelming number of choice options which also renders planning useless and increases uncertainty. Thus, a combination of sound reasoning, ‘plausibility’, brainstorming, and Delphi-type and decision-theoretic methods seems to be necessary to ensure a balanced approach to transportation planning, based on a broad social science perspective. In all cases choice options have to be evaluated from a broad, i.e. multidimensional, perspective. These observations also suggest that planning presupposes a **communication** between experts and policy-makers (see also Fig. 4), either as interactive decision procedures (based on a dialogue and information exchange about a given choice problem between all parties involved) or a cyclical decision procedures (based on an adaptation, feedback or restructuring of the planning problem at hand as a result of a consultation of parties involved).

In the literature[139], various types of information provision may be distinguished, depending on the information needs and decision style of actors. Examples of decision styles are:

1. *monetary* decision approach, based e.g. on cost-benefit or cost-effectiveness principles;
2. *utility* theory approach, based on a prior ranking of the decision-maker’s preferences;
3. *learning* approach, based on a sequential (interactive or cyclical) articulation of the decision-maker’s views;
4. *collective* decision approach based on multi-person bargaining, negotiation or voting procedures.

It is clear that monetary approaches are to be preferred, if decisions are to be based on efficiency arguments only[140]. Otherwise, other modes of plan or project evaluation may be necessary, in particular multi-objective optimisation and multicriteria analysis. In general, the latter classes of methods are based on a rational and consistent policy analysis and they allow for a reliable assessment and balanced evaluation of all foreseeable consequences and choice possibilities in relation to policy initiatives. The aim of generating and judging alternative frameworks of policy measures is a far from easy task for mainly two reasons. The process of generating meaningful choice options (cf. Chapter 4) in the context of policy analysis is extremely complicated in an open, multi-actor social system with diverging interests, while also the assessment of expected impacts of policy measures (see also Chapter 5) – especially in a dynamic spatial system – is fraught with many difficulties inherent in the uncertainty context of decision-making.

Before introducing the SAMI Evaluation Methodology a short glimpse on the work in other parts of the FP4 is given. In the TENNASSESS project two decision support tools have been developed (see Box 19).

Box 19. TENASSESS PAM and TENASSESS Barrier Model[141]

The TENASSESS Policy Assessment (PAM) tool helps to assess the degree of congruence between any **project**´s objectives and that of transport policy from the perspective of different actors´ viewpoints – in that it provides an interface between project appraisal and policy assessment. A central element in the method is the use of goal achievement matrices. The TENASSESS Barrier Model helps to identify and anticipate barriers likely to occur during the implementation process of any transport policy initiative.

The CODE-TEN project has developed DECODE Method which is aimed to complement other current evaluation methods when evaluating corridor development alternatives (see Box 20).

Box 20. DECODE Method[142]

The DECODE method combines top-down and bottom-up approaches. The top-down approach is used to describe potential future developments in the **policy field** at the interface with socio-economic trends. The bottom-up approach is used to examine each single **infrastructure project** that forms part of the infrastructure investment programme and, in turn, to establish infrastructure strategies. Thus the DECODE method includes the following six steps: i) to obtain or establish a geographical information system on the network; ii) to specify the socio-economic scenarios as well as the policy options for the future; iii) to define the infrastructure strategies for the whole network; iv) to examine the consistency between infrastructure strategies and scenarios; v) to measure the impacts on each of the selected (corridor) development alternatives; and vi) to use the results to arrive at policy-relevant recommendations.

6.3 Sami Evaluation Methodology

6.3.1 Introduction

In modern policy analysis we witness an increasing emphasis on analytical Decision Support methods. After the popularity of cost-benefit analysis and related financial-economic evaluation methods we have seen an increasing and widespread use of multicriteria methods. Such methods are capable of dealing with the multiple dimensions of evaluation problems (e.g. social, cultural, ecological, technological, institutional, etc.) and give attention to interest conflicts among various stakeholders (see Table 15) in a planning process. The aim of these methods is to combine assessment methods with judgement methods and offer a solid analytical basis for modern decision analysis[143].

The methodology designed for Project SAMI is based on these types of evaluation methods. The core of the methodology is formed by Regime analysis, extended with complementary approaches like the Flag Model, Rough Set Analysis and Saaty's hierarchical method. All of these methods are selected because they are based on the same foundation (welfare theory) as Cost-Benefit Analysis and can therefore complement the latter evaluation method[144].

6.3.2 Structure

The following steps are included in the methodology (see also Figure 5):

Step 1. Specification of Choice Problem
Before the evaluation phase can start the stages described before in this report have to be completed:

?? consideration of current transport trends and impacts (see Chapter 2);
?? definition of policy targets and related indicators (see Chapter 3);
?? formation of strategies (see Chapter 4);
?? prediction of impacts (see Chapter 5).

After the prediction of the impacts of infrastructure projects or policies, the valuation of these impacts has to be executed and it can be considered to form a starting point for the evaluation process. The result of this first step is the creation of a data set. This data set is still rough and needs to be analysed more closely in the second step.

Step 2. Analysis of Information
In this phase of the evaluation process the analysis of the gathered data takes place. Questions like, what type of data are at hand (ordinal, cardinal, etc.), is the data set complete, can relation among the data be recognised, can we reduce the data set without losing information, are addressed. Rough Set as a data classification method can be applied in this phase of the evaluation process. The result of this step is the assemblage of a structured information table, which forms the input for an evaluation method (or combination of methods).

Step 3 Choice of Appropriate SAMI Evaluation Method
The methods included in the SAMI methodology differ according to their aim and characteristics in practical decision support: level of measurement, classification, and use of reference values. Although the methods do differ they have one common feature, the aim to evaluate the pros and cons of a planned transport policy initiative or infrastructure investment.

There is clearly no single assessment method that can satisfactorily and unequivocally evaluate all complex aspects of modern transport policy. The choice of assessment methods (or combinations of methods) in any given transport policy context therefore depends on the features of the policy problem at hand, on the aims of the policy analysis, and on the underlying information base. The SAMI Evaluation Methodology will ensure coherence between the assessment method used and the actual transport problem to be tackled.

Clearly, this approach towards the selection of the class of multicriteria methods becomes relevant if traditional evaluation methods such as Cost-Benefit analysis cannot be applied (alone or at all) due to information shortages or specific requirements in a decision-support environment as is usually the case on the strategic level decision-making (cp. Chapter 3). Then the following steps can be included in the selection of the appropriate evaluation methods (see also step 3 in Figure 5):

1. If part of the information of the structured information table is expressed in monetary terms, apply Cost-Benefit Analysis to this part of the data set. This can only be done if all information requirements for this type of evaluation are met. After the application of Cost-Benefit Analysis combine the results with the remaining part of the data set. Apply on this new data set (mixed data set) Regime Analysis.
2. If effects are quantitative and/or qualitative, but not financial-monetary in nature, and there are no standards used in the evaluation process, then the application of Regime Analysis takes place. In Regime Analysis there is an option available to include weights in the evaluation process. Weights can be derived from the valuation of possible stakeholders (for a list of stakeholders see Table 15). This can be done by entering the weights in the weight module of SAMIsoft or by applying the SAATY principles in the evaluation process (SAATY module in SAMIsoft).
3. If effects are quantitative and/or qualitative, but not financial-monetary in nature, and there are standards used in the evaluation process, the application of the Flag Model takes place. The Flag Model evaluates the selected alternatives in relation to pre-defined standards.

Step 4. Evaluation of Alternatives; Hierarchy or Choice of Options

The final evaluation of alternatives takes place by means of the selected (combination of) SAMI Evaluation Method.

In conclusion, these methods show the diversity of modern multicriteria methods. They range from a complicated multidimensional assessment method (Regime Analysis) to critical threshold value approaches (Flag Model) and meta-analytic methods (Rough Set analysis). All of these methods are based on the foundations of Cost-Benefit analysis and can complement this type of analysis in an evaluation process. They are by no means meant to be a competing substitute. In the next sections we will give – after a short description of SAMIsoft - an overview and description of the methods included in the SAMI Evaluation Methodology.[145]

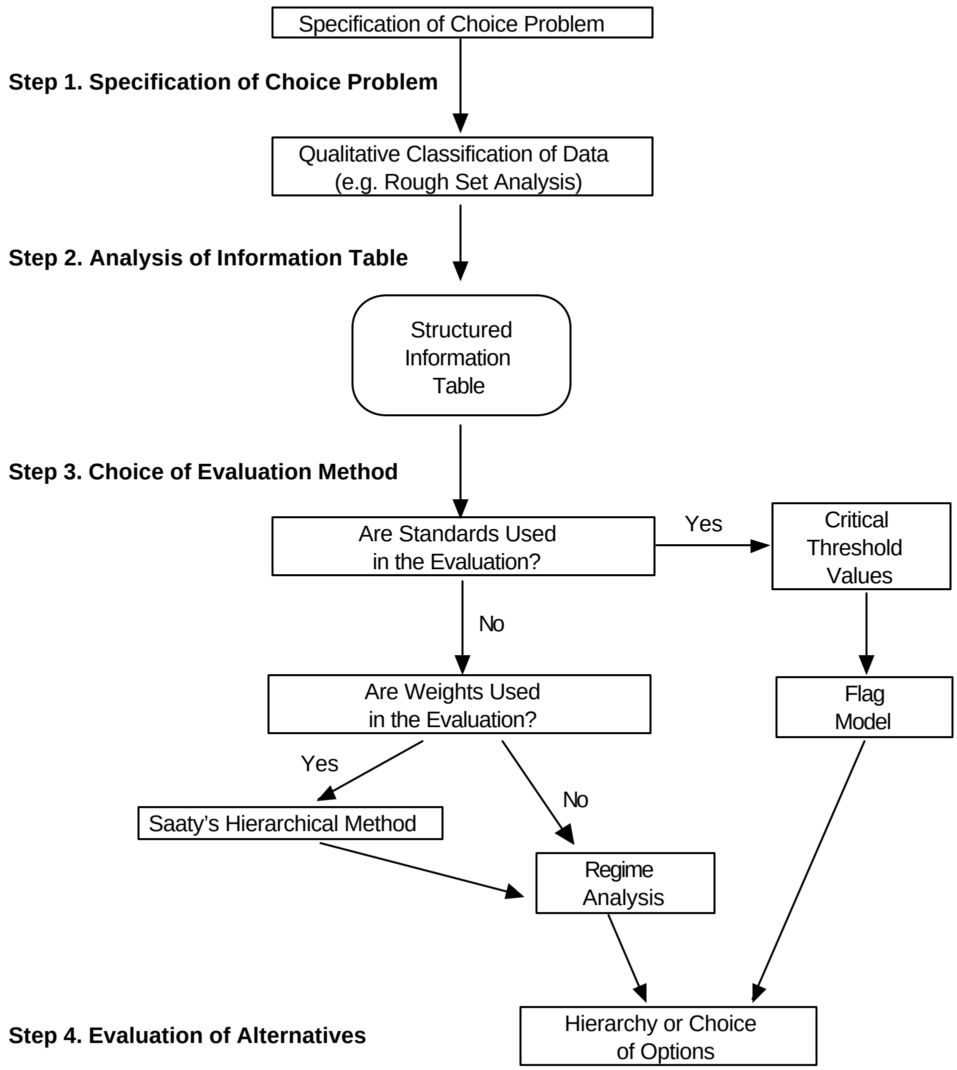


Figure 5. Steps in SAMI evaluation

6.3.3 SAMIsoft

In addition to the development of SAMI Evaluation Methodology a software package called SAMIsoft has been prepared in order to support the application of the methodology. SAMIsoft consists of Regime Analysis, the Flag Model as well as a module, which can incorporate the SAATY principles regarding the application of weights in an evaluation process. Since a commercially marketed software package is available for Rough Set Analysis, this method is not included in SAMIsoft. However, it is included in the SAMI Evaluation Methodology in the information analysis phase.[146]

6.3.4 Rough Set Analysis

Methodological Description

Often the choice among different alternatives of a problem can become very puzzling because of a vague and inaccurate description of the reality we need to examine. The aim of Rough Set Analysis is to reduce the cumbersome characteristics of fuzzy input in the decision making process. More precisely, Rough Set Analysis is designed to discover possible cause-effect relationships between the data-components, to underline the importance and the strategic role of some data, and to differentiate between irrelevant and relevant data. The intrinsic value of Rough Set Analysis is its ability to manage quantitative as well as qualitative data.[147]

Take into consideration a finite set of objects which has to be examined and classified. For each object a number of *n* attributes can be defined in order to create a significant basis for the required characterisation of the object. If the attribute is quantitative, it will be easy to define its domain. If the attribute is qualitative, its domain should be divided into sub-intervals in order to obtain an accurate description of the object. After the classification of objects by means of attributes a vector of attributes can be associated to each object under consideration.

The table containing all this organised information is called *the information table*.
From this table it can immediately be observed which objects share the same types of attributes (e.g. have the same characteristics). Two objects that are not the same have an indiscernible relation when they have the same descriptive attributes. Such a binary relation is reflexive, symmetric and transitive.

We can now introduce a fundamental concept in the Rough Set Analysis procedure. Let us imagine that Q is the set of attributes that describe the set of objects U. Let P represent a sub-set of the set of attributes Q, and X represent a sub-set of the set of objects U. We define as a sub-set of X those objects which all have the attributes belonging to set P. Such a set is the P-lower approximation of X set, and it is denoted as P_LX. We then define as P-upper approximation of X, denoted as P_UX, the sub-set of U having as its elements all objects belonging to the P set of attributes and which has at least one element in common with set X.

The definition of the upper and lower approximation sets is important in the methodology. Through these sets the load of uncertain information can be classified and examined. The representation of reality by means of Rough Set Analysis is indeed a reduction of the perceived real phenomena, but it is done in such a way to enable us to classify, distinguish, and express judgements about it.

Until now, we have focussed our attention on the classification of uncertain data. Let us now examine the case where we want to express a choice among different alternatives. We have previously described the *information table,* and this table is the essence of an assessment problem, we can distinguish two classes from the set of attributes: a class of condition attributes and a class of decision attributes.

The class of condition attributes are those which describe the object following the procedure that we have depicted above. The class of decision attributes is defined by all the attributes that the object must have in order to be selected as an acceptable alternative. For instance, a set of objects can be described by values of condition attributes, while classifications of experts are represented by values of decision attributes.

At this point, we must define a *decision rule* as an implication relation between the description of a condition class and the description of a decision class. The decision rule can be exact or deterministic when the class of decision is contained in the set of conditions, i.e. all the decision attributes belong to the class of the condition attributes (e.g. select all objects (alternatives) which lower CO_2 emissions with 10%).

We have an approximate rule when more than one value of the decision attributes corresponds to the same combination of values of the condition attributes. Therefore, an exact rule offers a sufficient condition for belonging to a decision class; an approximate rule admits the possibility of this.

The decision rule and the table of information are the basic elements needed to solve multi-attribute choice and ranking problems. The binary preference relations between the decision rules and the description of the objects by means of the condition attributes determine a set of potentially acceptable actions. In order to rank such alternatives, we need to conduct a final binary comparison among the potential actions. This procedure will define the most acceptable action or alternative.

Illustration in the Area of Distribution and Logistics

In this example the dependent variable is the suitability of an industrial site for distribution/logistics (or other selected economic activities). The Rough Set Analysis tries to explain the suitability of the sites with the aid of 11 independent variables, which are classified for five classes in the Information Table[148] (see Table 26).

The Rough Set Analysis generates then decision rules, which show how combinations of values of independent variables lead to a unique value of the dependent variable. For instance, if a site is between 0 and 50 ha, and if the site has a multi-modal terminal connection, then it is always a site that is suitable for distribution and VAL activities (Value Added Logistics). Of course, there may be more decision rules that explain sites, which are suitable for distribution & VAL activities.

Based on the 34 decision rules generated the analysis, Rough Set Analysis seeks to identify the minimal set of decision rules that explains all variation in the dependent variable (the classification of sites). Out of these minimal sets, the importance of the independent variables can be distilled.

Table 26. The Information Table; classification of the independent variables

Variable	Class 1	Class 2	Class 3	Class 4	Class 5
Size site	< 50 ha	50 – 100 ha	100 – 200 ha	> 200 ha	
% granted	< 25%	25 – 50%	50 - 75%	> 75%	
% planned	0	1 – 100%	> 100%		
Land price	< 50 dfl	50 – 100 dfl	100 – 200 dfl	> 200 dfl	
Accessibility by car	<= 8	8 < x <= 9	> 9		
Accessibility by public transport	<= 8	8 < x <= 9	> 9		
Multi-modal terminal	Yes	No			
Represent-ativeness	<= 8	8 < x <= 9	> 9		
Subsidy	Yes	No			
Greenfield/ Brownfield	Greenfield	Brownfield			
Region	Brussels	Ile-de-France	Westfalia	Randstad	Copenha-gen

The variables in this table (e.g. accessibility by car) can assume various values. These values determine whether the variable falls in Class 1, Class 2, Class 3, Class 4 or Class 5. For example, if an industrial site possesses a multi-modal terminal then variable 7 (multi-modal terminal) falls within Class 1. And if the site is situated in Copenhagen then variable 11 (region) fall within Class 5.

6.3.5 Flag Model

The main purpose of the model is to analyse whether one or more scenarios/policy alternatives can be classified as acceptable or not[149]. The Flag Model does so by comparing an impact value with a set of reference values (called Critical Threshold Values). The Flag Model has been designed to assess the degree alternatives fulfil predefined standards or normative statements in an evaluation process. There are three important components of the model:

1. identifying a set of measurable standards or indicators;
2. establishing a set of normative reference values;
3. developing a practical methodology for assessing alternatives.

The input of the Flag Model is an impact matrix with a number of *n* variables; this matrix is formed by the values that the indicators assume for each considered scenario. The methodology requires the identification and definition of policy relevant indicators or standards, which are suitable for further empirical treatment in the assessment procedure.

The **choice of indicators** corresponds to the problem that we decide to address; in general, the indicators must expose the problem under scrutiny as well as consider the objectives that such a problem much tackle (see also section 3.5). One significant dilemma encountered when defining indicators is the likelihood that the number of indicators always tend to grow; and, to complicate matters, some indicators are encompassed within other indicators. In order to avoid the complication of a large number of indicators, which would thus be difficult to examine, and which are often minor and unnecessary, a helpful methodology is to use a hierarchical approach based on a tree-like structure. Such an approach corresponds to the idea of aggregation and disaggregation of indicators that are deemed fundamental to the examination. For instance, a distinction can be made among macro, meso and micro indicators, or a distinction can be made by means of relevant time or geographical scales.

The indicators in the Flag Model have two formal attributes: class and type. There are three classes of indicators available in the program, which correspond to the following dimensions: i) biophysical, ii) social, and iii) economic. The second attribute, type, relates to the fact that some indicators such as water accessibility have high scores showing a preferable situation; while for others, such as a pollution indicator, low scores show also a preferable situation. This difference is in the model captured under the attribute type of the indicator; the first types are defined as *good indicators*, the second types are *bad indicators*.

For each indicator or standard **critical threshold** values has to be defined. These values represent the reference system for judging alternatives. Since in many cases experts and decision-makers may have conflicting views on the precise level of the acceptable threshold values, a bandwidth of values of thresholds – by way of sensitivity analysis – can be used in the analysis.

This bandwidth ranges from a maximum value (CTV_{max}) to a minimum value (CTV_{min}) (see Figure 6 and Table 27).

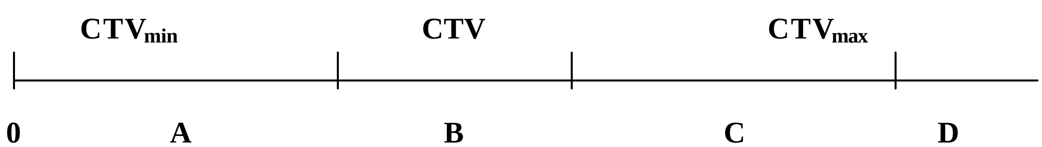


Figure 6 The bandwith of the Flag Model

Table 27. The colours of flags

Section A	**Green Flag**	**no reason for specific concern**
Section B	Yellow Flag	be very alert
Section C	Red Flag	reverse trends
Section D	Blue Flag	stop further growth

The third component of the model, the **assessment module**, provides a number of instruments for the analysis of alternatives. This analysis can be carried out in two ways: i) an inspection of a single alternative or ii) a comparison of two scenarios. In the former procedure we decide whether an alternative is acceptable or not. In the latter case by comparing two alternatives, we decide which alternative scores best. This last option may be interpreted as a basic form of multi-criteria analysis.

The Flag Model can operate both as a classification procedure and as a visualising method. In the former case, for example, in combination with Regime Analysis, the Flag Model can determine the acceptable alternatives that then will be ranked by means of the Regime Method. In the latter case, we can utilise the Flag Model in order to visualise better the results obtained for example from the Regime Method or a Rough Set Procedure.

One of the major aspects of the Flag Model is its representation. There are three approaches to the representation: a qualitative, a quantitative and a hybrid approach. The idea of having three possible levels of result representation is based upon the necessity for the program to be flexible to the requirements of its users.

Rather than to be used as substitutions, the three modes of analysis are complementary to each other. The qualitative approach only takes into account the colours of the flag. This entails flag counts and cross tabulation. This approach merely displays in various representative ways the results obtained by the evaluation. The quantitative approach defines the values of the standards that may be acceptable or not. To achieve such results, we need to standardise the indicators or standards which, because they refer to different aspects, are then expressed by different scales of measurement. Finally, the hybrid form regards the existence of both qualitative and quantitative aspects.

An example of the use of the Flag Model is included in section 6.3.8.

6.3.6 Regime Analysis

Methodological description

The multi-assessment method used in the SAMI evaluation methodology is the Regime Analysis[150]. Regime analysis is a discrete multi-assessment method suitable to assess projects as well as policies. The strength of Regime Analysis is that it is able to deal with binary, ordinal, categorical and cardinal (ratio and interval data), while it is also possible to use mixed data. This applies to both the effects and the weights in the evaluation of alternatives.

The fundamental framework of the method is based upon two kinds of input data: an impact matrix (structured information table) and a set of (political) weights. The impact matrix is composed of elements that measure the effect of each considered alternative in relation to each considered criterion. The set of weights gives information concerning the relative importance of the criteria in the evaluation procedure. In the case there is no prioritisation of criteria in the evaluation process, all criteria will have assigned the same numerical weight value.

Regime Analysis is a discrete multiple criteria method, and in particular, it is a generalised form of concordance analysis in essence a generalisation of pairwise comparison methods. In order to gain a better understanding of Regime Analysis, let us reiterate the basic components of concordance analysis.

Concordance analysis is an evaluation method in which the basic idea is to rank a set of alternatives by means of their pair-wise comparisons in relation to the chosen criteria. For instance, we consider a problem where we have a set of alternatives and a set of criteria. We begin our examination by comparing alternative i with alternative j in relation to all criteria. After having done this, we select all the criteria for which alternative i performs better than, or equal to, alternative j. This class of criteria we will call a “concordance set”. Similarly, we define the class of criteria for which alternative i performs worse than, or equal to, alternative j. This set of criteria is called a “discordance set”.

We now need to rank the alternatives. In order to do so, we introduce the concordance index. The concordance index will be the sum of the weights which are related to the criteria for which i is better than k. Let us call this sum, C_{ik}. Then we calculate the concordance index for the same alternatives, but by considering the criteria for which k is better than i, i.e., C_{ki}. After having calculated these two sums, we subtract these two values in order to obtain the index $?_{ik}=c_{ik}-c_{ki}$.

Because we have only ordinal information about the weights, our interest is focussed on the sign of the index $?_{ik.}$ If the sign is positive, this will indicate that alternative i is more attractive than alternative k; if negative, it will imply vice versa. We will therefore be able to rank our alternatives. We must note that due to the ordinal nature of the information in the indicator $?_{ik}$ no attention is given to the size of the difference between the alternatives; it is only the sign of the difference that is important.

We may also solve the complication that we may not be able to determine an unambiguous result, i.e. rank of alternatives. This is because we confront the problem of ambiguity with the sign of the index ?. In order to solve this problem we introduce a certain probability p_{ij} for the dominance of criteria i with respect to criteria j as follows:

$$p_{ij} \; ? \; prob \; (?_{ij} \; ? \; 0)$$

and we define an aggregate probability measure, which indicates the success score as follows:

$$p_i \; ? \; \frac{1}{I \; ? \; 1} \underset{j?i}{?} \; p_{ij}$$

where i is the number of chosen alternatives.

The problem here is to assess the value of p_{ij} and of p_i. We will assume a specific probability distribution of the set of feasible weights. This assumption is based upon the criterion of Laplace in the case of decision-making under uncertainty. In the case of probability distribution of qualitative information, it is sufficient to mention that in principle, the use of stochastic analysis, which is consistent with an originally ordinal data set. This procedure helps to overcome the methodological problems we can encounter by trying a numerical operation on qualitative data.

From the viewpoint of numerical analysis, the regime method then identifies the feasible area in which values of the feasible weight w_I must fall in order to be compatible with the condition imposed by their probability value. By means of a random generator, numerous values of the weights can be calculated. This allows us at the end to calculate the probability score (or success score) p_I for each alternative i. We can then determine an unambiguous solution and rank the alternatives.

Regime analysis can examine both quantitative and cardinal data. In the case where we confront problems with qualitative data, we first need to transform the qualitative data into cardinal data and then apply the regime method. Due to this necessity, regime analysis is classified as an indirect method for qualitative data. This is an important positive feature. When we apply the cardinalisation of qualitative data through indirect methods such as regime analysis, we do not lose information like in direct methods; this is due to the fact that in the direct methods only the ordinal content of the available quantitative information is used.

An example of the use of the Regime analysis in combination with cost-benefit analysis follows and a further illustration is included in section 6.3.8.

Illustration of Cost-Benefit Analysis combined with Regime Analysis

This case study relates to the evaluation of a new waterway-project. This project aims to connect two rivers in order to lower travel times related to inland shipping of freight. For reaching this goal six project alternatives are designed. Each alternative varies according to investment costs and benefits in both monetary and non-monetary terms. However, maintenance costs do not differ among the alternatives.

In this particular case the first step is to conduct Cost-Benefit Analysis on all monetary costs and benefits in order to calculate the Benefit/Cost Ratio. In the second step the results of the first step are combined with all non-monetary costs and benefits to calculate a rank order by means of Regime Analysis.

All monetary costs and benefits are used to calculate the Benefit Cost Ratio (Table 28). According to Cost-Benefit Analysis project alternative P6 would be preferred above all other alternatives.

Table 28. Costs and Benefits in monetary terms of the various project alternatives

Project Alternative	Total investment costs	Maintenance Costs	Benefits in monetary terms (NPV)	Benefit/Cost Ratio
P1	6540.8	631.1	17310.2	2.65
P2	5664.4	631.1	17861.4	3.15
P3	4197.7	631.1	18783.5	4.47
P4	3321.3	631.1	19334.6	5.82
P5	5532.6	631.1	17944.2	3.24
P6	3189.6	631.1	19417.4	6.09

In this example the results of Cost-Benefit Analysis are combined with the non-monetary values each project alternative scores on various indicators or criteria (noise, pollution and other negative environmental effects). This new impact matrix (Table 29) forms the input for a Regime Analysis. Since this impact matrix consists of both cost and benefit indicators we have to transform all scores to benefit values (see Table 30). This table forms the input for the Regime Analysis Module in the SAMIsoft software program. In this case we run a Regime Analysis without incorporating weights.

Table 29. Impacts of project alternatives in other than monetary terms

Project Alternative	Noise level (annoyance factor, cardinal data)	Soil Pollution (1000 m^3)	Other Environmental impacts (Ordinal Data)	Benefit/Cost Ratio
P1	0.11 (55-60 dB(A))	7513	High	2.65
P2	0.22 (60-65 dB(A))	7513	Low	3.15
P3	0.45 (65-70 dB(A))	3011	Low	4.47
P4	0.93 (70-75 dB(A))	3011	Medium	5.82
P5	0.11 (55-60 dB(A))	7513	High	3.24
P6	1.92 (> 75 dB(A))	3011	Medium	6.09

Table 30. Standardised impacts

Project Alternative	Noise level (annoyance factor)	Soil Pollution (1000 m^3)	Other Environmental Impacts	Benefit/Cost Ratio
P1	1	0.4	1	2.65
P2	0.5	0.4	3	3.15
P3	0.24	1	3	4.47
P4	0.12	1	2	5.82
P5	1	0.4	1	3.24
P6	0.06	1	2	6.09

According to the results of Regime Analysis (see Table 31) project alternative P3 is to be preferred. Although this alternative does not have the highest Benefit/Cost Ratio it shows high impact values for all other criteria. Project alternative P6 is not preferred since it has low impact values for the noise and other environmental impacts.

Table 31. Results of Regime Analysis (equal weights)

Rank	Alternative	Result (Probability)	Noise level (annoyance factor)	Soil Pollution (1000 m^3)	Other Environmental impacts	Benefit /Cost Ratio
1	P3	0.86	0.24	1	3	4.47
2	P4	0.62	0.12	1	2	5.82
3	P2	0.49	0.5	0.4	3	3.15
4	P6	0.40	0.06	1	2	6.09
5	P5	0.38	1	0.4	1	3.24
6	P1	0.25	1	0.4	1	2.65

One might argue that the addition of three new indicators is not in favour of the alternative that should be selected if Cost-Benefit Analysis is conducted on a stand-alone basis. In order to overcome this kind of criticism we might apply a Regime Analysis whereby we include weights for the criteria. In this example we assigned a weight of 70% to the Cost/Benefit Criteria and a weight of 10% to the three other criteria to test the robustness of our results. The new Regime Analysis does not give very different results, alternative P3 is still preferred above alternative P6.

6.3.7 Saaty's Method

The core of the Saaty´s method is an ordinal pair-wise comparison of all criteria. Per pair of criteria the decision-maker is asked to which degree a criterion is of more importance than the other. By means of these comparisons the method defines the relative position of one criterion in relation to all other criteria. In this way quantitative weights are assigned to the criteria.

The Saaty´s method (Analytic Hierarchy Process-AHP) has been developed by Thomas Lorie Saaty in the 1970s[151]. This method is based upon three basic components:
1. hierarchy articulation of the elements of the decision problem;
2. identification of the priority;
3. checking of the logic consistency of the priority.

The procedure is conducted in different steps. The first steps consist of the definition of the problem and of the identification of the criteria in a hierarchy of five levels:
1. general objective of sustainability;
2. criteria;
3. sub-criteria;
4. indicators;
5. index.

After defining the hierarchy articulation of the elements, the second step consists of assessing the value of the weights related to each criterion through the pairwise comparison between the elements.

The Saaty´s method employs a semantic 9-point scale (Table 32) for the assignment of priority values. This scale relates numbers to judgements, which express the possible results of the comparison in qualitative terms. In this way, different elements can be weighted with a homogeneous measurement scale.

Through this method, the weight assigned to each single criterion reflects the importance which every party /agent /group involved in the project attaches to the objectives. In addition to this, the method verifies the fit between the components of the weight vector and the original judgements. From the pair-wise comparison a 'comparison matrix' is derived out of which, through the eigenvector approach, it is possible to calculate the weight vector under investigation. Finally, the method is able to check the consistency of the matrix through the calculation of the eigenvalue.

Table 32. Semantic scale of Saaty´s method

Value	Definition
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Extreme importance
2,4,6,8	Intermediate value

An example of the use of the Saaty´s method is included in the next section.

6.3.8 Illustration on the Use of SAMI Methods

Introduction

The limited resources in the SAMI project did not allow a full scale test of the developed methodology. In order to illustrate some options opened by the SAMI methods an example where these methods have been used is next given. The example presents a real world case regarding the design of a new road network in the National Park of Cilento in Italy[152]. In it Saaty's hierarchical method is used to calculate the set of political weights, Regime Analysis to obtain a rank order of alternatives and the Flag Model to check the sustainability or acceptability of the alternatives in regard to a set of reference values (Critical Threshold Values). The example provided is mainly to be considered as a technical illustration of the methods. In other applications the way methods are used can be a different one. The Rough Set Analysis has already been illustrated in the later part of section 6.3.4.

In the early stages of the study the impacts each policy option has are summarised by means of an Impact matrix (see Table 33). In this matrix the pre-defined criteria are linked with the alternatives by means of the values each alternative scores on the defined criteria.

Table 33. The Impact matrix

	CRITERION	INDEX	A	B	C
Economic	Investment costs (-)	Mld	107	143	127
	Maintenance costs (-)	Mld/Year	1	1.3	1.3
	Transport costs by Car and Lorry (-)	Mld/Year	36	39	35.4
	Transport costs by Car and Lorry + time costs (-)	Mld/Year	64	71	63
Accessibility	Time needed from Car and Lorry on entire network (-)	Minute	32.2	37	32
	Time for Car to access from the communes to N.W point (-)	Average minute	30	34	29.7
	Time for Lorry to access from the communes to N.W point (-)	Average minute	32.5	38	32.2
	Time for Car to access from the communes to N.E point (-)	Average minute	38.7	42	38.4
	Time for Lorry to access from the communes to N.E point (-)	Average minute	43.8	48	43.5
	Time for Car to access from the communes to Roccadaspide (-)	Average minute	24.3	29.4	24.1
	Time for Lorry to access from the communes to Roccadaspide (-)	Average minute	26.8	32.7	26.5
Environment	Vicinity of population centres (+)	Qualitative	3	1	2
	Possibility of accidental fall of dangerous material (+)	Qualitative	2	3	3
	Landslide risk (+)	Qualitative	3	1	2
	Hydrology risk (+)	Qualitative	2	3	3
	Loss of vegetation (+)	Qualitative	2	1	2
	Alteration of fauna's habitat (+)	Qualitative	2	1	2
	Violation of regulation on natural environment (+)	Qualitative	3	1	1
	Fitting in the landscape (+)	Qualitative	2	3	1
	Change in the landscape morphology (+)	Qualitative	2	3	2

The Weight Vector; Application of the Saaty-module

In this case study the assignment of weights to the criteria has been performed on the basis of hierarchical logic as is described in section 6.3.7. Two sets of weights have been specified in this assessment, the first one refers to the three main classes (W_{main}) of indicators (economic, accessibility and environment), and the second set refers to the pre-defined sub-criteria (W_{sub}). These weight vectors have been calculated by means of the Saaty Module included in the computer programme for multicriteria evaluation (SAMIsoft). This programme derives a priority ranking through a pair-wise comparison of criteria based on a 9 point scale (from 1 = equally important to 9 = extremely more important).

The first step in the application of the methodology consisted of interviews held with political and technical experts by means of a questionnaire based on Saaty's fundamental scale. The aim of the methodology is to identify the respondents' preferences concerning the selected criteria.

In the second step the results of the interviews were used to calculate the two weight vectors in this evaluation. The first one represents the views and opinions of the politicians (WP_{main} and WP_{sub}), the second weight vector represents the views of technical experts (WE_{main} and WE_{sub}). This assessment also considers a vector of uniform weights (WU_{main} and WU_{sub}), in this case the priorities of criteria are assumed to be equal. Table 34 shows the three sets of calculated weights.

In this case political and technical experts were interviewed and then the weights used were based on their views. However, this cannot be considered to represent any guidance for further applications of the SAMI method. All stakeholders (see Table 15) can be considered for interviews and depending on features of the planning situation the relevant ones ought to be chosen.

If we take a closer look at the preferences expressed by the politicians and the group of technical experts we can draw the following conclusions:

?? "Investment costs" are regarded as the most important economic criterion;
?? "Time needed to travel the entire network" is regarded as the most important accessibility criterion;
?? According to the technical experts the criteria "landslide risk" and "hydrology risk" are of main importance in the environmental section. However, politicians attach a higher importance to the pollution problem.

In general, both the politicians and the technical experts labelled the accessibility criterion as the most important of the three main criteria classes. This is shown by the high value of the weight assigned to this criterion. The group of technical experts considers accessibility and environmental equally important, whereas the group of politicians assigns a higher value to the accessibility criterion compared to the economic and environmental criteria.

Table 34. The three sets of weights

		Uniform weight vector		Experts		Politicians	
		WU_{sub}	WU_{main}	WE-sub	WE_{main}	WP_{sub}	WP_{main}
Eco-nomic	Investment costs	0.25	0.33	0.749	0.06	0.584	0.056
	Maintenance costs	0.25		0.142		0.133	
	Transport costs by C and L	0.25		0.044		0.036	
	Transport costs by C and L+ time costs	0.25		0.315		0.247	
Accessibility	Time needed from C and L on entire network	0.143	0.33	0.396	0.49	0.384	0.702
	Time for C to access from the communes to N.W point	0.143		0.208		0.147	
	Time for L to access from the communes to N.W point	0.143		0.044		0.036	
	Time for C to access from the communes to N.E point	0.143		0.094		0.107	
	Time for L to access from the communes to N.E point	0.143		0.033		0.039	
	Time for C to access from the communes to Rocca-daspide	0.143		0.303		0.269	
	Time for L to access from the communes to Rocca-daspide	0.143		0.065		0.024	
Environment	Vicinity of population centres	0.111	0.33	0.28	0.45	0.41	0.242
	Possibility of accidental fall of dangerous material	0.111		0.059		0.024	
	Landslide risk	0.111		0.338		0.293	
	Hydrology risk	0.111		0.215		0.198	
	Loss of vegetation	0.111		0.082		0.026	
	Alteration of fauna's habitat	0.111		0.077		0.095	
	Violation of regulation on natural environment	0.111		0.199		0.233	
	Fitting in the landscape	0.111		0.068		0.038	
	Change in the landscape morphology	0.111		0.06		0.051	

Regime Analysis; Obtaining a Rank Order of Alternatives

The Regime Method as is described in section 6.3.6 allows us to analyze an impact matrix with mixed data and a weight vector in order to calculate a rank order of alternatives. The software used to evaluate all alternatives in this case study (SAMI-soft) considers all the scores as benefit criteria, this means that the higher a alternative scores on a criteria the better. When our impact matrix is (see Table 33) constructed of both cost and benefit criteria, we have to transform all cost criteria into benefit criteria. This is done by standardizing the scores (A_{min}/A) to obtain values between 0 and 1.

In this case study the Regime Analysis was conducted in two steps. First, a Regime Analysis was conducted on each of the main classes. By means of the values each alternative scores on the sub-criteria the scores per main class were determined. These results are presented by the intermediate results in Table 35 and 36. In the second step the intermediate results formed the input, together with the main weight vector, for the final Regime Analysis.

Actually, the Intermediate results show that alternative A is preferable according to both economic and environmental criteria, while alternative C is only preferable according to the scores on the accessibility criterion. Alternative B is not preferable at all.

Table 35. Rank order of alternatives using the uniform weight vector

Criteria	Intermediate results			Final results		
	A	B	C	A	B	C
Economic	1	0	0,5			
Accessibility	0,5	0	1	0,88	0	0,662
Environment	0,82	0,18	0,5			

If we use a different weight vector, for example the weight vector which describes the preferences of the technical experts (cf. Table 34), results of the Regime Analysis will be different (see Table 36).

In this case alternative C turns out to be preferred, even if the intermediate results show once more that alternative A scores better on both the economic and environmental criteria. The supremacy of alternative C depends on the high value of the weight assigned to the accessibility criterion.

Table 36. Rank order of alternatives using the preferences of technical experts

Criteria	Intermediate results			Final results		
	A	B	C	A	B	C
Economic	0,97	0.04	0,5			
Accessibility	0,5	0	1	0,65	0	0,79
Environment	1	0	0,5			

Acceptability of Aternatives; Aplication of the Flag Model

In this paragraph we will illustrate the application of the Flag Model (see section 6.3.5) to check the acceptability of alternatives, in this case the appliance of the sustainability concept, with regard to a set of reference values (Critical Threshold Values (CTV)). This analysis is carried out by means of the Flag Model, which is included in the multicriteria evaluation software - SAMIsoft.

In this case study the critical threshold values have been defined as is depicted in Table 37.

Table 37. Set of critical threshold values

Indicator	CTV_{min}	CTV	CTV_{max}
Investment costs	85 mld of lira	100 mld of lira	150 mld of lira
Maintenance costs		1,5 mld of lira per year	
Transport costs		33 mld of lira per year	
Transport costs + time costs		66 mld of lira per year	
Internal accessibility	15 minutes	20 minutes	30 minutes
External accessibility	30 minutes	45 minutes	60 minutes
Environmental indicators		Value 2 on the ordinal scale (1,2,3)	

The table above (Table 37) and Table 33 form the input for the Flag Model. Table 38 shows the results of the analysis by means of the frequency of flags per alternative in respect to each relevant main class of criteria.

Table 38. Frequencies of flags

	All Flags				Environmental				Economic				Accessibility			
	B	R	O	G	B	R	O	G	B	R	O	G	B	R	O	G
A	2	5	3	10	0	0	0	9	1	3	0	0	1	2	3	1
B	4	4	8	4	0	0	5	4	2	2	0	0	2	2	3	0
C	2	5	5	8	0	0	2	7	1	3	0	0	1	2	3	1

B means blue, R red, O orange, G green

Our investigation of the results in Table 38 shows that alternative A is the most acceptable/sustainable; it has in fact 10 green flags and 3 orange flags in the total scores. The scores on the environmental indicators mostly determine those 10 green flags. All alternatives appear to be unacceptable in respect to the scores on the economic indicators. We can also conclude that alternative A and alternative C are more acceptable than alternative B due to their scores on the accessibility indicators.

6.3.9 Conclusions

The above applications of the SAMI evaluation methods points out that these are very useful tools to deal with conflicts in a decision-making process. Three critical points deserve our attention. First, the software gives us the possibility to analyse conflicting targets and the degree of conflict between them (cf. section 3.4). Second, the software gives us the possibility to take into account the preferences of different stakeholders and to measure the impact of their viewpoints (cf. section 3.3.2). Finally, the use of critical threshold values offers us an operational framework for environmental sustainability analysis at a given spatial level (cf. sections 3.1 and 6.4).

One caveat is worth mentioning here. The final responsibility of a policy decision rests with the competent authority and can never be overruled by a decision support technique. However, such techniques can be useful in making a complex decision problem more transparent and thus in contributing to the accountability of policy decisions.

6.4 Strategic Environmental Assessment

The environmental impacts of the provision of transport infrastructure and its subsequent use are significant in scale and arise throughout the transport sector (see also section 2.2). However, whilst general global and national effects of the development of the transport system have been well documented, Environmental Impact Assessment is typically only applied to individual transport infrastructure projects rather than wider policies, plans and programmes (PPPs). As a consequence, the consideration of the environmental effects is usually concluded at a local level.

As a result there have been parallel moves in many countries towards developing an approach for the environmental assessment of policies, plans and programmes. The widespread nature of transport systems and their consequent environmental effects have meant that transport has been a sector where the potential benefits of the Strategic Environmental Assessment (SEA) have been identified.[153]

In this sense SEA could be defined as the formalised, systematic and comprehensive process of evaluating the environmental impacts of a policy, plan or programme and its alternatives, including the preparation of a written report on the findings of that evaluation and using the findings in publicly accountable decision-making.

The relationships between SEA and general assessment methodologies are still developing. Assessment methodologies have been developed and used in practice for a long time. SEA is a new phenomenon that is still under development. Its final role in the decision process will evolve during the following years. What happens in the transport sector is influenced also by development of SEA procedures in other sectors.

The Flag model described in section 6.3.5 will probably be a useful tool also in SEA, especially when critical threshold values for environment have or could be defined. By this way also SAMI optimisation procedure could be used in the connection of SEA (see section 4.3).

Elsewhere in the FP4, the COMMUTE project provided guidance for carrying out a SEA (see Box 21).

Box 21. COMMUTE framework for SEA[154]

1. Setting of Objectives and Targets (Stocktaking of the Political Environment)
2. Screening to determine the need for SEA at this stage of the planning process
3. Scoping: identification of:
   - the physical/regional limits;
   - the impacts to be addressed;
   - the alternative actions that need to be assessed.
4. Carrying out of the SEA:
   - Measuring/predicting the environmental impact of the action and its alternatives;
   - Evaluating the significance of the impact (e.g. through comparison with environmental objectives);
   - Proposing recommendations: preferred alternative, mitigation and monitoring measures.
5. Preparation of the decision
6. Taking the decision
7. Making arrangements for monitoring and follow-up
8. Conducting further environmental assessments (at later stages of planning process, e.g. project EIA)

7. CONCLUSIONS

7.1 SAMI´s Objectives and Accomplishments

7.1.1 Targets

The accomplishments regarding the first overall objective (for the objectives see section 1.2) of the SAMI project include:

?? *SAMI approach for setting transport policy targets* working through four different steps where targets and the acceptability of related lines of actions can be defined;

?? *SAMI framework for assessing interactions between targets* identifies the form (direction, intensity and precedence) and the type of an interaction (structural, circumstantial or instrumental);

?? Specification of three areas of policy development, related 11 policy issues and 21 candidate targets and definition of targets´ interactions and 8 hierarchical classes;

?? Specification of requirements for performance indicators and definition of overall indicators for above mentioned 21 candidate targets and operational indicators for related policy orientations.

7.1.2 Scenarios and Instruments

In this Guide we have presented various ways to develop *scenarios* and during the SAMI project two different Images of the Future have been created. Two sets of possible policy *instruments* related to above-mentioned targets have been identified. Because it is noticed that any instrument alone cannot be successful *SAMI Optimisation Method* with capabilities to combine optimal sets of instruments has been created and tested. For the testing procedure a new *EURO9 transport model* was developed.

7.1.3 Evaluation of Strategies

The core of *SAMI Evaluation Methodology* is formed by a qualitative-quantitative Regime analysis, extended with complementary approaches like the Flag Model, Rough Set Analysis and Saaty's hierarchical method. A *software* package was developed for all methods except Rough Set Analysis, for which a commercially marketed software package is already available.

7.1.4 CTP Implementation on the European Level

The major contributions of the SAMI project for clarifying the conditions for CTP implementation are models and tools developed which can be used for testing various strategies before implementation. In addition to that the current report includes an extensive presentation of facts and methods for all major building blocks of decision-making on the strategic level.

In addition to the methods and tools developed in the SAMI project also many relevant results are presented from other FP4 projects like AFFORD, ASTRA, CODE-TEN, COMMUTE, MAESTRO, POSSUM, EUNET/SASI, SCENARIOS, SCENES, STREAMS, and TENASSESS. In consideration of the future enlargement of the EU as well as relations to third countries the current transport trends and policies in the CEEC and CIS have also been presented.

The limited resources in the SAMI project did not allow any realistic participation in the transport planning on the European level. Because of that the provided tools and methods have been mainly tested separately. By this way they remain isolated innovations, which ought in the future to be formed into a combined package for strategic transport planning on the European level.

7.2 Need for guidance

One of the origins of the SAMI project has been the need for guidance in transport policy emphasised by the current situation facing the decision-maker with various interest groups and bewildering complexity of scenarios, objectives, instruments and models. SAMI´s contribution for the guidance has been in addition to the development of useful methods and tools also the compilation of this report. The report presents a comprehensive picture of the issues related to transport policy making on the European level.

However, it has to be admitted that the complexity of the policy-making world cannot be escaped. After the SAMI project the various interest groups and bewildering complexity of scenarios, objectives, instruments and models still exist. What SAMI has accomplished has to be seen as one effort in a huge process for the development of European transport policy.

7.3 From Policy to Reality

Europeans´ answer for the **traditional** transport problem during the last fifty years has been the purchase of huge amounts of cars, buses, vans and lorries and the construction of related infrastructure. The consequent increase in traffic has resulted in environmental problems and accidents, which form a key issue in **modern** transport problem. In addition to that a **post-modern** transport problem - with congested networks and without much room for further expansion - has emerged in densely populated areas. This makes earlier solutions – increase of transport capacity – difficult to execute and in addition to that also former local environmental problems have been transformed into global sustainability issues.

Above described development has increased the speed and distance the Europeans can daily cover. This trend is currently emphasised because of rapidly increasing aviation and new high speed rail connections. Especially rapid increase has been forecasted for air travelling.

The implementation of catalytic converters in cars has started to diminish major pollutants from road traffic. However, road traffic is still the major cause for nuisances in urban areas. Especially the total toll of deaths - over 40 000 yearly – is horrible.

There exists a need for travelling originating from daily human activities, but current transport patterns are forming one cause for endangering environmental sustainability. By that way it can be seen that there is a clear conflict – at least in the short time – between economic efficiency demands and the needs of environmental protection. This conflict has produced a kind of impasse in transport policy retarding the implementation of possible solutions. In spite of many policy documents and research efforts a *sustainable mobility* – as advocated by the European Commission – has not been reached.

GLOSSARY

ASSESSMENT
Analysis both before decisions are made (as in appraisal or ex-ante *evaluation*) and after the decision has been implemented (as in ex-post *evaluation*).

ASSESSMENT TOOL
A model and/or a methodology to carry out impact assessment or *policy assessment*.

BACKCASTING
A process of identifying actions (e.g. *policy instruments*) that lead from specific point in time to one or more specified future situations.

DEFENSIVE GOALS
Policy goals associated with a minimum threshold level (e.g. noise levels). See also *expansive goals*.

EVALUATION
Examination of an on-going or completed project, plan or programme in order to guide decision-makers. The evaluation might include the design, implementation and results with the aim of determining the efficiency, effectiveness, various impacts and the relevance of the objectives of the project, plan or programme in question. It often indicates an examination to be carried out after the implementation of a project, a programme or a plan, to test whether the aims of this project, programme or plan have been fulfilled.

EXPANSIVE GOALS
Policy goals associated with no threshold level – maximum values are sought (e.g. economic growth). See also *defensive goals*.

EXTERNAL SCENARIO
A medium or long term set of assumptions about changes in society that may affect the transport sector in the future. The external scenario describes assumptions about the autonomous development of parameters which are considered crucial for the strategy or policy to be formulated. Alternative external scenarios contain internally consistent sets of future socio-economic and technological parameters which influence the transport sector in some way.

FORECASTING
A process of constructing projections based on the extrapolation of recent trends (c.f. *backcasting*).

IMAGE OF THE FUTURE
A qualitative and/or quantitative description of a future situation, often forming part of the *backcasting* process.

IMPACT ASSESSMENT
An analysis of the effects on particular areas (e.g. on economic development, spatial distribution of activities, and the environment) derived from developments and initiatives (e.g. new infrastructure projects, road pricing and other policy measures).

INFRASTRUCTURE/TRANSPORT INFRASTRUCTURE
The fixed physical structures and other common facilities serving the operational parts of a transport system.

INTERMODAL (INTERMODALITY)
A route of an individual passenger or goods unit which consists of a combined chain involving at least two different modes. For freight transport in particular, intermodal transport indicates the transport between two points in which several modes of transport are used in succession without handling of the goods during mode changing operations. One carrier or operator may organise the whole journey.

INTEROPERABILITY
The ability of national and geographically defined transport networks to provide efficient operations and services across national borders and across physical and technical barriers respectively. Interoperability occurs when the rolling stock of a national railway company is able to operate on the whole or part of the trans-European railway network or when two previously separated national networks are being interconnected and able to serve common fleet operations. In telematics, interoperability is the ability of systems to provide services to and accept services from other systems and to use the services so exchanged to enable them to operate effectively together.

MULTI-CRITERIA (MODELS AND METHODOLOGIES)
Involves models and methodologies that deal with the analysis of two or more criteria measured in different units. In principle there are no limitations with respect to the number and nature of criteria to be used as far as they are considered relevant to the policy or impact assessment in question. Most multi-criteria analysis does not aggregate the impacts into one unit but represents them in a non-aggregated form.

POLICY ASSESSMENT
The assessment of alternative policy options (e.g. different *policy instruments*) in terms of specific *policy targets* or issues. The assessment includes ex-ante and ex-post *evaluation*.

POLICY GOAL
A broad objective of a policy or set of policies (e.g. the need for higher accessibility or mobility of a certain geographical area, reduction of congestion, increased safety, reduced environmental damage or energy consumption from transport). It may be formulated in either relative or absolute terms and usually has a specific time-frame.

POLICY INSTRUMENT
A specific policy (e.g. the construction of transport infrastructure, the introduction of road pricing).

POLICY ORIENTATION
A category or broad type of *policy instrument* (e.g. policies to internalise external costs, policies for parking restraint).

POLICY PACKAGE
A group of two or more *policy instruments* introduced together (which may introduce *synergies*).

POLICY SCENARIO (FOR TRANSPORT)
A transport policy option which represents a sequence of deliberately planned *policy instruments* according to a given *external scenario*. Alternative policy scenarios are often presented to decision-makers to make a comparison or choice. In this case, the scenarios are associated with *policy assessment*.

POLICY TARGET
A specific goal of policy which is often formulated in quantifiable terms. It is often used to measure the extent to which a specific *policy instrument* or *policy package* contributes to the goal (e.g. the percentage or number of accidents or casualties reduced, the effect on CO_2 emissions, the average travel time from one region to another, the modal split, etc.).

SCENARIO
A tool that describes a view of the future within a specified framework and under specified assumptions about external factors (see *external scenario*) and *policy instruments*. Scenarios are usually designed to compare and examine alternative futures.

STAKEHOLDERS
Groups who in some way affect and/or are affected by transport policy or the outcomes of policy.

SYNERGY
The complementary effect(s) between instruments in *policy packages* which result in more advantageous outcomes than the combined outcomes of the individual measures if introduced separately.

ABBREVIATIONS

CEEC
Central and Eastern European Countries

CIS
Confederation of Independent States

CTP
Common Transport Policy

CTAP
Common Transport Action Plan

EIA
Environmental Impact Assessment

NUTS
Nomenclature of Territorial Unit of Statistics

SEA
Strategic Environmental Assessment

TEN
Trans European Network

[1] Dugonjic, V., Himanen, V., Nijkamp, P. & Padjen, J. (1993) *The Links between Mobility and Environmental sustainability*, In: Banister, D. & Berechman, J. (eds.) Transport in a Unified Europe – Policies and Challenges, Elsevier Science Publishers, 195 – 219.

[2] For discussions on congestion see e.g. Banister, D. (1989) *The Final Gridlock,* Built Environment, 15(3/4), 163-165 and Goodwin, P.B. (1990) *Understanding Congestion*, Recherce – Transport – Sécurité, Revue de L´INRETS, English issue 5, 75-80.

[3] World Commission on Environment and Development (Bruntland report) (1987) *Our Common Future,* Oxford University Press, Oxford.

[4] For a thorough discussion on devolution of transport policy see Button, K.J. and D.E. Pitfield (eds.) (1990) *Transport Deregulation: A European Perspective,* MacMillan, London.

[5] Commission of the European Communities (1992) *The Future Development of the Common Transport Policy*, COM (92) 494, Brussels.

[6] Commission of the European Communities (1995) *Towards Fair and Efficient Pricing in Europe. Policy Options for Internalising the External Costs of Transport in the European Union, COM (95) 691,* Office for Official Publications of the European Communities, Luxembourg.

[7] Marchetti, C. (1993) *On Mobility,* Final Status Report, IIASA, Laxenburg.

[8] EUROSTAT (1997) *EU Transports in Figures*, Statistical Pocketbook, Office for Official Publications of the European Communities, Luxembourg.

[9] see for example OECD/ECMT (1995) *Urban Travel and Sustainable Development*, OECD, Paris.

[10] EUROSTAT (1997) *EU Transports in Figures,* Statistical Pocketbook, Office for Official Publications of the European Communities, Luxembourg.

[11] OECD (1988) *Transport and the Environment,* OECD, Paris.

[12] EUROSTAT (1997) *EU Transports in Figures,* Statistical Pocketbook, Office for Official Publications of the European Communities, Luxembourg.

[13] Ibid.

[14] Ibid.

[15] Ibid.

[16] Whitelegg, J. (1997) *Critical Mass; Transport, Environment and Society in the Twenty-First Century,* Pluto Press, London.

[17] EUROSTAT (1997) *EU Transports in Figures,* Statistical Pocketbook, Office for Official Publications of the European Communities, Luxembourg.

[18] Ibid.

[19] Ibid.

[20] Impacts can be categorised in various ways. In the MAESTRO project four types of impacts – transport system changes, economic efficiency, environment/safety/security and indirect impacts - were defined, see MAESTRO (1999) *Transport Evaluation Methodology,* Deliverable 2, Submitted to EU-DG VII Strategic Research, Brussels. In the COMMUTE project definitions of various environmental impacts are given see COMMUTE (1998) *Methodology Report, Volume 2: COMMUTE Framwork fo SEA,* Deliverable 2, Submitted to EU-DG VII Strategic Research, Brussels.

[21] For a thorough description on European travelling see Salomon, I., Bovy, P. & Orfeuil, J-P. (1993) (eds.) *A Billion Trips a Day; Tradition and Transition in European Travel Patterns,* Kluwer Academic Publishers, Dordrecht.

[22] Ibid., 40.

[23] For travel times, distances and speeds of different person groups see Himanen, V., Järvi-Nykänen, T. & Raitio, J. (1998) *Daily Travelling Viewed by Self-Organizing Maps*, In: Himanen, V., Nijkamp, P. & Reggiani, A. (eds.) Neural Networks in Transport Applications. Ashgate, Aldershot.

[24] OECD/ECMT (1995) *Urban Travel and Sustainable Development,* OECD, Paris.

[25] Department of the Environment (1996) *Indicators of Sustainable Development for the United Kingdom,* HMSO, London.

[26] see for example Howard, D. (1990) *Looking Beyond the Technical Fix,* Town and Country Planning 59(12), 343-345 or Department of the Environment (1997) *The United Kingdom National Air Quality Strategy,* The Stationery Office, London.

[27] European Environment Agency (1999).

[28] Commission of the European Communities (1998) *Communication from the Commission on Transport and* CO_2 *– Developing a Community Approach*, Office for Official Publications of the European Communities, Luxembourg.

[29] European Environment Agency (1999).

[30] Ibid.

[31] Ibid.

[32] Ibid.

[33] Commission of the European Communities (1992) *The Impact of Transport on the Environment: A Community Strategy for Sustainable Development*, Green Paper, DGVII, Brussels.

[34] Royal Commission on Environmental Pollution (1994) *Eighteenth Report; Transport and the Environment*, HMSO, London.

[35] see Taylor, S.M. and Watkins, P.A. (1987) *Health Effects from Transportation Noise Reference Book,* Butterworth, London or OECD (1991) *The State of the Environment,* OECD, Paris.

[36] Jones, D.M. (1990) *Noise, Stress and Human Behaviour,* Environmental Health 98(8), 206-208.

[37] Royal Commission on Environmental Pollution (1994) *Eighteenth Report; Transport and the Environment*, HMSO, London.

[38] Ibid.

[39] OECD (1997) *Energy Balances of OECD Countries, 1995-1996*, OECD, Paris.

[40] Central Statistical Office (1997) *Annual Abstract of Statistics,* The Stationery Office, London.

[41] Royal Commission on Environmental Pollution (1994) *Eighteenth Report; Transport and the Environment*, HMSO, London.

[42] Ibid.

[43] Banister, D. (1998) *Introduction: Transport Policy and the Environment,* In: Banister, D. (ed.) Transport Policy and the Environment. E. and F.N. Spon, London, 1-16.

[44] See Jones, P.H. (1981) *Snow and Ice Control and the Transport Environment*, Environmental Conservation 8 (1), 33-38 or Murray, D.M. (1977) *Economic analysis of the environmental impact of highway deicing salts,* Washington D.C. Transportation Research Board, Transportation Research Record 647, 229-40.

[45] Maritime and Coastguard Agency (1997) *The Sea Empress Incident: Summary Report*. Maritime and Coastguard Agency, Southampton.

[46] Banister, D. and Berechman, J. (2000) *Transport Investment and Economic Development*, University College London Press, London, Section 12.2.

[47] For a thorough discussion on transport infrastructure investment and economic development see Ibid.

[48] Vickerman, R. (1995) *Location, accessibility and regional development: the appraisal of trans-European networks*, Transport Policy 2(4), 225-234.

[49] see for example Krugman, P. (1991) *Increasing returns and economic geography?* Journal of Political Economy 99(3), 483-499 or Romer, P.M. (1986) *Increasing returns and long-run growth*, Journal of Political Economy 94(5), 1002-1038 or Vickerman, R. (1994) *Transport infrastructure and region building in the European Community,* Journal of Common Market Studies, 32(1), 1-24.

[50] This review of impacts on regional development is taken from Schürmann, C., Spiekermann, K. and Wegener, M. (1997) *Accessibility Indicators: Model and Report.* EUNET/SASI, Deliverable D5, Institut für Raumplanung, Universität Dortmund.

[51] Ibid.

[52] Committee on the Medical Effects of Air Pollutants (1998) *The Quantification of the Effects of Air Pollution on Health in the United Kingdom,* The Stationery Office, London.

[53] Appleyard, D. and Lintell, M. (1969) *The Environmental Quality of City Streets: The Resident Perspective,* Journal of the American Planning Association 35, 84-101.

[54] For spacial equity see also Banister, D. and Berechman, J. (2000) *Transport Investment and Economic Development*, University College London Press, London.

[55] See also Handy, S. (1993) *Regional versus local accessibility: implications for non-work travel.* Transportation Research Record 1400, 58-66.

[56] Himanen, V., Järvi-Nykänen, T. & Raitio, J. (1998) *Daily Travelling Viewed by Self-Organizing Maps*, In: Himanen, V., Nijkamp, P. & Reggiani, A. (eds.) Neural Networks in Transport Applications, Ashgate, Aldershot.

[57] IRF, AIMSE (1990) *The motorway Project for the Europe of Tomorrow,* Geneva.

[58] Goodwin, P.B., Hallet, S., Kenny, F. & Stokes, G. (1991) *Transport: The New Realism,* Transport Studies Unit, University of Oxford, Report to the Rees Jeffreys Road Fund, Oxford.

[59] Finnish Road Administration and Economic Planning Centre (1987) *A forecast for traffic and car ownership 1987-2010,* TVH 713092, Helsinki. (in Finnish)

[60] Svidén, O. (1983) *Automobile Usage in a Future Information Society,* Furtures 15, 261-274 and Jansson, J.O. (1989) *Car Demand Modelling and Forecasting,* Journal of Transport Economics and Policy 23, 125-140.

[61] De Jong, G.C. (1989) *An Indirect Utility Model of Car Ownership and Private Car Use,* European Economic Review 34, 971-985 and Vleugel, J.M., van Gent, H.A. & Nijkamp, P. (1990) *Transport and Environment: Experiences with Dutch Policies,* In: Barde, PH. and Button, K.E. (eds.) Transport Policy and the Environment, Earthscan, London, 121-156.

[62] One half of the increase in travel kilometrage was due to changed travelling habits and the other half depended on the increase in car ownership in Finland during 1986-1992 according to Himanen, V., Järvi-Nykänen, T. & Raitio, J. (1998) *Daily Travelling Viewed by Self-Organizing Maps*, In: Himanen, V., Nijkamp, P. & Reggiani, A. (eds.) Neural Networks in Transport Applications, Ashgate, Aldershot, 87.

[63] ECMT according to ERTI (1991) *Missing Networks, a European Challenge,* Brussels, 31.

[64] Goodwin, P.B., Hallet, S., Kenny, F. & Stokes, G. (1991) *Transport: The New Realism*, Transport Studies Unit, University of Oxford, Report to the Rees Jeffreys Road Fund, Oxford.

[65] Finnish Road Administration and Economic Planning Centre (1987) *A forecast for traffic and car ownership 1987-2010,* TVH 713092, Helsinki. (in Finnish)

[66] STREAMS (1999) Deliverable 8/10, Submitted to EU-DG VII, Strategic Research, Brussels, 6.6.

[67] Ibid., 6.20.

[68] The current phase in developed western countries has been named depending on the standpoint: information society, communication or interference society, service society, third wave, learning society etc. The third wave, information society, started in 70´s with the technological change triggered by micro chips.

[69] SCENES (1999), *CEEC data and method*, Deliverable 1, Submitted to EU-DG VII, Strategic Research, Brussels.

[70] Le Clercq (1987) *Policy cycles and new planning issues,* Quoted in Salomon, I., Bovy, P. & Orfeuil, J-P. (1993) A Billion Trips a Day; Tradition and Transition in European Travel Patterns, Kluwer Academic Publishers, Dordrecht, 170.

[71] According to two studies of the Club of Rome – Meadows, D.H., Meadows, D.L., Randers, J. (1972) *The Limits to Growth,* Universe Books, New York and Meadows, D.H., Meadows, D.L., Randers, J. (1992) *Beyond the Limits; Global Collapse or Sustainable Future,* Earthscan Publications Ltd, London – the world is not developing according to a sustainable way.

[72] Commission of the European Communities (1998) *The Common Transport Policy – Sustainable Mobility: Perspectives for the Future*, Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions, Brussels, December, COM (1998) 716 Final.

[73] See Banister, D. (1994) *Transport Planning*, Spon, London or Banister, D. and Berechman, J. (eds.) (1993) *Transport in a Unified Europe: policies and Challenges*, Elsevier, Amsterdam.

[74] Commission of the European Communities (1985) *Official Journal of the European Communities*, C 144, June 13.

[75] European Parliament (1991) *Community Policy on Transport Infrastructures, European Parliament*, Research and Development Papers, Series on Regional Policy and Transport 16, European Parliament, Luxembourg.

[76] Vickerman, R. (1991) *Transport Infrastructure in the European Community: New Developments, Regional Implications and Evaluation*, in Vickerman, R.W. (ed.), Infrastructure and Regional Development, Pion, London.

[77] European Parliament (1991) *Community Policy on Transport Infrastructures, European Parliament*, Research and Development Papers, Series on Regional Policy and Transport 16, European Parliament, Luxembourg.

[78] Gérardin, B. (1989) *Possibilities for, and Costs of, Private and Public Investment in Transport*, European Conference of Ministers of Transport, Round Table 83, ECMT, Paris.

[79] Source: Abbati, C. (1986) *Transport and European Integration,* European Perspectives, Commission of the European Communities, Brussels.

[80] Commission of the European Communities (1993) *Towards Sustainability. A European Community Programme of Policy and Action in Relation to the Environment and Sustainable Development (Fifth Environmental Action Plan),* Brussels, Commission of the European Communities.

[81] Commission of the European Communities (1992) *The Impact of Transport on the Environment: A Community Strategy for Sustainable Development*, Green Paper, DGVII, Brussels.

[82] Commission of the European Communities (1992) *The Future Development of the Common Transport Policy,* COM (92) 494, Brussels, para. 127.

[83] Ibid., para. 128.

[84] Ibid., para. 140.

[85] Ibid., para. 143.

[86] Hey, C. (1996*) The incorporation of the environmental dimension into the transport policies of the EU*, EURES Discussion Paper No 50, Freiburg.

[87] Commission of the European Communities (1995) *The Common Transport Policy Action Programme 1995-2000*, Communication from the Commission, COM (95) 302 Final, July.

[88] OECD (1993) *Indicators for the integration of environmental concerns into transport policies,* Environment Monograph No. 80, OECD, Paris.

[89] Commission of the European Communities (1995) *The Common Transport Policy Action Programme 1995-2000*, Communication from the Commission, COM (95) 302 Final, July.

[90] Commission of the European Communities (1998) *The Common Transport Policy – Sustainable Mobility: Perspectives for the Future*, Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions, Brussels, COM (1998) 716 Final.

[91] Commission of the European Communities (1995) *The Citizens' Network,* COM (95) 601, Office for Official Publications of the European Communities, Luxembourg.

[92] Commission of the European Communities (1995) *Towards Fair and Efficient Pricing in Europe; Policy Options for Internalising the External Costs of Transport in the European Union,* COM (95) 691, Office for Official Publications of the European Communities, Luxembourg.

[93] Commission of the European Communities (1995), *Strategy for Revitalising the Community's Railway,* COM (96) 421, Office for Official Publications of the European Communities, Luxembourg.

[94] Commission of the European Communities (1997). *Intermodality and Intermodal Freight Transport in the European Union*, Communication from the Commission. COM (97) 243, Office for Official Publications of the European Communities, Luxembourg.

[95] Commission of the European Communities (1998) *Communication from the Commission on Transport and CO_2 – Developing a Community Approach*, Office for Official Publications of the European Communities, Luxembourg, para 46.

[96] Commission of the European Communities (1998) *The Common Transport Policy – Sustainable Mobility: Perspectives for the Future*, Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions, COM (1998) 716, Office for Official Publications of the European Communities, Luxembourg.

[97] Sichelschimdt, H. (1999) *The EU programme "trans-European networks" – a critical assessment*, Transport Policy 6, 169-181.

[98] Banister, D. and Banister, C. (1994) *Energy Consumption in Transport in Great Britain: Macro Level Estimates*, Transportation Research A. 29A(1), 21-32.

[99] UK House of Lords (1995) *Report from the Select Committee on Sustainable Development*, Vol. 1, HMSO, London.

[100] Royal Commission on Environmental Pollution (1994) *Eighteenth Report; Transport and the Environment*, HMSO, London.

[101] European Commission (1996) *European Sustainable Cities*, Report of the Expert Group on the Urban Environment, Luxembourg, Office for Official Publications of the European Communities.

[102] Elvik, R. (1993) *Quantified Road Safety Targets*, Accident Analysis and Prevention 25(5), 569-583.

[103] Jacobs, M. (1993) *Sense and Sustainability*, Council for the Protection of Rural England, London.

[104] Hey, C., Nijkamp, P, Rienstra, S.A. and Rothenberger, D. (1997) *Assessing scenarios on European transport policies by means of multicriteria analysis*, In: Button, K., Nijkamp, P. and Priemus, H. (eds.) Transport Networks in Europe, Edward Elgar, Cheltenham.

[105] Banister, D. (1995) *Transport and the Environment*, Town Planning Review, 66(4), 453-458.

[106] For a complete presentation of this process see SAMI (1998) *Targets and Scenarios*, Deliverable 1, Submitted to EU-DG VII, Strategic Research, Brussels.

[107] For the relationships between all targets see Ibid., Chapter 4.

[108] For the comments on the acceptability of policy orientations related to the targets see Ibid., Appendix 2.

[109] See for example OECD (1993) *Indicators for the integration of environmental concerns into transport policies*, Environment Monograph No. 80, OECD, Paris or USEPA (1996) *Indicators of the environmental impact of transportation*, Office of Policy, Planning and Evaluation, United States Environmental Protection Agency, Washington or World Bank (1995) *The use of sectoral and project performance indicators in bank-financed transport operations*, Report TWU21, Transportation, Water and Development Department, World Bank, Washington DC.

[110] MAESTRO (1999) *Transport Evaluation methodology*, Deliverable 2, Submitted to EU-DG VII, Strategic Research, Brussels.

[111] Kings, A. & Schneider, B. (1991) *The First Global Revolution*, A Report by The Council of The Club of Rome, Simon & Schuster, London, 105.

[112] See for example OECD/ECMT (1995) *Urban Travel and Sustainable Development*, OECD, Paris.

[113] Acutt, M. and Dodgson, J. (1996) *Policy Instruments and Greenhouse Gas Emissions from Transport in the UK*, Fiscal Studies, 17(2), 65-82. They also considered the impacts of these

policy options on issues of air pollution, traffic congestion, consumer expenditure and public sector finance.

114 POSSUM (1998) *The Construction of Policy Paths,* POSSUM Briefing Paper 2, available from the Bartlett School of Planning, University College London.

115 Full technical details of SAMI optimisation approach are given in SAMI (1999) O*ptimisation of CTP Instruments*, Deliverable 3, Submitted to EU-DG VII, Strategic Research, Brussels.

116 Ibid.

117 See Press, W.H., Flannery, B.P., Teukolsky, S.A. and Vetterling, W.T. (1990), (Reprinted) Numerical Recipes, Published by the Press Syndicate of the University of Cambridge, 289-293.

118 For details of the objective function see Minken (1998) *A sustainability objective function for local transport policy evalution,* Paper presented to the 8th World Conference on Transport Research, Anwerp.

119 For detailed information about the use of objective functions in the context of marginal social cost pricing see AFFORD (1999) *Operationalisation of Marginal Cost Pricing within Urban Transport,* Deliverable 1, Submitted to EU-DG VII, Urban Transport Research, Brussels.

120 These targets are adapted from the Kyoto agreed targets for the whole economy - as given in DETR (1998) *EU Agrees Kyoto Climate Change Share-Out,* UK Department Of The Environment, Transport And The Regions, Press Release 482\Env 17 June 1998 - by assuming that percentage CO_2 reductions for the transport sector should be the same as for the whole economy. The targets are aggregated from the Country level to the nine zones used in the EURO9 model via a simple weighted average using population as the weight.

121 The differences between the unconstrained and constrained approach are discussed in detail in SAMI (1999) O*ptimisation of CTP Instruments,* Deliverable 3, Submitted to EU-DG VII, Strategic Research, Brussels.

122 Ibid.

123 A quote from Gaston Berger (contemporary French philospher), In: Kings, A. & Schneider, B. (1991) *The First Global Revolution,* A Report by The Council of The Club of Rome, Simon & Schuster, London, 101.

124 May, G. (1982) *The argument for more future-oriented planning*, Futures 14 (4), 313-318.

125 Commission of the European Communities (1994) *Strategic Transport Glossary*, European Commission, Brussels.

126 SCENARIOS (1998) *Global Reference Scenarios,* Deliverable C5, Submitted to EU-DG VII, Strategic Research, Brussels.

127 A fuller description of the different scenario-building approaches can be found in Rienstra, S. (1998) *Options and Barriers for Sustainable Transport Policies: A Scenario Approach,* Netherlands Economic Institute, Rotterdam or Becker, H. (1997) *Social Impact Assessment,* UCL Press, London.

128 See for example Johansson, T.B., Steen, P., Fredriksson, R. and Bogren, E. (1983*) Sweden beyond oil: the efficient use of energy*, Science 219, 355-361 or Löhnroth, M., Johansson, T.B. and Steen, P. (1980) *Sweden beyond oil: nuclear commitments and solar options*, Science 208, 557-563 or Olson, R.L. (1994) *Alternative images of a sustainable future*, Futures 26 (3), 156-169.

129 POSSUM (1998) *Final Report*, Submitted to EU-DG VII, Strategic Research, Brussels.

[130] The approach for constructing Images of the Future is similar to that used in the POSSUM project, for a thorough description of the approach see POSSUM (1998) *Images of Future Transport in Europe,* Deliverable 2, Submitted to EU-DG VII, Strategic Research, Brussels.

[131] The concept of decoupling in the transport sector is used to denote a situation where the link between economic growth and transport increase is broken.

[132] Dematerialisation refers to the substitution of transport with services or information such as the reduction of commuting by teleworking or the replacement of book distribution by on-line publications.

[133] STREAMS (1999) Deliverable 8/10, Submitted to EU-DG VII, Strategic Research, Brussels.

[134] SCENARIOS (1998) *Recommendations for future developments in Strategic Transport Modelling,* Deliverable C4, Submitted to EU-DG VII, Strategic Research, Brussels.

[135] ASTRA (1999) *The ASTRA System Dynamic Model Platform, Deliverable 3,* Submitted to EU-DG VII, Strategic Research, Brussels.

[136] COMMUTE (1998) *Methodology Report, Volume 1, Introduction and Summary,* Deliverable 2, Submitted to EU-DG VII, Strategic Research, Brussels, 13.

[137] Rietveld P., and F.R. Bruinsma (1999) *Transport systems, economic change and policy analysis,* Vrije Universiteit, Amsterdam.

[138] Nijkamp P. and Ouwersloot H. (1998) *A Decision Support System for Regional Sustainable Development: The Flag Model, Theory and Implementation of Sustainable Development modelling,* Kluwer Academic Publisher, Dordrecht, the Netherlands.

[139] Bergh, J.C.J.M., van den, K. Button, P. Nijkamp and G. Pepping (1997) *Meta-Analysis in Environmental Economics,* Kluwer, Dordrecht and Nijkamp P., Rietveld P., Voogd H. (1990) *Multicriteria Evaluation for Physical Planning*, Elsevier Science, Amsterdam, The Netherlands.

[140] On the strategic planning it is usually very difficult to assess in an accurate manner all direct and indirect impacts. This limits the use of monetary approaches even though there has been considerable efforts in the assessing and valuation of e.g external effects (see e.g. Weiss J. (ed.) (1994) *The Economics of Project Appraisal and the Environment,* Edward Elgar, Aldershot, England.

[141] TENASSESS (1999) *EURO-TENASSESS,* Final Report, Submitted to EU-DG VII, Strategic Research, Brussels.

[142] CODE-TEN (2000) *The DECODE Method: Theory and Application,* Final Report, Submitted to EU-DG TREN, Strategic Research, Brussels.

[143] For a review of methods see SAMI (1998) *Review of Strategic Assessment Tools and Methods,* Deliverable 2, Submitted to EU-DG VII, Strategic Research, Brussels.

[144] See also Pelt, M.J.F. van (1994*) Ecological sustainability and project appraisal*, Aldershot, Avebury.

[145] For examples of the practical application of the SAMI Evaluation Methodology and SAMI-soft see SAMI (2000*) SAMI Evaluation Methodology,* Deliverable 4, Submitted to EU-DG TREN, Strategic Research, Brussels.

[146] For details of SAMIsoft see SAMI (2000*) SAMIsoft; Software for Applications of SAMI Evaluation Methodology,* Deliverable 5, Submitted to EU-DG VII, Strategic Research, Brussels.

[147] For the theory of Rough Set Analysis see Pawlak, Z. (1991) *Rough Sets*, Kluwer, Dordrecht and Slowinski, R. (1995) *Intelligent Decision Support*, Kluwer, Dordrecht; and for an extensive

discussion of Rough Set Analysis techniques see Bergh, J.C.J.M., van den, K. Button, P. Nijkamp and G. Pepping (1997) *Meta-Analysis in Environmental Economics,* Kluwer, Dordrecht and Button, K. and P. Nijkamp (1997) *Environmental policy assessment and the usefulness of meta-analysis*, Socio-economic Planning Sciences, 31, 231-240.

[148] For the details of this illustration see Bruinsma F.R., Nijkamp P., and R. Vreeker (2000), *Competitiveness analysis of industrial sites: a Cross-National Comparative Study Using Spider Models and Rough Set Analysis,* Vrije Universiteit, Amsterdam.

[149] Nijkamp P. and Ouwersloot H. (1998*) A Decision Support System for Regional Sustainable Development: The Flag Model*, Theory and Implementation of Sustainable Development modelling, Kluwer Academic Publisher, Dordrecht, the Netherlands.

[150] For the application of the Regime Analysis and the Flag Model see Nijkamp P. and Torrierri F. (2000) *a Decision Support System For Assessing Alternative Projects For the Design of A New Road Network*; Methodology and application to a case study, Vrije Universiteit, Amsterdam.

[151] Saaty T.L. (1988) Decision Making for Leaders, Rws Publication, Pittsburgh.

[152] For the complete examples see SAMI (2000*) SAMI Evaluation Methodology*, Deliverable 4, Submitted to EU-DG TREN, Strategic Research, Brussels.

[153] See Steer Davies Gleave (1996) *State of the Art on Strategic Environmental Assessment for Transport Infrastructure*, Final Report, Submitted to EU-DG VII, Brussels, ii-iii.

[154] For details of COMMUTE approach see COMMUTE (1998) *Methodology Report, Volume 2, COMMUTE Framework for SEA ,* Deliverable 2, Submitted to EU-DG VII, Strategic Research, Brussels, 13.