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Abbreviations

CBA - Cost Benefit Analysis
PPP – Public-Private Partnership
Executive summary

The growing demand for the transport of people and goods in Europe presents transport users, operators and public authorities with increasing problems, notably concerning cost-effectiveness, congestion and environmental impacts. Whereas, in the past, we have tended to think about specific modes of transport - road, rail, air and waterborne - there is now growing recognition that sustainable mobility is about inter-connecting transport systems which have to provide a door-to-door service.

Transport system causes a number of serious health and environmental problems and requires a considerable amount of finite resources, for example, fuel. In order to evaluate the advantages and disadvantages of changes in the transportation system it is necessary to find a tool which helps in the decision finding process. Cost Benefit analysis (CBA) was identified as the most used appraisal methodology in regard to transport projects.

The main purpose of work package (WP4) is to develop an integrated methodology for the evaluation of intermodal passenger services and/or intermodal technical solutions. Ideally, such methodology would serve as a contribution to a common “European” approach for the evaluation of passenger intermodality-enhancement initiatives in order to assist policy makers and planning bodies in assessing investments and policies, by showing benefits and costs associated with each measure being considered.

The general methodological framework of this work package will be based on a standard Cost-Benefit Analysis (CBA) adapted for the evaluation of intermodal passenger travel issues. A general overview of intermodal transport in Europe is given, and in the scope of Intermodal Transport RTD Projects there were several projects financed by the European Commission within the Fourth Framework Programme for Research and Development between 1994 and 1998 in areas such as intermodal passenger transport and intermodal mobility questions. However, the first bases for CBA on passenger intermodality occur only in the
study “Towards Passenger Intermodality in EU”, a project that was commissioned by the DG TREN between 2004 and 2005. This project included the “last urban mile” of the intermodal chain.

For the analysis the elements of cost-benefit analysis were grouped into 11 categories (according to HEATCO (2005)). The vast majority of the surveyed countries in HEATCO include the following effects with a money value:

- construction costs,
- system operating and maintenance costs,
- passenger transport savings,
- time savings to goods traffic,
- vehicle operating costs,
- user charges and revenues; and
- safety effects.

To better define the evaluation framework, some relevant aspects of CBA, such as the discount rates used in the evaluation process, the service operator type and the contract arrangements that will be considered in the project evaluation, the treatment of risk and uncertainty that is dictated by data availability, resources, and also whether probabilistic distributions of variables are known or not and some other aspects.

Finally, it also focus the identification of the best practice of estimation costs. The estimation of congestion costs is based on speed-flow relations, value of time and demand elasticities. For air pollution and noise costs, the impact pathway approach is broadly acknowledged as the preferred approach, using Values of Statistical Life based on Willingness to Pay. Marginal accident cost can be estimated by the risk elasticity approach, also using Values of Statistical Life. Given long-term reduction targets for CO₂ emissions, the avoidance cost approach is the best practice for estimating climate cost. Other external costs exist, e.g. costs related to energy dependency, but there is for the time being no scientific consensus on the methods to value them.

From the literature review that has been done we can say that the evaluation of intermodality is an activity in continuous progress, for which assessment methods for specific benefits of intermodal measures are widely lacking and in general the data availability for specific intermodal issues is rather weak.
1 Introduction

1.1 General description of WP4

The growing demand for the transport of people and goods in Europe presents transport users, operators and public authorities with increasing problems, notably concerning cost-effectiveness, congestion and environmental impacts. Whereas, in the past, we have tended to think about specific modes of transport - road, rail, air and waterborne - there is now growing recognition that sustainable mobility is about inter-connecting transport systems which have to provide a door-to-door service.

The main purpose of this work package (WP4) is to develop an integrated methodology for the evaluation of intermodal passenger services and/or intermodal technical solutions. Ideally, such methodology would serve as a contribution to a common “European” approach for the evaluation of passenger intermodality-enhancement initiatives in order to assist policy makers and planning bodies in assessing investments and policies, by showing benefits and costs associated with each measure being considered.

Thus, the main goal is to show which effects and impacts are to be expected for all the measures developed and how they can be quantified. In addition to the technical and information oriented approaches of WP5 and WP6, this work package will elaborate a “catalogue” of intermodality-enhancing measures, with a qualitative assessment on related costs and benefits, and guidelines of available methodologies for their calculation (when possible).

The methodological framework will be based on a standard Cost-Benefit Analysis (CBA) but will be particularly directed and specified for the evaluation of intermodal passenger travel issues. This work has to bear in mind that devising a common methodological framework will have to take into account the probable trade-off between theoretical adequacy and practical implementation.
Task 4.1
The objective is to give an overview about what has been done in this area so far and to identify the relevant costs and benefits of intermodality measures, techniques and policies (identified within WP5). From the outset, this work entails a review of the state-of-the-art methodologies for cost benefit analysis of transport.

This review of the literature shall enable the identification of the main issues that we have to be aware to define a methodological approach based on a CBA. These issues are explained in this task to create the base of knowledge that allows the definition of an adequate evaluation framework.

This task will be described in the next chapter.

Task 4.2
The main purpose of this task is the assessment of methodologies according the levels of data availability and quality (short term perspective) and the data collection from WP 3 (long term perspective), see figure below.
**Task 4.3**

This task will be an analysis tool for the assessment of intermodal measures based on the cost benefit analysis framework developed in the previous task. It will be in excel format and it will have a user manual.

The next chapter explains the position of D10 within WP4.

**1.2 Position of the D10 within WP4**

This document D10 concerns the KITE work package 4, task 4.1 on intermodal transport.
The objective is to give an overview about what has been done in this area so far and to identify the relevant costs and benefits of intermodality measures, techniques and policies (identified within WP5). From the outset, this work entails a review of the state-of-the-art methodologies for cost benefit analysis of transport.

This review of the literature shall enable the identification of available state-of-the-art (e)valuation methodologies that could be applied in the cost benefit analysis of the intermodality measures e.g. addressed in WP5 and WP6. Ideal data requirements will be identified in order to render the application of the feasible methodologies. An assessment will also be made on the role of each item for the purpose of inclusion in the CBA. For example, non-valuable items will also be addressed and convenient considerations will be made on their hypothetical impact on the overall result of the CBA. Given its eminently theoretical perspective it is in task 4.1 that these impacts will be assessed. Additionally, the issues of risk and uncertainty in the evaluation process have to be dealt with, also in this mainly theoretical stage. Evaluation methodologies assessment will include this analysis.

This task will also address the issue of discounting rates used in the evaluation process. This seems particularly relevant given that, increasingly, national states (and for that purpose, European Union policy) aim to create incentives for the private sector’s participation in the provision of transport infrastructure and services, namely through privatisations and Public-Private Partnerships (PPP).

Furthermore, another aspect related to private sector participation has to be taken into consideration: it relates to the fact that intermodal competition may occur between private and public providers. Although not a central issue of this project, it should nevertheless be borne in mind during the determination of costs, benefits and the determination of the discount rates.
1.3 Content and structure of D10

The work undertaken in D10 will constitute the basis of the work that is going to be developed in D11.

This report presents the results of the research undertaken and is organised along the following main chapters:

- General methodological approach of WP4
- Literature review
- General methodological framework for the assessment of measures – main issues of the CBA approach
- Conclusions and further work steps
2 General methodological approach of WP4

The general methodological framework of this work package will be based on a standard Cost-Benefit Analysis (CBA) adapted for the evaluation of intermodal passenger travel issues.

The elaboration of the catalogue mentioned above, will be thus approached in four parallel perspectives:

**Figure 4 – Methodological approach of the catalogue**

1. Identify, per measure or package of measures, the costs and benefits involved
   - Data quality
   - Data availability

2. Review methodologies for quantitative analysis of measures
   - Data collection
   - WP3 conclusions

3. Re-assess the methodologies according to the “real world”

4. Re-assess evaluation options and methodologies

Source: Own elaboration

The first one limits itself to identify, per measure, the costs and the benefits involved and whether they are valid on a per-measure analysis (or only make sense by integration with a ‘package’ of intermodality-enhancing initiatives). This analysis will mainly be descriptive and qualitative.

The second approach will draw on the existing theoretical building and describes, per measure (or packet of measures, if this is the case), what are the available methodologies for quantitative analysis (with the consortium’s opinion on the most adequate ones).

The third approach will re-assess this opinion taking into consideration available information and statistical sources thus theoretically adapting optimal evaluation techniques to ‘real-world’ restrictions on data availability and quality. This approach is biased for a short-term application of the catalogue, given current gaps in data availability.
The fourth approach, which takes a longer term perspective, will again re-assess evaluation options according to what could be done in terms of data collection (thus leveraging on WP3) in order to optimise evaluation procedures and techniques and to bring them closer with the theoretical construct identified previously.
3 Literature review

This chapter summarises the literature review that has been carried out and its important findings about intermodality.

First a general overview of intermodal transport in Europe is given, and then some projects will be presented in more detail for their importance in this work package and for being the state of the art in this area, namely:

- HOROWITZ
- RECORDIT
- IASON
- HEATCO
- Towards Passenger Intermodality in EU

3.1 Overview of intermodal transport in Europe

From the review of the literature, very little has been done in this issue.

In the scope of Intermodal Transport RTD Projects several projects were financed by the European Commission within the Fourth Framework Programme for Research and Development between 1994 and 1998 in the following specific areas:

- Intermodal freight transport;
- Intermodal passenger transport; and
- Intermodal mobility questions.

The Task Force Transport Intermodality has been created in 1995 with the goal to develop a consistent intermodal RTD effort at a European level (freight and passenger transport). An important role of the Task Force was to create synergy between (on-going) research activities in this field and to increase co-ordination among research programmes.
Based on an inventory of intermodal transport related RTD projects at the EU level and at the Member State level a range of priority themes have been defined by the Task Force “Transport Intermodality”. (Kinnock, 1995) These are:

- **transfer point efficiency** through the optimalisation and rationalisation of their design and, in particular for freight, of transfer technologies;

- the **efficiency of the intermodal networks** for both passengers and freight, from the point of view of logistics as well as infrastructure, through better alignment of single-mode operations, better integration of high and low transport flows, and improved traffic management systems;

- **information technology** for transport management purposes to improve service quality to the user, e.g. tracking and tracing, multimodal ticketing, and information applications;

- **marketing**: development of conditions and strategies for intermodal and inter-operable service operations;

- **transport means**: modular and better aligned design of road vehicles, rail rolling stock, and vessels in conjunction with the harmonisation of loading units;

- **training**: to spread to best practices by know-how transfer, and raise the level of professional skills.

Intermodality has been put forward in several European policy documents. The Transport Policy White Paper (2001) identifies integrated ticketing, baggage handling and continuity of journeys as priority aspects for passenger transport. In the follow-up of the White Paper DG TREN has put priority on activities in the freight sector (MARCO POLO, intermodal loading units, freight integrators). A number of EU-research projects regarding strategy, operations and design, technology as well as standardisation activities have been carried out in the passenger domain.

The next table presents the latest contributing projects according the research sub-theme.
Table 1 – Thematic Research summary (2006)

<table>
<thead>
<tr>
<th>Research sub-theme : Drivers of demand for freight and passenger transport</th>
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<tr>
<td>-PROTRANS;</td>
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<td>-SULOGTRA;</td>
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<td>-Transport Intensities within industrial Branches in Finland.</td>
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<th>Research sub-theme : Costs in relation to pricing infrastructure use</th>
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<td>-DESIRE;</td>
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<td>-IMPRINT-EUROPE;</td>
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<td>-MC-ICAM;</td>
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<td>-RECORDIT;</td>
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<td>-UNITE;</td>
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<tr>
<th>Research sub-theme : Socio-economic impacts of transport investments and policies</th>
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<tr>
<td>-IASON;</td>
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<td>-TRANSECON;</td>
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<td>-Building damages due to road and rail transport in Switzerland: Update of external costs in 2000;</td>
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<td>-Costs imposed by heavy goods vehicles;</td>
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<tr>
<td>-Passenger rail services and economic performance.</td>
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<tr>
<th>Research sub-theme : Policies and conditions for sustainable mobility</th>
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<td>-FORESIGHT for transport;</td>
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<td>-PROPOLIS;</td>
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<td>-SPECTRUM;</td>
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<td>-SPRITE.</td>
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<tr>
<th>Research sub-theme : Market structures</th>
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<tr>
<td>-MARETOPE;</td>
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<tr>
<td>-Quality bus partnerships and market structure.</td>
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Source : Adapted from Third Annual Thematic Research Summary – Economic Aspects (2006)

In the next chapter, an up-to-date view of the state of the art is given, describing some projects about intermodality and evaluation.

3.2 Previous research in the field of intermodal transport

The objective of this chapter is to describe relevant projects in this issue, presenting only the objectives, methodological approach, conclusions and results that address the objectives of this work package.
3.2.1 HOROWITZ – Evaluation of Intermodal Passenger Transfer facilities

This project was conducted under the sponsorship of the Federal Highway Administration of the US Department of Transportation in 1994.

It is a study into the feasibility of locating an intermodal passenger transportation facility, which requires an evaluation of a very wide range of alternatives. The previous concerted effort to develop evaluation criteria for intermodal passenger transfer facilities in the US dates to the 1970’s. Since then issues, technologies, experiences and priorities have shifted and evolved, so a new look at intermodal evaluation was appropriate. This study presents several methods for preliminary design, location and evaluation of intermodal passenger transfer facilities. The priorities attached to several methods was established by first creating a list of 70 generic objectives for the evaluation of an intermodal passenger transfer facility and then having a large panel of experts rate each generic objective.

As mentioned in HOROWITZ (1994) the generic objectives spanned all categories of system planning, internal design, external design and modal interfaces. An analysis of the ratings revealed that most important were objectives for assuring safety and security and objectives for improving transfers and transfer opportunities. The 12 classes of objectives in order of importance were:

- Safety/ Security
- The transfer
- Access
- Efficiency
- The passenger
- Coordination
- Environment, physical
- Environment, nonphysical
- Finance
- Space/Site
- Modal enhancement
This study mentions the important issues to the evaluation of stations and terminals. It also makes the review of the evaluation methods that are related to these issues.

The design and evaluation of an intermodal transfer facility are dictated by the nature of the transfers occurring there. All trips that involve more than one mode require a transfer, as do many trips on a single mode. Transfers are considered one of the negative points of any trip, so they can be improved by including better facilities, better operations and better institutional arrangements.

**Methodological approach**

The methodological approach followed in this report is presented below:

**Figure 5 – Methodological approach of HOROWITZ**

<table>
<thead>
<tr>
<th>Step1</th>
<th>List goals</th>
<th>Obtain a list of goals for the intermodality facility develop by a policy committee.</th>
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<tr>
<td>Step2</td>
<td>Establish a panel</td>
<td>Determine who will be doing the selection of objectives.</td>
</tr>
<tr>
<td>Step3</td>
<td>Create a questionnaire</td>
<td>A questionnaire can be used to obtain importance ratings of each generic objective.</td>
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</table>

Source: Adapted from HOROWITZ (1994)

**Conclusions and recommendation**

In order to ascertain levels of improvement for project alternatives it is necessary to represent the facility and its modes as a network and to measure the changes
in the difficulty of travel across that network. Improvements in trip making can come from:

- reductions in cost,
- in-vehicle time,
- out- of- vehicle time and
- barriers to transferring and from positive changes to the transfer environment.
3.2.2 RECORDIT – Real Cost Reduction of Door-to-Door Intermodal Transport

This project was funded by the EU under the Competitive and Sustainable Growth Programme (5th Framework Programme) between 2000 and 2001.

The main objective of the RECORDIT\(^1\) project was to improve the competitiveness of intermodal freight transport in Europe through the reduction of cost and price barriers which currently hinder its development, while respecting the principle of sustainable mobility.

It analyses the real costs i.e. internal and external costs and benefits of door-to-door intermodal freight transport services, and makes a comparison with unimodal road transport. It follows the principles of cost benefit analysis.

The objectives of RECORDIT were to:

- Investigate the current market conditions (costs and prices) of intermodal door-to-door freight transport in Europe;
- Develop a methodology for the calculation of real costs (internal + external) of intermodal transport;
- Calculate real costs for three door-to-door European corridors;
- Identify and analyse current imbalances (prices vs. costs, intermodal vs. all road); and to
- Identify and investigate policy options to increase the competitiveness of door-to-door intermodal transport (reduction of costs, correction of distortions).

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\(^1\) For further information: [http://www.recordit.org/](http://www.recordit.org/)
Methodological approach

A methodology has been designed and validated for the calculation of real (internal and external) costs of intermodal freight transport and for the understanding of cost formation mechanisms. For selected corridors external costs from direct emissions as well as lifecycle emissions have been calculated, using two different approaches:

1) Internal Cost approach:
   - Corridor-specific, bottom-up costs for each block;
   - Direct measures/observations;
   - Published case studies;
   - Company accounts; and
   - Expert estimates;

2) External Cost approach:
   - Impact Pathway Approach (ExternE methodology);
   - EU-wide reduction target for Greenhouse gases (climate change);
   - LCA (Life Cycle Analysis) includes vehicles and fuels;
   - Loading Units (no infrastructure provision);
   - Segments of variable length;
   - Reference (representative) technology (vehicle, device, etc.); and
   - Impacts (on health, crops, building materials, climate change) expressed in Euro/LU.

Conclusions and Recommendations

The main conclusions of RECORDIT were:

- Intermodal transport is currently slower than individual motorised transport and its costs (internal, taxes and charges) are higher;
- External costs of intermodal transport are significantly lower than for individual motorised transport;
- Current taxes and charges do not seem to favour individual motorised transport;
- Internalisation of external costs alone is not sufficient to promote intermodality;
- Technological and organisational improvements can significantly contribute to reduce both internal and external costs of intermodality; and
- Individual measures can yield positive results, but integrated packages are needed to achieve radical changes.
3.2.3 IASON - Integrated assessment of spatial economic and network effects of transport investments and policies

This project was carried out under the 5th Framework European Research Programme, between 2001 and 2003.

The goal of the IASON project was to improve the understanding of the impact of transportation policies on short and long term spatial development in the EU, as well as developing a unified assessment framework for the European Level, integrating the network, the regional economic and macro-economic impacts.

The objectives of the IASON project were:

- To improve existing assessment frameworks by ensuring that direct and indirect impacts are clearly distinguished within the appraisal, that the incidence of benefits and costs as well as of sources of additionally and/or double counting are transparent;

- To perform a systematic and quantitative analysis of the network, spatial and socio-economic impacts of transport investments as well as of the policy by refining to existing EU-level models (i.e. CGEurope, SASI and SCENES) and carrying out scenario simulations;

- To provide a discussion platform which 1) offers broad guidance for the usage of the assessment framework within projects of the other sub-tasks of this cluster (TRANSECON and TIPMAC), 2) allows the validation of this framework and tools developed in these subprojects, 3) joins assessment experiences from the scientific community and 4) stimulates the discussion of other topics of mutual interest, such as methodological development, comparison of results, linking the macro-level analysis to the micro-level, etc. and (5) ensures feedback from the policy-makers as to the relevance and usefulness of the IASON approach; and

- Finally, to learn from the experience of applying the framework in practical contexts so as to provide recommendations for project analysis of transport investments and policies and for the development of supporting tools and databases.
Methodological approach

This project followed a transport cost benefit analysis, according the principles that are reflected in the current practice across EU member states.

Conclusions and recommendation

The state of the art of appraisal of transport projects and policies is developing rapidly. However, the TEN-T projects and in particular the opening of Europe to the East poses formidable challenges for transport appraisal. Better transport infrastructure will link together places with quite different labour markets, standards of living and access to goods and services. In such conditions the general conclusions are:

• For major projects and policies, a good quality transport sector cost-benefit analysis is vital. This requires adequate data and modelling of the transport networks to generate the inputs to the analysis. A wider economy model linked to a transportation model does offer a way forward in modelling the total effect, including the economic network effects. The outputs of such models include forecast changes in GDP, employment by region and consumer surplus. Conceptually, such models generate the total economy-wide benefit of a project or policy.

• An appraisal that is consistent in its treatment of effects from both national and supranational perspective is capable of dealing with cross-border effects. The choice of scale and models is important to highlight these effects.

• The relationship between the total benefit and the benefit measured in a transport-only cost-benefit analysis is understood in principle, but the size of the difference between them in practical cases is as yet poorly understood. Markets which are notoriously imperfect, such as land and labour have not yet been fully incorporated into the wider economy models used within IASON.

• From the perspective of the policy makers, the spatial pattern of gains and losses is important, and spatial economic models can help to identify these. Therefore, a consistent approach of transport cost-benefit analysis plus spatial economic modelling may be an attractive combination providing insight into the absolute value, the social rate of return on investment as well as into the spatial and social distribution of winners and losers.
The project has made available a new set of interconnected instruments that now can be used to assess the spatial and economic consequences of transport policies. Besides producing broad pictures of the overall economic impact for the EU, the function of the models is in particular to point the attention of policy makers to those regions, sectors or policy packages where the indirect impacts of infrastructure and pricing policies are above average. While the wider economic impacts can be substantial as transport impacts propagate over time through the economy, these are not necessarily always welfare effects that are additional to the transport impacts. If this is the case, they can be of significant magnitude, and these cases cannot be uncovered by models like CGEurope and E3ME, when linked to the appropriate transport modelling tools.

The key outputs of IASON were the following:

- Rules for the CBA of transport projects and policies, including an overarching assessment framework and approaches to measure network and socio economic effects;
- New and improved methods to carry out evaluations: a Spatial Computable General Equilibrium
- Model and the improved SASI model. These models work on the basis of the new IASON spatial database which covers whole Europe at a high level of detail;
- Guidance on the suitability of the methods for answering various appraisal questions such as the economic value of projects and policies, the spatial distribution of benefits and the impact on cohesion and
- Case studies into the socio-economic and network effects of measures proposed in the EU White Paper.
3.2.4 HEATCO - Developing Harmonised European Approaches for Transport Costing and Project Assessment

This project was funded by the EC under Competitive and Sustainable Growth Programme the 6th Framework Programme, between 2003 and 2005.

HEATCO’s\(^2\) primary objective was the development of harmonised guidelines for project assessment on EU level, in the areas such as:

- Value of time and congestion;
- Value of accident risk reduction;
- Costs from health impacts and costs of other nuisances due to pollutants and noise;
- Wider economic effects, i.e. indirect effects;
- Infrastructure costs; and
- General Cost-Benefit Analysis (CBA) aspects; e.g. inter and intra-generational distribution, risk and uncertainty.

This includes the provision of a consistent framework for monetary valuation based on the principles of welfare economics, contributing in the long run to consistency with transport costing. The current project assessment practice in the EU member states and Switzerland has been reviewed and analysed, existing practice in the assessment of the value of time and congestion, accident risk reduction, health impacts and nuisances from pollutant and noise emissions, and infrastructure costs is compared to the theoretical and empirical evidence from the literature.

Stated-preference surveys were carried out to help to fill the most significant gaps in monetary values and add knowledge on the issue of transferability and comparability of values between countries. The proposed harmonised guidelines

\(^2\) For further information: [http://heatco.ier.uni-stuttgart.de/](http://heatco.ier.uni-stuttgart.de/)
were applied to 3 TEN transport infrastructure projects to illustrate differences in existing CBA evaluations.

**Methodological approach**

Common definitions and consistent valuation methods were agreed. The framework is based on welfare economics and cost-benefit analysis:

- To achieve as much as possible convergence of national guidelines within an international framework by organising interaction with policy makers and other relevant stakeholders;

- The design of harmonised guidelines was not a straightforward task. The gap between research and practice is large and can certainly not be bridged by research alone. In addition many vested (though legitimate) interests exist in the various guidelines for economic appraisal in different countries. In order to propose guidelines at EU level, the existing differences in guidelines required a careful mediation and uncovering of underlying assumptions and preferences. Therefore, a process approach was required rather than a linear sequence of development tasks. As a consequence a cyclical approach with a series of meetings was established. In cases of non-convergence different options were proposed in order to bridge the gap or insight was provided for the existence of different practices;

- To conduct surveys for selected impacts contingent-valuation studies for valuing noise annoyance and travel time changes were carried out in Norway, the UK, Spain, Hungary, Germany and Sweden to explore differences from different geographical, cultural and traffic conditions;

- To perform case studies on a number of TEN transport infrastructure projects the assessment framework was demonstrated by applying it to selected TEN transport projects and comparing the results with those of existing CBAs.

Based on current practice and latest thinking the HEATCO team identified elements of a consistent framework for project appraisal on EU-level:

- General issues (incl. non-market valuation techniques, benefit transfer, treatment of non monetised impacts, discounting and intra-generational equity issues, decision criteria, the project appraisal evaluation period, treatment of future risk and uncertainty, the marginal costs of public funds,
producer surplus of transport providers, the treatment of indirect socio-economic effects);

- Value of time and congestion (incl. business passenger traffic, non-work passenger traffic, commercial goods traffic time savings and treatment of congestion, unexpected delays and reliability);
- Value of changes in accident risks (incl. accident impacts considered, estimating accident risks, valuing accident costs);
- Environmental costs (incl. air pollution, noise, global warming);
- Costs and indirect impacts of infrastructure investment (incl. capital costs for the infrastructure project, costs for maintenance, operation and administration, changes in infrastructure costs on existing network, optimism bias, residual value).

Conclusions and Recommendations

The HEATCO project achieved the following results:

- An overview of existing national transport infrastructure project assessment practice in EU25 member states and Switzerland (see HEATCO D2);
- A set of harmonised guidelines for project assessment and transport costing on the EU level as described above (see HEATCO D5);
- A set of monetary values for noise annoyance based on a number of contingent valuation studies in different countries with different geographical, cultural and traffic conditions (see HEATCO D4);
- A set of case studies illustrating the applicability of the proposed guidelines and comparing the results with those of existing CBAs (see HEATCO D6).
3.2.5 Towards Passenger Intermodality in EU (2004)

This project was commissioned by DG TREN between 2004 and 2005.

The purpose of this project was to create the basis for an EU work plan in the field of passenger intermodality, aiming at the enhancement of passenger intermodality in Europe for long distance and cross-border transport (both including the “last urban mile”).

Methodological approach

Each phase of the project has followed a distinct approach. Desktop analysis of existing research and policies have been combined with the original research by the consortium and a number of contributing national experts.

The first phase of the study examined the current status of passenger intermodality in Europe, the key issues and the barriers that hinder its implementation. This was accomplished through the realisation of a comprehensive literature review that was focused mainly on European research carried out up to now.

The second phase of the study included a broad screening of existing policies, frameworks and practices of 28 European countries and Japan.

Both phases give input to the third phase, which formulate practical recommendations.

Conclusions and recommendation

As a result of this study, several key issues were identified in connection with the improvement of inter and intramodal passenger transport integration. The subsequent national inventories were structured along these issues within the three domains identified in the first analysis phase.

The country reports are structured along 3 domains with 14 categories of issues:
- Context: market, assessment and evaluation, policy and politics, legal and regulatory framework;
- Products and services: network and interchanges, information, ticketing, fares, booking and payment, baggage handling, highly integrated products/services;
- Planning and implementation: planning, co-ordination and co-operation, promotion, resources and technical issues.
4 General Methodological Framework for the assessment of measures

The main purpose of this chapter is the discussion of the main issues that are important to understand in order to be able to define a suitable evaluation framework, especially focussed on intermodal passenger issues.

To this end, the following chapters will present and discuss the various types of analysis frequently used in project assessment in EU Member States and Switzerland, the main issues of CBA as well as other important aspects of the evaluation process, namely:

- Introduction to the theory of CBA: definition/purpose
- The main steps of CBA
- Discounting rates used in the evaluation process
- Type of operator and contract, and their impact in the evaluation process
- Treatment of risk and uncertainty in the evaluation process
- Treatment of non-monetised items
- Estimation of Cost/Benefit categories of the transport activities

4.1 Assessment of measures in general

Defining the accounting framework for the assessment of measures requires the definition, categorisation of all cost items arising on unimodal and intermodal transport and the allocation to the possible kinds of means of transport.

The transport system causes a number of serious health and environmental problems and requires a considerable amount of finite resources, for example, fuel. In order to evaluate the advantages and disadvantages of changes in the transportation system it is necessary to find a tool which helps in the decision finding process.
Appraisal is the generic term for the process of weighing up the impacts, positive and negative, of a project or policy action, so as to inform the decision maker. As part of the HEATCO project in developing harmonised guidelines for project assessment and transport costing at EU level, Deliverable 1 identified the different types of analysis frequently used in project assessments in EU members and Switzerland, namely:

- Cost Benefit Analysis (CBA);
- Multi-Criteria Analysis (MCA);
- Quantitative Measurements (QM); and
- Qualitative Assessment (QA).

Both CBA and MCA include the effects in an overall economic appraisal but while on CBA the effects are assigned a monetary value on MCA effects are not assigned a monetary value, but are assigning non monetary weights to the individual effects.

The quantitative measurements (QM) estimates effects in physical units or numbers (cardinal scale), but the difference to the MCA is that no specific weights are assigned to the effects.

In the qualitative assessment (QA) the effects are classified into an ordinal scale.

Cost Benefit analysis (CBA) was identified as the most used appraisal methodology in regard to transport projects (see Annex I).

To better support the methodological approach framework of CBA, the next sub-chapter will define what a Cost Benefit Analysis is and will present some relevant issues that are important to the definition of our framework.

4.2 Cost Benefit Analysis issues

Cost-benefit analysis is a formal analysis of the impacts of a measure or programme, designed to assess whether the advantages (called benefits) of the measure or programme are greater than its disadvantages (called costs). Cost-benefit analysis is one of a set of formal tools of efficiency assessment, which allows determining how to use scarce resources to obtain the greatest possible
benefits of them. This analysis is a technique which is based on welfare economics and requires all policy impacts to be stated in monetary terms.

The purpose of the following chapter is to give an up-to-date view of the state of the art of Cost Benefit Analysis (CBA), mentioning questions of principle and practice.

This chapter will present the existing practice at EC and national levels, namely the main cost/benefit categories (also here called effects) that are considered in CBA, the general principles and main steps to follow when carrying out a CBA.

It also gives an up to date view about the issue of discounting, namely which discount rates are used in the evaluation process and also about the issue of risk and uncertainty in the evaluation process and evaluation methodologies.

One of the problems of CBA is how to deal with the relevant impacts of the project which have not been valued in money terms or in other words, the non-monetised impacts. In this chapter this issue, as well as several techniques that are used to quantify and monetised non-market impacts, are reported.

4.2.1 Introduction to the theory of CBA: definition/purpose

CBA has its foundation in the theoretical framework of microeconomics and in the theory of social choice. It is an application of these theories to the practical problems of public sector decision making.

Cost-benefit analysis is conducted from an overall social viewpoint rather than a particular agent, and uses monetary values (where feasible and valid), as the weights applying to the various impacts which are relevant to the decision. CBA is undertaken from a social perspective, considering all relevant costs and benefits. There are practical issues of defining both what is relevant and who is included.

CBA can be useful as a public sector decision making tool. In practice, its usefulness depends on its accuracy. One way to examine the accuracy of CBA is to perform analyses of the same project at different times and to compare the results.
CBA consist in a systematic cataloguing of impacts as benefits (pros) and costs (cons), valuing in dollars (assigning weights), and then determining the net benefits of the proposal relative to the status quo (net benefits equal benefits minus costs)." Boardman et al. (2006)

In practice, there are two possibilities to portray the net benefit, the benefit-cost difference and the benefit-cost ratio. In benefit-cost difference, if the result is positive, the activity will have a positive impact on the welfare of the economy. In benefit-cost ratio, if the quotient is higher than one, the net benefit is positive. So, if there are several alternatives, the decision-maker should choose the opinion which maximises the net benefit.

According the data presented in HEATCO D1, some form of CBA is used in all the surveyed countries\(^3\). In the East region of the EU, cost-benefit analysis is most commonly or exclusively used for projects which are promoted for EU co-funding. However, the country reports show that cost-benefit analysis is gaining acceptance also for locally financed projects in several of the countries in the East region of the EU.

For the analysis the elements of cost-benefit analysis were grouped into 11 categories. The analysis shows that there are large differences between the surveyed countries regarding whether and how the 11 main effects should be included in the project appraisal. The vast majority of the surveyed countries include the following effects with a money value:

- construction costs,
- system operating and maintenance costs,
- passenger transport savings,
- time savings to goods traffic,
- vehicle operating costs,
- user charges and revenues; and
- safety effects.

\(^3\) Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, Netherlands, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom.
Around half of the countries also include in cost-benefit analysis:

- noise effects, and
- the effects on local and regional air pollution.

The effects that most of the countries do not include with a money value in the project appraisal are:

- climate change effects, and
- disruption from construction.

In general countries in the East and South regions of the EU seldom include environmental effects with a money value.

According the EC project HEATCO, there are 15 general principles to follow, when carrying out a Cost-Benefit Analysis:

(A) Appraisal as a comparative tool

To estimate the costs and benefits of a project, one has to compare costs and benefits between two scenarios: the ‘Do-Something’ scenario, where the project under assessment is realised, and a ‘Do-Minimum’ scenario, which needs to be a realistic base case describing the future development. If there are several project alternatives, one has to create a scenario for each alternative and compare them with the ‘Do minimum case’.

(B) Decision criteria

Recommend the use of NPV (net present value) to determine, whether a project is beneficial or not. In addition, depending on the decision-making context respectively the question to be addressed, BCR (benefit cost ratio) and RNPSS (ratio of NPV and public sector support) decision rules could be used.

(C) The project appraisal evaluation period

Recommend the use of a 40 year appraisal period, with residual effects being included, as a default evaluation period. Projects with a shorter lifetime should, however, use their actual length. For the comparison of potential future projects, a common final year should be determined by adding 40 years to the opening year of the last project.
(D) Treatment of future risk and uncertainty

For the assessment of (non-probabilistic) uncertainty, consider a sensitivity analysis or scenario technique as appropriate. If resources and data are available for probabilistic analysis, Monte Carlo simulation analysis can be undertaken.

(E) Discounting issue

It is recommended to adopt the risk premium-free rate or weighted average of the rates currently used in national transport project appraisals in the countries in which the TEN-T project is to be located. The rates should be weighted with the proportion of total project finance contributed by the country concerned. In lower-bound sensitivity analyses, in order to reflect current estimates of the social time preference rate, a common discount rate of 3% should be utilised. For damage occurring beyond the 40 year appraisal period (intergenerational impacts), e.g. for climate change impacts, a declining discount rate system is recommended.

(F) Intra-generational equity issues

Recommends that a “winners and losers” table should be developed and presented alongside the results of the monetised CBA.

Distributional matrices for alternative projects might be created and compared amongst each other. Additionally stakeholder analyses should be undertaken as well. It is recommended to use local values to assess unit benefit and cost measures.

(G) Non-market valuation techniques

If impacts in transport project appraisals cannot be expressed in market prices, but are potentially significant in the overall appraisal, it is recommended by HEATCO that – in the absence of robust transfer values – non-market techniques to estimate monetary values should be considered. Recommend that the choice of technique used to value individual impacts should be dictated by the type of impact and the nature of the project. However, Willingness to Pay (WTP) measures is preferable to cost-based measures. Values should be validated against existing European estimates.
**(H) Value Transfer**

Value transfer means the use of economic impact estimates from previous studies to value similar impacts in the present appraisal context. Value transfers can be used when insufficient resources for new primary studies are available. The decision as to whether to use unit transfers with income adjustments, value function transfer and/or meta-analyses will depend on the availability of existing values and experience to date with value transfers related to the impact in question.

**(I) Treatment of non-monetised impacts**

Recommend, at a minimum, that if impacts cannot be expressed in monetary terms, they should be presented in qualitative or quantitative terms in addition to evidence on monetised impacts. If only a small number of non monetised impacts can be assessed, sensitivity analysis may be used to indicate their potential importance. Alternatively, non-monetised impacts may also be included directly in the decision-making process by explicitly eliciting decision maker’s weights for them vis-à-vis monetised impacts.

**(J) Treatment of indirect socio-economic effects**

Recommend that if indirect effects are likely to be significant, an economic model, preferably a Spatially Computable General Equilibrium (SCGE) model, should be used. Qualitative assessment is recommended, if indirect effects cannot be modelled due to limited resources (high costs for the use of advanced modelling), insufficient availability of data, or lack of appropriate quantitative models or unreliable results.

**(K) Marginal Cost of Public Funds**

HEATCO’s recommendation is to assume a marginal cost of public funds of 1, i.e. not to use any additional cost (shadow price) for public funds. Instead, a cut-off value for the RNPSS (ratio of net present value and public sector support) of 1.5 should be used when relevant.
(L) Producer Surplus of Transport Providers

Recommend to estimate (changes in) the producer surplus generated by changed traffic volumes or by the introduction and adjustment of transport pricing regimes.

(M) Accounting procedures

a) Factor costs should be the adopted unit of account. This requires measures expressed in market prices - which include indirect taxes and subsidies – to be converted to factor costs. b) It is recommend to convert all monetary values into € with a price level for a fixed year (HEATCO project choose 2002 as base year). However, the monetary values should be adjusted with the Purchasing Power Parity (PPP). HEATCO recommends that two calculations should be made – one with and one without PPP adjustment –assuming that the true value will lie between the two results. c) Monetary values, i.e. preferences, for non-market goods like reduced risk of getting ill or reduced damage to the environment will increase with increasing income; thus it is recommended to increase monetary values based on GDP growth.

(N) Up-dating of values

The unit values supplied should represent the state-of-the-art for the individual impacts addressed. Nevertheless, all values should be subject to change as new empirical evidence becomes available and methodological developments take place. As a consequence, it is recommended that values should be reviewed and up-dated on a regular basis e.g. after three years at maximum.

(O) Presentation of results

As far as possible, impacts should be expressed in both physical and monetary terms. The results of the sensitivity analysis and the non-monetised impacts should be reported together with the central monetised results.” (Source: Adapted from HEATCO D5).
4.2.2 The main steps of a cost-benefit analysis

The main steps of a cost-benefit analysis can thus be synthesized as follows:

• Develop measures or programmes intended to help reduce a certain social problem (e.g. road accidents or environmental pollution).

• Develop alternative policy options for the use of each measure or programme.

• Describe a reference scenario (sometimes referred to as business-as-usual or the do-nothing alternative).

• Identify relevant impacts of each measure or programme. There will usually be several relevant impacts.

• Estimate the impacts of each measure or programme in “natural” units (physical terms) for each policy option.

• Obtain estimates of the costs of each measure or programme for each policy option.

• Convert estimated impacts to monetary terms, applying available valuations of these impacts.

• Compare benefits and costs for each policy option for each measure or programme. Identify options in which benefits are greater than costs.

• Conduct a sensitivity analysis or a formal assessment of the uncertainty of estimated benefits and costs.

• Recommend cost-effective policy options for implementation.

The main steps above will be better explained in D11, where they are going to be addressed to the measures identified within WP5.

After the main steps of CBA, in the following paragraphs it will be explained how to treat the issue of the discount rates used in the evaluation process, once the discount rates allow the comparison of costs and benefits that occurred in different time periods. It will also be discussed the difficulties, the different types of discount rates and the European discount rates used.
4.2.3 Discounting rates used in the evaluation process

When we want to compare costs and benefits that occur in different time periods, discounting is the used method. The purpose of discounting is to express in present values the flow of costs and benefits involved in a project lifetime – or a determined appraisal period. Once the set of future values are expressed in present values they are comparable.

The costs and the benefits of one political decision can arise several periods after the decision taking. Especially concerning some environmental effects, the consequences could occur in the future should be given a different weight than consequences occurring today. So one of the central concepts of the cost-benefit analysis is that the costs and the benefits resulting out of the political decision have to be discounted on one period (the same period). This mean a cost or benefit of X euro appearing in the year T has a capital value of $X/(1+r)^T$, referred to the present year $t=0$.

There are two kinds of discount rate usually used, the one used in the financial project appraisal and the other used in economic assessments.

“Financial discount rate can be defined as the opportunity cost of capital, which represents the maximum rate of return of capital obtained with alternative investment projects. It relies on the market interest rate determined by individual preferences expressed in financial markets.” (HEATCO D2)

The economic discount rate, also known as social discount rate, measures the rate at which social welfare or utility of consumption for society changes over time. “It is determined by time preference, therefore depending on the rate of pure time preference, on how fast consumption grows and, in turn, on how fast utility falls as consumption grows.” (HEATCO D2). As mentioned in the HEATCO project the social rate of time preference is given by:
The difficulty in choosing discount rates in the context of transport derives from the current understanding that some effects, especially environmental effects, may be quite slow, and result in problems of intergenerational equity.

The impact on project net present value due to different evaluation periods is higher if the discount rate used in the assessment is low.

Regarding the data presented in HEATCO D2, the European discount rates used (see table in Annex) in general exceed the recommendation of the project UNITE of 3%. EU DG Regional Policy (1999) suggests the use of a European social discount rate equal to 5%.

After discussed the discount rates used in the evaluation process, it seems particularly relevant given that, increasingly, national states (and for that purpose, European Union policy) aim to create incentives for the private sector’s participation in the provision of transport infrastructure and services, namely through privatisations and Public-Private Partnerships (PPP). The next chapter will briefly discuss the incentives given to the private sector in the provision of transport infrastructure and services, through privatizations and PPP.

\[
i = z + n \times g
\]

Where:

\(z\): is the rate of pure time preference (impatience – utility today is perceived as being better than utility tomorrow) plus catastrophe risk;

\(g\): is the rate of growth of real consumption per capita;

\(n\): is the percentage fall in the additional utility derived from each percentage increase in consumption (\(n\) is referred to as the elasticity of the marginal utility of consumption).
4.2.4 Type of operator and contract: Their impact in the evaluation process

Privatisations involve the complete transfer of ownership to the private sector. In PPPs arrangements the private party is responsible for the service provision and the public party is an immediate final purchaser of the privately provided services. In these more complex forms of private involvement, states transfer risks to the private party and usually introduce “artificial” incentives (generally not present in free markets). (Adapted from Grout (2003)).

Since both privatisations and PPP arrangements depend on private capital in the form of loans or equity, project risks will have a price imposed by banks or finance institutions. Usually this would not be taken into account by a public provider (or at least not translated into money terms). In contrast, it might be argued that public operators are more able to diversify and reduce non-systemic risks that private parties and therefore have a lower discount rate for their projects. A large literature has been developed on this issue, currently with a special focus on determining the discount rate to evaluate PPP projects.

So, the service operator type and the contract arrangements influence not only the cash-flows (incremental costs and benefits) that will be considered in the project evaluation but also which discount rate must be applied. Moreover, even when the service operator is a public entity the project CBA depends whether the public entity is acting as a social planner or as a financial restricted actor which aims the maximization of tax revenues. For example, the externalities imposed by a project are usually only taken into account when the service operator is acting as a social planner.

Although not a central issue of this project, these issues should nevertheless be borne in mind during the determination of costs, benefits and the determination of the discount rates. Specially when there is also another aspect related to private sector participation that has to be taken into consideration: it relates to the fact that intermodal competition may occur between private and public providers.

There is another important issue to be discussed, due to the fact that costs and benefits that arise from transport projects are uncertain, which is the treatment of
risk and uncertainty in the evaluation process. The next chapter will focus about that. (Adapted from ENACT (2008).

4.2.5 Treatment of risk and uncertainty in the evaluation process and evaluation methodologies assessment

In transport project the costs and benefits are uncertain. This is because many of the elements of the NPV estimation are subject to error. It is therefore important to analyse the sensitivity of the calculated net benefit indicators to ranges in individual parameters (capital cost, traffic growth rate, etc.).

The future outcome of a project is not known with certainty. We define the situation where the analyst has poor knowledge of the probability of an event being realised and the magnitude of the likely consequences arising from this event, as uncertainty. Where the analyst is reasonably confident of the probability of an event, we define the problem as being one of risk. Techniques exist for dealing with these aspects in a project appraisal.

The main probabilistic (risk based) techniques used, are the ones such as Monte-Carlo simulation that result in expected values.

Figure 6 – Risk vs. Uncertainty

Source: Mackie et al. (2003)
Where the decision-maker does not have an estimate of the probability distributions he will have to define alternative possible scenarios for the variable under consideration using non probabilistic ways. In this case sensitivity analysis or scenario analysis may be the appropriate techniques.

**Role in project appraisal**

The expected net present value is an important indicator when assessing and comparing projects, when the probability of occurrence of each possible outcome is known. When the probabilities are not known we may then generate a range of NPVs determined by the use of sensitivity analysis relating to key variables, and/or using scenario analysis. Since these estimates essentially determine the choice of the ‘best’ project, the decision-maker will want to know, in general, how sensitive the future estimates are to the input data and modelling approach used by the analyst, as well as the key assumptions adopted.

**Existing practice at EC and national levels**

According the existing practice revealed in the country reports of HEATCO, the vast majority of the European countries have explicitly formulated basic principles to undertake sensitivity analyses for project appraisal in the transport sector. Risks are incorporated in the discount rate and scenario analysis. Additional methods for treatment of risk and uncertainty are used in a number of countries.

A number of techniques exist for analysing the key factors that underpin the estimated outcomes in a decision problem. Chief amongst these are:

- **Sensitivity analysis** (non-probabilistic approach).

Sensitivity analysis (sometimes known as “side-analysis”) focuses on alternative assumptions that have a significant effect on the study’s results (for example NPV or benefit cost ratio). It can be applied in all cases in which anticipated costs and benefits are quantified. The purpose of sensitivity analysis is to show how large the risks of a project are and in particular to show whether a favourable project becomes unfavourable (or vice versa) if some assumption is changed. The importance of sensitivity analysis is borne out by the consideration of the
optimism bias phenomenon relating to capital costs. Scenario analysis is a variation of sensitivity analysis involving the construction of alternative visions of how the future might look, and the implications of these on the key variables in the analysis.

While in sensitivity analysis only one assumption is changed at a time, in scenario analysis several assumptions are altered. An extension of this idea is interval analysis. Interval analysis simply involves taking the (absolute) lower value of the range of estimates for each model input, and combining them to define the lower bound of the final result; likewise, the (absolute) upper value of the range of estimates for each model input can be combined to define the upper bound of the final result. Lower bound and upper bound are also called worst and best case. In other words, interval analysis identifies the extreme lower and upper estimated outcomes for a given set of input variables, modelling assumptions etc. When undertaking interval analysis, we must be aware that the worst and best cases are both highly improbable since it is not likely that all assumptions take the worst or best values at the same time.

A further extension of the principle of sensitivity analysis is the use of switching values. A switching value may be calculated in the following way. If, under base case assumptions, a positive Expected NVP (ENPV) is calculated, the switching value shows the percentage increase in a specific cost item (or equally, the percentage decline in a specific benefit item) required for the ENPV to become zero. The switching value is a percentage – basically, the percentage change in a variable required for the estimated ENPV to change sign. If the switching value is relatively high, a very substantial change in the variable is required before the ENPV changes sign. Conversely, if the switching value is relatively low, a small change in the variable is required to change the ENPV sign.

- **Monte Carlo Simulation** (probabilistic).

In Monte Carlo simulation typically computers are used to draw a large number of random samples assuming an underlying probability density function, calculate outcome descriptors, and record them. This is repeated a large number of times until an accurate picture of the distribution of possible outcomes has been built up. The resulting frequency distribution provides information about both the
expected outcome (i.e. the mean value) and how far it is likely to deviate from the mean (i.e. the standard deviation).

These two measures can be used to make statistical inferences, e.g. to identify the probability that the outcome will fall below some value.

The Monte Carlo analysis has two main drawbacks compared to the sensitivity analysis. First, it is more complex than sensitivity analysis and its findings cannot be explained to decision makers as easily. Second, Monte Carlo simulations are based on probability distributions of several assumptions (for example, a probability distribution of the GDP growth rate). These distributions are not known, so that assumptions made by the analyst are still necessary. The result of the Monte Carlo simulation therefore heavily depends on these assumptions. In sensitivity analysis, however, only a lower and upper value of each input are required, and no data are needed on the probability density functions of each model input.

The treatment of risk and uncertainty is dictated by data availability, resources, and whether probabilistic distributions of variables are known or not. Experience in the context of transport project appraisal suggests that it is critically to define the issue of resources (modelling time, person-days etc.) for the analysis to be done, and that variables to be tested should therefore be prioritised. This constraint should be taken into account.

A major issue of CBA (and also a major concern) is how to treat the relevant impacts of the project which have not been valued in money terms or in other words, the non-monetised impacts/items. That is the subject of the next chapter, how to deal with those kind of items.
4.2.6 Treatment of non-monetised items and evaluation methodologies assessment

One of the problems of CBA is how to deal with the relevant impacts of the project which have not been valued in money terms or in other words, the non-monetised impacts.

To the extent that the impacts of projects can be expressed in the same (monetary) terms the difference between them (i.e. the net cost or benefit of the project) provides a valid measure of the aggregate ‘worth’ of that project. Reducing the outcome descriptions to a single dimension is useful in the sense that it simplifies the selection of the ‘best’ project. However, it is highly likely that there will be many situations where appropriate quantitative data are simply not available, thereby making economic valuation extremely difficult, if not impossible. It is also likely, given state of the art economic valuation, that it will not be possible to cost certain impacts even where quantitative data are available.

The lack of a monetary value for specific impacts does not mean that those impacts can be overlooked in any decision-making process.

In order to ensure that these impacts are not overlooked, alternative project appraisal tools should be use. The objective is to bring both (monetised and non-monetised) impacts into a common method of analysis. For that, there are two possibilities: one possibility is to use a variation of sensitivity analysis (qualitative analysis based on switching values), in the other the non-monetised impacts may be presented in qualitative or quantitative terms alongside evidence on the monetised impacts in the cost-benefit analysis. These non-monetised impacts may also be evaluated separately from the CBA, making use of a multi-criteria analysis (MCA).

The following techniques described below are used to quantify and monetised non-market impacts. The figure represents one possible procedure to the use of the adequate non-market valuation techniques.
**Figure 7 – Non-market valuation techniques**

<table>
<thead>
<tr>
<th>Determine whether</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Impacts can be measured and quantified</td>
<td></td>
</tr>
<tr>
<td><strong>AND</strong></td>
<td></td>
</tr>
<tr>
<td>Prices can be determined from market data</td>
<td></td>
</tr>
<tr>
<td>If this cannot be readily done</td>
<td></td>
</tr>
<tr>
<td>Use ‘Willingness to Pay’ for a benefit</td>
<td>Willingness to pay</td>
</tr>
<tr>
<td>determined by</td>
<td>Revealed preference or a subset of this called Hedonic pricing</td>
</tr>
<tr>
<td>Inferring a price from observing consumer behaviour</td>
<td></td>
</tr>
<tr>
<td>If this does not provide values, determine whether:</td>
<td></td>
</tr>
<tr>
<td>Willingness to pay can be estimated by asking people what they would be willing to pay for a particular benefit</td>
<td>Stated preference</td>
</tr>
<tr>
<td>or whether</td>
<td></td>
</tr>
<tr>
<td>In the case of a cost: identifying the amount of compensation consumers would demand in order to accept it</td>
<td>Willingness to accept</td>
</tr>
</tbody>
</table>

Source: Adapted Greenbook treasury

The results of a survey of European Transport Ministries (presented in HEATCO (2005) regarding the use of non-market valuation in transport-related project appraisal considered 3 types of approaches as best practice

- Production function approaches
- Indirect revealed preference techniques

Deliverable D10: General methodological framework
Stated preference techniques

“Production function approaches

Production function approaches estimate the value of a given non-market good/service from the measurement of changes in marketed output as a consequence of changes in the provision of (usually environmental) inputs in the production of the output. In the dose-response, or exposure-response, method the physical output change as a result of a change in environmental quality is multiplied by the market price of the affected good to estimate an economic (use) value of the good. An example is the impact of low-level ozone caused by road transport on crop yields. Assuming that the loss of yield can be quantified using an exposure-response function, the quantity of crop lost can be multiplied by the market price of the crop. The great advantage of this method is that it relies on the use of market prices to derive values rather than having to infer values through indirect means.

The replacement or restoration cost method assumes that the economic cost of a non-market good can be estimated by the market price of a substitute market good that can replace or restore the original quantity or quality level of the non-market good. For example, a habitat may be disturbed in the construction of rail infrastructure, but its original condition may be restored by expenditure on the import of certain plant species. This expenditure may therefore be seen as a proxy for the value of this aspect of the habitat. If the expenditure is made it is, at best, a lower bound on true willingness to pay (WTP). If the expenditure is not made, it may be seen as an upper bound on true WTP.

Indirect revealed preference techniques

These techniques use models of relationships between marketed goods/services and the non-market good/service of interest, assuming that there is some kind of substitute or complementary relationship between the two goods. The advantage of this group of techniques is that they make use of information about people’s actual behaviour and related personal preferences.

Their principal disadvantage is that the statistical models used to isolate the value of interest from other influences are sensitive to the specification and functional form assumed.
A number of econometric issues are generally involved in the estimation of the value of the desired attribute and it is a resource intensive exercise to make these estimates. Note that WTP values should be derived from individual’s decisions and preferences rather than using those values derived from policy decisions since this would imply assuming that the policy decision is optimal (welfare optimising).

The travel cost method estimates recreational use values through the analysis of travel expenditures incurred by consumers to enjoy recreational activities.

Avertive/abatement costs, or defensive/preventive expenditures, assumes that individuals spend money on certain activities that reduce their risks (e.g. impact of pollution, risks of accidents) and that these activities are pursued to the point where their marginal cost, (i.e. the expenditure on the last unit purchased), equals their marginal value of reduced impact. Averting goods related to pollution include e.g. air filters, water purifiers, and noise insulation, while averting goods that reduce risks of death may include seat belts and fire detectors.

Hedonic price analysis refers to the estimation of non-market values by deriving prices for individual attributes of a market commodity that are implicit when environmental goods/services can be viewed as attributes of a market commodity, such as properties or wages. Thus, the hedonic price model provides the basis for deriving welfare change measures from observed differences in properties’ prices or wages offered in the job market. For example, differences in ambient noise levels in two areas, and the values individuals place on these, may be reflected in relative house prices in the two areas.

Stated preference techniques

Stated preference is a generic name for a variety of techniques including the contingent valuation and choice experiments including contingent ranking, contingent choice and conjoint analysis. Using these techniques, researchers pose contingent or hypothetical questions to respondents, inducing responses that trade off improvements in public goods and services for money. From the responses, preferences for the hypothetical good or the value of changes in provision of the hypothetical good can be inferred. Values are derived from preferences made in relation to (hypothetical) prices, or via trade-offs with other attributes. The major advantage of the technique is that the questions put to respondents can define exactly what needs to be valued. The main limitation is
that the method provides hypothetical answers to hypothetical questions, which means no real payment is undertaken, so that no real commitment is made.

A belief that increased uncertainty is attendant to the values derived from techniques that move from production function approaches, through revealed preference approaches to stated preference in the UK has led the UK public sector appraisal guidance to recommend that, as data and resources allow, analysts should consider the use of the former approaches before considering the latter. In Switzerland, stated preference techniques are preferred to abatement and replacement costs. Other existing guidelines e.g. those of DG Regional Policy are not as prescriptive (EC DG Regional Policy (2002)). These guidelines recommend that the most satisfactory valuation technique should be used, this being determined by the type of project, the types of impact being considered, and on the wider socio-economic and political context.” (HEATCO D5 (2005)).

The next chapter will present the estimation and calculation of cost/benefit categories that are used in the CBA.
4.2.7 Estimation of Cost/Benefit categories of the transport activities

In the following paragraphs it is going to be presented the classification and allocation of the some costs categories, such as environmental impacts, accidents and congestion. It will also summarise the research undertaken about the best practice methods (or at least the ones that have a wider consensus) to calculate the external costs because in the next stage (D11) it is going to be necessary to select the relevant cost categories for intermodal passenger travel and disregard the others.

Classification and allocation of external costs

Transport activities give rise to environmental impacts, accidents and congestion. In contrast to the benefits, the costs of these effects of transport are generally not borne by the transport users. Without policy intervention, these so called external costs are not taken into account by the transport users when they make a transport decision. Transport users are thus faced with incorrect incentives, leading to welfare losses.

The internalisation of external costs means making such effects part of the decision making process of transport users. According to the welfare theory approach, internalisation of external costs by market-based instruments may lead to a more efficient use of Infrastructure, reduce the negative side effects of transport activity and improve the fairness between transport users.

The external costs mostly considered are:

- Congestion
- Accident
- Air pollution
- Global warming
- Noise

Methods for estimating external costs

Although the estimation of external costs has to consider several uncertainties, there is a wide consensus on the major methodological issues. The best practice estimation of congestion costs is based on speed-flow relations, value of time and demand elasticities. For air pollution and noise costs, the impact pathway
approach is broadly acknowledged as the preferred approach, using Values of Statistical Life based on Willingness to Pay. Marginal accident cost can be estimated by the risk elasticity approach, also using Values of Statistical Life. Given long-term reduction targets for CO$_2$ emissions, the avoidance cost approach is the best practice for estimating climate cost. Other external costs exist, e.g. costs related to energy dependency, but there is for the time being no scientific consensus on the methods to value them.

**Available input values and EU default unit values**

It is concluded that external costs of transport activities depend strongly on parameters like location (urban, interurban), time of the day (peak, off-peak, night) as well as on vehicle characteristics (EURO standards). Within the same Member State, the cost of one lorry kilometre in urban areas at peak hour can be at least five times higher than the cost of an interurban kilometre by the same vehicle at off-peak time.

The following table presents the main issues as cost elements, critical valuation issues, cost functions, data needs and the main cost drivers per cost category.
<table>
<thead>
<tr>
<th>Cost category</th>
<th>Cost elements</th>
<th>Critical valuation issues</th>
<th>Cost function</th>
<th>Data needs</th>
<th>Main cost drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congestion costs (roads)</td>
<td>Time and operating costs&lt;br&gt;Add. safety and environmental costs</td>
<td>Speed-flow relations&lt;br&gt;Valuation of economically relevant value of time (reliability)</td>
<td>Increasing marginal cost in relation to traffic amount, depending on time of the day/week/year and region</td>
<td>Speed-flow data&lt;br&gt;Level of traffic and capacity per road segment</td>
<td>Type of infrastructure&lt;br&gt;Traffic and capacity levels mainly depending on:&lt;br&gt;- Time of the day&lt;br&gt;- Location&lt;br&gt;- Accidents and construction</td>
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<td>Scarcity costs (scheduled transport)</td>
<td>Delay costs&lt;br&gt;Opportunity costs&lt;br&gt;Loss of time for other traffic users</td>
<td>Valuation approach as such (measurement of opportunity costs, WTP enlargement costs, optimisation model)</td>
<td>Increasing marginal cost in relation to traffic amount, depending on time of the day/week/year and region</td>
<td>Level of traffic, slot capacity per infrastructure segment</td>
<td>Type of infrastructure&lt;br&gt;Traffic and capacity levels, mainly depending on:&lt;br&gt;- Time of the day&lt;br&gt;- Location</td>
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<td>Accident costs</td>
<td>Medical costs&lt;br&gt;Production losses&lt;br&gt;Loss of human life</td>
<td>Valuation of human life&lt;br&gt;Externality of self accidents in individual transport&lt;br&gt;Allocation of accidents (causer/victim related)</td>
<td>Only limited correlation between traffic amount and accidents, other factor (such as individual risk factors and type of infrastructure)</td>
<td>Accident database&lt;br&gt;Definition of facilities and heavy/slight injuries very important</td>
<td>Type of infrastructure&lt;br&gt;Traffic volume&lt;br&gt;Vehicle speed&lt;br&gt;Driver characteristics (e.g. Age, medical conditions, etc.)&lt;br&gt;Others</td>
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<tr>
<td>Air pollution</td>
<td>Health costs&lt;br&gt;Years of human life lost&lt;br&gt;Crop losses&lt;br&gt;Building damages&lt;br&gt;Costs for nature and biosphere</td>
<td>Valuation of life years lost&lt;br&gt;Market prices for crops&lt;br&gt;Valuation of building damages&lt;br&gt;Valuation on long term risks in biosphere</td>
<td>Correlation with traffic amount, level of emission and location</td>
<td>Emission and exposure data (exp. PM, NOx, SO2, VOC)</td>
<td>Population and settlement density&lt;br&gt;Sensitivity of area&lt;br&gt;Level of emissions, dep. On:&lt;br&gt;- Type and condition of vehicle&lt;br&gt;- Trip length (cold start emission)&lt;br&gt;- Type of infrastructure&lt;br&gt;- Location&lt;br&gt;- Speed characteristics</td>
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<tr>
<td>Cost category</td>
<td>Cost elements</td>
<td>Critical valuation issues</td>
<td>Cost function</td>
<td>Data needs</td>
<td>Main cost drivers</td>
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<td>Noise costs</td>
<td>Rent Losses</td>
<td>Valuation of annoyances</td>
<td>Declining marginal costs curve in relation to traffic amount</td>
<td>Noise exposure data (persons)</td>
<td>Population and settlement density Day/Night Noise emissions level, depending on: - Type of infrastructure - Type and condition of vehicle</td>
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<tr>
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<td>Annoyance costs</td>
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<td>Prevention costs to reduce risk of climate change</td>
<td>Long term risks of climate changeLevel of damage in high altitudes (aviation)</td>
<td>Proportional to traffic amount and fuel used (marginal cost close to average cost)</td>
<td>Emission levels</td>
<td>Level of emissions, depending on: - Type of vehicle and add. equipment (e.g. air conditioning) - Speed characteristics - Driving style - Fuel used and fuel type</td>
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<td>Costs to reduce separation effects Compensation costs to ensure biodiversity</td>
<td>Valuation approach as such (replacement versus WTP approach)</td>
<td>Most of the costs are infrastructure related, and do not vary very much with traffic volumes</td>
<td>GIS information on infrastructure</td>
<td>Type of infrastructure Sensitivity of area</td>
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<td>Cost for nature and landscape</td>
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<td>Cost to reduce soil and water quality</td>
<td>Valuation approach as such (avoidance versus damage cost approach)</td>
<td>Complex: increasing marginal costs curve in relation to traffic amount</td>
<td>GIS information on infrastructure, emission levels</td>
<td>Level of emissions Type of infrastructure</td>
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<td>Costs to ensure soil and water quality</td>
<td>Valuation approach as such (avoidance versus WTP approach)</td>
<td>Increasing marginal cost curve in relation to traffic density</td>
<td>Infrastructure data in urban areas (network data, data on slow traffic)</td>
<td>Type of infrastructure Level of traffic</td>
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<td>Costs for pedestrians Costs of scarcity for non motorised traffic</td>
<td>Valuation approach as such (avoidance versus WTP approach)</td>
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<td>Data on energy processes and electricity mix</td>
<td>Level of indirect energy need Electricity mix (level of non renewable)</td>
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<td>Costs of the whole energy cycle (environmental and risk effects of energy supply)</td>
<td>Valuation of a long term energy risks, such as climate change and nuclear risk</td>
<td>Rather proportional correlation with traffic amount and (marginal cost close to average costs)</td>
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Source: Adapted from *Handbook on estimation of external cost in the transport sector (2007)*
5 Conclusions and next steps

From the literature review that has been done we can say that the evaluation of intermodality is an activity in continuous progress, for which assessment methods for specific benefits of intermodal measures are widely lacking and in general the data availability for specific intermodal issues is rather weak.

In the scope of Intermodal Transport RTD Projects there were several projects financed by the European Commission within the Fourth Framework Programme for Research and Development between 1994 and 1998 in areas such as intermodal passenger transport and intermodal mobility questions. However, the first bases for CBA on passenger intermodality occur only in the study “Towards Passenger Intermodality in EU”, a project that was commissioned by the DG TREN between 2004 and 2005. This project included the “last urban mile” of the intermodal chain.

The difficulty in producing a comprehensive cost benefit analysis of intermodality issues based on existing research and information is partly due to information shortages as described below, but partly to the individual nature of markets. This latter factor means that it is difficult to generalise about the costs and benefits.

There are still significant deficiencies in the knowledge about intermodal travel demand and supply as no sufficient information is at hand, decision makers lack the information that is necessary to support assessment (e.g. for reliable cost-benefit analysis).

The overview about existing data sources identified three types of relevant surveys:

- national travel surveys with focus on daily mobility
- travel survey elements dedicated to long distance mobility
- long distance travel surveys
Despite the availability of survey data, the generation of harmonised figures on long distance travel demand faces some obstacles, mainly because surveys differ widely with respect to survey design, methodology and content.

Currently, knowledge on the market of intermodality for long distance travel is rather poor and there is not much information available on the possible impacts of intermodal products and services through cost-benefit analyses or impact assessment studies.

In the next steps (task 4.2) the objective will be shift from the traditional CBA approach presented in this deliverable through its main issues to a CBA approach adapted to the evaluation of the intermodal transport measures.

There will be a selection of the relevant cost categories for intermodal passenger transport; the others will be disregarded. Some categories will be adapted to intermodal transport, and the intermodal measures will be identified against results of WP5 and WP6.

Intermodal transport chains include several modes and terminal handling which means specific costs. To assess intermodal transport, it is necessary to evaluate the intermodal chains and to investigate each link in the chain as regards cost and possible damage (accidents, air pollution, global warming, congestion, etc).

The desire to develop an intermodal passenger evaluation framework has created the need to further understand the current system as well as the barriers and opportunities to intermodal issues.

On a shorter term perspective there will be a re-assessment of the methodologies according the levels of data availability and data quality. On a longer term perspective there will be a re-assessment of the methodologies according data collection from WP3.
6 References


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(15-01-2008)


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Available online at: [http://greenbook.treasury.gov.uk](http://greenbook.treasury.gov.uk)


7 Annex 1

Table 3– General appraisal framework

<table>
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<tr>
<th>Region</th>
<th>Country</th>
<th>Road</th>
<th>Rail</th>
<th>Air</th>
<th>Inland waterway</th>
<th>Sea</th>
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Codes:
1: Cost-benefit analysis (CBA) 4: Qualitative assessment/Not covered (QA/NC)
2: Multi-criteria analysis (MCA) 5: No information/not relevant
3: Quantitative measurement (QM)

Note: In Latvia CBA is used for rail, sea and air in case the project is promoted to get EU-funding. In Germany the guidelines reported in the proforma have been used for selecting projects for the federal transport investment plan. They are relevant for early stage project assessment of long-distance infrastructure projects. However, as the appraisal of infrastructure projects for airports and sea port is not in the responsibility of the federal institutions they are not covered in the guidelines. This does not mean that there are no appraisal guidelines for air and sea in Germany.

Source: HEATCO D1 (2005)
### Table 4— Criteria used in CBA

<table>
<thead>
<tr>
<th>Region</th>
<th>Country</th>
<th>Net present value</th>
<th>Benefit/cost ratio</th>
<th>First year benefit</th>
<th>Internal rate of return</th>
<th>Other</th>
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**Codes:**
- : No information
- : Not relevant

a) Varies by mode/annual

Source: HEATCO D1 (2005)
Table 5 – How are risks evaluated?

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Codes:
- /: No information
- -: Not relevant

* Correction made compared to country report for Sweden due to comments.

Source: HEATCO D1 (2005)
Table 6 – Discount rate and appraisal period

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Note: For details on how the information given in the country report have been interpreted see Annex IV.

Source: HEATCO D1 (2005)