Deliverable D9:

Measurement and Valuation of the Impacts of Transport Initiatives

Volume 1: Main Text

(Work Package 4)

EUNET

Socio-Economic and Spatial Impacts of Transport

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Work Package 4 - Measurement and valuation of socio-economic development effects

Deliverable D9:

Measurement and Valuation of the Impacts of Transport Initiatives

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1. Introduction

1.1 Objectives of EUNET Work Package 4

1.1.1 Work Package 4 (WP4) is responsible for recommending the monetary values and non-monetary measures needed within the EUNET methodology in order to evaluate socio-economic effects of transport infrastructure investment. It therefore complements the Transport Cost Database of WP3 which deals exclusively with vehicle and system operating costs and the direct costs of infrastructure. WP4's outputs feed into Work Package 1 (the assessment tool) and Work Package 7 (the demonstration examples). Values are also required in order to model the effects of travel time changes on travel behaviour in Work Package 6 (the regional economic and transport model). The EUNET Technical Annex, Strategic Task 1.2/19 gives the full Work Package description.

1.1.2 Within its work, WP4 covers relevant issues of appraisal practice, such as how to achieve consistency across different uses of the EUNET model, eg. projects in different countries, projects on different modes, or even appraisals by different users for the same project.

1.1.3 More generally, it is an important part of the purpose of EUNET as a whole that the appraisal tool which is developed is both innovative and reflective of current best practice within the European Union. These aims apply also at the individual Work Package level. In relation to WP4 they have been interpreted to mean that the outputs of WP4 should take account of recent technical developments in project appraisal and should balance this against the need to reflect best current practice (and to make use of real data in estimating values and so on). Also, in producing its outputs WP4 should be innovative insofar as this is necessary to satisfy the demands of the connected Work Packages 1, 6 and 7.

1.2 Impacts of Transport Infrastructure Investment

1.2.1 At the outset, the impacts of transport infrastructure investment were divided by WP4 into three categories:

- direct transport impacts
- environmental impacts, and
- indirect socio-economic effects.

1.2.2 Direct impacts include the economic effects within the transport sector, such as investment costs, operating and maintenance costs, travel time savings, safety improvements and revenue. Environmental impacts include local, regional and global effects: for example, air pollution, landscape effects and severance. The 'indirect socio-economic' category contains a range of other impacts which extend more widely than just the transport sector, including land use change, employment, and economic output. It was believed that these three categories provided some useful boundaries between essentially different types of impacts, to which different approaches might be needed.

That is not to say that the approach to any category was pre-judged, but simply that the debates surrounding the appraisal of certain groups of impacts were recognised as distinctive and believed to warrant considering the group as whole, as well as looking at each of the individual impacts. There is an ongoing debate in the wider transport community over environmental valuation, for example, and another over the appraisal of transport, land use and economic development taken together. In order to produce a practical project appraisal tool, a view needs to be taken about the various issues which arise.

1.3 Scope of the Deliverable

1.3.1 The following Chapters 2-7 describe the principal findings and conclusions of the research within WP4. Chapter 2 considers appraisal methodology overall and sets out the framework within which Work Package 4 carried out its detailed analysis. The recommendations for individual impacts, in terms of their definition, measurement and valuation, are then summarised in Chapters 3, 4 and 5. Chapter 6 addresses issues of practical application, including those raised by the Commission in the light of the earlier version of this Deliverable, and Chapter 7 adds some concluding remarks.

1.3.2 The appendices present further detail on key areas of the research. The first Appendix describes the findings of the review of current appraisal practice, which informed the development of the definitions, measures and value sets. Appendices II-IV provide detailed analysis of individual impacts in support of the main text. They include the full value sets for time, safety and air pollution and explain their derivation. They also include alternative treatments of the individual impacts which were considered but rejected in favour of the recommended method. Appendix V contains three case studies illustrating current European practice regarding indirect impacts. Appendix VI lists partners' contributions to the review. Finally, Appendix VII gives information on the standard economic series used. The Appendices are preceeded by a comprehensive Bibliography.

2. Methodological Framework for EUNET WP4

2.1 Problems Faced in Developing a Consistent Approach to Appraisal

2.1.1 As soon as one considers the question 'what should be the basis for appraisal of the Trans-European Network projects and other major European transport initiatives', some significant problems present themselves. These are partly political and partly technical.

2.1.2 The **political points** are simple enough to state: firstly, different Member States have different appraisal traditions which may vary across modes. Secondly, there is no clear-cut resolution of the respective roles of the EU and national governments in the assessment of major transport projects. If appraisal is a matter for subsidiarity - ie. to be devolved to the Member States, that is one solution, but the EU would then have no basis for the allocation of transport infrastructure funds according to value for money. If the EU wished for this reason to have commonality of appraisal, that implies the need for technical agreement on the best common approach. It also, probably, implies the need for differences in appraisal methods between purely national projects and trans-national projects, which could affect internal prioritisation. An intermediate position might be to regard the EU as a 'top-up' agency, that is, providing grant-aid in pursuit of pan-European benefits over and above those included in the national appraisal. Then only the pan-European impacts might be subject to a common form of assessment since the EU contribution would be in respect of those impacts only. Thus, although these problems are easily stated, they are acutely difficult to resolve since they go to the heart of the evolving roles of the EU and the national governments in European transport policy.

2.1.3 It follows from the above that there is no uniquely defined political framework within which transport appraisal is to take place. Inevitably, therefore, any appraisal framework must be sufficiently flexible to cater for a variety of contexts and needs. This implies the following:-

- There should be a common appraisal framework for the assessment of European transport projects.
- The basic rules for the assessment should be common. For example, should market prices or resource costs be used? Should willingness to pay based values be used for impacts such as time savings and safety benefits? Should financial effects such as transfer payments be shown explicitly? How are non-quantified impacts to be presented? For which subset of impacts can monetary values safely be used?
- Finally, decisions will ultimately have to be reached on the degree of commonality of the values themselves. A spectrum of views exists on this. At one extreme are those who favour pure willingness to pay based values. These people would argue for the most local 'market' based values possible and see no reason why the values of time used for a project in, say, London and Liverpool should be the same. A second position is that nations are sufficiently homogenous for there to be sensible standard national values, but that values between countries are likely to differ for both income-level and cultural reasons and should not be averaged. One practical difficulty which arises with this position is what is to be done about the valuation of time savings for Belgian trucks travelling on German roads carrying Italian goods. A third position is that 'we are all Europeans now' and that this should imply the use of a common value set by the EU for the appraisal of all transport infrastructure projects in which EU funding might play a part.

2.1.4 The view taken after some deliberation within the EUNET consortium is that both a European value set and a Country-Specific value set are necessary. Projects of European significance will need to be appraised within a common framework for European institutions to determine funding allocation issues. Member states may wish to appraise projects

using a similar framework, though with values relating to country-specific circumstances.

2.1.5 Within this approach, several **technical issues** then arise. The first is the wide variation in the appraisal values used at national level for some impacts. Why do these differ and can they be reconciled for the purposes of deriving a European value set? Clearly, cultural differences in tastes and preferences may be a factor, but variation in real incomes, the definition of impacts, methods of empirical estimation or foreign exchange issues may also be important. These concerns are elaborated throughout this report.

2.1.6 Secondly, are separate values needed for forecasting and evaluation, and for financial and economic appraisal? In the former case, the view being taken is that they are: the basis of the appraisal values should be real resource costs (ie. prices net of indirect taxes and subsidies), whilst forecasting should adopt behavioural values. In reaching this basis, however, the flows of taxation and other financial effects (such as tolls and revenue) should be explicitly shown in the appraisal framework, so that the financial consequences for Governments can be presented within the financial appraisal.

2.1.7 Thirdly, is some detail irrelevant at certain 'higher' levels of appraisal - for example, are local environmental impacts relevant in corridor-level appraisals? The view here is that such detail is not irrelevant, but as a practical matter it may be very difficult to handle. For this reason it is essential to have a clear understanding of the stage(s) of the planning process at which the appraisal will be carried out. Will this be where the project is an outline concept, or where it is a fully-designed scheme? If the former, some impacts can only be estimated in a relatively general way and proxies may be needed (such as mitigation costs for local environmental impacts). The definitions of these proxies, measurement methods and existing values for them then become a concern in defining the set of appraisal values to be used.

2.1.8 Finally, what are appropriate summary measures for the CBA, and for what purpose? It was agreed that the EUNET method should be designed so as to be readily capable of outputting the Net Present Value (NPV), Benefit:Cost Ratio (BCR), Internal Rate of Return (IRR) and First Year Rate of Return, as well as potentially various derived indicators, such as NPV(B-A) to show incremental comparisons between project alternatives.

2.2 European Values in EUNET

2.2.1 In the light of the conclusions reached, two sets of values are provided for all monetised impacts:

- **country specific values** for each impact for each member state, reflecting differences in preferences between parts of Europe; and
- **standard European values** for each impact, to assist the decision maker in comparing projects across national boundaries.

2.2.2 Two previous approaches to the task of generating European values were identified, in the EVA-Manual (EVA Consortium, 1991) and the EURET road study (CEC, 1994a) respectively. It was decided that EUNET could proceed on a similar basis to both of these, whilst updating the base year to 1995.

2.2.3 Thus in EUNET, the process of generating European values should have the following features:

- existing country values should be inflated (or deflated, as necessary) to 1995 prices using the Eurostat Consumer Prices General Index;
- values expressed in local currency should be converted to ecu using the European Commission's published Official Annual ECU Exchange Rates for 1995;
- where the country values are clearly based on a non-comparable definition or measurement method, the value should be adjusted based on any available evidence and ultimately by judgement to reflect the common EUNET definition and measurement method. For example, where a value of time is given per vehicle hour instead of per person hour, vehicle occupancy data can be used to infer the per vehicle hour value;
- Standard European Values for each impact should be based on an average of the adjusted country values, weighted according to the population concerned (eg. in the case of working time, this should be the working population);
- missing values for particular countries in relation to particular impacts should be infilled as far as possible by calculating a proxy value, drawing on the available country-specific values and our understanding of the relativities in the dataset as a whole. For example, where working time values for car passengers are missing there might nevertheless be an average working time value across modes for the country concerned and relativities between the two values for other countries - subject to careful consideration, values may therefore be inferred.

2.2.4 This approach was applied to those impacts for which WP4 recommends monetary valuation and for which values are not determined under Work Package 3 Costs of Transport. Looking ahead to Chapters 3 and 4, value sets are required for:

- travel time (working and non-working passenger, and freight);
- safety (differentiating between different severities of accident); and
- regional and global air pollution.

2.2.5 The practical application of both the national and EU values raises a number of issues concerning the selection of appropriate values to input to the CBA and the implications for the output of the CBA. These are discussed later, in Chapter 6, following the presentation of the value sets themselves in Chapters 3 and 4.

2.3 The Framework for Individual Impacts

2.3.1 For each impact, WP4 has provided guidance in three parts:

- a **definition** - describing what the impact would consist of, to whom it would accrue and whether there is any significant heterogeneity to be considered (as with working versus non-working time);
- a **measure** (or measures) of impact - proposing the units in which the impact would be measured in EUNET, including any necessary disaggregations (eg. passengers' time should be measured in person hours by trip purpose by mode of transport); and
- **value sets** - firstly, recommending whether the impact is appropriately located in the CBA or in the MCA; secondly, providing values (where appropriate) to be attached to the impact measures specified. For inputs appearing in the MCA only, proposals have been made for scoring scales to assist the work of WP1, although it is expected that the detail of the MCA implementation will have a great influence over the form of scoring scale used in practice.

2.3.2 Separate behavioural and appraisal values sets are provided where appropriate on a perceived cost versus a resource cost basis respectively.

2.3.3 In generating European values, use is made of weighted averages of Country Specific values, as above (Section 2.2). However, the raw country values obtained through the data gathering exercise will differ because of variations in the following:

a) definitions

b) measures

c) income

d) preferences

2.3.4 Even in the case of the Country Specific values, it is desirable to control for all but the last of these. When the raw country values are considered, there may be differences in definition leading inevitably to inconsistencies among the values themselves. In an appraisal where impacts may be added or compared across member states, consistency is required - there is therefore a clear rationale for considering how to adjust the values in order to compensate for the identified differences in their underlying definition. Using identical reasoning, we would also wish eliminate the effects of any differences in measures.

2.3.5 Income differences between countries may also influence values. This can be taken into account through the calculation of the European equity value in which the values are weighted by the relevant population - ie. for working time, the working population - since the individual country values are already equity values themselves.

2.3.6 Finally, the values will still differ. It is recognised that there are differences in preferences and that this is reason enough to leave what differences in the values remain. In practice there will also be undetected differences in the above, and there will also be errors introduced in the adjustment process.

Ultimately, the values presented include an element of judgement, based on our broader understanding of the national procedures gained through the country reports.

2.4 Recommended Set of Impacts and Form of Assessment

2.4.1 In Table 2.1, a list is given of the impact headings which it is proposed should be included in the EUNET assessment method within Work Package 1. These are selected in order to satisfy the principles of comprehensiveness and additivity as far as practically achievable. Therefore:

i) the set of impacts as a whole is designed to encompass the objectives set for transport by the EU (see Appendix IV Chapter 2);

ii) the range of impacts included in the CBA is wide compared with some national methods (see Appendix I), however it was tempered by two principal *practical* factors. Firstly, data on noise impacts and local air quality is expected to be very limited given the strategic nature of the transport initiatives to which the EUNET tool is targeted (see EUNET Deliverable D10, Volume 1, Section 1.2). Without a uniform quantitative basis, these impacts had to be excluded from the CBA. Secondly, *transferable* unit values are not available for some other impacts. For example, since national governments have not yet embraced the idea of applying monetary values for damage to Special Sites in transport appraisal, research into transferable unit values has not yet been done. Considering the longer-term research agenda, there is a clear application here for values for a wider range of impacts if monetary values can be elicited and transferability can be achieved.

iii) the CBA impacts are selected and defined in order specifically to avoid double-counting of any costs and benefits. The MCA impacts are selected and defined with the same objective in mind, whilst recognising that for policy-based objectives (where the relative weights come in the first instance from the decision-maker) it is inherently very difficult to test definitively whether any two effects are strictly additive in their effect on social welfare. It is also difficult to determine, if two effects are not strictly additive, to what extent the decision-maker is likely to be aware of this (and possibly make some compensating adjustment) in setting the weights. The weight definition process in EUNET is designed to encourage careful consideration of the relative importance of particular pairs of impacts, and the reader is referred to EUNET Deliverable D10 for further explanation.

2.4.2 Those impacts for which monetary valuation is recommended are shown with a ✓ under CBA. The results of the CBA for individual impacts should be carried over into the MCA, indicated by additional ✓ in the final column for the group of Direct and Environmental Impacts concerned.

Table 2.1: Recommended EUNET Impacts

Impact		CBA	MCA
Direct	Investment Costs	✓	✓
	System Operating and Maintenance Costs	✓	✓
	VehicleOperating Costs	✓	✓
	Revenues/User Charges	✓	✓
	Time	✓	✓
	Safety	✓	✓
	Service Quality	✗[1]	✓
Environmental	Noise	✗	✓
	Local Air Pollution	✗	✓
	Regional Air Pollution	✓	✓
	Global Air Pollution	✓	✓
	Landscape	✗	✓
	Land Take	✓	✓
	Land Amenity	✗	✓
	Special Sites	✗	✓
	Severance	✗	✓
	Water Pollution	✗	✓
Indirect Socio-Economic	Output	✗	✓
	Employment	✗	✓
	Land Use	✗	✓
	Strategic Mobility	✗	✓
	Other Policy Synergy	✗	✓

[1]Note: as discussed in Appendix II Section 8.3 an original CBA approach is being pursued for the Trans-Pennine demonstration example within WP7

3. Recommendations for Direct Impacts

3.1 Overview

3.1.1 By including revenues and user charges in the set of Direct Impacts (see Table 2.1) we ensure that the EUNET method relates to modes which charge passenger fares and freight tariffs - ie. rail, air, short sea, inland waterways and tolled roads - as well as those which do not - ie. primarily private car travel on roads without tolls. Other direct impacts are common to all modes, although there may be differences in the groups in society who are directly affected: for example, whilst most car drivers pay their own vehicle operating costs, vehicle operating costs of buses and trains are met directly by the service providers rather than the user. Whether or not any saving is passed on depends upon market conditions, business strategy and other factors. How to deal with this uncertainty over the final incidence of benefits is an issue with which any appraisal concerned with equity has to grapple, but it does not affect the total benefit on a monetary measure. The presence of service quality reflects EUNET's interest in the adaptability of the appraisal method to a wide range of transport initiatives including those with demand management or quality-related goals.

3.1.2 For each direct impact, WP4 addresses questions of: current European practice, definition, measurement and valuation. All CBA impact values are provided in resource cost terms for appraisal purposes. Values of travel time and vehicle operating cost are also given at perceived cost for use in behavioural modelling.

3.2 Travel Time

3.2.1 Travel time savings (or increases) are included in major transport project CBA in all EU member states (except Luxembourg) on at least one mode (see Appendix I). The search for a consistent European approach to values for travel time is aided considerably by the widespread concurrence between member states on issues of definition. Thus in EUNET:

Passenger travel time is defined as personal travel time from Origin to Destination including in-vehicle time and interchange - overall travel time should be disaggregated into non-working and working time in appraisal, and further into commuting/other non-working/working time for behavioural modelling.

Freight transit time is defined as total freight transit time from Origin to Destination.

3.2.2 The recommended measures of time saved are in hours:

Table 3.1: Measures of Time Saved

Measures	for Appraisal	Disaggregations
	Non-working time in person hours	by country
	Working time in person hours	by mode by country
	Freight transit time in freight unit hours	by country
	for Forecasting	Disaggregations
	Non-working time in person hours	by commuting/other by mode by country
	Working time in person hours	by mode by country
	Freight transit time in freight unit hours	by country

3.2.3 The issues identified and addressed by EUNET, in relation to both definition and measurement, were:

i) *large and small time savings.*

For both theoretical and practical reasons (which are discussed in depth in Appendix II Chapter 2) it is recommended that EUNET should value large and small time savings at the same unit rate, in accord with practice in all-but-one EU member states.

ii) *differences in currency and base year.*

The available values, which were for a range of base years and were mostly expressed in national currency, were uplifted to 1995 prices using the Eurostat Consumer Prices General Index and converted to ecus at the European Commission's published Official Annual Exchange Rates. In the light of findings of recent value of time studies (in particular Gunn and Rohr, 1996) that values do not increase proportionately with personal income growth as had previously been believed, it was not felt to be appropriate to make any earnings adjustments.

iii) *adoption of the Hensher approach to working time.*

In common with Dutch and Swedish appraisal methodology, WP4 recommends the use of values based on an examination of both the employer's and the employee's components of working time values. Existing values on the alternative, wage rate basis are adjusted so as to be comparable, in line with the relativities between Hensher-type and wage rate-type values in situations where both have been calculated.

iv) *adjustment to resource cost for appraisal values.*

The few values expressed at market prices or in pure willingness-to-pay were adjusted to resource cost by identifying and then excluding the component which reflects indirect taxation net of subsidy.

v) *differences in the measure of time savings.*

Values which were already on the recommended EUNET measure (ie. 'value per person hour (purpose X)(mode M)') were identified and adopted. Values on related (and convertible) measures (eg. values per vehicle hour, values for purpose unspecified, etc) were converted to the recommended measure. This was done using the appropriate data (eg. vehicle occupancy, purpose split data, relativities elsewhere in the dataset) and ultimately, in some cases, judgement based on our understanding of the underlying relationships and experience working with the dataset.

3.2.4 EU values were derived from the Country Specific values by calculating an average weighted by the size of the relevant population (ie. the working population for working time; the whole population for non-working time).

3.2.5 The EU value set generated for appraisal purposes is presented in Table 3.2. Tables of Country Specific appraisal values are given in Appendix II. For the appraisal of non-working time savings, it is concluded that standard appraisal values for use with any mode are preferable to mode-specific values. In particular, mode-specific values are prone to distortion through self-selectivity. Standard appraisal values have the effect of preventing modal differences in user incomes influencing the assessment. Thus a 'General Value of Time - non-working time' is presented (first row of Table 3.2).

Table 3.2
EUNET WP4 Appraisal Values of Time
ecu per hour at 1995 prices and values

	EU
General values of time	
non-working time	4.5
Mode-specific values of time	
car	
- working occupant	17.8
bus and coach	
- driver	12.0
- working passenger	12.9
rail	
- working passenger (SWE basis)	11.7
- working passenger (UK basis)	22.7
air	
- average passenger (FRA basis)	37.7
freight	
- drivers' wage value	23.0
- freight user value (lorry)	1.9
- freight user value (truck - articulated)	7.9

Note: derived from Country Specific Values (Appendix II)

3.2.6 The values relate specifically to in-vehicle time (IVT). For other aspects of personal travel time, including time spent walking, waiting or interchanging between modes, the evidence is that time spent in these activities may be valued differently: in the light of the evidence, it is recommended that the value used should be double the value for in-vehicle time.

3.2.7 By contrast, the recommended working time values are mode-specific: differences exist between modes in terms of the ability to work in transit; and income differences between employers are not seen as an equity issue in the same way as income differences between consumers. The key values for passenger travel modes (ie. bus/coach, rail and air) are the values per passenger hour, since the driver’s time is included separately in the personnel cost component of vehicle operating costs (Section 3.3).

3.2.8 Behavioural values (Table 3.3) for use in modelling were calculated from the appraisal values at the country specific level, making the following assumptions and drawing on empirical evidence from Eurostat data series and recent value of time research:

- that the perception of non-working time values differs from their resource cost in that perceived/behavioural costs *include* indirect taxes (net of subsidies);
- that for working time valued in line with the Hensher approach, the employee’s share is subject to the same resource-perceived differential as non-working time, whilst for the employer’s share, behavioural and appraisal values are identical.

Table 3.3
EUNET WP4 Behavioural Values of Time
per hour at 1995 prices and values

	AUS	BEL	DEN	FIN	FRA	GER	GRE	IRE	ITA	NRL	POR	SPA	SWE	UK
	ecu	ecu	ecu	ecu	ecu	ecu	ecu	ecu	ecu	ecu	ecu	ecu	ecu	ecu
Mode-specific values of time														
car														
- working occupant	15.2	18.8	22.8	23.9	22.1	21.4	13.3	14.5	15.4	22.1	6.6	13.9	18.3	17.5
- commuting occupant	5.0	4.9	6.3	3.4	7.2	7.4	4.3	6.0	7.4	7.2	4.6	4.4	4.7	5.6
- other occupant	3.7	3.6	3.8	2.5	5.3	5.5	3.1	4.4	5.4	5.6	3.4	3.2	4.0	4.1
bus and coach														
- driver	10.0	12.3	14.9	15.6	14.5	14.0	8.7	9.5	10.1	14.5	4.3	9.1	9.8	13.6
- working passenger	10.8	13.3	16.2	16.9	15.7	15.2	9.5	10.3	10.9	15.7	4.7	9.9	10.6	14.7
- non-working passenger (bus)	2.6	2.6	2.8	1.8	3.8	3.9	2.3	3.2	3.9	3.9	2.4	2.3	2.8	3.0
- non-working passenger (coach)	4.0	3.9	4.2	2.7	5.7	5.9	3.4	4.8	5.9	5.9	3.6	3.5	4.1	4.5
rail														
- working passenger (SWE basis)	10.0	12.4	15.0	15.7	14.6	14.1	8.8	9.5	10.2	14.6	4.3	9.2	12.0	11.5
- working passenger (UK basis)	19.4	24.0	29.1	30.5	28.2	27.3	17.0	18.5	19.7	28.2	8.4	17.8	23.3	22.4
air														
- average passenger (FRA basis)	32.5	40.1	48.7	51.0	47.3	45.7	28.5	30.9	32.9	47.3	14.1	29.8	39.0	37.4
freight														
- drivers' wage value	23.4	23.7	25.2	21.4	35.8	34.2	21.4	23.2	18.9	35.2	8.8	14.4	21.2	21.2
- freight user value (lorry)	1.8	2.2	2.7	2.8	2.6	2.5	1.6	1.7	1.8	2.6	0.8	1.6	2.1	2.1
- freight user value (truck - articulated)	7.5	9.0	11.3	11.6	10.8	10.4	6.5	7.0	7.4	10.6	3.2	6.6	8.7	8.6

3.3 Vehicle Operating Costs

3.3.1 Summarising from EUNET Deliverable D6, arising from Work Package 3 (PLANCO, 1997), vehicle operating costs (VOCs) are defined as comprising both *standing costs*, which are invariant with distance travelled, and *operating costs*.

Standing cost components:

- Depreciation (time-dependent share)
- Interest on Capital
- Repair and Maintenance Costs
- Materials Costs
- Insurance
- Overheads
- Administration

Operating cost components:

- Personnel Costs
- Depreciation (distance-related share)
- Fuel and lubricants

3.3.2 Note that Personnel Costs include drivers' wages. Care is therefore needed to avoid double-counting of this component with the Time values, both in modelling and in appraisal.

3.3.3 Measures of VOCs contained in the database of costs (Deliverable D12, PLANCO, 1998) are as follows:

Table 3.4: Measures of VOCs

Road	standing cost per hour by vehicle type operating cost per km by vehicle type
Rail	standing cost per hour by train type operating cost per km by train type
Air	standing cost per block hour cost per passenger cost per landing unit
Inland Waterway	standing cost per year by vessel size and daily operating time fuel cost per hour by vessel size and waterway type labour cost per hour by vessel size and daily operating time
Short Sea	standing cost per operating day

3.3.4 For input to the EUNET transport model, all costs are translated into ecu per passenger km or ecu per tonne km. Disaggregations are by vehicle type for roads, by train type (rail), or by vessel size (inland waterway). For short sea shipping, a single average vessel size is used since data is insufficient to differentiate larger and smaller vessels.

3.4 Safety

3.4.1 In order to provide a consistent set of values for safety impacts, definitions are needed for: casualty severities; accident severities; and the various components of costs associated with them. The definitions adopted by WP4 are shown in Table 3.5. The corresponding measures are: for accident-related costs, ecu per accident; and for casualty-related costs, ecu per casualty.

Table 3.5: Safety Impact Definitions

Casualty severities:

- 'fatality' - death within 30 days for causes arising out of the accident;
- 'serious injury' - casualties who require hospital treatment and have lasting injuries, but who do not die within the recording period for a fatality;
- 'slight injury' - casualties whose injuries do not require hospital treatment or, if they do, the effects of the injuries quickly subside.

Accident severities:

A 'damage-only' accident is one in which there are no casualties. A 'fatal' accident is one in which there is at least one fatality. A 'serious' accident is one in which there is at least one serious casualty but no fatalities. A 'slight' accident is one in which there is at least one slight casualty but no serious injuries and no fatalities.

Accident-related costs:

- material damage
- police and fire services
- insurance administration
- legal and court costs

Casualty-related costs:

- medical and healthcare costs incl. administration
- lost output
- human costs - pain, grief and suffering.

The total appraisal value of an accident is the sum of the accident-related and casualty-related costs.

3.4.2 The principal challenge for EUNET WP4 has been to address the large discrepancy between the appraisal values supplied by the member states of the EU. To give an example, after adjusting for price inflation but not for any other differences, the appraisal values for a (statistical) fatality differ between the two extreme cases of Portugal and Sweden by a factor of 48. This, it turns out, is largely reflective of fundamental differences in definition and measurement. Within EUNET WP4, adjustments were made to put the appraisal values on a common basis in terms of definition and measurement, as a result of which this difference was reduced to a factor of approximately

4.5. This seems much more plausible as an indicator of differences in attitudes to risk of mortality. For use in international comparisons of projects (if required), EU values have been calculated as a population weighted average of the Country Specific Values. These EU values are given in Table 3.6. The full set of Country Specific values for 15 member states are given in Table 4.12 of Appendix II. The recommendation regarding modes is that as in the German and Swedish appraisal methods, casualty-related costs are treated as transferable across modes, whilst the accident-related costs are mode-specific. The latter reflects the scale of damage done in, for example, a typical rail as opposed to a road accident.

Table 3.6
EUNET WP4 Appraisal Values for Accidents and Casualties
ecu at 1995 prices and values

	EU
Casualty-related costs:	
per fatality	770,000
per serious injury	91,000
per slight injury	7,000
Accident-related costs (Road):	
per fatal accident	13,200
per serious accident	8,800
per slight accident	4,400
per damage-only accident	1,800
Accident-related costs (Rail):	
per injury accident	26,000
per damage only accident	9,000

3.5 System Operating and Maintenance Costs

3.5.1 Definitions and measures for System Operating and Maintenance Costs have been derived by EUNET Work Package 3. Deliverable D12 describes the Transport Cost Database, within which Chapter 6 addresses System Operating and Maintenance Costs. In summary, these costs are defined as consisting of the costs of infrastructure operation (eg. signalling/traffic control) the costs of maintenance (eg. cleaning, minor repairs, winter servicing) and the costs of renewal (eg. road resurfacing). The measures differ between modes as shown in Table 3.7.

Table 3.7: Measures of System Operating and Maintenance Cost

Mode	Cost Items and Measures (all per annum)
Road	Maintenance (ecu per km of road) Winter Servicing (ecu per km of road) Renewal (ecu per million freight vehicle km)
Rail	Operation and Maintenance (ecu per km of railway)
Inland Waterways	Maintenance (ecu per km) Operation of Locks (ecu per lock)
Ports	Maintenance per ecu invested
Aviation	Operation and Maintenance per ecu invested

3.6 Investment Costs

3.6.1 The definition of investment costs in EUNET is provided by Work Package 3 Deliverable D6. In summary, the component costs are to be:

- planning costs - including the design costs, planning authority resources and other costs incurred after the decision to go ahead;
- land and property costs - including the cost of acquiring land needed for the scheme (and any associated properties), compensation payments necessary under national laws and the related transactions and legal costs;
- construction costs - including materials, labour, energy, preparation, professional fees and contingencies;
- disruption costs - the disruption to existing users to be estimated using the same values of time as are used for travel time savings arising from the scheme.

3.6.2 Investment cost will be measured in ecu per year for each project. Where possible, an investment profile should be given indicating a definite start year for which the price base applies, and detailing how the flow of investment will vary in each year of the investment period. Where such detailed information is not available, the preferred alternative is for the user of the assessment tool to supply just the total investment cost consistent with the above definition and length of investment period. The software would then distribute the cost over time based on an assumed standard investment profile. If no investment cost estimate is available, defaults may be available from WP3.

3.6.3 Other key recommendations relating to investment costs are that:

- environmental impact mitigation measures should be included in the project design and costed accordingly as part of the investment costs.

- the costs of finance are not relevant to the investment cost item in CBA as these are taken into account through the discounting procedure, although any financial administration costs should be included.
- in the interests of consistency between appraisals, localised shadow pricing of labour should not be allowed.

3.7 User Charges and Revenues

3.7.1 User charges are defined as money payments between parties in the transport industry, in compensation either:

- for a complete transport service (eg. passenger transport fares and freight tariffs), or
- for the right to make use of infrastructure using ones own vehicle (eg. road tolls, track access charges for access to rail lines, landing fees for access to airports, and port and harbour dues for access to shipping berths).

3.7.2 Revenue is the same set of charges seen from the perspective of the recipient. For example, road tolls appear as toll revenue to a road operator. Likewise, rail fares appear as revenue to train operating company.

3.7.3 These impacts share certain characteristics, one of which is that in terms of social cost-benefit analysis, they are money prices and do not necessarily reflect the resource cost of providing the service in question. The classic example would be a toll road, where the marginal cost to the operator is close to zero, but a positive price is set to recover the fixed costs of building and maintaining the road. Secondly, however, they are all highly relevant to a distributional analysis of the effects of constructing Trans-European Networks, since user charges benefit the recipient financially whilst disbenefitting the user, and must therefore appear in the appraisal both as a (negative) user benefit and as a (positive) revenue. Given the intention to provide a distributional breakdown of the CBA output within WP1, it is recommended that user charges and revenues should be identified in the EUNET appraisal and that they should be included at market prices net of any indirect taxes and subsidies. The estimation of user charges and revenues will be carried out within the EUNET transport model (WP6), where they play a role in the forecasting process. An adjustment to deduct indirect taxes net of subsidies will then be required for appraisal purposes.

3.7.4 If the appraisal has the scope to consider the effects of different levels of fares or tolls, rather than just one pre-determined charging regime, then pricing principles become relevant as well as appraisal methodology. Current research projects in that area include CAPRI (Concerted Action on Pricing) and PETS (Pricing European Transport Systems), both for DGVII, and the user of EUNET may want to study their recommendations. In particular, the thrust of much recent work is to ensure that all external effects are internalised within transport prices. If such prices are set, we should find that the appraisal outcomes improve, taking environmental as well as economic effects into account. If these prices are achieved through taxation, the distributional consequences should in principle be made explicit in the appraisal, the flows of tax revenue appearing as a monetary loss to transport users and a monetary gain to government.

3.8 Service Quality

3.8.1 The impacts considered here relate to the non-time, non-safety, non-monetary part of the transport user's utility function - ie. those aspects of transport services which are typically referred to as quality factors.

3.8.2 On the road mode, quality may refer to *surface quality*, ie. the smoothness, etc, of the pavement. The same features from the user's perspective may be included as *'driver comfort'*. Other aspects of quality of service provided by roads which are becoming more significant as technologies develop, include driver *information* - provided by, for example, roadside variable message signs offering route guidance and advance warning about road conditions ahead. Other Intelligent Transport Systems (ITS) technologies which may offer significant user benefits in the future include Advanced Vehicle Safety Systems, offering automated accident avoidance technology built into vehicles, and the 'intelligent highway' which promises to increase highway capacity by taking vehicle control out of the hands over drivers and passing it to the infrastructure system itself. Appraisal issues in relation to ITS/ATT systems are discussed in the APAS/ROAD/3 Evaluation report (CEC, 1995b).

3.8.3 On inter-urban public transport modes, service quality features include various aspects of the in-vehicle environment, including comfort and availability of catering services, and the quality of information available to passengers before and during the trip. Service frequency is sometimes treated as a service quality issue in appraisal, although for high-frequency services where users do not plan their departure but instead 'turn-up and go' it could also be seen as an extension of the journey time variable. The latter is more likely to be true in the urban than the inter-urban context.

3.8.4 Finally, reliability is a potentially important service quality issue on all modes, and has been identified in some studies (eg. Halcrow Fox, 1995) as being one of the most important factors in freight service choice. There is, however, a widespread neglect of this in transport project appraisal, which we have not found it possible to redress within the confines of WP4. Given the interdependence of traffic and reliability at the link level (on any mode), there are complex network modelling issues involved in determining overall reliability, which are unfortunately beyond our scope here.

3.8.5 For the Trans-Pennine demonstration example in Work Package 7, the co-ordinating partners are proposing to offer an original CBA approach, which recognises that where there are trends towards longer freight routes or increasing freight costs, this can be due to the freight user choosing - and benefitting from - higher quality services in some other dimension (reliability or security, for example). The utility function would be used to obtain corresponding measures of user benefit. However, in general, and for the other demonstration examples, no such set of indicators is available. It is therefore proposed for these cases that service quality be excluded from the

CBA. Inclusion of service quality in the MCA should be based on a judgemental scoring approach, taking into consideration the effect of the project both directly on the quality of service provided on the new links and more generally on quality of service throughout the network. Where the project consists largely of new road infrastructure, it may be appropriate to make use of the World Bank HDM roughness measure (see Appendix 2 Chapter 8) as a quantitative indicator of surface quality improvement. The treatment of this impact will therefore need to be considered on a case-by-case basis.

4. Recommendations for Environmental Impacts

4.1 Local, Regional and Global Effects

4.1.1 It has been agreed within the consortium that the EUNET method is addressed primarily to transport initiatives of a strategic nature (see EUNET Deliverable D10 Section 1.2) and for which detailed design work on the project may or may not have not have been completed at the time of the appraisal. Both of these characteristics have implications for the ability of the appraisal to identify and rigorously quantify local environmental effects. These effects are likely to be highly dependent upon the specific route and design chosen (for infrastructure projects), and in particular the precise proximity of the route to areas of dense urban population. At the time of appraisal it is on balance unlikely that such a level of detail will be available. It was therefore agreed at an early stage by the consortium that local environmental effects could not be subject to the same rigour as they would in an appraisal of a town bypass or of a new local rail station, for example. Instead, location-specific variations in environmental effects should be included in the MCA. Meanwhile, environmental impacts which are less dependent upon the characteristics and population of the immediate surroundings, including regional and glocal air pollutants, could be included in the CBA subject to plausible monetary values being available.

4.2 Noise and Vibration

4.2.1 There is a fair degree of consensus on the appropriate measure for noise, with the majority of member states using L_{eq} dBA, measured over a variety of periods, normally to reflect daytime and night time noise levels. However, the location(s) in which noise is measured do vary. A number of countries use formulae to predict facade noise, in order to estimate the impacts on individual houses. Others construct noise bands or contours with 5dBA separation (see Appendix III Chapter 2), then assess the numbers within each band. The bands are intended to reflect noise disturbance. Given the strategic nature of the projects to be assessed in EUNET the latter approach is to be preferred.

4.2.2 The next step is to define appropriate bands. The widespread use of 5dBA bands appears reasonable given that a change of 3dBA is normally the smallest change in noise levels that the human ear is able to perceive. It is therefore recommended that, where possible, bands of, 55-60, 60-65, 65-70, 70-75 and >75 be used to define areas affected by schemes.

4.2.3 It is then necessary within each band to estimate the number of households affected by the change. It is possible to stop at this point if the information is to be used in a descriptive framework. However, for the MCA it is necessary to consider ways in which the importance of changes in different bands can be weighted in appraisal (the CBA approaches used at national level are discussed in the Appendix). The recommended approach involves a weight being allocated to each band, which is multiplied by the best available estimate of the number of households in the band. Inevitably, this estimate will often be highly approximate for the reasons given above. The bands and weights are shown in Table 4.1. When combined with the numbers affected a noise nuisance index is created and changes in this would be included in the MCA.

Table 4.1: Noise Bands and Weights

dBA	**Weight**
55-60	0.11
60-65	0.22
65-70	0.45
70-75	0.93
>75	1.92

Source: Danish Road Directorate, 1994

4.2.4 Very few countries consider vibration as a separate impact in appraisal. There are two forms of vibration, one of which is unlikely to occur on a new piece of infrastructure (ground-borne vibration, normally due to defects in the running surface) and the other can normally be proxied by a noise measure (air-borne vibration). The recommendation is therefore to exclude vibration from the EUNET appraisal, except in special circumstances where it is expected to be a significant additional impact over and above the normal levels of vibration associated with the prevailing levels of noise. In this case, vibration can be included in the MCA.

4.3 Air Pollution

4.3.1 Air pollution is an issue of increasing concern throughout Europe. The main pollutants are: Nitrogen Oxides (NO_x); Sulphur Dioxide(SO_2); Particulates (PM); Hydrocarbons (HC); Lead (Pb); Carbon Monoxide (CO) and Carbon Dioxide (CO_2). All recent reviews and valuations (including the latest findings within the ExternE project - Friedrich et al, 1998) show particulates to be the most significant, due to the extra illnesses and deaths caused, although other pollutants also impact on health. Other effects of these pollutants are soiling, crop and forest damage, erosion of buildings and contribution to global warming. The impact of a marginal increase in these emissions varies by circumstance: in the countryside the impacts are much lower in total than in urban areas.

Global Air Pollution

4.3.2 In this category we consider only the effects of global warming and ozone depletion to be truly global in nature. The Kyoto summit reached agreement on a reduction in CO_2 emissions, overall, for the EU of 8% by 2020. Given the concern to reduce emissions of greenhouse gases we concentrate on that effect here. As with other impacts, the appraisal process for CO_2 in EUNET involves both forecasting (of emissions) and monetary valuation. Forecast changes in CO_2 emissions (tonnes) will be provided by the emissions model within Work Package 6. A monetary value has been recommended by WP4 after reviewing both values in current use by member states (see Appendix III Section 3.2) and values arising from various research studies, including ExternE.

4.3.3 The EUNET WP4 recommendation is to place a value on CO_2 emissions equivalent to the cost of prevention within the transport sector, of 50 ECU per tonne. This is the equivalent to approximately 10.4 ECU per 1000 car kilometres (note that the calculation of CO_2 within EUNET is more sophisticated, being based on traffic speed as well as flow). For comparison, the IPCC (International Panel on Climate Change) value range adopted by ExternE was 1-30 ECU per tonne of CO_2, whilst ExternE's own preliminary valuation is 41 ECU per tonne. On the precautionary principle, a value of 50 ECU per tonne seems a reasonable, and comparable, working estimate. The uncertainty associated with all these values, arising from assumptions made in their derivation (eg the choice of discount rate, or the type of ecosystem model) could be as great as +/-95%. This makes it particularly important that the appraisal offers the facility to test the sensitivity of the results to the value used.

Regional and Local Air Pollution

4.3.4 Account is taken here of the findings of the ExternE project which have become available since the EUNET review was carried out (Friedrich et al, 1998; Bickel et al, 1997). As a result, the basis of the EUNET recommendations on particulates and NO_x has been modified, in recognition that ExternE's work on dispersion and impact modelling has advanced understanding in these areas. Nevertheless, comparisons are drawn between the ExternE and national-level values and they are found to be broadly consistent with one another. The principal change is in the basis for particulate measurement, which changes from PM_{10} (ie. particles less than 10 microns in diameter) to $PM_{2.5}$.

4.3.5 A exposure-response approach is to be recommended. This should fully reflect the impacts on the environment (including on health, crops and materials), with the caveat that there is still some uncertainty surrounding the scientific relationships estimated. In order to allow the total monetised impact to respond to variations in the composition of traffic flow, it is recommended that damage costs per unit mass of pollutant emitted (rather than per vehicle km) be applied to the output of the WP6 emissions model. Variations in impact due to the nature of the local environment (eg. densely/sparsely populated) are very difficult to determine for projects of a strategic nature: these are therefore treated separately under *Local Air Pollution.* Table 4.2 gives the monetary values recommended for the EUNET CBA.

Table 4.2: Regional (and Local) Air Pollution - CBA Values*

Emission	**Value per kg, 1995 ecus**
Primary particulates, $PM_{2.5}$**	185
NO_x	4.6
SO_2	1.7
HC	1.8

*relevant to EU member states in which WTP for environmental protection is likely to be relatively high (including Finland, Germany, The Netherlands, Sweden and the UK, and potentially others). Re-scaling of values for member states where WTP is expected to be lower should be considered as appropriate: Appendix III Para 3.1.16 suggests a rationale.

**revised unit of measurement since original Deliverable D9; see Appendix III Section 3.1.

Local Air Pollution - Rural/Urban Variations

4.3.6 The differential local effects of air pollution in rural vs. urban areas are clear from the Swedish appraisal values and from the ExternE Case Studies (see Appendix III Table 3.3). Damage costs in the urban case studies (per vehicle km) are approximately 2-4 times their magnitude in the rural case studies, and even greater in the Parisian agglomeration. In comparing projects within EUNET, opportunities for quantitative modelling of atmospheric concentrations/incident populations/exposure are limited. However, as a pragmatic alternative, an MCA scoring approach is recommended, in the form of a separate MCA indicator. The five point scoring scale suggested is based upon the % of emissions expected to occur in urban areas, calculated by allocating the outputs of the WP6 emissions model to links in the network classified as ‘urban’ or ‘non-urban’ based on map observation. In effect this impact therefore acts as a modifier to the Regional Air Pollution impact, allowing the user to consider (and subsequently to weight as they wish within the Assessment Tool) the additional local environmental impact of projects.

Table 4.3: MCA Scoring Scale for Local Air Pollution

% of Emissions Occurring in Urban Areas	**Score**
81-100	1
61-80	2
41-60	3
21-40	4
0- 20	5

...where 1 reflects the most severe impact and 5 the slightest.

4.4 Landscape

4.4.1 Thus far no Member State has included the monetary valuation of landscape in appraisal. Recent theoretical work on the external effects of transport barely addresses the valuation of landscape (eg. Rothengatter and Mauch, 1995; Tinch, 1995 and Maddison et al, 1996). Yet if landscape is considered to contribute to the quality of life of this and future generations, then it must become part of a sustainability objective. Bowers et al (1991) provide a definition of the minimum sustainability objective, which is: "to pass on to future generations a portfolio of landscape qualities at least as good as current generations enjoy".

4.4.2 The proposal for treatment of landscape impacts is:

- to standardise the approach to landscape assessments, through consistent use of objective indicators;
- to rate landscape quality on a common scale, quality to be determined nationally based on the classification systems which already exist for landscape areas of national and regional importance in most Member States;
- to assess the impact of the project on landscape quality;
- to consider and cost mitigation measures, total mitigation or replacement cost being a proxy value;
- any remaining impact after mitigation to be entered into the MCA (Appendix III Chapter 4 gives the scoring scale and its interpretation).

4.5 Land Take

4.5.1 The question of land take is closely linked to issues of landscape and land use (land use is dealt with elsewhere). Land required for transport projects is usually included in a CBA at the purchase price of the land, which is often a market or proxy market price. Such a price may not reflect the future opportunity cost of the land for a number of reasons:

- Land subject to compulsory purchase may have the price driven down by Governments, this may be especially true where lengthy decision making processes leave land under threat or blighted for many years.
- Land may be subject to speculative purchase.
- Agricultural subsidies distorting prices for farmland away from world market values.
- Values and preferences change over time as will the value and role of land.
- The private and public sectors are likely to use different discount rates.
- The long run value of land will necessarily be subject to uncertainty.

4.5.2 The market value of the land will normally enter the appraisal as an investment cost. Where possible this should be supplemented by an assessment of the opportunity cost of the land. Where this is greater or smaller than the market value an adjustment value can be entered using the land take value. Where the market price of the land accurately reflects the opportunity cost or it is not possible to estimate the opportunity cost, the value should be zero.

4.6 Other Environmental Impacts

4.6.1 The following impacts are in practice largely nationally-specific. Concerns change and whilst it is essential that Work Package 4 recommends a full set of impacts as a resource for WP1, it is not necessarily expected that WP1 will take on board every impact in every appraisal: the MCA component of the EUNET methodology is intended to give the user greater flexibility in these areas. However, in certain situations the following issues may become relevant. More detailed discussion of the nature of the impact and recommendations on scoring are contained in Appendix III Chapter 6.

Land Amenity

4.6.2 Quite apart from the market value of land or the opportunity cost issues considered under Land Take is the question of amenity value, most particularly where access is free, eg footpaths through the countryside. These values represent positive externalities to non-paying users and will not be picked up in market prices. In EUNET, where land is accessible to the public and where the nature of the project proposal makes it appropriate to consider localised impacts, this impact should be considered in the MCA. The impact should be assessed against the importance of the amenity and the extent of the impact upon it. The outcome should be a score (Appendix III Section 6.1). In the case of both Land Amenity and Special Sites (Paragraph 4.6.3) it is recommended that the MCA score be supplemented by descriptive assessment highlighting any key individual effects of a project which would have a bearing on its public acceptability - eg. Project A involves the demolition and clearance of three privately occupied castles dating from the 18th century in the area of the Wallersee. The descriptive assessment would be passed to the decision maker along with the CBA, MCA and Financial Appraisal results.

Special Sites

4.6.3 Another value that land may possess over and above the market value or amenity value is a specialist value reflecting, for example, its role as home to a rare plant or animal, the site of an historic event, the site of an historic/unique building(s), or the site of archaeological remains. Such sites can be of world (Pompeii), National (national parks, cathedrals) or regional/local (castles) significance. Certain sites and species will be protected under international agreements. Countries will have their own procedures for designating sites and buildings as being worthy of preservation. However, while there may be a presumption against development, total protection is rarely secure.

4.6.4 As for amenity, the recommendation is for an MCA scoring approach, taking into account the importance of the site and the severity of the impact (see Appendix III Section 6.2).

Severance

4.6.5 Large scale inter-urban projects will almost inevitably result in some severance which could affect, local or regional road traffic, cyclists, pedestrians or horses. The issue of severance as it affects land (eg farms which are bisected) should be considered under the heading of Land Take. In this section consideration is given to journeys, for whatever purpose and by whatever mode which are affected by the scheme in that they are delayed, rerouted, redestinated, or discouraged completely. Delays to motorised journeys should be covered under time costs to travellers. However, this will not be the case for non-motorised traffic, where impacts on existing journeys would otherwise be ignored.

4.6.6 Assessment will consider all routes bisected by the new or enhanced route, this should include, roads, footpaths and bridleways. In considering severance the following issues may be of significance:

- numbers using the route
- presence of alternatives
- purpose of use
- attractiveness of the route
- use by vulnerable groups.

4.6.7 An assessment of the severity of the impact or benefit from relieve of severance should ideally reflect all of these points to fully reflect the impact on the communities affected. A five point scoring scale is again suggested, to allow the impact to be included in the MCA.

Water Pollution

4.6.8 The pollution of water can be a problem particularly in relation to ports, sea and river shipping, airports and roads. The potential importance of the impact will be heavily dependant on local conditions, regulations and targets for water quality. Water quality targets and standards should be the key for this indicator and treated as constraints.

Resource Consumption

4.6.9 The issue is here is whether there is an identifiable additional cost/benefit arising from increased/reduced resource consumption that is not fully accounted for elsewhere in the appraisal. Impacts such as vehicle operating cost, infrastructure cost, air pollution, land take etc all implicitly value the consumption of resources through their purchase and use and the impacts on the environment. However, where sustainability is an objective there is a case for including changes in resource consumption at least descriptively and maybe with a weight in the MCA. Suitable general indicators would be:

- change in energy consumption;
- change in non-renewable resource consumption (eg. metals; fossil fuels; road stone);

- change in renewable resource consumption (eg. forests; flora and fauna).

4.7 Other Issues

4.7.1 Aggregation may prove difficult for certain effects, eg severance and special sites. Over the range of a trans-European network, rankings might be expected to tend towards the mean. However, the method will applied at several levels, eg sub-projects within TEN corridors up to the TENs as a whole. Some variables would be expected to be more significant at local or national level.

5. Recommendations for Indirect Socio-Economic Impacts

5.1 Output and Employment

5.1.1 The sixth EU transport objective identified by EUNET WP1 (Deliverable D10, p19) is ‘Strategic Economic Development’. Implicit in this is the idea that investment in new or upgraded transportation systems can influence the economic performance of European regions and potentially of the EU as a whole. The same idea is embodied in numerous project appraisal methods at the national level, where economic development impacts are given an explicit place in the appraisal framework and in some cases a standard method exists for their estimation (see Appendix IV Chapter 3).

5.1.2 The objective in EUNET WP4 is to provide common guidelines within which to consider these potential economic development impacts of Trans-European transport initiatives. We do not shirk the question of whether in some cases there may be no impact (with particular reference to perfect competition arguments - see Appendix IV Section 4.2), or indeed the regional impact may be negative (SACTRA, 1998). Nor do we seek to replace the existing standard national approaches to economic impact assessment - for a project developed at the national level it is possible that such an assessment will already be available and if so, it may be more practical to re-interpret the findings than to start again from nothing. Furthermore, the methodology chosen for forecasting of output and employment effects in a particular region will depend heavily on the types of data already in existence (input-output tables, employment multipliers, etc). Therefore, the focus is on setting out the relevant principles so that either an existing assessment or a fresh analysis can be admitted into the EUNET assessment on a common basis. The key desirable characteristics of the forecasting process are:

- a precise definition of the study area so that it is absolutely clear within what boundaries a certain economic development response is projected (eg. “the regional income multiplier for NUTS2 Area ‘West Yorkshire’ is 1.47”);

- an explicit statement of the mechanisms and linkages by which changes in the transport sector are being taken to impact on the wider economy, eg. through an input-ouput table, or through a regional multiplier system, etc, so that the analysis could be replicated if necessary;
- careful consideration and analysis of additionality and displacement - the former being the extent to which the output and employment are greater in the Do-Something than in a realistic Do-Minimum scenario (ie. consider to what extent it is the transport project which is responsible rather than other factors), the latter being the extent to which employment and output which are additional to the region in question have been displaced from other regions;
- careful consideration of the effects in the capital market and labour market (crowding-out and wage changes) as a consequence of large projects, whatever forecasting model is used; and
- a clear separation of effects within the investment period vs. the operating period, and of direct, indirect and induced effects.

5.1.3 The key outputs from the forecasting process - and the two impacts which it is proposed to take into account within EUNET - are:

- *output,* defined as the change in EU Gross Domestic Product (Eurostat definition); and
- *employment,* defined as the change in Employment (full time equivalent) *net of displacement* from within the EU (ie. with displaced jobs deducted; employed persons as defined by Eurostat.

5.1.4 The necessity to include both output and employment arises from the real possibility that they could move by different magnitudes or in opposite directions. For example, when a transport improvement facilitates industrial consolidation, this is likely to lead to an increase in productivity, which might manifest itself as a combination of increased output and lower employment.

5.1.5 The recommended measures are:

- for *output:* increment in GDP in the year 2020 in ECU, converted at the EC Official Conversion Rates for 1995.
- for *employment:* increment in Employment in the year 2020 in thousands of persons employed (full time equivalent).

5.1.6 As regards evaluation, a CBA approach was considered but rejected. Principal objections to monetary valuation given the current state of knowledge are that:

- the linkage between forecasting models of the macro-economy and microeconomic evaluation measures is under-developed - there is, in other words, very little convincing theoretical or empirical evidence to support a set of values per job created (or safeguarded);
- it is doubtful whether there exists a CBA methodology suitable for transfer between countries: the German and Spanish methods both

involve a certain number of country-specific assumptions and require country-specific data;

- furthermore, the alternative cost of creating an additional job is not nessarily related to its opportunity cost, which is the theoretically consistent basis for evaluation; and lastly

- there is a fundamental theoretical difficulty that CBA is an efficiency analysis with serious potential limitations in the field of economic growth and changes in output and employment (Cheung, 1993; De Brucker et al, 1995), which would first have to be overcome by theoretical research.

5.1.7 Instead, we recommend an MCA approach, whereby the employment and output impact measures are treated (either directly or by transformation - see Appendix IV Paragraph 4.7.10) as scores. It should be emphasised that we do not hold that the MCA approach can overcome the problems of measurement of employment impacts, the inherent risk of double counting or difficulties in comparing transport with other sectors. Rather, by excluding the employment and output impacts from the CBA we intend to avoid giving a false impression of the degree of analytical rigour and reliability of the outputs. We consider that to recommend values for additional employment would be to give an exaggerated impression of the state-of-the-art in transport CBA (or CBA more generally). Furthermore, we view the forecasting of employment and output impacts as a particularly challenging exercise, fraught with theoretical and practical difficulties, including those identified throughout Appendix IV Chapter 4 (and under examination by the UK's SACTRA Committee). A degree of uncertainty is therefore likely to be associated with the outcome. Depending on which MCA evaluation methodology is chosen (see EUNET Deliverable D10, Section 3.4) this uncertainty can (and should) be taken into account implicitly or explicitly in the evaluation process.

5.1.8 In order to take into account the differential effect, in relation to policy, of employment impacts in high versus low unemployment regions, it would be appropriate for the scoring scale to distinguish the Objective 1, 2 and 5 areas eligible for assistance under the Structural Funds from other areas. There is a risk here of attributing employment effects to the region containing the project without further analysis, and so neglecting some of the spatial effects which may occur; for example where employment impacts accrue to users of the new infrastructure who are themselves based elsewhere in the EU or even outside it. To determine where the employment impacts occur, the use of a credible land-use and transport interation model is essential. In EUNET, the use of the EUNET WP6 Regional Economic Model (or related models) will meet these needs. More generally, methods which satisfy the 'desirable characteristics of the forecasting process' summarised in 5.1.2 are more likely to meet the need for rigour in forecasting.

5.2 Land Use

5.2.1 The other aspects of Strategic Economic Development (EU transport policy objective) with which EUNET is concerned are spatial planning considerations. The definition of the Land Use impact is therefore:

- the extent to which the project conforms to (or conflicts) with land use policy.

5.2.2 Conformity is defined in terms of:

- the extent to which types of development likely to be encouraged by the project conform to the existing (or an equally acceptable alternative) land use plan -eg. if residential development is likely to be encouraged, does this fit with the planning authority's zoning of that locale? Or if commercial development is likely to be encouraged, are the sites which will become more attractive to developers zoned for the types of development which is expected.
- the extent to which discouragement of some types of development likely to follow by the project is in conformity with the existing (or an equally acceptable alternative) land use plan - eg. if severance arising from a project is likely to discourage local commercial of residential development in an area, does this fit with the relevant plan (eg. is the area zoned for recreational purposes or conservation?; is there a plan to limit population growth, or the reverse?); and
- extent to which localised changes in zoning enforced directly by the project itself are acceptable to the planning authority - eg. if the project involves construction of an airport and associated services (eg. terminal retail, hotels), does the land use change to 'transport' and 'services' conform with plans and zoning?

5.2.3 Given that land use planning takes place at various levels in the planning hierarchy in each member state, it is proposed that the measure of land use impact for the MCA take the form of an average weighted by population of scores attributed to each authority whose planning area is likely to be affected. The steps involved in calculating the measure would be as follows:

i) identify areas likely to be affected by land use change;

ii) identify responsible bodies;

iii) compare land use plans with anticipated qualitative effects;

iv) score each plan area (ie. each authority) according to the following scoring scale:

Scoring Scale for Planning Area A

Score	Scale Point Definition
+2	Strong positive conformity with the land use plan
+1	General conformity (some minor or localised conflicts)
0	Mixture of conformity and conflict within Area A - on balance neutral
-1	Some significant areas of conflict with the land use plan - on balance project conflicts with land use plan
-2	Strong conflict with land use plan (and few or no parts of the planning area for which the project can be said to make a significant postive contribution to implementation of the plan)

v) take an average of the scores recorded, weighted by the population of each planning area, giving a single score for the project as a whole.

5.2.4 In order to ensure that the average is not biased toward zero (neutral), it will be important to define clearly *only those areas where a land use change is expected* at step (i). Within these areas, scoring will necessarily be subjective in the absence of a land use model, however the scoring scale given offers a consistent basis across projects. Consistency is likely to be further enhanced if there is consistency of *appraiser* between projects, since this would bring a single interpretation of the scoring scale to bear on the judging process.

5.2.5 For major infrastructure projects, we would expect the use of a land use and transport interaction (LUTI) type model, such as MEPLAN or DELTA. This would assist considerably with the analysis at step (i). In all cases, it would preferable for the appraiser to seek the views of the relevant planning authorities, and ideally seek their agreement with the judgements made.

5.3 Strategic Mobility

5.3.1 The fourth EU transport policy objective (Deliverable D10, p19) 'Improve Strategic Mobility' is the responsibility of Work Package 5. Issues being addressed by WP5 include regional accessibility, peripherality, equity and social cohesion. Two MCA indicators will be calculated for each project, reflecting the improvement as a result of the project in accessibility and social cohesion. Each indicator will give a single value for Europe as a whole. Both will be calculated as the difference between the Project Scenario and the Do-Minimum Scenario, measured as a percentage improvement, and the results will be transferred to the MCA stage of the assessment tool where matching weights will be generated. Further definition of the two indicators will be provided by the WP5 Deliverable.

5.4 Other Policy Synergy

5.4.1 Finally, these optional, user-defined impacts arise from the analysis of EU Transport Objectives under Work Package 1 (Beuthe et al, 1998). It may be that a EUNET user sharing these objectives may wish to include the impacts of the project on ‘Technology Development’ (through technological spin-offs), on ‘Implementation of the Single Market’ (eg. by assisting the harmonisation of technological standards and thus extending producers’ geographical markets), or on the ‘External Dimesion’ (enhancing the EU’s trading links with other areas). For these reasons, it is recommended that the user of EUNET is given the option to include Technology Development, Implementation of the Single Market and/or External Dimension in the MCA, subject to appropriate definition in the context of the projects being assessed.

6. Issues in Practical Application

6.1 Valuing Trans-National Impacts

6.1.1 Projects which alter transport conditions in just one country and affect only the citizens of that country, can be appraised using the corresponding Country Specific value set alone. However, the EUNET method is designed primarily for projects which do not fit this model. In particular it is aimed at:

- projects for which part of the impact is felt by international traffic using the network sections improved by the project;
- projects for which impacts may occur beyond the boundaries of the country containing the project; and
- projects including Trans-European Networks where the project itself may span more than one country.

6.1.2 In these cases the issue arises: which values should be used for each category of traffic and each type of impact? This turns out to be a fairly complex problem to which the immediate practical solutions are necessarily relatively simplistic, even though they do exploit as far as possible the trans-national modelling capability of the EUNET WP6 transport model. It is a problem which would certainly bear further research, perhaps using detailed data on international travel behaviour beyond what has been available to EUNET. In the interim, the following recommendations apply.

6.1.3 Clearly, one option open to the appraiser is to use the EU values for all impacts. The implications of doing so are discussed in the next section (6.2). However, it has been agreed (Chapter 2) that Country Specific values will also be made available for appraisal purposes, the choice between the two being open to the authority conducting the appraisal. If the decision-maker opts to use Country Specific values, which country’s values are appropriate? In general, the guiding principle should be that values appropriate to the incident population (ie. those individuals directly affected) and to any actual resource costs incurred should be used as far as possible. In so far as the incident population are difficult in practice to identify, a set of assumptions will be required for each impact as to which value or combination of values is appropriate to each situation.The suggested base set of assumptions, to be adjusted in the light of experience with the EUNET demonstration examples, is as follows.

6.1.4 In the case of travel time, the incident population consists of: individual travellers whose time is saved; in the case of working time, the employer who also benefits from time saved by his or her employees; and freight users who benefit from faster movement of goods. The connection with country-specific values is therefore through the home country: the country of residence in the case of the individual traveller, and the business location for employers and freight users. With limited information available in practice, the obvious proxy for all of these would be country of trip origin. We are in fact restricted by the WP6 Transport Model to a cruder indicator - the country of origin for the *current leg of the trip*. This will inevitably get ‘country of trip origin’ wrong on the return leg of international trips, but there is no practical alternative (taking an average of origin country and destination country values for each leg leads to exactly the same total benefit). The implications of this assumption are that for flows from a peripheral (or low VoT) country into a core (high VoT) country (and return) then use of *leg-origin* VoT will overstate time savings on the return leg. For flows from a high VoT country to a low VoT country and return, the value of time savings on the return leg will be understated. However, to the extent that the flows of trips balance out in each direction, the problem is minimised in relation to the total benefits. A definitive solution in the longer term could involve developing the transport model to identify flows by true country of origin and apply these to individual trips in the evaluation.

6.1.5 In the case of Safety, accidents on any mode can involve both inter-urban passengers or freight *and* local users with whom the inter-urban traffic comes into conflict. For example, fatal road accidents on inter-urban primary roads in the UK in 1995 included 10% involving pedestrians (Department of Transport, 1995). A further proportion (not identified in the national statistics) would have been between international traffic and national inter-urban and local users in (or on) motor vehicles. In appraisal, the aim is to reflect the true costs of the total set of accidents as far as possible. With accident numbers forecast for each zone (EUNET WP6) but not by country of trip origin within those zones, a sensible approach would appear to be to allocate country specific values on the basis of some informed assumptions about the incidence of costs - especially the split between the country where the accident occurred and the country of origin of the vehicles involved. Data from the UK for 1994 (Hopkin and Simpson, 1995, Table 16) categorises safety costs as: lost output, human costs (pain, grief and suffering), medical costs, damage to property, insurance administration and police costs. Of these, the only two whose value is likely to be specific to the location of the accident are medical costs (assuming casualties are on the whole hospitalised locally) and police costs. These make up just 3.5% of the total costs across all accidents. The remaining costs are likely to be borne primarily by the individuals in the respective vehicles or by others in their country of origin (their employers and insurance companies, for instance). The main exception would be costs associated with pedestrian casualties, however pedestrians account for only 4% of those killed or seriously injured on motorways - on which international traffic is likely chiefly to flow. In the light of this evidence, a simplifying assumption is made: that the costs of accidents in particular European member states should be valued according to the proportions of total vehicle kms in that member state contributed by trips originating in each member state of the whole fifteen. Thus to value accidents in Country A where 5% of vehicle kms are contributed by trips originating in Country B, the values applied should be calculated as 0.95 times the Country Specific values for A plus 0.05 times the Country Specific values for B. The proportions used in a particular appraisal should be derived from the EUNET WP6 transport model.

6.1.6 In the case of air pollution, the nature of the incident population depends upon the dispersion of particular pollutants across geographical space and the damage inflicted by those pollutants at different atmospheric concentrations. However, the general classification of air pollution effects into Regional or Global groups within the CBA is designed to distinguish between effects where the incident population will be primarily within the country where the pollution is emitted and effects which impinge upon the entire world population wherever the pollution is emitted. It is assumed that the trans-boundary (national boundary) effects of regional pollutants emitted by transport are small relative to their effects within the member state: this generally accords with the principle of dispersion over distance, although acid rain effects of electricity generation may prove an exception which in the presence of a full environmental model one may wish to take into account. Thus the allocation of appraisal values is fairly straightforward. Country Specific values are directly applicable to regional air pollution in the member state where it is emitted. An appraisal conducted at a European level would probably choose to use a single value for global air pollution given the pan-European incidence of the effects, whilst an appraisal restricted to costs and benefits at the national level might want to consider whether preferences in that country suggest a lower, or higher, value per tonne of CO_2 than the European average.

6.1.7 Vehicle operating costs (VOCs) differ from travel time in that some of the resource costs involved are determined not by the economic circumstances of the individual travelling or their employer, but by conditions at locations where vehicle operating costs are incurred, including fuel and maintenance stops. In principle, the true resource costs should be identified as far as possible: in practice, information is limited and simplifying assumptions are needed. First consider fuel costs: for example, an HGV making international trips is likely to refuel en route, probably exploiting differences in prices as far as possible. However, it is far from clear that this significantly influences the resource cost. National differences between fuel prices are strongly influenced by differences in tax regimes, but indirect taxes are specifically excluded from the calculation of resource cost. Remaining differences in resource cost owing to the remoteness or otherwise of fuel retailers from the refineries may not be particularly great: one study showed that over the period 1985-95, prices in the Highlands and Islands of Scotland, the remotest part of the UK, ranged between 5 and 10% above the national average (Halcrow Fox, 1995b) - even this may be partly attributable to the local market power of petrol retailers rather than underying resource cost differences. Vehicle maintenance activities can be typified as taking place at the home location, ie. in the country of origin (this is an assumption based on judgement in the absence of quantitative research). Personnel costs for freight vehicles and buses are similarly assumed to depend upon the labour market in the country of trip origin, rather than the country travelled through. Thus the VOC value for traffic in EUNET should be set as for travel time: according to the country of trip origin or a proxy for it. This implies that the VOC for a freight trip beginning in Germany is the German Country Specific value.

6.1.8 Finally, note that the issue raised by Roy in “The Community Component of the Economic Return ... on PBKAL” (see Appendix IV Paragraphs 4.3.11-13) is taken care of in EUNET through the inclusion of all passenger trips, including trans-national traffic, and the inclusion of the associated time savings in all member states within the benefits.

6.2 Implications of Using EU Equity Values for Resource Allocation

6.2.1 The decision to use either the Country Specific values or the EU values in appraisal is likely to have a material effect on the CBA result, hence also on the MCA result, and potentially on the ranking of projects. In particular, there may be implications for the geographical distribution of investment and for the allocation of resources between sectors (both between transport and other sectors and within transport).

6.2.2 In general, inspection of the Country Specific value sets reveals that geographically peripheral countries tend to have lower values than the EU weighted average whilst central countries tend to have higher values. If the EU rather than the Country Specific values were used in appraisal, projects in peripheral countries would therefore find both *costs* and *benefits* valued more highly. If such a project had a positive NPV, it would be more attractive in comparison with a project in a central country than it would under Country Specific values. The reverse would be true for central country projects with positive NPVs: these would appear less attractive under EU values. Projects in peripheral countries with negative NPVs would however find themselves looking less favourable, since the costs as well as the benefits are subject to increase. As the national relativities between Country Specific values differ between time, safety and so on, the implications for a particular set of projects would depend on the mix of benefits (and costs) from each project. Nevertheless, *in general*, when allocating investment resources between geographical areas within the EU, and assuming that all projects put forward have a positive NPV, the use of EU values is likely to favour peripheral areas, compared with an identical appraisal using Country Specific values. To do so at the European level would be in line with practice in most member states, which use national equity values in their national CBA methods.

6.2.3 In terms of allocation between sectors of the economy, use of EU equity values combined with project ranking based on NPVs alone in a peripheral country could be expected to have the following effects, relative to the use of Country Specific values: i) to increase expenditure in sectors of the transport industry dealing primarily with local trips (eg. urban and suburban transport) even more strongly than than those dealing with international trips (eg.

airports) since the former would exhibit the widest gap between for example the average values of time based on country trip origin and the EU equity value of time; and ii) if a direct comparison were made by a decision-maker between the NPV of a transport CBA using EU equity vales and the NPV of a CBA elsewhere in the economy using national or local values (although we would obviously caution strongly against such a comparison), then one might expect expenditure to be favoured relative to expenditure elsewhere.

7. Conclusions

7.1.1 Inter-urban, large scale transport initiatives of the kind which EUNET is designed to assess (Deliverable D10, Section 1.2) typically give rise to a wide range of impacts on people and the environment. It is the responsibility of the appraiser to reflect these impacts in a systematic, consistent way from one initiative to the next, yet existing national appraisal methods do not provide a basis for such a comparison when more than one member state is affected. Definitions and measures differ, modal coverage is limited, in places ad hoc procedures apply and the monetary values used are not always comparable.

7.1.2 This Work Package has sought to redress this situation, drawing on a number of strands of evidence, in particular: i) the more robust techniques which form a common theme running through current best practice in Europe (notably the treatment of travel time, safety and costs in cost-benefit analysis); ii) recent research in transport economics and appraisal (eg. the growing environmental valuation literature) and iii) the more diffuse (and sometimes contradictory) literature on other impacts which, although they cannot yet be subject to the highest degree of rigour, are clearly identified by member states and the European Commission alike as relevant in the allocation of transport investment. There is a place for this last group of impacts (including employment impacts amongst others) in the MCA, the weight accorded to them then being at the discretion of the decision maker. Substantially new guidance, including definitions, measures and scoring scales were found to be necessary for this third group and have been reported in this Deliverable.

7.1.3 For use in the EUNET CBA, Work Package 4 has derived monetary values for time, safety and regional and global air pollution, complementing those provided by Work Package 3 for transport costs. These values include (where appropriate) both Country Specific values for each member state and EU values, the latter being the European equivalent of the single ‘equity’ values used by almost all member states for investment appraisal throughout their own territories. Both types of values allow the CBA to cover a range of inter-urban modes. All are at resource cost (ie. net of indirect taxes less subsidies). Where the Country Specific values derive from values in use in national-level appraisal (chiefy for time and safety) the raw values have been adjusted to reflect the conversion to a common definition, measure and base year (1995) in EUNET. As a by-product of this standardisation process, WP4 has been forced to address issues such as the valuation of small vs large travel time savings, the definition of fatal casualties and the valuation of effects caused by (or felt by) international traffic. The explicit recommendations on each of these will help ensure comparability among assessments using the EUNET method.

7.1.4 In addition to the appraisal values is a set of behavioural values for travel time only (by country, mode and trip purpose), which will inform the transport model (WP6). Aside from the monetary values, WP4 has recommended definitions and measures for all 22 of the impacts considered (some optional), including those which fall outside the CBA but within the MCA. Finally, more widely, EUNET has considered the implications of different views of the role of appraisal at the European and national levels. It is concluded that a common appraisal framework is needed for the appraisal of European transport projects, with common basic rules (eg. a resource cost basis, common definitions and measures for accidents and casualties (and each other impact), consistent presentation of non-monetised effects, and so on). However, the debate over the commonality of the appraisal values themselves is unresolved: for now, the consortium have taken the view that both the Country Specific and the EU value sets may be required in different contexts and so both are presented. Provided that care is taken in practice to compare like with like, and to bear in mind the allocative implications (discussed in Chapter 6) of using one system rather than the other, this should be a sustainable position. An alternative solution in the longer term might be to use country specific (or even local) values but also identify the effects on different income groups explicitly in the appraisal, allowing the decision maker to take income inequality into account explicitly when allocating investment. That, however, will depend on the development of transport and environmental models capable of identifying different income groups throughout their forecasts, and such models are not yet widely available.

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Deliverable D9:

Measurement and Valuation of the Impacts of Transport Initiatives

Volume 2: Appendices

(Work Package 4)

EUNET

Socio-Economic and Spatial Impacts of Transport

Contract: ST-96-SC.037

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Volume 2: Appendices

APPENDIX I - REVIEW OF CURRENT APPRAISAL PRACTICE IN EUROPE

1. Data Gathering and Reference Material

1.1 Country Reports

1.1.1 The review of current appraisal practice was based on data gathered by ITS, University of Leeds, and other EUNET partners whose contribution is gratefully acknowledged (see Appendix VI). The information was recorded in a series of Country Reports addressing for each of 14 member states:

- the role of appraisal in the planning process
- forms of appraisal in use,
- the values, weights and measures used,
- their derivation, and
- any new developments in methodology.

1.1.2 The fifteenth member state, Luxembourg, is understood not to have a tradition of formal project appraisal in either the CBA or MCA paradigm for transport projects, and is therefore omitted from the analysis throughout this Chapter. In the remaining countries, the modes under scrutiny were road, rail, air, short sea shipping, and inland waterways, although in many cases there was no evidence of formal appraisal methods on some of these modes.

1.1.3 It should be emphasised that although the Country Reports are not deliverables, as the principal source of input data to WP4 they are frequently cited in this report, and are identified using the abbreviations “CR: Belgium”, “CR: Portugal”, etc. However, where possible we endeavour to name the original source documents as well, to enable the reader to cross-refer if necessary.

1.2 EU Research

1.2.1 A helpful baseline against which to conduct the review was provided by previous research undertaken for the European Commission, including:

- CEC Directorate General for Transport (1994a), *EURET Concerted Action 1.1, Cost-Benefit and Multi-Criteria Analysis for New Road Construction, Final Report,* DOC EURET/385/94 R&D Unit, DGVII, Brussels.
- CEC Directorate General for Transport (1995a), *EURET Concerted Action 1.1, Cost-Benefit and Multi-Criteria Analysis for New Transport Infrastructure in the Field of Railways,* DGVII, Brussels.
- CEC Directorate General for Transport (1995b), *EVALUATION,* DGVII, Brussels

1.3 Additional Material

1.3.1 Finally, some additional information was gathered through academic or official channels: this is itemised in the bibliography to this report.

2. The Review of Current Appraisal Practice

2.1 Method

2.1.1 The review of current appraisal practice itself took the form of a comparative analysis of the Country Reports, focusing on a number of appraisal issues including the usage of Cost Benefit Analysis and Multi-Criteria Analysis, the inclusion or exclusion of the various WP4 impacts in different countries and the form of CBA where used (ie. appraisal periods, discount rates, treatment of taxation, etc). The findings in all these areas were of use in developing the EUNET method in such as way as to incorporate current best practice from the member states. A selective summary is given in the following sections.

2.2 The Role of Appraisal in the Planning Process

2.2.1 We were interested in the role of appraisal in the planning process as a possible explanation for some of the differences between national methods. For example, CBA and MCA give different types of output information and we wanted to identify what sort of decisions this information was used to inform.

2.2.2 To avoid any potential confusion, we are defining CBA as a purely economic appraisal, in which all effects are assigned a money value. MCA includes the other quantitative types of method, where judgmental weights are used instead of money values to compare and add up the effects of the project. Anything else is labelled 'descriptive assessment'.

2.2.3 As a first observation, appraisal is not used in the initial creation of strategies, 'visions' or new transport policies, nor is it used in generating options within a project, although it may be used in selecting between them later on. It is, however, widely used as an aid to decision-making over the allocation of public sector funds, so where infrastructure is in public ownership, formal project appraisal is widespread, as is the case for roads and railways throughout most of the European Union.

2.2.4 Where privately-owned infrastructure is eligible for public support, some form of project appraisal is usually carried out as part of the funding process. This is true for example of passenger rail investments in the UK, where the infrastructure owner is the company Railtrack plc and the public subsidy would be paid by the Office for Passenger Rail Franchising, which requires an appraisal with the emphasis on CBA (OPRAF, 1997).

2.2.5 Project appraisals have also been required by the EU for major infrastructure part-financed by Europe, and in some cases this has led to the development of a new appraisal methodology. In Greece, the selection of outline options to be included in the Community Support Framework programme was made using an MCA-based appraisal system (CR:Greece; Ministry of National Economy and Ministry of Environment, Physical Planning and Public Works, 1994). The framework did not include any weighting systems or rules for manipulation (including notably *no facility to add up across the impacts to a total score*). Each option was given a score from 1 to 4 on each of 15 criteria, one of which was the result of a *draft* CBA. The MCA table for each option was then compared by the decision-maker in deciding priorities. In Ireland, cost-benefit methods were developed under a research contract let as part of the Technical Assistance provisions in the Operational Programme on Peripherality 1989-93, with the objective of having a consistent, easily applied system for comparing projects (DKM Economic Consultants, 1994).

2.2.6 To be more specific, appraisal is usually part of a sequential, iterative planning process, in which it features predominantly as a means of selecting projects for a programme, and prioritising or setting timing. The importance of CBA outputs as a value-for-money measure is often stressed in principle, but the incomplete nature of most CBAs and the increasing importance attached to the environment and other non-monetised impacts of transport projects, means that in reality the CBA result is taken among several inputs to the decision - ie. the role of appraisal in decision-making is not dominant.

2.2.7 Finally, it might be worth noting that input to investment decision making is only one of the roles that CBA and MCA can play. Ex post evaluation of programmes is becoming more widely recognised as important, particularly at a European level, where expenditure through the Structural Funds is subject to periodic review and re-targeting (eg. EC DGXIX/XX, 1996), and at a national level where the wisdom of past investments has been questioned. Overall, though, current transport infrastructure appraisal at the national level is *prior* appraisal, and there is a great deal of commonality in its roles across member states.

2.3 Forms of Appraisal in Use

2.3.1 A key finding was that all countries (with the exception of Luxembourg) do use CBA on at least one mode in the transport infrastructure planning process. Road and rail projects were the ones most commonly subject to CBA. Air, sea and inland waterway CBAs were much less common, and this has implications for the range of appraisal values available (eg. numerous values exist for time saved by car passengers, but few exist for air travellers).

2.3.2 In many countries the overall appraisal embraced not only the CBA result but also some form of qualitative appraisal of the social, economic and environmental effects. In four countries, the CBA result was input to a Multi-Criteria framework.

2.4 The Scope of Existing Appraisal Methods

2.4.1 The scope of particular methods reflects their objectives. For example, the German ‘macro-economic evaluation’ (a CBA method), which is used to evaluate and rank projects for the Federal Transport Infrastructure Plan, extends to include employment effects. At the level of the regional macroeconomy, weak regions suffer from structural unemployment perpetuated by low factor mobility, problems which are especially acute in the former East German Länder. Investment in transport infrastructure has the potential to raise factor mobility, and the Federal Minister of Transport uses an empirical estimate of between 8 and 24 additional employed per km of autobahn constructed, based on an econometric analysis of past experience. There is also as allowance for the employment effects of project construction, based on input-output analysis. The net change in employment is valued using an alternative cost figure, derived from the cost of a long-running job creation project, and included in the CBA (CR: Germany).

2.4.2 To give another example, the Greek multi-criteria analysis method developed to identify a set of priority projects for European funding has a ‘private financing attractiveness’ criterion. This works by assigning a score to reflect the project’s ability to generate a commercial revenue stream. It is an interesting way of recognising that in a world where the public sector budget is constrained, joint public-private finance can be a way of increasing the social benefits of each ecu of public investment.

2.4.3 Both these examples illustrate what can be done by building on the scope of a conventional appraisal method. Although they have been worked-out in detail for specific countries, their transferability depends on the appropriate data (such as input-output tables) being available elsewhere. This is a practical issue which will be examined further in relation to the individual impacts concerned.

2.4.4 However, these are exceptional cases. The review also highlighted a number of areas in which the appraisals tended to take a common approach. To illustrate this, we have included a table (Table 2.1 overleaf) showing which impacts are included in which form - CBA, MCA or descriptive - in each member state.

Table 2.1

2.4.5 Table 2.1 is based on our understanding of the appraisal methods used. These are official or standard methods where possible, although where none exists the methods reviewed are examples drawn from recent appraisal practice. The latter was the case in Belgium, Greece and Spain. Each column of the table represents appraisal practice in one member state and each row represents one impact. The rows are intended to be comprehensive and are divided into three broad groups of impacts: Direct, Environmental and Socio-Economic.

2.4.6 The impacts included in appraisal in each country are identified by a shaded cell in the corresponding row: dark shading indicates a monetised form (CBA); whilst lighter shading indicates measurement (but not valuation) or a qualitative assessment only (see the Key). Where a country has very distinct appraisal methods for different modes of transport, the mode with the best-developed CBA procedures is given in the table (eg. COBA10 for roads in the UK (Department of Transport (1997)).

2.4.7 The scope of the various appraisal methods - that is to say, the range of impacts valued and included - revealed an encouraging degree of commonality. On the basis of the evidence, some useful general conclusions can be drawn:

- CBA is widely used for impacts categorised here as 'Direct' - in particular Construction Costs, Vehicle Operating Costs, Time Savings and Safety are valued and included in CBA in all countries (on at least one mode);
- Among 'Environmental' impacts, Noise and Local Air Pollution are included in appraisal across member states and are valued and included in CBA in around half of these;
- Treatment of the 'Indirect Socio-Economic' impacts is uneven. Germany includes employment effects in its CBA (see above). Economic Development and Employment are the most commonly included impacts in this category. Other impacts are included in less than half the member states, and even then in widely divergent forms. Nevertheless, there is a widespread recognition that conventional CBA omits this category of impacts and that they may be important in economies with substantial unemployed resources.

APPENDIX II - TREATMENT OF DIRECT TRANSPORT IMPACTS

1. Introduction

1.1 Direct Transport Impacts

1.1.1 The initial list of 'direct' impacts considered by WP4 (and included in the Appeal to Partners for Information) was intended to be comprehensive. The following impacts were included, and the table distinguishes between those which are expected to occur solely during the financing and construction period - the capital costs - and the other, recurring, costs and benefits.

Table 1.1: Initial Direct Impacts in Work Package 4

Capital	Construction Costs Disruption Costs Land and Property Costs
Recurring	Maintenance Costs Operating Costs VOCs Revenues Passenger Cost Savings Time Savings Safety Service Level Information Enforcement Financing / Taxation

Source: EUNET WP4 Appeal to Partners for Information

1.1.2 The final set of WP4 direct impacts (Main Text, Section 2.4) was derived from this initial list after taking into account the findings of the review of current practice, and considering carefully the feasibility of extending current best practice to include additional impacts. In the event, the various capital costs were subsumed under the heading Investment Costs. It should be noted that operating and investment costs are the subject of Work Package 3, whose deliverable D6 (PLANCO, 1997) contains a description of the operating cost model whose outputs will feed WP6 (the regional economic and transport model). The inclusion here of VOCs is for completeness, and the specification is largely a summary of the work of our WP3 partners.

2. Travel Time

2.1 Current European Practice

2.1.1 The travel time savings, or increases, forecast to arise out of infrastructure investment are included in project appraisal across all 14 countries reviewed on at least one mode of transport (always on roads, usually on rail, more erratically on air and inland waterways). A monetary value is accorded, and the quantity of time saved in various categories is combined with the unit value for that category to give a total travel time benefit in money terms. It is frequently noted that travel time benefits represent a large proportion of monetised benefits in project appraisal (eg. ~80% in the UK), although this should be seen in context - the monetary part of the appraisal typically excludes user benefits such as reliability and non-time quality of service, and non-user benefits or disbenefits for the environment.

2.1.2 Unlike safety impacts (Chapter 4), the difficulties in finding a consistent European approach to travel time values relate primarily to measures and estimation methods and not to definitions. The member states' transportation ministries are broadly in agreement about what a time saving is, and to whom its effects accrue. What definitional differences there are (eg. over the inclusion or exclusion of small time savings) are considerably easier to deal with than the multifarious inconsistencies over what constitutes a fatality, accident- versus casualty-related costs and the inclusion and exclusion of numerous items with which the safety analyst has to grapple. Nevertheless, there are a small number of clear distinctions to be made within the various national approaches to the value of time. In line with the Framework set out in Chapter 2 of the Main Text, these will be identified and corrected for as far as possible with a view to reaching a set of definitions, measures and values on a common basis for use in EUNET.

2.2 The Influence of Mode and Journey Purpose

2.2.1 Between most European origins and destinations, different modes of transport can offer different combinations of money cost (to the user) and journey time. Some individuals can be observed using one mode whilst others can be observed using another: this divergence in mode choice could reflect a range of differences in personal preferences and circumstances, but a key determinant in many situations is the individual's preference between time and money. Those with a higher value of time (VoT) will choose faster, more expensive modes of transport, all other things being equal, and this *self-selectivity* shows through in the behavioural values of time estimated empirically on different modes of transport (eg. Gunn & Rohr, 1996; Accent/HCG, 1996; MVA/ITS/TSU, 1987).

2.2.2 There are three notable reasons why VoTs may differ from one choice situation to the next:

- trip purpose,
- disposable income, and
- underlying preferences between time and money in each choice situation (note that preferences may differ according to characteristics of the mode(s) concerned, eg. service quality or comfort, since these characteristics affect the disutility of time spent using each mode).

2.2.3 By distinguishing values of time between different trip purposes, we acknowledge that the same individual may make different choices between time and money in different choice situations, depending on the motives for the trip and the constraints associated with it. The common distinction is between trips for *work* purposes, *commuting* trips and *other* trips. The values below demonstrate the importance of doing this for accurate behavioural modelling and for economic appraisal to reflect individual consumer preferences.

2.2.4 It is also true that under conventional microeconomic assumptions, individuals with a higher disposable income will tend to trade off time and money at a different rate. Table 2.1 shows how experimental non-working VoTs varied with income in the UK in 1985. Referring back to the Framework (Main Text Section 2.3), we would wish to control for this. One approach would be to disaggregate the appraisal values by income group, but the practical difficulties of forecasting flows by income group and the lack of consistent national appraisal values of time make this an unattractive option (measures of flows by income group do not appear in the output of the EUNET WP6 Model (Project Note 023, July 1997). We do not therefore propose to stratify the appraisal values in this way.

Table 2.1: UK Behavioural Values of Non-Working Time by Mode (pence per minute in mid-1985 prices)

Gross Household Income	Car	Bus	Rail	Coach	Walk
< £5,000 p.a.	3.6	2.4	3.6	3.6	4.8
£5-10,000 p.a.	3.9	2.6	4.4	3.9	5.2
£10-15,000 p.a.	4.2	2.8	5.4	4.2	5.7
£15-20,000 p.a.	4.6	3.1	6.3	4.6	6.1
>£20,000 p.a.	5.0	3.4	7.5	5.0	6.7

Source: Department of Transport, 1987
Note: values relate to non-retired, non-student members of two-person households, and where persons are employed, they are not working variable hours

2.2.5 Instead, some of the national appraisal values are specifically controlled for income, the value representing a VoT for an individual receiving the national average wage, or some form of weighted average. We propose to accept these national *equity* values for each mode as part of our response to the income problem. We also go one step further and, for non-work trip purposes, argue that a single appraisal value is appropriate for time savings in personal travel across all modes (see section 2.5).

2.2.6 Any remaining differences in underlying preferences between time and money should be brought out in the appraisal values, which will be input to WP1. Furthermore, behavioural values proposed by WP4 for input to WP6, should be as disaggregated as possible in order to accurately reflect influences on behaviour.

2.3 Definitions

Who are the beneficiaries?

2.3.1 In an economic appraisal, reductions in travel time are of interest to individuals as consumers and as producers. As consumers, individuals are believed to value changes in their own journey times. As producers, individuals are affected both by the personal journey times of themselves and their employees and by the time taken in the course of freight movements. These items are given values in project appraisal.

In-vehicle time and other components of travel time

2.3.2 Personal travel time typically consists of short periods of time spent walking, waiting or interchanging between modes, as well as in-vehicle time. The evidence is that time spent in these activities may be valued differently from the 'main' mode (see Section 2.11). Meanwhile, values given for the main modes - car, bus and coach, rail and air - relate solely to in-vehicle time.

Large and small time savings

2.3.3 It is sometimes argued that large and small time savings should be treated differently. Amongst the member states, only Germany carries this through into the appraisal values of time (and then only for non-working time). The value is reduced by 29.4% to reflect the consequences of disregarding all time savings below a certain minimum amount per journey (in a sample of past road project evaluations). The French guidelines acknowledge the difference in perception but do not recommend different values for small time savings.

2.3.4 At a theoretical level, the debate can become quite esoteric. At the outset, the key questions can be posed as: i) does the perception of small time savings differ from large ones so as to significantly alter traveller *behaviour* (ie. observable choices such as mode choices, route choices, choice of travel speed, etc) in response to a transport initiative over the (say 30 year) appraisal period, and ii) in carrying out a Cost-Benefit Analysis based on changes in social welfare, what is the appropriate *value* to attach to a unit of time saved by an individual in a particular activity? In answer to the first question, which is concerned with behaviour, four points seem particularly relevant:

- The idea that individuals do not always notice small or gradual changes in travel time arises from a particular view of the psychology of the individual, whereby he or she is often unaware of small or gradual changes in his or her environment. If this does apply to small travel time savings, then we would expect individuals questioned about whether their travel time has reduced to respond "no", erroneously, even when a small time saving had occurred. However, this does not imply that small time savings will *always* not be noticed...
- *If* an individual is faced with a real choice - eg. a route choice situation as part of his/her journey to work where the advantages and disadvantages of each route are quite finely balanced - one might expect the individual to be particularly sensitive to small changes in the advantages and disadvantages of each alternative - so that for eg. a 1 minute average time saving on one of two routes could quite plausibly lead to a behavioural response (change of route) in most individuals. Conversely, one can imagine 'mode choice' situations where the choice is not finely balanced at all - one mode dominates. In these situations, small changes in car or PT journey time are not relevant to the decision and so the individual can safely ignore them in any case. Thus, the responsiveness of individuals to small time savings can be seen as dependent on their relevance to travel decisions, and where they are relevant there are good reasons to expect rational individuals to change their behaviour.
- Some individual decisions on transport are made periodically, a good example being whether or not to own a car (eg. whether to replace a broken vehicle / whether to buy one's first car). On these occasions, a rational individual will look at travel times and other conditions <u>at that particular point in time</u> (and probably in the future) in deciding whether or not the car would be a good purchase. The issue of whether the transport system has evolved through a series of many very small improvements which the individual may not have perceived at the time is not relevant - the individual wants to know what the system is like <u>now</u> and what it can be expected to be like during the expected lifetime of the car. Thus when car ownership decisions are made, the issue becomes 'do individuals misperceive the current journey times on their key journeys'? It is very much not in their interests to do so. Insofar as mode and route choice decisions are also made periodically, the same logic can apply, and the issue of whether small individual changes are perceived or not can be seen as being less important.
- Finally, in a world of ongoing transport system improvements, the argument in favour of widespread misperception weakens over time. Over the period of a EUNET CBA, journey times will change many times. Even if a one minute time saving on a particular journey is not perceived, five successive one minute improvements will together

produce a significant saving on a 30 minute journey. In order to accurately model the behavioural impact of the 5 minute saving, we cannot exclude each of its components from the modelling procedure: the current state of the art in modelling does not allow subtle and complex effects such as this to be handled in the precise way that they are handled psychologically by individual travellers.

2.3.5 In view of these points, we conclude that the best approach to forecasting travel behaviour (in WP6) is to use the same values for small time savings as for large ones.

2.3.6 In answer to the second question, “what are the appropriate values for CBA?”, we must consider to what extent small time savings contribute to social welfare. Some of the points made in relation to behaviour are relevant here too: we have already argued that where time savings are relevant to travel decisions, they will be perceived by rational individuals. Thus even a 1 minute time saving will be perceived when it is relevant to an individual’s life choices - which way to drive to work, whether to switch to public transport, whether to buy a car and so on.

2.3.7 Even if small time savings are not perceived individually, a series of small time savings is likely to be perceived eventually as the whole becomes large enough to overcome the initial failure to notice. Appraisal needs to take account of the welfare effect of these changes, and the only practical way of doing so is to include each small change when it occurs.

2.3.8 Finally, we refer back to the individual whose journey time is cut by a small amount but for a number of reasons (perhaps he/she cannot see any physical improvement works en route; perhaps he/she is not sensitive to journey time on that mode because no other mode comes close in terms of door-to-door journey time, cost, convenience, etc) the individual does not notice the change. In this case, can we say that the individual’s welfare is not increased? Even then, not necessarily: in the time saved, the individual must engage in an alternative activity - work, recreation, relaxation, housework, doing nothing at all... The utility associated with that activity in relation to spending time travelling is real, and we speculate that this could contribute to welfare irrespective of the individual’s perception (or not) of *why* they are spending more time doing more pleasurable things.

2.3.9 Turning to the practical objections to separating large and small time savings, we note that:

- separating large and small time savings doubles the amount of data to be transferred between the forecasting and evaluation stages of the assessment tool - there may be more worthwhile uses of the additional computing power required,
- the definition of ‘small’ time savings would be arbitrary (as there is no convincing evidence on a threshold value across different modes and countries) and the sensitivity of the CBA results to this choice would therefore need to be tested,
- when appraising two phases of the same project (or complementary projects more generally, eg. sections of a TEN route), the benefits of

the whole investment would be understated if the time savings on each phase fell below the threshold level - problems of path-dependency may also arise, and

- using a single value also avoids the potential for scheme promoters to exploit the ‘quirks’ introduced by the above.

2.3.10 In conclusion, a sensitivity analysis could in principle be introduced for the exclusion or lower valuation of small time savings - this might be an interesting experiment. However, given the overwhelming theoretical and practical arguments, the more usual approach - that of treating large and small savings equally - is recommended in EUNET, pending future fundamental research into this question.

Trip purposes

2.3.11 Definitions of trip purposes are as follows:

- *work* - trips made on the employer’s business or, in the case of self-employed individuals, in the course of his/her occupation;
- *commuting* - trips made between home and workplace;
- *other* - trips made for reasons unrelated to work, including personal business, shopping, education and leisure.

2.4 Values of Time - Working Car

Estimation Methods

2.4.1 The traditional approach to the valuation of business travel time involves the following steps and assumptions (eg. Department of Transport, 1997):

- assume that during working time the employee always acts in the interests of the employer, about which he/she has perfect knowledge;
- assume that the employee’s marginal value to the employer is equal to the average hourly cost of employing labour (ie. assuming that after long-run adjustment, travel time changes will impact upon output rather than employment);
- add to the average hourly wage rate an allowance for employee-related costs and overheads, to obtain an estimate of the working value of time.

2.4.2 This approach is taken in several member states (Table 2.2).

Table 2.2: Estimation Methods for Working Time (Car)

Country	Estimation Method for Working Time Value	
	Average gross wage or output	Employee's WTP + Employer share (as below)
Germany	✓	
Netherlands		✓
Portugal	✓	
Sweden		✓
UK	✓*	

Note: *values derived using the Hensher approach were recommended following the 1994 UK Value of Time Study which reported in 1996 (Accent/HCG, 1996).

Other member states are assumed to use the average gross wage approach.

2.4.3 The alternative approach, following Hensher,1977, is to avoid making the first assumption in 2.4.1, and instead to examine the employee's and employer's preferences separately. An interview with the traveller is used to attempt to identify the employer's component of the value of time (ie. productive net worth) to add to the direct estimate of the employee drawn from the SP exercise.

The formula for the employer's component is:

$$VoT_{employer} = PVWT \times \left(\%W - \left(\%TW \times \%PTW \right) \right)$$

where PVWT = the productive value of an hour of work time

%W = the % of travel time savings returned to work

%TW = the % of travel time used for work

%PTW = the relative productivity of work during travel

2.4.4 The effect on appraisal values of adopting the Hensher approach in place of the traditional average gross wage approach was identified in the UK as an increase in the working value of time by 4% for car drivers and 25% for car passengers (Accent/HCG, 1996, Table 132). Combining this with working car vehicle occupancy data (Table 2.3) suggests an overall increase of 6.1% for an average working car occupant.

Measures

2.4.5 The measure proposed for working time (car) is:

- time saved, person hours

2.4.6 Consequently the VoT is in units of ecu per person per hour.

V*ehicle Occupancy*

2.4.7 Vehicle occupancy information may be helpful in applying a value per person per hour in an appraisal where flow data gives only vehicles and not people. Furthermore, it may be essential in relating appraisal values for different member states. The car and working car occupancy information available from the Country Reports is given in detail in Table 2.4: however, the contrast between working car and average car occupancy is highlighted by Table 2.3.

Table 2.3: Vehicle Occupancy Information (Car and Working Car)

	BEL	DEN	FIN	FRA	GER	GRE	POR	UK
Occupancy								
per car	1.34	1.59	1.9	1.8		1.9		1.65
per car (working)			1.3		1.1		1.7	1.11

Source: Extract from Table 2.4

Values

2.4.8 To generate a set of Country Specific and European Values, we make use of the values and supporting information available from the Country Reports. In order to put these values on a consistent basis across the member states, a number of adjustments are required.

2.4.9 Firstly, as the available values relate to a range of different base years and many are expressed in national currency, the values are uplifted to 1995 prices using the Eurostat Consumer Prices General Index and converted to ecus at the European Commission's published Official Annual Exchange Rates. In the light of findings of recent value of time studies (eg. Gunn and Rohr, 1996) that values do not increase proportionately with personal income growth as had previously been believed, it was not felt to be appropriate to make any earnings adjustments. Table 2.4 overleaf shows the uplifted and converted values.

2.4.10 Secondly, in the light of the UK VoT Study findings regarding the effect of adopting the Hensher approach to empirical estimation (para. 2.4.3), an adjustment is needed to avoid leaving an inconsistency between the Dutch and Swedish values and the rest. It is expected that the Hensher approach will be adopted more widely in the future, so it is the majority of national values which are adjusted (upwards by 6%) whilst the Dutch and Swedish values are left unchanged.

2.4.11 Thirdly, we remove the Taxation Factor (equal to 1.23) from the Swedish values to restore these to resource cost.

Table 2.4

(see D9.XLS

Sheet VOT '95)

2.4.12 Next we begin the process of estimating the missing country values:

i) we identify values which are on the correct measure - ie. **value per person hour (work purpose) (car mode)** - which exist for Denmark, Netherlands, Portugal and Sweden (Table 2.4), and adopt these;

ii) we identify values on related (and convertible) measures such as**:**

- values per person hour (work purpose) **(any mode)** - which exist for FIN/GER/IRE;
- values per person hour (work purpose) (car mode) **(disaggregated by driver/passenger)** - UK only;
- values per person hour **(average purpose)** (car mode) - for AUS/FRA/ GRE;
- values per **vehicle hour** (work purpose) (car mode) - Portugal only; and
- values per **vehicle hour (average purpose)** (car mode) - Spain only.

2.4.13 In order to convert the above values back to the common measure we make use of various information and relationships:

- the relationship between working time (any mode) and working time (car) evident in the UK data;
- relationships between average car and working car values for DEN and UK; and
- vehicle occupancies (Table 2.4).

2.4.14 Finally, in the case of France and Greece we make the judgement that the UK relationship between average car and working car values gives a more plausible result than the Danish relationship, and so make use of the former.

2.4.15 Combining these adjustments, we reach a set of Country-Specific values for working time (work purpose) (car mode) which are consistent as far as possible given the available data. These are given in Table 2.5.

Table 2.5: Proposed Appraisal Values of Time (working car), ecu per person per hour (1995 prices and values)

	AUS	BEL	DEN	FIN	FRA	GER	GRE	IRE	ITA	NRL	POR	SPA	SWE	UK
Value of Time purpose: **work** mode: **car** per person per hour	14.6	18.2	21.8	23.0	21.3	20.7	12.9	14.0	15.0	21.4	6.3	13.6	17.7	16.8

2.4.16 The range of values is wide, from 6.3ecu in Portugal to 23.0ecu in Finland. However, a factor in their determination (according to the theory) is likely to be the average income per capita, which varies significantly between member states (see for example Eurostat series on Wages in Industry). In general, working values of time in the more northerly member states (with exception of Ireland) appear to exceed the working time values in southerly ones (eg. Greece, Portugal, Spain), which can be interpreted as a reflection of real income variations.

2.4.17 By taking an average of the Country-Specific VoTs weighted by working population, we obtain a European equity value of 17.8ecu at 1995 prices and values.

2.5 Values of Time - Non-Working Car

2.5.1 Whilst not all countries use separate appraisal values for working and non-working time, a majority do so. On first analysis (Nellthorp, Bristow and Mackie, 1997b), the values equate on average to just over 20% of the value for working time (the range is from 10-50%) and this in itself illustrates an important reason for separating the two: using an averaged value would distort the results wherever the proportions of working and non-working travellers were different from the 'average' situation. For those countries which use a separate appraisal value for non-working time, Table 2.6 shows the range of values after adjusting to resource cost.

Table 2.6: Non-Working Time Values - First Estimates

Value of Non-Working Time, ECU/hr	Countries
1.5-2.5	Finland
2.5-4.5	Denmark, Germany, Netherlands, Portugal, UK
4.5-8.0	Ireland, Sweden

Sources: EUNET WP4 Country Reports; exchange rates from Eurostat.
Reproduced from Proceedings of Seminar E, PTRC/ETF, Brunel University, September 1997.
Base years differ.
Other countries use 'average' values, except Austria and Italy which lack data.

Estimation methods

2.5.2 The estimation methods used by member states in generating their non-working values of time are dominated by a mix of Revealed Preference (RP) and Stated Preference (SP) survey based approaches. In the former, time values are inferred from statistical analysis of real choice data (eg. choice of mode, choice between tolled and un-tolled routes), whilst in the latter hypothetical choices are presented in which the survey respondent is required to trade off time against money cost - in this method repeated questioning posing different choices is possible. It has been a finding of the late 1980s and 1990s value of time studies that RP and SP methods give comparable results (MVA/ITS/TSU, 1987; Gunn and Rohr, 1996). Table 2.7 summarises current practice. The Portuguese approach is the only one which we know to be substantially different, and the consequences of this are dealt with below.

Table 2.7: Estimation Methods for Non-Working Time (Car)

Country	Estimation Method for Working Time Value	
	RP/SP survey methods	Other
Finland	✓	
France		derived from traffic models
Germany	✓	
Ireland		income-based adjustment of UK value
Netherlands	✓	
Portugal		set at 75% (commuting) and 50% (other) of working time value
Sweden	✓	
UK	✓	

Other member states are assumed to use RP/SP survey-based values.

Measures

2.5.3 The measure proposed for non-working time (car) is:

- time saved, person hours

2.5.4 Consequently the value of time is in units of ecu per person per hour.

Values

2.5.5 A set of Country Specific and European Values have been generated as follows (using information in Table 2.4, which contains values uplifted and converted to 1995 ecu):

i) identify values on the correct measure - ie. **person hours (non-work purpose) (car mode)**;

ii) identify values on related (convertible) measures such as **person hours (commuting purpose) (car mode)** or **person hours (other purpose) (car mode)** - countries - **person hours (non-work purpose) (any mode)** - - and **vehicle hours (non-work purpose) (car mode)** - ;

iii) adjust Portuguese value to reflect typical relationship between work and non-work values;

iv) identify information useful in estimating missing values - ie. average VoTs per person hour (car) and per car hour; relationships between average VoTs and work purpose VoTs; and occupancies as above;

v) use information in iv) to estimate missing Country Specific values;

vi) by taking an average of the Country-Specific VoTs weighted by working population, obtain a European *equity value*.

2.5.6 The values generated are shown in Table 2.8 and the corresponding EU value is 4.5ecu per person per hour. It should be pointed-out before proceeding that the appraisal value for non-working time (car) is not ultimately recommended for use in EUNET, since modal non-working values are ruled out in favour of a standard appraisal value (any mode - see Table 2.20 for clarification of the final set of appraisal values). The non-working car values are nevertheless a useful step in the calculations, and are also needed to derive the behavioural values for non-working time, where the modal disaggregation is restored.

Table 2.8: Proposed Appraisal Values of Non-Working Time (car), ecu per person per hour (1995 prices and values)

	AUS	BEL	DEN	FIN	FRA	GER	GRE	IRE	ITA	NRL	POR	SPA	SWE	UK
Value of Time purpose: **non-work** mode: **car** per person per hour	3.4	3.5	3.6	2.4	5.0	5.3	3.0	4.6	5.3	5.3	3.2	3.2	3.7	3.9

2.6 Value of Non-Working Time - Any Mode

2.6.1 In certain countries, namely Finland, Germany, Ireland, Sweden and the UK, the view is taken that for appraisal purposes the same value(s) for non-working time should be applied across all modes of transport. This is believed to be a response to the practical benefits of using a single value: in particular, the clear impression of comparability between appraisals of infrastructure investment on different modes. In addition, for a country whose appraisal values are not adjusted for income differences between the modes, adoption of a single non-working value of time helps to overcome the equity problems which would otherwise arise.

2.6.2 Drawing on the relationships established in the course of developing the non-working car values, non-working time values (any mode) were calculated. Those for Belgium, Denmark, France, Greece, the Netherlands, Portugal, Spain and Sweden were derived from the non-working car values using the average ratio from elsewhere. Table 2.9 gives the results. The corresponding population-weighted EU equity value is 4.5ecu.

Table 2.9: Proposed Appraisal Values of Non-Working Time (any mode), ecu per person per hour (1995 prices and values)

	AUS	BEL	DEN	FIN	FRA	GER	GRE	IRE	ITA	NRL	POR	SPA	SWE	UK
Value of Time purpose: **non-work** mode: **any** per person per hour	3.5	3.6	3.7	2.4	5.0	5.3	3.1	4.3	5.3	5.3	3.2	3.2	3.8	3.9

2.7 Values of Time - Bus and Coach

2.7.1 As local bus and long distance coach are collective modes of transport, the analysis of values of time is complicated slightly relative to private transport by the need to consider the driver - the operator's employee - as well as the other occupants who are using the bus or coach to reach their destination.

Evidence on bus and coach time values is limited to six member states, and the information requires a certain amount of processing before it is possible to compare between countries on a common measure.

2.7.2 The analysis is further complicated by the long-distance/short-distance distinction. Some member states make this distinction in appraisal whilst some do not, yet the evidence that is available suggests a significant difference in the behavioural values of time.

2.7.3 Bus and coach values of time are estimated using (as far as we are concerned here) the same methods as for working time and non-working time (car) described above, so the same general adjustments apply - ie. the inflation of the majority of the working values by 6% to bring them into line with those derived using the Hensher approach, and the restoration of the Swedish values to resource costs in common with the rest by removing the 'Tax Factor'.

Measures

2.7.4 Bus/coach occupants can be broken down as follows:

- driver
- passengers (working)
- passengers (non-working)

2.7.5 The aggregate value of time for the occupants of the vehicle as a group would be given by:

$$VOT_{BUS} = VOT_{driver} + \left(VOT_{pax(wk)} \times Occ_{pax(wk)}\right) + \left(VOT_{pax(nwk)} \times Occ_{pax(nwk)}\right)$$

where VOT_{BUS} - total value of time including all occupants

VOT_{driver} - driver's value of time

$VOT_{pax(wk)}$ - working bus passenger's value of time

$VOT_{pax(nwk)}$ - non-working bus passenger's value of time

Evidence from the Country Reports

2.7.6 Four countries give an aggregate value for all occupants of the vehicle:

Table 2.10: Values of Time (Bus - Aggregate Value), ecu per hour

Country	**Value**
Austria	66.7
Finland	68.1
Greece	23.3
UK	61.3

1995 prices and values

Note: these values are not adjusted for Hensher approach to working time - occupancies by trip purpose are unknown.

2.7.7 Values of time per occupant relate to different disaggregations of occupants in different member states:

Table 2.11: Values of Time (Bus and Coach Occupants), ecu per person per hour

Occupants	GRE	NRL	POR	SWE	UK
Bus driver					12.3
Bus passenger					
average	0.8				4.0
working					13.3
non-working					3.9
commuting				3.3	
other				2.4	
Coach passenger					
working				10.3	
non-working				6.5	
PT passenger					
average		4.6	1.5		

1995 prices and values

Note: these values are not adjusted for Hensher approach to working time - occupancies by trip purpose are unknown.

2.7.8 In addition we have average bus occupancy figures for three countries:

Table 2.12: Bus Vehicle Occupancy

Country	Occupancy			
	Total	Driver	Passengers (working)	Pax (non-working)
Germany	21			
Greece	30			
UK	13.1	1	0.1	12

Values

2.7.9 Given the number of blank spaces in Tables 2.10-12, we should first consider whether the information is useful in deriving Country Specific and European values for bus/coach travel time in EUNET. A number of helpful comparisons can be made:

- the UK and Greek ‘average bus user’ and Dutch ‘average PT user’ values can be compared with each other and with the respective ‘average car user values’;

- the Swedish and UK 'bus passenger by trip purpose' values can be compared with the same countries' 'car passenger by trip purpose values';
- the UK 'bus driver' figure can be compared with the average UK working value of time;
- the Swedish (and UK from Table 2.1 above) short-distance and long-distance values can be compared.

2.7.10 In bringing this information together, we bear in mind that the data generated by the transport model in WP6 will contain time and flow matrices by origin-destination pair in 'flow units' (TAM.DAT, see ME&P Project Note 023) and time and load data for links in the network, by vehicle type (TAN.DAT).

2.7.11 The evidence suggests the following relationships between bus and car user values (all are for in-vehicle time only - walking is excluded):

Table 2.13: Ratios of Bus User to Car User Values of Time

Relationship	**Country**	**Ratio (values)**	**Ratio (1:?)**
Average PT User : Ave. Car User	NRL	4.4 : 6.8	1 : 1.55
Bus Commuter : Car Commuter	SWE	3.3 : 4.2	1 : 1.29
Bus Leisure : Car Leisure	SWE	2.4 : 3.7	1 : 1.50
Bus Working : Car Working	SWE	10.3 : 17.9	1 : 1.74
	UK	14.5 : 17.3	1 : 1.19

2.7.12 The Swedish and UK evidence on long-distance coach suggests that the non-working time values for coach should be equal to those for car mode, but that working time should be valued as for bus.

2.7.13 On the available evidence, it is not possible to propose a value for each member state for the total value of time per bus hour because of the uncertainties over vehicle occupancy, however, the following values per occupant are proposed:

Table 2.14: Proposed Values of Time (bus), ecu per person per hour (1995 prices and values)

Value of Time	AUS	BEL	DEN	FIN	FRA	GER	GRE	IRE	ITA	NRL	POR	SPA	SWE	UK
Bus driver	9.6	11.9	14.3	15.1	13.9	13.5	8.4	9.2	9.8	14.0	4.1	8.9	9.5	13.0
Bus passenger (working)	10.3	12.9	15.4	16.3	15.1	14.6	9.1	9.9	10.6	15.2	4.5	9.6	10.3	14.1
Bus passenger (non-work)	2.3	2.4	2.4	1.6	3.3	3.5	2.0	2.8	3.5	3.5	2.1	2.1	2.5	2.6
Coach passenger (working)	10.3	12.9	15.4	16.3	15.1	14.6	9.1	9.9	10.6	15.2	4.5	9.6	10.3	14.1
Coach passenger (non-work)	3.4	3.5	3.6	2.4	5.0	5.3	3.0	4.3	5.3	5.3	3.2	3.2	3.7	3.9

2.7.14 The corresponding EU equity values are:

- bus driver: 12.0ecu
- bus passenger (working): 12.9ecu
- bus passenger (non-working): 3.0ecu
- coach passenger (working): 12.9ecu
- coach passenger (non-working): 4.5ecu

2.8 Values of Time - Passenger Rail

2.8.1 Mode-specific values of time for rail passengers are limited to five member states and raise some formidable problems. The chief inconsistency in measures used is that Sweden disaggregates between regional and inter-regional trips, whilst the UK gives 'Underground' and 'Rail passenger', France gives 1st and 2nd class, Italy gives a value for a High Speed rail project and only Greece gives a value for an average rail user. The values give further cause for concern because the French and UK values are significantly higher than for car mode on the equivalent measure, whilst the Greek and Swedish values are significantly lower than for car mode, and the Italian value is similar to the car mode value.

2.8.2 These empirical differences may reflect the different roles that railways play in the respective countries. For example, some countries' rail systems might play a substantial role in urban and suburban transit, whilst others may provide predominantly long-distance services. Some might, because of the distances involved and the extent of intermodal competition, provide a large proportion of services in 'high-quality, high-price' segments of business travel markets, whilst others might fulfil the opposite role.

2.8.3 The differences in rail values may also reflect differences in the on-board environment which allow the working traveller to work more or less productively on the train, thereby reducing or increasing the value of travel time savings

2.8.4 If these explanations are true, then we are not in a position to give a single definitive value set for working rail passengers: the value will depend on the types of business travel catered for, quality factors, the competitive position and so on. However, the appraisal value appropriate to each country is likely to be within the range indicated in Table 2.15, based on the Swedish (low) and UK (high) values. For practical implementation within the WP1 Assessment Tool, we therefore tentatively suggest that a combination of assumed 'central' values and a careful sensitivity analysis is appropriate. The 'central values' would be the unweighted mean of the Swedish and UK-based values given in Table 2.15. The sensitivity tests should then be to changes of +/- 32% in the rail mode value of working time.

2.8.5 In appraisals where the EU equity values are used, the need to test the sensitivity of the results to individual Country-Specific values of working rail travel time will be avoided. Only the sensitivity to the overall EU value will need to be considered.

2.8.6 Two sets of working time values for rail have been calculated, taking the Sweden (arithmetic mean of regional and inter-regional values) and UK 'rail passenger' figures respectively as a basis. Variation across countries has been assumed to be in line with working time values for car (ie. in strict proportion). Table 2.15 gives the results. The corresponding EU values are 11.7ecu (low) and 22.7ecu (high) per person per hour, respectively.

Table 2.15: Proposed Appraisal Values of Working Time (rail), ecu per person per hour (1995 prices and values)

	AUS	BEL	DEN	FIN	FRA	GER	GRE	IRE	ITA	NRL	POR	SPA	SWE	UK
Value of Time purpose: **work** mode: **rail**														
SWE basis	9.6	12.0	14.3	15.2	14.0	13.6	8.5	9.2	9.8	14.1	4.2	9.0	11.7	11.1
UK basis	18.6	23.2	27.8	29.4	27.1	26.4	16.4	17.8	19.1	27.4	8.1	17.4	22.6	21.4
per person per hour														

2.8.7 Non-working time on the rail mode should be evaluated using the 'any mode' values of non-working time given in Table 2.9, unless there are pressing reasons to the contrary.

2.9 Values of Time - Air

2.9.1 We have only one air mode value of time: this is for France and the value is 45.4ecu per person per hour. This is an average across all air users and is an appraisal value.

2.9.2 The value is high in relation to any of the others derived for road, rail, bus and coach. As with rail, in order to obtain a set of appraisal values across the member states, we apply the 'working car' profile to the French air value. The results are as follows, with an EU value of 37.7ecu per person per hour.

Table 2.16: Proposed Appraisal Values of Time (air), ecu per person per hour (1995 prices and values)

	AUS	BEL	DEN	FIN	FRA	GER	GRE	IRE	ITA	NRL	POR	SPA	SWE	UK
Value of Time purpose: **average** mode: air per person per hour	31.1	38.8	46.5	49.2	45.4	44.1	27.5	29.9	32.0	45.8	13.5	29.1	37.9	35.9

2.10 Values of Time - Freight

2.10.1 In order to derive freight values of time, we begin by considering the potential components of the value. Several points of view are relevant: firstly, those of the freight users - ie. those dispatching and receiving goods - since reductions in freight transit time may have benefits at both ends of the haul and any time cost reduction may be shared between them, and also that of the driver, since there could conceivably be benefits to them which were not fully compensated by reductions in earnings. This approach suggests the following set of potential benefit items following a freight journey time saving:

- driver's wage cost reduction (benefit to employer);

- efficiency gain to freight user - despatch (benefit to freight user);
- efficiency gain to freight user - recipient (benefit to freight user);
- uncompensated utility gain to driver.

2.10.2 A considerable part of the discussion over the value of freight time savings has focused on the extent to which rescheduling is possible on the part of haulage firms, thereby allowing drivers' time saved to be utilised productively elsewhere. We make the simplifying assumption that full rescheduling is possible, so that the benefit to the haulage firm is correctly measured by the pro rata saving in drivers' wage costs (adjusted if necessary in line with resource cost approach as far as possible - see Main Text Paragraph 2.1.6).

2.10.3 With regard to any potential uncompensated utility gain to the driver, we make the further simplifying assumptions that at the margin, the driver's disutility associated with time spent driving is exactly equal and opposite to the utility gained from their current wage rate, and that the freight journey time changes associated with project are small enough in proportion to the driver's working day to be marginal in the economic sense to him/her - ie. to be valued by the wage rate. These assumptions allow us to rule out any additional benefit to the driver of the form suggested in the fourth bullet point above.

2.10.4 Focusing then on the first three components, we turn to the evidence on appraisal values gathered by Work Package 4. Before any adjustments are made for differences in approach between countries, Table 2.17 shows the values available, all converted to the 1995 price base year. The table also shows the recommended working time values for car occupants (per hour) for comparison.

Table 2.17: Current Appraisal Values of Time for Lorries (per vehicle hr)

	AUS	BEL	DEN	FIN	ITA	POR	SPA	SWE	UK
Lorry	22.4	21.2	21.6	18.9	17.0	7.7	13.3	19.1 +7.5	11.8
Car (per occupant hour)	14.6	18.2	21.8	23.0	15.0	6.3	13.6	17.7	16.8

Notes: AUS value is for non-articulated lorries; ITA value is for goods vehicles over 3.5 tons; Swedish value is the sum of a driver's wage cost component (quoted first) and a "goods cost" component for an average lorry; UK value is for an OGV - ie. a goods vehicle other than a light goods vehicle.

2.10.5 The Table reveals an encouraging degree of commonality between the movement of the two sets of indicators, considering that the latter is divorced from the 'per vehicle hour' value by variations in occupancy rates between countries. We would interpret this commonality as reflecting the underlying relationship between values of working time and wage rates as discussed in Section 2.4. The apparently high Austrian value is likely to be due to the inclusion of an unknown element of "goods costs" as in the Swedish value. The UK value appears low, although this partly reflects the low assumed occupancy of 1.0. The UK value for Light Goods Vehicles is much more consistent in this context, at 18.4ecu per vehicle hour.

2.10.6 The breakdown of the Swedish values into driver's wage costs and goods costs (Sweden is the only country to provide such a breakdown) is vital in enabling us to provide values in the form required by EUNET Work Packages 1 and 6, because the Vehicle Operating Costs estimated by Work Package 3 already include drivers' wage costs for freight vehicles. These cost items correspond to the first component bulleted above (at the start of this section) and the second and third items combined, ie.:

- *driver's wage cost reduction* is given by the Swedish 'driver's wage cost'; and
- *efficiency gain to freight user - despatch and recipient* - is given by the 'goods costs'.

2.10.7 In order to obtain costs on this basis across member states, assumptions are needed, and we make the following:

- drivers' wage cost reductions vary, for countries not listed in Table 2.17, in the same proportion to the working time value for car occupants as the weighted average of countries listed in Table 2.17 (weighted by working population);
- freight user time benefits are additional to drivers' wage cost reductions, and in countries other than Sweden vary in proportion to the working time value for car occupants; and
- an appropriate distinction amongst freight vehicles in terms of the freight user time benefits is between articulated and non-articulated vehicles (or 'lorries' and 'trucks' in WP3's terminology), and that the Swedish relativities can be applied elsewhere.

2.10.8 Thus the recommended freight time values are as shown in Table 2.18.

Table 2.18: Proposed Appraisal Values of Time (freight), ecu per vehicle hour (1995 prices and values)

	AUS	BEL	DEN	FIN	FRA	GER	GRE	IRE	ITA	NRL	POR	SPA	SWE	UK
Value of Time														
mode: freight														
Drivers' Wage Value	20.2	21.2	21.6	18.9	31.3	30.4	18.9	20.6	17.0	31.5	7.7	13.3	19.1	18.4
Freight User Value (Lorry)	1.6	1.9	2.3	2.5	2.3	2.2	1.4	1.5	1.6	2.3	0.7	1.5	1.9	1.8
Freight User Value (Truck)	6.5	8.1	9.7	10.3	9.5	9.2	5.7	6.2	6.7	9.6	2.8	6.1	7.9	7.5
per vehicle hour														

2.11 Interchange

2.11.1 The evidence on values of time for interchange is as follows. Analysis of follow-up surveys to the Netherlands Value of Time Study identified the following factors on In-Vehicle Time (IVT) for Interchange between modes.

Table 2.19: Interchange Time Factors (1990)

ACTIVITY	FACTOR ON IVT		
	Business	Commuting	Other
Interchange	1.6	2.1	1.6

Source: Gunn and Rohr 1996

2.11.2 Swedish rail appraisal gives values for interchange on rail trips at double the IVT value.

2.11.3 UK Department of Transport guidelines recommend that a factor of two be applied to the IVT value for non-working time spent waiting (DOT, 1997). However, for working time no factor is applied.

2.11.4 In the light of this evidence, and given the adoption of the Hensher approach to working time in EUNET, it is recommended that:

- in non-working time, interchange time savings be valued at double the value for IVT;
- in working time, the employee's component of interchange time savings be valued at double the value for IVT to reflect their disutility in that situation, whilst the employer's component be unchanged.

2.12 Behavioural Values

2.12.1 In order to calculate behavioural values at the country level from the appraisal values gathered in the course of this work package, we make the following assumptions:

- that the perception of non-working time values differs from their resource cost in that perceived/behavioural costs *include* indirect taxes (net of subsidies);
- that for working time valued in line with the Hensher approach, the employee's share is subject to the same resource-perceived differential as non-working time, whilst for the employer's share, behavioural and appraisal values are identical.

2.13.2 Using Eurostat data series on the share of indirect taxes (net of subsidies) in GDP at market prices, we adjust appraisal values upwards to restore the non-resource components. To determine what share of the working time value to apply the adjustment to, we refer to the findings of the UK Value of Time Study by Hague Consulting Group, which concluded that the original behavioural values were in the ratio 6.7 pence per minute (employee's share) to 14.7 pence per minute (employer's share) (see Gunn & Rohr, 1996). For reference the 'share of indirect taxes in GDP' series is given in Appendix VII.

2.14 Summary of Values

2.14.1 Tables 2.20 and 2.21 summarise the values of time which arise from the work reported in this Chapter, giving both the Country-Specific and EU values. Table 2.20 contains the values for appraisal purposes; Table 2.21 contains the behavioural values for modelling purposes. The reader may observe that the movement of working and non-working values are not strictly correlated between countries - this should not be a cause of concern since working and non-working values depend on different causal factors, the former on time/money preferences and the wage rate, the latter on preferences only.

Table 2.20

EUNET WP4 Appraisal Values of Time

per hour at 1995 prices and values

	AUS	BEL	DEN	FIN	FRA	GER	GRE	IRE	ITA	NRL	POR	SPA	SWE	UK	EU Equity
	ecu	ecu	ecu	ecu	ecu	ecu	ecu	ecu	ecu	ecu	ecu	ecu	ecu	ecu	ecu
General values of time															
non-working time	3.5	3.6	3.7	2.4	5.0	5.3	3.1	4.3	5.3	5.3	3.2	3.2	3.8	3.9	4.5
Mode-specific values of time															
car															
- working occupant	14.6	18.2	21.8	23.0	21.3	20.7	12.9	14.0	15.0	21.4	6.3	13.6	17.7	16.8	17.8
bus and coach															
- driver	9.6	11.9	14.3	15.1	13.9	13.5	8.4	9.2	9.8	14.0	4.1	8.9	9.5	13.0	12.0
- working passenger	10.3	12.9	15.4	16.3	15.1	14.6	9.1	9.9	10.6	15.2	4.5	9.6	10.3	14.1	12.9
rail															
- working passenger (SWE basis)	9.6	12.0	14.3	15.2	14.0	13.6	8.5	9.2	9.8	14.1	4.2	9.0	11.7	11.1	11.7
- working passenger (UK basis)	18.6	23.2	27.8	29.4	27.1	26.4	16.4	17.8	19.1	27.4	8.1	17.4	22.6	21.4	22.7
air															
- average passenger (FRA basis)	31.1	38.8	46.5	49.2	45.4	44.1	27.5	29.9	32.0	45.8	13.5	29.1	37.9	35.9	37.7
freight															
- drivers' wage value	20.2	21.2	21.6	18.9	31.3	30.4	18.9	20.6	17.0	31.5	7.7	13.3	19.1	18.4	23.0
- freight user value (lorry)	1.6	1.9	2.3	2.5	2.3	2.2	1.4	1.5	1.6	2.3	0.7	1.5	1.9	1.8	1.9
- freight user value (truck - articulated)	6.5	8.1	9.7	10.3	9.5	9.2	5.7	6.2	6.7	9.6	2.8	6.1	7.9	7.5	7.9

Table 2.21
EUNET WP4 Behavioural Values of Time

per hour at 1995 prices and values

	AUS	BEL	DEN	FIN	FRA	GER	GRE	IRE	ITA	NRL	POR	SPA	SWE	UK
	ecu	ecu	ecu	ecu	ecu	ecu	ecu	ecu	ecu	ecu	ecu	ecu	ecu	ecu
Mode-specific values of time														
car														
- working occupant	15.2	18.8	22.8	23.9	22.1	21.4	13.3	14.5	15.4	22.1	6.6	13.9	18.3	17.5
- commuting occupant	5.0	4.9	6.3	3.4	7.2	7.4	4.3	6.0	7.4	7.2	4.6	4.4	4.7	5.6
- other occupant	3.7	3.6	3.8	2.5	5.3	5.5	3.1	4.4	5.4	5.6	3.4	3.2	4.0	4.1
bus and coach														
- driver	10.0	12.3	14.9	15.6	14.5	14.0	8.7	9.5	10.1	14.5	4.3	9.1	9.8	13.6
- working passenger	10.8	13.3	16.2	16.9	15.7	15.2	9.5	10.3	10.9	15.7	4.7	9.9	10.6	14.7
- non-working passenger (bus)	2.6	2.6	2.8	1.8	3.8	3.9	2.3	3.2	3.9	3.9	2.4	2.3	2.8	3.0
- non-working passenger (coach)	4.0	3.9	4.2	2.7	5.7	5.9	3.4	4.8	5.9	5.9	3.6	3.5	4.1	4.5
rail														
- working passenger (SWE basis)	10.0	12.4	15.0	15.7	14.6	14.1	8.8	9.5	10.2	14.6	4.3	9.2	12.0	11.5
- working passenger (UK basis)	19.4	24.0	29.1	30.5	28.2	27.3	17.0	18.5	19.7	28.2	8.4	17.8	23.3	22.4
air														
- average passenger (FRA basis)	32.5	40.1	48.7	51.0	47.3	45.7	28.5	30.9	32.9	47.3	14.1	29.8	39.0	37.4
freight														
- drivers' wage value	23.4	23.7	25.2	21.4	35.8	34.2	21.4	23.2	18.9	35.2	8.8	14.4	21.2	21.2
- freight user value (lorry)	1.8	2.2	2.7	2.8	2.6	2.5	1.6	1.7	1.8	2.6	0.8	1.6	2.1	2.1
- freight user value (truck - articulated)	7.5	9.0	11.3	11.6	10.8	10.4	6.5	7.0	7.4	10.6	3.2	6.6	8.7	8.6

3. Vehicle Operating Costs

3.1 Current Appraisal Practice

3.1.1 Approaches to VOCs vary widely. A number of highly specialised models have been developed relating VOCs (variously disaggregated) to speed and distance travelled, gradients, etc. Nevertheless, averaged values are in use in Denmark (road appraisal) and the Netherlands (public transport appraisal), where the appraisal may be required for small schemes and in the early stages of appraisal when the resource requirements of an appraisal are a consideration.

3.2 Definition and Measurement

3.2.1 See Main Text, Section 3.3.

4. Safety

4.1 Introduction and Overview

4.1.1 By comparison with many of the environmental and socio-economic effects of transport infrastructure, there is some consistency in the handling of safety impacts across the Member States. This is particularly true of roads, where all member states apply monetary values and include safety within the Cost-Benefit Analysis, and where countries use similar impact classifications. The magnitude of the values does however vary dramatically. This has been noted by previous studies (see eg. the DRIVE EVA Manual (EVA Consortium, 1991) or the EURET Roads study (CEC 1994a)). As discussed in the Framework (Main Text, Chapter 2), we wish to adjust values as far as possible to offset discrepancies between countries in terms of *definitions* and *measurement* of safety impact. These issues are analysed below, with a view to recommending a common approach for EUNET.

4.1.2 Appraisal for other modes is formalised in fewer countries. Those elements of road safety evaluation which relate to the cost of human casualties (rather than to material damage) have in some frameworks been transferred from road appraisal to rail or more broadly to ‘all modes’ (CRs: France, Germany and Spain). However, the nature and amount of material damage is altogether more mode-specific and there are some particular values here for rail. See Section 4.6.

4.1.3 No distinction is drawn in the national appraisal methods between values for economic appraisal and values for financial appraisal. Neither are behavioural values provided for input to forecasting models, reflecting the widespread omission of safety when modelling transport user behaviour. We therefore necessarily limit ourselves to an analysis of economic appraisal values for the various components of safety impacts.

Components of Total Accident Costs

4.1.4 Safety impacts are taken into account in CBA by applying ‘accident cost’ values to the forecasts of future accidents with and without the project. The common approach in Europe is to think about accident costs as a combination of items, some of which are resource costs incurred by society as a consequence of the accident (emergency services, medical aid, material damage, etc), some of which represent a part of the individual’s expected contribution to production which is no longer possible due to their injuries (ie. lost output) and some of which represents the individual’s personal loss of welfare (or ‘human costs’). These human costs are sometimes characterised as ‘pain, grief and suffering’.

4.1.5 A more specific list of accident cost items identified within the national appraisal methods would be:

- material damage - damage to property (vehicles, their contents, pedestrians and cyclists' property, buildings and street furniture, etc - also engineers/ assessors' fees);
- emergency services - police, fire and ambulances;
- legal and court costs;
- insurance administration;
- medical costs (including hospital treatment);
- lost economic output;
- welfare loss (consumption);
- reductions in leisure time;
- willingness to pay to reduce risk; and
- human costs including pain, grief and suffering.

4.1.6 If this list were used as the basis for an appraisal value, there would be extensive double-counting. A proper rationale is needed, including *definitions* and *measures*, and this must be capable of being used along with the available national values to generate a value set for EUNET. Proposals on this are made in Section 4.2 below.

Accident Classifications

4.1.7 Since an important consequence of many transport accidents is the human casualties which result, accidents tend to be classified according to the severity of the worst casualty (with fatalities as the worst form of casualty). Even where this is not the case, and the accidents themselves are not classified, the casualties usually are.

Table 4.1: Severity classifications used for road accidents

	AUS	BEL	DEN	FIN	FRA	GER	GRE	IRE	ITA	NRL	POR	SPA	SWE	UK
Fatality	?	✓	✓	✓	✓	✓	✓	✓	?	✓	✓	✓	✓	✓
Injury/Personal Injury	?	×	×	×	×	×	✓	×	?	×	×	✓	×	×
Permanent	?	×	×	✓	×	×	×	×	?	×	×	×	×	×
Serious/Severe	?	✓	✓	✓	✓	✓	û	✓	?	✓	✓	×	✓	✓
Slight	?	✓	✓	✓	✓	✓	û	✓	?	✓	✓	×	✓	✓
Damage-only	?	✓	×	✓	×	✓	✓	✓	?	✓	×	×	✓	✓
Minor damage	?	×	×	×	×	✓	×	×	?	×	×	×	×	×
Major damage	?	×	×	×	×	✓	×	×	?	×	×	×	×	×

Key: ✓- used in national level roads appraisal, × - not used, ? - unknown

4.1.8 Table 4.1 shows the severity classifications for road accidents across the member states. Appraisal values for accidents are averages across accidents of a particular severity classification. The usual classification is into fatal, serious, slight and damage-only accidents, although there are some variations, as shown in the Table. There are some differences in the definitions of each category, but we do not have sufficient information to attempt an adjustment of the values on this basis. There have been some moves towards harmonisation. For example, Austria changed its definition of a fatality from ‘death within 3 days’ to ‘death within 30 days’ in 1992 (CR Austria). Broadly speaking, the accident severity categories have the following meaning:

- ‘fatal accident’ - accident involving at least one fatal casualty;
- ‘serious accident’ - accident involving at least one serious casualty but no fatalities;
- ‘slight accident’ - accident involving at least one slight casualty but no serious casualties or fatalities;
- ‘damage-only accident’ - accident involving no casualties.

4.1.9 For the casualties involved:

- ‘fatality’ - death within 30 days for causes arising out of the accident;
- ‘serious injury’ - casualties who require hospital treatment and have lasting injuries, but who do not die within the recording period for a fatality;
- ‘slight injury’ - casualties whose injuries do not require hospital treatment or, if they do, the effects of the injuries quickly subside.

4.1.10 The proposals for safety impact measures accept these definitions as an appropriate basis.

Accident Costs per Casualty vs. Accident Costs per Accident

4.1.11 There is a fundamental difference between accident cost values expressed ‘per casualty’ and those expressed ‘per accident’ since accidents may involve multiple casualties. Since the member states take differing approaches in this respect, care is needed in comparing values. To highlight the difference, Table 4.2 illustrates how the number of accidents and the number of casualties are related for the UK in 1994.

Table 4.2: UK Injury Accidents (Road) and Casualties per Accident, 1994

Accident Severity	Number of Accidents	Casualties per accident:		
		Fatal	Serious	Slight
Fatal	3,326	1.10	0.47	0.57
Serious	39,286	0	1.44	0.40
Slight	191,489	0	0	1.29

Source: based on Road Accidents Great Britain: 1994 - The Casualty Report, Department of Transport, HMSO, London.

Estimation methods

4.1.12 Estimation techniques differ between accident cost items and between countries. In some cases the values are not estimated at all, but are chosen politically - eg. allowance for human costs is a political judgement in Sweden. See Sections 4.3-6.

4.2 Total Accident Costs

Definition and Measures

4.2.1 Total accident costs are believed to consist of two groups of costs:

- casualty-related costs - those costs which vary with the number of casualties involved in the accident; and
- accident-related costs - other costs, which are taken as an average per accident

4.2.2 Taking the list of individual components in 4.1.5 and eliminating those which are double-counted, it is proposed that total accident costs consist of the following items:

- material damage*
- police and fire services*
- insurance administration*
- legal and court costs*
- delays to other passengers and freight*
- medical and healthcare costs incl. administration
- lost output
- human costs - pain, grief and suffering.

4.2.2 Those marked * are treated as accident-related (ie. cost varies proportionately with the number of accidents) whilst the remainder are casualty-related. This means that in order to calculate the safety impact of a project or policy in monetary terms, forecasts of both the number of accidents and the number of casualties are required, as well as the corresponding values. Since the forecasts arising from the EUNET model (WP6) are for accidents only, some assumptions and/or average data about the relationship between accidents and casualties will be required (see separate memorandum to ME&P).

4.2.3 Following the common European practice described in the Introduction, casualties will be categorised as fatal, serious or slight. Accidents will be categorised as fatal, serious, slight or damage-only, according to the nature of the most severe casualty involved. Thus a ‘fatal accident’ may involve not only one or more fatalities, but also a number of serious and slight injuries so that the total accident costs incurred are the sum of multiples of four different values: the accident-related cost of a fatal accident, $c_{acc(FAT)}$, the casualty-related cost of a fatality, c_{fat}, the casualty-related cost of a serious injury, c_{ser} and the casualty-related cost of a slight injury, c_{sli}.

4.2.4 The total cost of a fatal accident is given by:

$$c_{FAT} = c_{acc(FAT)} + \left(\frac{n_{fat}}{n_{FAT}} \times c_{fat}\right) + \left(\frac{n_{ser(FAT)}}{n_{FAT}} \times c_{ser}\right) + \left(\frac{n_{sli(FAT)}}{n_{FAT}} \times c_{sli}\right) \qquad (1)$$

where c are the values and n are the numbers of accidents or casualties in the dataset.

In the subscripts, capital letters indicate accident categories (ie. fatal) while lower-case letters indicate categories of casualty (or cost), so that:

c_{FAT} - total cost of a fatal accident,

c_{fat} - casualty-related cost of a fatality,

$c_{acc(FAT)}$ - accident-related cost of a fatal accident,

n_{FAT} - total number of fatal accidents (in the dataset),

n_{fat} - total number of fatal casualties,

$n_{ser(FAT)}$ - number of serious casualties in fatal accidents, and

$n_{sli(FAT)}$ - number of slight casualties in fatal accidents.

Note that this assumes that the slight and serious injuries suffered in fatal accidents exhibit the same distribution of severities as in accidents in general.

Note also that we are abstracting from the modal issue for the moment.

4.2.5 Given forecasts of accidents and casualties, the total accident cost for a given appraisal scenario would be calculated as follows:

$$TC = \begin{array}{l}(c_{acc(FAT)} \times n_{FAT}) + (c_{acc(SER)} \times n_{SER}) + (c_{acc(SLI)} \times n_{SLI}) + (c_{acc(DAM)} \times n_{DAM}) \\ +(c_{fat} \times n_{fat}) + (c_{ser} \times n_{ser}) + (c_{sli} \times n_{sli})\end{array}$$

Again we abstract from the modal issue.

4.2.6 However, a complication with accident-related (rather than casualty-related) costs is that these will vary (dramatically according to the evidence of the Country Reports) between modes. The multi-modal total accident cost for a particular appraisal scenario would then be:

$$TC = \begin{array}{l}\sum_{k=1}^{K}\Big[(c_{acc(FAT)k} \times n_{FATk}) + (c_{acc(SER)k} \times n_{SERk}) + (c_{acc(SLI)k} \times n_{SLIk}) \\ +(c_{acc(DAM)k} \times n_{DAMk})\Big] + (c_{fat} \times n_{fat}) + (c_{ser} \times n_{ser}) + (c_{sli} \times n_{sli})\end{array}$$

where $c_{acc(FAT)k}$ is the accident-related cost of a fatal accident on mode k, and there are K different modes.

4.3 Fatalities

Definition

4.3.1 The casualty cost per fatality, or 'value of a statistical life', irrespective of mode, is given by (drawing on Persson and Ödegaard, 1995 and Hopkin and Simpson, 1995):

$$c_{fat} = c_h + c_l + c_m + c_a$$

where

c_{fat} - casualty-related cost per fatality

c_h - human costs - pain, grief and suffering

c_l - gross lost output, comprising:

c_{lc} - lost consumption, and

c_{ln} - net lost output

c_m - medical costs

c_a - other casualty-related costs, potentially incl. some administration

4.3.2 Human costs or 'pure human value', c_h, are non-resource costs. They represent those negative effects such as physical pain or loss of ability to communicate which go beyond the lost consumption of goods and services, and which are often characterised in appraisal as 'moral damages' or 'pain, grief and suffering'. As it is difficult to define what exactly these human costs consist of, the approach to estimating them empirically tends to involve a process of elimination, starting with a total willingness to pay for changes in the risk of injury or death, and then deducting the other more tangible components (usually changes in consumption - see below).

4.3.3 Gross lost output, c_l, is the contribution which the casualty would have made to future production had the accident not occurred. A proportion of the value of this production would have been returned to the individual as income, and he/she would then have spent a proportion of this on goods and services - lost consumption, c_{lc}. The remainder is treated as net output, c_{ln}, and is also valued in appraisal.

4.3.4 Medical costs, c_m, include ambulances to transport casualties from the scene of the accident and all subsequent health and care services.

4.3.5 The component c_a, 'other casualty related costs', captures any remaining items which are casualty-related rather than accident related. Given the conclusions on composition of accident-related costs (Section 4.6), this is a very small category.

Estimation Methods

4.3.6 Empirical work on the value of a statistical life makes use of a range of data including:

- health and emergency service cost data
- responses to Willingness to Pay (WTP)/Contingent Valuation Method (CVM) surveys on aversion to risk of death
- output/income data
- insurance claim data

4.3.7 WTP work is regarded as state of the art in terms of two of the cost items. In terms of equation (1), the outcome of a WTP valuation is a measure for the individual of the human costs (c_h) plus lost consumption (c_{lc}). However, in a paternalistic altruistic society, society's willingness to pay is 1.1 to 1.4 times the individual's. This total WTP is what is relevant to project appraisal.

Social willingness to pay, $c_{wtp} = c_h + c_{lc}$

4.3.8 Estimates of net lost output, medical costs and any casualty-related administration costs must then be added. Net lost output can be assessed by looking at lifetime earnings and making an assumption about the percentage of net lost output in gross lost output. COST 313 (CEC Expert Group, 1994) observes that:

$$c_{ln} = 0.2c_l$$

4.3.9 For example, in the UK data on c_l is obtained from current incomes data, activity rates, future economic growth predictions and life expectancy forecasts (Hopkin and Simpson, 1995). Material costs must be derived from fieldwork.

Values

4.3.10 Existing appraisal values relating to fatal casualties in road accidents fall into three groups:

- casualty cost per fatality (ie. c_{fat})
- total cost per fatality (ie. c_{fat} *plus* a share of accident-related costs); or
- total cost per fatal road accident (including costs associated with multiple casualties, *plus* accident-related costs $c_{acc(FAT)}$ - see Equation (1) in 4.2.4)

4.3.11 Table 4.3 overleaf (rows 1 to 3) shows the values given for each member state in units of national currency. Table 4.4 on the following sheet shows these values uplifted from their respective Base Years to 1994 prices using the Eurostat Consumer Prices General Index and converted to ecus at the European Commission's published Official Annual Exchange Rates.

Table 4.3: Current Appraisal Values for Road Accidents and Casualties

Country	**AUS**	**BEL**	**DEN**	**FIN**	**FRA**	**GER**	**GRE**	**IRE**	**ITA**	**NRL**	**POR**	**SPA**	**SWE**	**UK**
Currency, 000s	Sch	BFr	Kr	Mkk	F	DM	drs	IR£	L	Gld	Esc	Pta	Kr	£
Fatalities														
casualty cost per fatality	18,801	14,262		7,800	3,700	1,320	30,000	750					14,200	784
total cost per fatality			5,227							231	7,161	10,589		
Fatal accidents														
total cost per fatal road accident				9,100										913
Serious injuries														
casualty cost per serious injury		2,209		84	381	60							2,600	89
total cost per serious injury			214							84	2,866			
Serious accidents														
total cost per serious road accident														108
Slight injuries														
casualty cost per slight injury				19	81	5							150	7
total cost per slight injury			44							47	719			
Slight accidents														
total cost per slight road accident														11
Injuries														
casualty cost per injury				146			3,000	25						28
total cost per injury												3,180		
Injury accidents														
total cost per injury road accident				975										40
Damage/accident-related costs														
per average accident		430											13	1.11
per injury accident		430												1.98
per fatal accident														7.07
per serious accident (major damage)						35								2.95
per slight accident (minor damage)						6								1.69
per vehicle involved per average accident							650							
Damage only accidents														
cost per accident		430		47				2		4				1.05
Base Year for Value	1994	1993	1992	1995	1994	1989	1992	1994		1992	1996	1994	1998**	1994
Notes	(6)			(7)	(1)	(2)	(3)			(4)			(5)	

Table 4.4: Current Appraisal Values for Road Accidents and Casualties, 1994 ecus

Country	**AUS**	**BEL**	**DEN**	**FIN**	**FRA**	**GER**	**GRE**	**IRE**	**ITA**	**NRL**	**POR**	**SPA**	**SWE**	**UK**
Fatalities														
casualty cost per fatality	1,389	368		1,214	562	789	132	945					1,643	1,010
total cost per fatality			716							113	34	67		
Fatal accidents														
total cost per fatal road accident				1,416										1,177
Serious injuries														
casualty cost per serious injury		57		13	58	36							301	115
total cost per serious injury			29							41	14			
Serious accidents														
total cost per serious road accident														139
Slight injuries														
casualty cost per slight injury				3.0	12.3	3.1							17.4	8.9
total cost per slight injury			6.0							22.9	3.4			
Slight accidents														
total cost per slight road accident														13.7
Injuries														
casualty cost per injury				23			13	31						36
total cost per injury												20		
Injury accidents														
total cost per injury road accident				152										51
Damage/accident-related costs														
per average accident		11.1											1.5	1.4
per injury accident		11.1												2.6
per fatal accident														9.1
per serious accident (major damage)						21.1								3.8
per slight accident (minor damage)						3.6								2.2
per vehicle involved per average accident							2.9							
Damage only accidents														
cost per accident		11.1		7.2				1.9		1.9				1.4
Base Year for Value	1994	1993	1992	1995	1994	1989	1992	1994		1992	1996	1994	1998**	1994
Notes	(6)			(7)	(1)	(2)	(3)			(4)			(5)	

4.3.12 For three countries, we also have information about the composition the value per casualty, which is summarised in Table 4.5. In compiling this table, account has been taken of the different basis of the Danish value, which includes a share of accident-related costs. Given the ratio of accident-related costs per fatal accident to casualty-related costs per fatality for Belgium/Finland/Germany/Ireland/Netherlands/Sweden/UK, a proportion (estimated at 1.4%) of the Danish ‘total cost per fatality’ value is deducted to obtain ‘casualty cost per fatality’.

Table 4.5: Composition of Fatality Values (Casualty-Related Costs)

Fatality UK	Fatality DEN	Fatality SWE	Cost Category		
65%	68%	92% {	c_h		- human costs
35%	32% {		c_l	c_{lc}	- lost consumption
		8% {		c_{ln}	- net lost output
0.07%			c_m		- medical & healthcare costs
-			c_a		- other casualty-related costs

4.3.13 Whilst the above is clearly a small sample, it is reassuring that the relationships between the four components appear to be broadly consistent between the three countries, and also with the relationship observed in COST 313 (see 4.3.8). For countries where particular components are known to be missing from the definition, if it is assumed that the relativities remain stable then the above proportions can be used to adjust values to a consistent definition.

4.3.14 Adjustments to the uplifted-converted values are outlined in Table 4.6 overleaf.

4.3.15 The final proposed EUNET values are given in Table 4.12 at the end of this Chapter.

Table 4.6: Proposed Adjustments to National Values

Country	Definitions/ measures consistent?	Comments
AUS	✓	no basis for changing the value
BEL	✓	no basis for changing the value
DEN	×	need to extract the accident-related costs as above, but note that this makes very little difference (+/- 1.5%) to the fatality value
FIN	✓	no basis for changing the casualty costs
FRA	✓	no basis for changing the value
GER	✓	no basis for changing the value
GRE	×	includes lost output and medical costs - add on an allowance for human costs (~66% of casualty costs)
IRL	✓	no basis for changing the value
NRL	×	need to extract the accident-related costs; need to add an allowance for human costs (~66% of casualty costs)
POR	×	extract accident-related costs and add an allowance for c_h+c_{ln} - these are unlikely to be compensated by the insurance company - (~92% of casualty costs)
SPA	×	as Portugal
SWE	✓	clear WTP basis
UK	✓	WTP basis

4.4 Serious Injuries

4.4.1 Having reviewed the Country Reports and other data, inconsistencies of definition are too severe to make detailed use of the national values, where these are provided. Instead, the variation in the final fatality values derived in 4.3 is used in conjunction with the UK Serious Injury value (which fits the definition given in 4.1.8) to give a set of casualty-related costs for Serious casualties. The values are shown in Table 4.12.

4.5 Slight Injuries

4.5.1 The same approach was taken as for Serious Casualties.

4.6 Accident-Related Costs

Definition

4.6.1 There are some discrepancies between different member states' definitions of accident-related costs - see Table 4.7.

Table 4.7: Composition of Accident-Related Costs

Country	Accident related costs per...	Material damage	Police and fire	Insurance admin	Delays to traffic	Legal and court
Belgium	- accident	ü	ü	ü		ü
Finland	- damage only accident	ü	û			
Germany	- major/minor damage - urban/rural/BAB roads/rail	ü	ü	ü		ü
Greece	- vehicle involved - 1.68 vehicles per accident	ü	û	û	û	û
Ireland	- damage only	ü	ü	ü	û	û
Netherlands	- damage only	ü	ü			ü
Sweden*	- accident	ü		û		
UK	- fatal/serious/slight/Personal Injury/ /damage only/average accident	ü	ü	ü	û	û

Note: * material damage (Sweden) includes damage to vehicles

4.6.2 All these countries include material damage. This is by far the largest item where the costs are itemised (ie. in the UK), indeed it accounts for approximately 90% of costs. However, the UK omits legal costs, which some countries include. Those which do - Belgium, Germany - have notably higher accident-related costs for injury accidents.

4.6.3 Evidence on the ratio of serious to slight accidents includes that for Germany and the UK given in the tables below and, for Greece, a share of 80% light to 20% heavy injuries.

Table 4.8: Germany - Share of Casualties, %, 1989

Severity	Urban	Rural	BAB
Fatal	0.9	3.2	2.3
Serious	19.7	31.4	21.2
Slight	79.4	65.4	76.5

Table 4.9: UK Accidents, 1994

Severity	Number
Fatal	3,326
Serious	39,286
Slight	191,486

4.6.4 Given this evidence, we assume that the average cost of serious and slight accidents = (0.2*cost of serious accident)+(0.8*cost of slight accident). This implies that for Germany:

= (0.2*18)+(0.8*3.6) kecu

= 6.5 kecu (1994 prices)

4.6.5 For Belgium, average injury accident cost = 11.1kecu (1994 prices).

4.6.6 For Greece, average accident cost (given 1.68 vehicles per accident) = 5 kecu.

4.6.7 Given the above, let average values on a common definition for Belgium/Finland/Germany/Ireland/Netherlands/Sweden/UK be:

Table 4.10: Accident-Related Costs, Mean Value for Selected Countries

$c_{acc(INJ)}$ =	6 kecu
$c_{acc(FAT)}$ =	15 kecu
$c_{acc(SER)}$ =	10 kecu
$c_{acc(SLI)}$ =	5 kecu
$c_{acc(DAM)}$ =	2 kecu

4.6.8 The definition is c_{acc} = material damage, police and fire, insurance administration, legal and court costs. We will exclude delays to other traffic because nobody considers it - but note this could be another component. Depends whether VOC figures incorporate an average number of accidents and affect on traffic speeds. Value of expected vs. unexpected delays.

Accident-related costs on other modes

4.6.9 There is a modal issue, which is that accident-related costs need not be the same across transport modes. It is also suggested in the French appraisal method that the casualty-related costs of transport accidents on collective modes of transport (eg. railways and air services) differ *per casualty* from those on individual modes (eg. roads).

4.6.10 In Germany, casualty values (DM/person) are common between road and rail (by deduction - CR Germany Tables 3.1,3.2,3.16). Accident-related costs differ between ‘major damage’ and ‘minor damage’ for road. For rail they average within 0.01% of the road (major damage) figure, but as they are derived from damage statistics produced by the Federal Railways this must be coincidental. For inland waterways, improvements can contribute to safety (eg. realignment of curves or improved access to locks). However, in general the impact of waterway investments on waterway safety is low. The benefits are reflected in savings in insurance costs (unspecified).

4.6.11 In Sweden, road and rail casualty costs are the same, whilst damage costs differ explicitly (13,000SKT per road accident or 90,000SKT per rail accident).

4.6.12 In France, casualty values are common across modes, but a balancing weight of 15 is applied where the number of passengers is greater than 8, because it is thought necessary for collective modes to be safer than individual modes.

4.6.13 For EUNET, a common basis is needed for evaluating rail accidents. We therefore make use of the Swedish and German information on accident-related costs.

Table 4.11: Accident-related costs for railways

	Germany		**Sweden**	
	c_{acc}, DM/accident	$c_{acc\ rail}$ as a % of $c_{acc\ road}$	c_{acc}, SK/accident	$c_{acc\ rail}$ as a % of $c_{acc\ road}$
Road			13000	
- minor damage	5900			
- major damage	30100			
- est. average*	8320			
Rail	35298	600% / 120% / 420%	90000	690%

* Accidents involving only minor damage are excluded from the calculation of accident cost in the German appraisal system, even though a value is given in CR Germany. No rates are given for minor damage accidents.
Based on an assumption that 10% of accidents involve major damage, an average value for accident-related costs in a German road accident would be as shown.

4.6.14 For Germany, the ratios 600% and 120% represent the limits to the possible range of accident-related costs for rail vs. accident-related costs for road. Assuming that there are many more road accidents involving minor damage than major damage (see table), an average ratio closer to 600% than to 120% is obtained. Considering both the German and the Swedish evidence, we take a ratio of 500% as a rule of thumb.

4.7 Summary of Values

4.7.1 Table 4.12 summarises the values recommended for Safety impacts, both the accident-related cost and casualty-related cost components, in the common EUNET base year of 1995 prices and values.

Table 4.12: Proposed Values for Safety Impacts, 000s ecu (1995 prices and values)

	Casualty-related costs: (human costs, lost output, medical and support services)			Accident-related costs (Road): (material damage, police and fire, insurance administration, legal and court costs)				Accident-related costs (Rail): (components as for Road)	
	Fatal, c_{fat}	Serious, c_{ser}	Slight, c_{sli}	Fatal, $c_{acc(FAT)}$	Serious, $c_{acc(SER)}$	Slight, $c_{acc(SLI)}$	Damage-only $c_{acc(DAM)}$	Injury $c_{acc(INJ)\ rail}$	Damage-only $c_{acc(DAM)\ rail}$
Country specific values									
AUS	1,459	172	13.3	25.0	16.7	8.3	3.3	50	17
BEL	384	45	3.5	6.6	4.4	2.2	0.9	13	4
DEN	741	87	6.8	12.7	8.5	4.2	1.7	25	8
FIN	1,329	156	12.1	22.8	15.2	7.6	3.0	46	15
FRA	577	68	5.3	9.9	6.6	3.3	1.3	20	7
GER	828	97	7.5	14.2	9.5	4.7	1.9	28	9
GRE	410	48	3.7	7.0	4.7	2.3	0.9	14	5
IRE	942	111	8.6	16.2	10.8	5.4	2.2	32	11
ITA	-	-	-	-	-	-	-	-	-
NRL	310	37	2.8	5.3	3.5	1.8	0.7	11	4
POR	352	41	3.2	6.0	4.0	2.0	0.8	12	4
SPA	676	80	6.2	11.6	7.7	3.9	1.5	23	8
SWE	1,660	195	15.1	28.5	19.0	9.5	3.8	57	19
UK	978	115	8.9	16.8	11.2	5.6	2.2	34	11
European values									
EU	770	91	7.0	13.2	8.8	4.4	1.8	26	9

5. Investment Costs

5.1 Current European Practice

5.1.1 The Appeal for Information identified three components within the group of what may be termed ‘investment’ or ‘capital’ costs:

- construction costs;
- disruption costs; and
- land and property costs.

5.1.2 Construction typically includes materials, labour, energy, preparation, professional fees and contingencies, although there are some variations in practice. For example, the Dutch CBA specifically excludes preparation costs. The justification for doing so is that these vary too little to be useful in choosing between projects (CR: Netherlands). The Belgian CBA places a zero shadow price on labour, given a very high rate of unemployment in the construction sector, with the result that total scheme costs are reduced on average by 40% for road schemes and 35% for waterways projects (CR: Belgium).

5.1.3 Disruption costs are specifically included in only three countries. In the UK, the QUADRO program forecasts and evaluates delays due to maintenance and construction: values are consistent with those in the COBA cost-benefit program for inter-urban roads (CR: UK). The Belgian approach is particularly interesting since standard congestion costs from construction are given, based on certain assumptions.

Table 5.1: Belgian Congestion Costs of Construction

Type of Road	Cost, francs per month per km at 1981 prices
2 lane single carriageway	480,000
3 lane single carriageway	800,000
4 lane single carriageway	1,280,000
4 lane dual carriageway	2,168,000
2x2 lane motorway	3,056,400
3x2 lane motorway	3,024,000

Source: CR:Belgium

5.1.4 The assumptions underlying the above are that:

- the work continuously blocks one lane;
- traffic flow composition is equal to the national average;
- capacity is reduced by a half;
- the normal values of time apply.

5.1.5 Land and property are included and costed in most countries. Values per unit length may be standardised by mode and land use classification, as has been done in Finland. In Denmark, Sweden and the UK, values relevant to compensation payments are determined by an official valuer, who takes into account primarily the property's market value, although also some measure of its underlying worth (especially in cases where the market has been affected by knowledge of the infrastructure proposal).

5.2 Definition

5.2.1 For EUNET, it is proposed that the uniform definition of investment costs should include the following items, all at resource cost:

- planning costs - including the design costs, planning authority resources and other costs incurred *after* the decision to go ahead;
- land and property costs - including the cost of acquiring land needed for the scheme (and any associated properties), compensation payments necessary under national laws and the related transactions and legal costs;
- construction costs - including materials, labour, energy, preparation, professional fees and contingencies;
- disruption costs - the disruption to existing users to be estimated using the same values of time as are used for travel time savings arising from the scheme.

5.2.2 Environmental impact mitigation measures should be included in the project design and costed accordingly as part of the investment costs, taking into account the planning, land and property, construction and disruption costs as with any other investment cost. The environmental impact of the project in its completed form with these measures in place should then be included in the 'local environment' and 'strategic environment' sections of the appraisal. This will avoid any possible double counting of environmental costs or of mitigation benefits.

5.2.3 The costs of finance are not relevant to the investment cost item in CBA as these are taken into account through the discounting procedure, although in principle any financial administration costs should be included. It is suggested that any such costs falling on the finance provider be seen as being absorbed within the discount rate (analogous to the Annual Percentage Rate concept in the personal finance sector), whilst costs falling on the scheme planner should be included in the planning costs component.

5.2.4 In the interests of consistency between appraisals, localised shadow pricing for unemployment will not be allowed. There is insufficient agreement on the appropriate basis for shadow pricing labour to justify making any firm proposal on this.

5.3 Measures

5.3.1 Investment cost will be measured in ecu per year for each project. Where possible, an investment profile should be given indicating a definite start year for which the price base applies, and detailing how the flow of investment will vary in each year of the investment period.

5.3.2 Where such detailed information is not available, the preferred alternative is for the user of the assessment tool to supply just the total investment cost consistent with the above definition and length of investment period. The software would then distribute the cost over time based on an assumed standard investment profile.

5.3.3 If no investment cost estimate is available, defaults may be available from WP3.

6. System Operating and Maintenance Costs

6.1 Current European Practice

6.1.1 Standardised - or partially standardised - approaches to system operating (henceforth 'sysop') and maintenance costs are in use in some countries. For example, the non-traffic related component of road sysop/maintenance costs in the UK is calculated for scheme appraisals using a standard table of charges where local data is unavailable. These non-traffic related components include drainage, street lighting and road markings, amongst others.

Table 6.1: UK Standard Road Sysop/Maintenance Costs

ROAD MAINTENANCE TYPE	1	2	3	4	5	6
Carriageway Standard	S2	D2	D3	D2M	D3M	D4M
Non-Traffic Related Cost (£/km)	6000	8500	10500	14000	16000	16000

Source: Design Manual for Roads & Bridges Volume 13 (Dept. of Transport)

6.1.2 Standard Finnish maintenance and sysop costs are available for road and rail modes.

Table 6.2: Finnish Standard Road and Rail Sysop/Maintenance Costs

Cost Item	Road	Rail
Average maintenance costs, FIM per line km	21,000	78,000
Operating costs, FIM per train km	-	5

Source: CR:Finland

6.1.3 In Sweden, maintenance/sysop costs are integrated with operating costs for rail appraisals, giving an overall 'total train operating cost' variable with time-related and distance-related elements (ie. cost per passenger/tonne minute and cost per passenger/tonne km).

6.2 Definition and Measures

6.2.1 It is important for EUNET that figures for operating and maintenance costs associated with both the infrastructure and the vehicles which use it are available for all modes, so that the appraisal is comprehensive and consistent across modes. The individual components of system operating and maintenance costs vary across modes. The reader is referred to Work Package 3 Deliverable D6 (PLANCO, 1997) for further information.

6.2.2 A particular point made by the WP3 team is that in the appraisal, non-traffic related sysop/maintenance costs will only be required for parts of the network which are changed by the project. Other parts of the network will by definition experience identical non-traffic related costs in the Do-Something and Do-Minimum scenarios.

7. Fares, Tolls, Revenue and Private Financing Attractiveness

7.1 Overview

7.1.1 The group of effects under discussion here all relate back in one way or another to the levying of user charges as defined in the Main Text (Section 3.7). By *fares*, we mean charges for the use of a passenger transport service. By *tolls*, we mean charges for access to road infrastructure. We could add *track access charges* for access to rail lines, *landing fees* for access to airports, and *port and harbour dues* for access to shipping berths. For freight, we could add the unit *tariffs* paid by end customers.

7.1.2 *Revenue* is the same set of charges seen from the perspective of the recipient. Private financing attractiveness - a concept under discussion within Work Package 1 - is a more complex variable which relates the stream of revenues obtainable from a particular project to the private costs to a potential promoter giving a net indicator of the scope for profit.

7.2 Current European Practice

7.2.1 As a first observation, roads appraisal generally omits these effects, since the majority of roads appraised have historically been free at the point of use. However, one individual toll road project appraisal was included within the Country Reports: the A22-A31 Highways Linkage Appraisal Study, Italy (CR: Italy Annex 1) whose objective was to select the best layout from five alternatives. The appraisal was a cost-benefit analysis, which included forecast revenues both for existing traffic diverted to the toll road and for generated traffic. Two growth scenarios were tested, with high or low growth assumptions on the key socio-economic variables. Tariffs were set to equalise generalised costs between the tolled and un-tolled routes. The revenues were estimated at 1,129 billion lira in the low growth or 1,314 billion lira in the high growth scenario (1991 liras over 30 years from 2002).

7.2.2 The German Federal Transport Infrastructure Plan appraisal method excludes revenues (and tolls, fares, etc) for all modes (PLANCO et al, 1993). This approach reflects the appraisal principle that resource costs should be used throughout, without any adaptation to show financial flows which cancel out between groups (users and operators, for example) in the appraisal.

7.2.3 Other methods include revenues for public transport and rail freight modes. Specifically, Finland includes public transport revenues in CBA. Illustrative fares are given for bus (Regular/Express) and train (1st/2nd class) per km. In Sweden, revenues appear in rail CBA both for passengers and freight. The calculation for passenger revenue takes average ticket price and multiplies by factors of 1.14 to obtain a representative ‘work trip’ fare and 0.54 for ‘leisure trip’ fare. These fares are multiplied-up by the passenger flow split by trip purpose then added to give total revenue.

7.2.4 Greece has a financial appraisal method for sea port projects (CR:Greece - Additions) in which six forms of revenue are distinguished and calculated. Detailing these highlights what complexity could be involved in taking a full financial approach to project appraisal in addition to the social CBA. The six items are:

- ticket revenues from passenger/ro-ro ferries
- revenues from port services (ie. mooring and steering)
- revenues from other services
- rental on port accommodation
- interest earned on bank deposits
- other - taxes, tariffs, funds received

7.3 Definitions

7.3.1 User charges in general are of interest to the EUNET appraisal, including the cases listed in 7.1, which are:

- tolls on road infrastructure
- fares on passenger transport services
- tariffs on freight services
- track access charges
- landing fees
- port and harbour dues

7.3.2 These may all be identified as forms of one impact - **revenue** - in the CBA framework.

7.3.3 It is proposed to hold the discussion of private financing attractiveness over to Work Package 1, as this is a more complex issue potentially involving a revenue streams over time and comparison with costs.

7.4 Measures

7.4.1 Revenues should be included at market prices net of any indirect taxes and subsidies.

8. Service Quality and Driver Convenience

8.1 Current European Practice

8.1.1 In Austria, an objective of 'quality of transport services' is included in the MCA. The three indicators for this objective are 'traffic flows', 'frequency of services' and 'comfort'. No service quality measures are included in the CBA.

8.1.2 In Greece, 'service level' is measured by 'permitted speed' for roads and by 'permitted speed and the rolling stock' for rail, but not included for other modes. 'Information' is measured by the 'cost of telematic systems' for road and 'cost of operating schedule information tables' for air and rail.

8.1.3 In Sweden, 'service level' is included in roads appraisal. This is a comfort factor of 11SKr/hour for the perceived difference between a gravel surface and an asphalt one, compared with values of time per person per hour for short-distance commuting of 35SKr and for other non-work travel of 26 SKr.

8.1.4 In Spain, studies of the relative perceived comfort of 2nd class versus Intercity trains generated a value of 0.035 ecu per passenger per km in relation to an average value of time of 3.9 ecu per hour. The figure is used in appraisal as an indicator of comfort rather than an absolute value.

8.1.5 None of the appraisal methods reviewed took reliability into account.

8.1.6 An international standard measure of road surface quality is available in the Highway Design and Maintenance Standards Model (HDM), developed by the World Bank. The measure focuses on longitudinal roughness of the surface, which is the most important although not the only element of surface quality. An instrument consisting of a vertically mobile weight attached to a vehicle is used to estimate vertical movement in metres per km of road. The scale goes from 0 to 20, points below 2.7 indicating a very smooth road.

8.2 EUNET Approach

8.2.1 Service quality is a network-wide issue in EUNET - that is, a major transport infrastructure investment is likely to have traffic flow implications across most of the model zones and many of these flow changes will be accompanied by changes in service quality due for example to switching between modes or to changes in routes or to congestion levels on those routes. In order to estimate the net effect of the investment on service quality, a set of consistent and credible service quality indicators would be required across all modes. In general, no such set of indicators is yet available, therefore it is recommended that service quality normally be excluded from the CBA. See Main Text, Section 3.8.

APPENDIX III - TREATMENT OF ENVIRONMENTAL IMPACTS

1. Introduction

1.1 Environmental Impacts - Measurement and Valuation

1.1.1 Appendix IV contains detailed information on the treatment of environmental impacts in EUNET in support of Chapter 4. A circuitous review of past valuation methodologies is avoided, in what is a rapidly-changing area of economics. The focus is on technically up-to-date methodologies reported by EUNET partners and on methods recently developed or still under development within the European Union, including work specifically for the European Commission under the Fourth Framework Programme.

1.1.2 For convenience, we bundle these impacts into five broader groups within this Appendix:

- Chapter 2: Noise and Vibration
- Chapter 3: Air Pollution
- Chapter 4: Landscape and Townscape
- Chapter 5: Land Take and Land Amenity
- Chapter 6: Other Environmental Impacts

2. Noise and Vibration

2.1 Noise

Measurement

2.1.1 There is a fair degree of consensus on the appropriate measure for noise, with the majority of countries using L_{eq} dBA, measured over a variety of periods, normally to reflect daytime and night time noise levels. While the UK uses an L_{10} measure for roads, L_{eq} is used for rail.

2.1.2 Noise bands adopted by member states include the following:

Table 2.1: Bands and Weights Used in Denmark

dBA	Weight
55-60	0.11
60-65	0.22
65-70	0.45
70-75	0.93
>75	1.92

Table 2.2: Bands and Percentage Population Assumed to be Disturbed

France - bands	% disturbed	Finland - bands	% disturbed
55-60	5	55-65	33
60-65	20		
>65	75	65-70	50
		>70	100

2.1.3 The UK methodology for roads uses an estimated relationship between noise and nuisance that shows 20% are bothered very much or quite a lot at 68dBA. There are then discrepancies in the levels of disturbance assumed to occur at different noise levels in different countries. This may reflect variations in sensitivity to noise, but also differences in methodology and age of the data used to derive the relationships.

Modelling Issues

2.1.4 An issue for EUNET is how to forecast noise levels for Trans-European Networks. There are a variety of forecasting models for road traffic noise that could be used. These would normally require information on:

- traffic flow (18hour)
- traffic composition (percentage HGV)
- traffic speed (average)
- road surface
- gradient
- distance from the road.

2.1.5 If this information is available then a method such as the UK Department of Transport, (1988) Calculation of Road Traffic Noise will be appropriate. Otherwise a more simplified approach should be adopted.

Values or Weights

2.1.6 Noise is valued in appraisal in a number of EU countries, see Table 2.3.

Table 2.3: Values of Noise and Derivation Methods

Method	Value
Hedonic Pricing	**Belgium**, a 1dBA change at levels exceeding 50dBA is assumed to cause a reduction in house prices of 0.4 to 0.5%. This has been converted to a value of 0.0996BF per additional car kilometre.
	Denmark, a noise nuisance index is constructed and a 1 unit change in this is valued at 34,300DK.
Disturbance	**Finland**, values disturbance at 5300FIM per year based on assumptions about the economic losses involved.
	Sweden, formula gives a value of 130SEK per dBA, derivation of value unclear.
Avoidance cost	**Germany**, cost of sound absorbing windows
	Spain, 0.002ECU per passenger kilometre is a benefit for rail reflecting diversion from road.

2.1.7 Ideally a value reflecting noise disturbance based on individual willingness to pay derived using stated preference would probably be best, as it would reflect individual valuation and stated preference avoids some of the biases of straightforward willingness to pay studies. At present, such values do not appear to exist for countries in the EU. Experimental work has recently taken place in Edinburgh to establish values for transport related noise nuisance (Wardman et al 1998). However, this gives a value for only one urban area.

2.1.8 An alternative is to consider hedonic pricing. The hedonic pricing values used in Belgium are from studies in the USA. We do have a problem in finding values from European studies, however, a number of hedonic pricing studies have been undertaken in Switzerland. Perkins (1998) has used these hedonic values to produce a willingness to pay per 1 dBA change in noise levels of 20.6ECU per person exposed per year. Our own work in Edinburgh suggested values of, at a lower bound £8.00 per household per year using stated preference techniques.

Noise: Recommendation

2.1.9 There is still a degree of uncertainty over the valuation of noise and a lack of values across the European Union. It therefore seems advisable to include noise in the MCA rather than the CBA (see Main Text, Section 4.2).

2.1.10 Noise mitigation measures included as part of a project should be included in the Investment Costs. The impact of the project should then be assessed with the measures in place (including not only the (reduced) noise impact, but for example any additional Landscape impacts arising from noise mitigating structures).

2.2 Vibration

2.2.1 Very few countries consider vibration as a separate impact in appraisal. There are two forms of vibration, one of which is unlikely to occur on a new piece of infrastructure and the other can normally be proxied by a noise measure.

i) Ground-borne vibration - this form of vibration results from the interplay of the vehicle and the road surface or track. The effect normally arises where there are defects in the road surface, eg potholes and irregularities, so it is unlikely to be feature of new roads. Similarly, old and worn rail lines are more likely to create a problem.

ii) Air-borne vibration, low frequency noise, measurement and treatment as for noise.

2.2.2 The recommendation is to exclude vibration from the EUNET appraisal, except in special circumstances where it is expected to be a significant additional impact, over and above the normal levels of vibration associated with the prevailing levels of noise. In this case, vibration can be included in the MCA.

3. Air Pollution

3.1 Local and Regional Air Pollution

Measurement and Modelling Issues

3.1.1 Forecasts will be required for all the pollutants deemed to have a significant impact on people, the built and natural environment, unless one pollutant is sufficiently closely correlated with the others to allow us to use one pollutant as a proxy for the others. Carbon Monoxide is used in this way in the French appraisal. While different pollutants behave in different ways as speeds and other variables change, there may be a case, given the very strategic nature of the model for such an approach to be used. However, it would make it more difficult to assess schemes that perhaps led to an increase or decrease in other pollutants while having a marginal impact on CO emissions.

3.1.2 Possible emissions models suitable for use at the European level include, COPERT II (Ahlvik et al, 1997), MEET, which has produced methodologies for rail (Jorgenson and Sorenson, 1997), heavy duty vehicles (both freight and passenger) (Hickman, 1997) and ships (Trozzi and Vaccaro, 1997), but has yet to report on light duty road vehicles; and COMMUTE.

Current Appraisal Practice

3.1.3 The methods used to address local and regional air pollution in the European Union are varied, with 6 countries valuing the impacts and the rest covering descriptively or in a way that is not specified. Of those valuations where the basis is known, two are based on avoidance costs and two on dose response measures. The Belgian value includes CO_2 emissions based on a $10 tax per barrel of crude oil. While the values for the other pollutants are based on the costs of investments required to reach targets set by international agreements. The average costs per vehicle kilometre are:

- 0.595 BF Motorways
- 0.684 BF Urban
- 0.559 BF Other

3.1.4 The Danish values are also based on an avoidance cost approach, in this case the present value over a lifetime of a catalytic converter, giving a value for cars of 0.22 DKr (1992 prices) per vehicle kilometre. This value increases to 0.65 DKr for lorries based on NOx emissions being three times higher for lorries than cars. While both these approaches use avoidance cost, they do not necessarily look forward to the cost of further reductions in emissions.

3.1.5 For values per vehicle km without an emissions model, we are limited to this Belgian and Danish data. Table 3.1 shows the values, converted to 1995 ecus.

Table 3.1: Regional Air Pollution - Current Values (ecus at 1995 prices and values)

Measure	Belgium	Denmark
Motorways	0.0154	
Urban	0.0177	
Other	0.0145	
Cars		0.0318
Lorries		0.0938

Sources: CR Belgium; CR Denmark; Official EU Annual Exchange Rates (DGII)

3.1.6 In Finland values are based on impacts on health and material damage and are expressed as FIM per tonne of pollutant:

- 5900 FIM SO_2
- 5200 FIM NOx
- 94,000 FIM Particulates.

3.1.7 The German approach utilises toxicity factors and converts emissions and their impacts to CO equivalents. In this case the values are in DM per impact per tonne CO equivalent:

- 3.50DM Vegetation
- 2.50DM Health and Buildings - long distance
- 12.00DM Health and buildings - urban.

3.1.8 France and Sweden also values local and regional air pollution, but the basis of the values is not clear. The values for Sweden are expressed as Skr/kg and split into rural and urban, it is inferred that they are based on damage costs. The French values are similarly split but based on vehicle kms run and in centimes. The French approach is also interesting in that it uses CO as a proxy for all other pollutants, simplifying the process.

3.1.9 Table 3.2 gives a comparison of the Finnish and Swedish values, and provides a population-weighted average. Strictly, the Swedish ‘Regional’ values are the only ones to exclude purely local effects and are therefore preferred ones for use. In application, it would be necessary for the appraiser to make a judgement about whether, and if so in what way, to adjust the values for regional population density differences and to consider the influences on valuation discussed in Main Text Section 2.3 Framework for Individual Impacts. If the Swedish regional values were used as a first approximation, the uncertainties associated with this approach (eg. the possibility that true values vary with real income, or in some other, unspecified way) should be borne in mind and clearly stated as a caveat to the conclusions of the analysis.

Table 3.2: Regional (and Local) Air Pollution - Values

Pollutant	Value per kg, 1995 ecus			
	Sweden			Finland
	Regional impact	Rural (Total impact)	Urban (Total impact)	Total impact
Particulates	19.3	19.3	116.3	16.5
NO_x	4.6	4.6	9.9	0.9
SO_2	1.7	1.7	12.2	1.0
HC	1.8	1.8	7.1	-

The ExternE Project

3.1.10 ExternE, part funded by the European Commission under the Non Nuclear Energy Programme JOULE III, is broadly concerned with external impacts of energy supply and use, to which the transport sector is an important contributor (Friedrich et al, 1998). Its methodology clearly identifies the stages in assessment as: i) emissions modelling; ii) dispersion modelling; iii) estimation of physical impacts using exposure-response functions, and iv) valuation of impacts.

3.1.11 For the transport sector, 14 case studies were established, covering extra-urban areas, urban areas and agglomerations (ie. larger cities). Emissions and dispersion models for transport were adopted from elsewhere and applied (selectively) to the case study situations. Exposure-response functions were drawn from a review of the literature. Monetary values (all at 1995 prices) were based on a re-examination of values used to assess the damage costs of electricity generation in previous phases of ExternE. It is worth noting that the value of a statistical life lost due to the effects of air pollution in ExternE is 3.1 MECU - substantially higher than the values of a statistical life lost in transport accidents recommended for accident valuation in EUNET (Main Text, Chapter 3; Appendix III, Chapter 4). This reflects both the significantly higher willingness-to-pay found in non-transport mortality/morbidity studies (Friedrich et al, 1998) and also the lower willingness-to-pay to avoid transport fatalities in many of the member states covered by EUNET and included in its EU value per fatality. In deciding how to use the ExternE values, it is therefore necessary to consider whether they can be scaled to give EU values representative of the populations of *all* member states.

3.1.12 Table 3.3 shows the ExternE damage cost estimates for the two most significant local and regional pollutants: primary particulates ($PM_{2.5}$) and nitrate aerosols (which arise from NO_x emissions). Costs are measured in mECUs, where 1 mECU = 0.001 ECU.

Table 3.3: ExternE Damage Costs per vehicle km (1995 mECUs)

	Agglomeration	Urban			Extra-Urban	
	Paris	Stuttgart	Amsterdam	Barnsley (UK)	Stuttgart-Mannheim	Tiel Drive (NRL)
Petrol car						
Primary particulates ($PM_{2.5}$)	53.41	3.73	1.96	4.17	1.10	0.74
Nitrates	16.14	4.58	1.60	2.76	5.89	2.59
Diesel car						
Primary particulates ($PM_{2.5}$)	534.09	50.43	78.60	97.40	18.77	29.50
Nitrates	18.18	9.14	2.70	2.82	7.24	3.80

Source: Bickel et al (1997) Table 5.3

3.1.13 In Table 3.4, the extra-urban values are converted using the ExternE emissions factors to ECU per kg of emissions.

Table 3.4: ExternE Damage Costs per unit mass emitted (1995 ECU/kg)

	Extra-Urban	
	Stuttgart-Mannheim	Tiel drive (NRL)
Petrol car		
Primary particulates ($PM_{2.5}$)	220	185
NO_x (Nitrates)	14.76	4.64
Diesel car		
Primary particulates ($PM_{2.5}$)	341	255
NO_x (Nitrates)	15.1	4.68

Sources: Table 3.2 above; Friedrich et al (1998) Tables 12.2 and 17.3

3.1.14 From these tables it is apparent that:

- damage costs are higher in urban areas than for inter-urban (extra-urban) travel, perhaps by a factor of 2-4, and even higher in agglomerations;
- for the inter-urban movements on which the EUNET CBA is focused (Main Text, Chapter 4 Paragraph 4.1.1), damage costs per kg of NO_x emitted are consistent between petrol and diesel vehicles, although the Stuttgart-Mannheim values are substantially higher than the Tiel drive values;
- damage costs per kg of $PM_{2.5}$ emitted are of comparable orders of magnitude between petrol and diesel and between countries, although there are some differences in the values, probably due to non-linearities in the dispersion and damage functions. Given the limitations on dispersion and exposure modelling within EUNET, it will be necessary to make use of average values for particulates.

Regional Air Pollution: Recommendation

3.1.15 A exposure-response approach is to be recommended, given that it should fully reflect the impacts on the environment, with the caveat that there is still some uncertainty surrounding the ability of the scientific relationships estimated to reflect the impacts of the pollutants alone and in combination. Whilst this kind of measure fails to reflect individual preferences, it can be argued that health impacts are not sufficiently well perceived for a contingent valuation method to be used.

3.1.16 In reaching a set of values, comparisons were drawn between the national appraisal values (summarised in Table 3.2) and the ExternE values for inter-urban case studies (Table 3.4). In the absence of dispersion and exposure modelling, an inter-urban value is required which can represent typical regional population densities. For this reason, the Tiel drive values are preferred to the (higher) Stuttgart-Mannheim values. Comparing with the Swedish regional values indicates a close correspondence between the Swedish and the Tiel drive values for NOx (approximately 4.6 ECU/kg). The values for particulates are on a different basis and so are non-comparable, although one would expect there to be many more particles under 10 microns than under 2.5 microns, and since it is the latter which cause most of the damage then their higher value per unit mass seems entirely plausible. The recommended approach - intended as a reasonable first attempt to be used cautiously rather than a definitive value set - is to therefore to adopt the following values (Table 3.5) for countries expected to have a relatively high willingness to pay to avoid environmental damage. These countries would probably include Germany and The Netherlands, Finland, Sweden and the UK and potentially others. Meanwhile, it is expected that the underlying values in certain other EU member states could be substantially lower. It is not thought possible on the available evidence to make a unique recommendation on how to do this. One clear rationale for re-scaling the values in Table 3.5 to reflect country-specific differences would be in proportion to the EUNET accident fatality values. However, it has already been noted that willingness-to-pay to avoid death through accidents is not equal to willingness-to-pay to avoid death through environmental damage, so the two should not be expected to move strictly together from one country to another. Care is therefore needed in applying the values: any assumptions made should be explicitly stated so that the process remains transparent to the decision-maker, or any other individual interpreting the appraisal results.

Table 3.5: Regional (and Local) Air Pollution - ExternE/Swedish Values

Emission	Value per kg, 1995 ecus
Primary particulates, $PM_{2.5}$*	185
NO_x	4.6
SO_2	1.7
HC	1.8

*revised unit of measurement since original Deliverable D9; value derived from ExternE (see Table 3.4)

3.2 Global Air Pollution

Current Appraisal Practice

3.2.1 Table 3.6 shows methods in use in EU countries to include these impacts in appraisal.

Table 3.6: Methods used to assess global air pollution impacts

Method	Countries
Monetary valuation	Belgium, Denmark, Finland, France, Portugal, Sweden
Emissions standards or thresholds	Austria, Greece
Measure emissions	United Kingdom
No detail available or excluded	Germany, Ireland, Italy, Luxembourg, Netherlands, Spain

3.2.2 A number of EU countries use some form of monetary valuation. These have varying values and definitions but a similar ethos based on costs imposed and/or avoidance costs. Values derived from international studies include CO_2 valued at: 35 ECU per tonne (Portugal), 30 ECU per tonne (Finland - 1995) and 42.7 ECU per tonne (Sweden - 1995). These values appear to represent the impact of a unit of CO_2 and hence are assumed to rely on dose-response relationships. However, the predicted impacts of global warming vary considerably. Estimates by Cline, Fankhauser and Tol of the impact on the US economy of doubling of CO_2 concentrations from pre-industrial levels, give fairly similar aggregate results. There is, however, great variation in their estimates for individual effects (Tinch, 1995). Hohmeyer (quoted in Rothengatter and Mauch, 1995) suggests a damage cost of approximately 400 ECU per tonne, which is far higher than those given here. There is still a high degree of uncertainty connected with predicting the effects of climate change and their economic cost.

3.2.3 A different approach adopted by some countries is to look at the avoidance or prevention costs. How much will it cost us as a society to remove each ton of CO_2 emissions? Values are based on EU carbon tax proposals in France, while in Denmark the present lifetime cost of a catalytic converter is used as a proxy for avoidance costs. Rothengatter and Mauch themselves estimate the prevention costs for a tonne of CO_2 reduction to be in the range 30-70 ECU. This is the cost to achieve a 40% reduction in the EU compared with 1990 by 2025. Given the policy targets, placing a value on CO_2 emissions equivalent at a minimum to the costs of prevention appears a sound argument. In the case of a reduction in CO_2 there is a resource cost saving elsewhere in the economy, where funds do not have to be spent on emissions reduction. In the case of an increase in CO_2 there will be a real resource cost incurred in obtaining a reduction elsewhere.

4. Landscape and Townscape

4.1 Landscape and Townscape

4.1.1 We have very little knowledge of the treatment of impacts on landscape in EU Member States. Where landscape is considered it is in the shape of some kind of qualitative assessment. The assessment of landscape can never be wholly objective. However, the classification process can be made objective by the use of attributes (presence or absence) (Countryside Commission, 1991). The steps that follow retain elements of subjective judgement, how good or bad is a landscape? Even more important, how valuable is it? Value will depend not only on quality but location: "a landscape which may not seem particularly attractive using general criteria could be important in the context of an unattractive surrounding area" (Department of Transport, 1997).

4.1.2 Theoretically, the valuation of landscape is scantily covered - in recent studies of the external effects of transport (Rothengatter and Mauch, 1995; Tinch, 1995 and Maddison et al, 1996) it is barely mentioned as a possibility. Thus far no Member State has included the monetary valuation of landscape in appraisal. Every landscape is in some way unique, which suggests that standardised values will be impossible and inappropriate. Moreover, values of different types of landscape will vary between areas and over time as cultural preferences change. Stated preference methods are probably those most suited to obtaining individual preferences. However, if surveys are undertaken when an area is perceived to be 'threatened' by proposed infrastructure development they will be exposed to the risk of strategic bias. It would also be expensive to undertake such surveys for every proposal. It might, however, be possible to obtain standard values for different classes of landscape quality.

4.1.3 If landscape is considered to contribute to the quality of life of this and future generations, then it must become part of a sustainability objective. This argument is developed in Bowers et al (1991) where a minimum sustainability objective is proposed: "to pass on to future generations a portfolio of landscape qualities at least as good as current generations enjoy". Landscape value in this context becomes the cost of restoration or total mitigation, for example placing a road in a tunnel or the costs of restoring a despoiled landscape elsewhere to the quality of the original landscape. Either way ensures that the stock of landscapes of various qualities remains constant.

4.1.4 Quality landscapes may be given protection through the creation of designated areas, eg. National Parks and Areas of Outstanding Natural Beauty in the UK, where development is either prohibited or severely restricted. Such an approach avoids the need for valuation, but only offers protection to specific areas, and the degree of protection afforded in practice may be limited.

Landscape and Townscape: Recommendation

4.1.5 A consensus on weighting will be difficult to achieve in the near future. However, the sustainability approach is a place to start the discussion. For landscape, please read 'landscape and townscape'. The proposed treatment in EUNET is given in the Main Text (Paragraph 4.4.2).

4.1.6 Any mitigation costs incurred will appear in the infrastructure costs as a mitigating measure. Any additional impact should appear in the MCA in the form of a scoring scale based on the importance of the landscape or townscape and the impact upon it.

Table 4.1: MCA Scoring Scale for Landscape Impacts

Importance	Impact	Score
National	Severe	1
Regional National	Severe Moderate	2
Local Regional National	Severe Moderate Slight	3
Local Regional	Moderate Slight	4
Local	Slight	5

...where 1 reflects the most severe impact and 5 the slightest.

4.1.7 In most Member States, classification systems already exist for landscape areas of national and regional importance, and it is envisaged that these would be used selectively in the countries affected by individual projects. Locally important landscapes may be identified through consultation with local authorities.

4.1.8 The interpretation of the impact severity classifications Severe, Moderate and Slight must be partly dependent upon the nature of projects being assessed - eg. trans-national corridor infrastructure/regional improvements/localised link upgrading. For any scheme, the key components of the impact severity assessment will be: length of route affected, magnitude of effect per unit length of route. Consequently, a larger scheme will tend to have a proportionately larger total effect. In order to be able to allocate a reasonable range of scores to projects (and so distinguish one from another on this criterion), the appraiser needs to set appropriate interpretations of Severe, Moderate and Slight. To give examples for the case of major corridor-level infrastructure-type projects, Severe impacts could include the complete destruction of a local landscape such as a marsh or level-land to make way for a motorway standard road on embankments, or the levelling of a foothill to give access to a mountain pass. An extreme example might be the complete loss of an island landscape following the construction of a new land bridge. Slight impacts might involve detectable intrusion of a transport corridor into a landscape but without substantially changing the character of the landscape (eg. a ‘Fitting Road’ in the sense of a highway which by hugging contours and keeping below or beyond the sightlines of non-users achieves a degree of ‘fit’ with the landscape (Halcrow Fox, 1994)). Moderate impacts might involve substantial but not Severe changes to the character of the landscape - eg. a road passing through a hillside in a deep cutting and emerging on a high embankment, obscuring sightlines as it does so, or a railway whose embankments and catenary obscure sightlines on a level area.

5. Land Take

5.1 Definition

5.1.1 Land take is distinguished from the following impact, land amenity, in that it aims to capture differences between the market price of land and its opportunity cost *to the owner*. Quite apart from this value is the question of amenity value to others, most particularly where access is free, eg footpaths through the countryside - this is dealt with in Chapter 6.

5.1.2 Land used for a transport project can reasonably be expected to be used for that purpose for the economic life of the project and often beyond (eg. redundant railway sidings, minor roads offering alternative routes, canals). The value of the land used should reflect the true opportunity cost and for reasons given in the Main Text (Section 4.5) this is unlikely to be reflected in the market price.

5.2 Current Appraisal Practice

5.2.1 Most member states use market values in some form to value land used in transport projects. Only Belgium uses a measure of marginal productivity when valuing agricultural land (Bublot & Dewit, 1980).

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6. Other Environmental Impacts

6.1 Land Amenity

6.1.1 Where there is some public access to the land or to a view point then the amenity value of the land should be considered:

- how will the amenity be affected?
- are there close substitutes nearby?
- for what purposes is the land used?
- how many people use it?

6.1.2 When these questions are answered it should be possible to rate the amenity as of local, regional or national importance. The main indictors of the amenity role should be type of use and frequency of use. The impact of the scheme can be assessed through forecasts of change in use and/or frequency of use and any change in benefit derived (should include an assessment of alternative sites. Suitable methods might involve combinations of revealed preference, stated preference and travel cost. The output should be a score reflecting both the importance of the amenity and the extent to which it is affected (see Table 6.1).

Table 6.1: MCA Scoring Scale for Land Amenity

Importance	Impact	Ranking
National	Severe	1
Regional National	Severe Moderate	2
Local Regional National	Severe Moderate Slight	3
Local Regional	Moderate Slight	4
Local	Slight	5

...where 1 reflects the most severe impact and 5 the slightest.

6.1.3 Land whose amenity is of national importance might include, for example, urban parks and common land which are in heavy use for a wide range of purposes (exercise, relaxation, sports) where are there are no ready substitutes. Regionally important amenity land may include major walking routes and countryside recreational areas. Locally important amenity may be provided by green space immediately adjacent to residential areas in towns and villages.

6.1.4 Severity of impact should include consideration of both the proportion of users who may have cause to switch to alternative, less convenient facilities and the qualitative implications on the amenity of that land for those who remain. A Severe impact might involve the complete or effective removal of recreational opportunities at the location. Slight impact may involve some relatively slight yet detectable reduction in the area available or the conditions for recreation, A Moderate impact might involve a substantial reduction in recreational opportunities falling short of total effective withdrawal of the facility.

6.1.5 Finally, in the case of both Land Amenity and Special Sites (Section 6.3) we recommend that the MCA score be supplemented by descriptive assessment highlighting any key individual effects of a project which would have a bearing on its public acceptability - eg. Project A involves the demolition and clearance of three privately occupied castles dating from the 18th century in the area of the Wallersee. The descriptive assessment would be passed to the decision maker along with the CBA, MCA and Financial Appraisal results.

6.1.6 Recent work for the UK Department of Transport (Willis et al, 1997) suggests the use of Stated Preference or Contingent Ranking methods to determine values on a case by case basis. Unfortunately, this is unlikely to be feasible in EUNET given the uncertainties over exact routes discussed in the Main Text, Section 4.1.

6.2 Special Sites

Table 6.2: MCA Scoring Scale for Special Sites

Importance	Impact	Score
World	Severe	1
National World	Severe Moderate	2
Regional/Local National World	Severe Moderate Slight	3
Regional/Local National	Moderate Slight	4
Regional/Local	Slight	5

... where 1 reflects the most severe impact and 5 the slightest.

6.2.1 The interpretation of Severe, Moderate and Slight is analogous to their interpretation for Land Amenity, the three classes implying: Severe = total (or effective) elimination; Moderate = substantial impairment of character or inherent characteristics of the site, or ability of individuals to benefit from it; Slight = detectable but relatively minor reduction in character, loss of characteristics or ability of visitors to benefit.

6.2.2 As with Land Amenity, a supplementary descriptive assessment would be useful in highlighting issues of public sensitivity and could contribute to the usefulness of the overall set of information provided to the decision maker.

6.3 Severance

6.3.1 Severance is explicitly considered by nine of the fifteen member states and is given a monetary value in two. Recommendations for treatment in EUNET are given in the Main Text, Section 4.6.

6.4 Resource Consumption

6.4.1 An alternative to the MCA approach would be to shadow price resources to reflect scarcity, again based on sustainability objectives. This a more elegant solution in that the value would be subsumed within the monetary values for infrastructure and operating costs, reducing the risk of double counting. In practice, however, the difficulty of determining the shadow prices is likely to preclude this type of approach. The objective of sustainability is therefore likely to be reflected in EUNET through the inclusion in the MCA of the indicators listed in the Main Text, 4.6.9.

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APPENDIX IV - TREATMENT OF INDIRECT SOCIO-ECONOMIC IMPACTS

1. Introduction

1.1 EUNET Work Package 4 and Indirect Impacts

1.1.1 An initial set of Indirect Socio-Economic Impacts was provided in the EUNET WP4 Appeal to Partners for Information, and provides a starting point for the analysis.

Table 1.1: Initial Indirect Impacts in Work Package 4

Indirect	Land Use Economic Development Employment Economic and Social Cohesion International Traffic Interoperability Regional Policy Conformity to Sector Plans Peripherality/Distribution

Source: EUNET WP4 Appeal to Partners for Information

1.2 Structure of Appendix IV

1.2.1 Appendix IV begins at Chapter 2 with a statement in summary form of European Union objectives in relation to transport, in order to identify what kinds of indirect socio-economic effects are of policy relevance (the summary objectives are drawn from work conducted by EUNET WP1). It then examines current appraisal practice for these effects throughout the member states, using information gathered by WP4 through the Appeal for Information (Chapter 3). Taking the conclusions of both of these Chapters into account, Chapter 4 puts forward proposals for the set of impacts to be considered by the EUNET assessment tool.

1.2.2 Chapters 5 to 8 present the methodological analysis and recommendations for each individual impact, including theoretical background where appropriate, alternative practical options for implementation and finally a recommendation. The recommendations cover:

- impact definition
- measures
- MCA scoring approach.

2. EU Transport Objectives

2.1 Summary of EU Transport Objectives

2.1.1 IVTB and COWI Consult, in their contribution to the deliverable under EUNET WP1 (Beuthe et al, 1998), list 10 objectives of EU transport policy, based on a review of relevant documents including particularly:

- Commission of the European Communities (1992), *The Future Development of the Common Transport Policy,* COM(92)494, Brussels;
- Commission of the European Communities (1995c), *The Common Transport Policy Action Programme 1995-2000,* COM(95)302, Brussels.

2.1.2 The identified objectives are to:

1. Maximise transport efficiency
2. Improve transport safety
3. Contribute to environmental improvement
4. Improve **strategic mobility**
5. Contribute to strategic environmental improvement
6. Contribute to **strategic economic development**
7. Contribute to **technology development**
8. Contribute to **implementation of the Single Market**
9. Contribute to **social dimension**
10. Contribute to **external dimension**

2.1.3 Here, we associate the EUNET Indirect Socio-Economic Impacts with the emboldened objectives 4 and 6-10 above. We do this by a process of elimination: objectives 1, 2, 3 and 5 are already addressed under Work Package 4 - the first two by Direct impact measures and the latter two by Environmental impact measures. There is no apparent need to duplicate them here.

2.1.4 In order to focus the rest of this report, we now interpret Objectives 4 and 6-10 in terms of a series of potential impacts of transport projects and state as clearly as possible where within EUNET the analysis of these effects will be carried out.

2.2 Strategic Mobility and Social Dimension (Objectives 4 & 9)

2.2.1 These objectives are described in more detail in Beuthe et al, 1998, as follows:

Objective 4 - Improve strategic mobility

(accessibility and European network, nodal points, peripheral areas, missing links, etc)

Objective 9 - Contribute to social dimension

(equity, working conditions, “Citizens’ Network”, people with reduced mobility,etc)

2.2.2 It is anticipated that within EUNET, this group of objectives will be addressed by the outputs of Work Package 5 ‘Indicators of accessibility and social cohesion’. Data from WP5 will then be drawn into WP1 and presented in the form of two criteria within the MCA. Further details of the content and scoring basis of these indicators is given in Chapter 7 below.

2.3 Strategic Economic Development (Objective 6)

2.3.1 This objective includes: ‘regional economics, spatial planning considerations, etc’. These are not part of WP5. They do however appear in the appraisal methods used at national level by the member states (see Chapter 3), with typical outputs being indicators of change in employment and output, and conformity with land use plans.

2.3.2 We propose to handle this objective by splitting the effects into three EUNET impacts, which are developed in more detail in Chapters 5 and 6. The impacts are titled:

- Output;
- Employment, and
- Land Use.

2.4 Technology Development, Implementation of the Single Market and the External Dimension (Objectives 7, 8 and 10)

2.4.1 For Objectives 7, 8 and 10, we take the view that the impacts will be project specific. For example, consider France’s investment in TGV/LGV as a project which is likely to have yielded substantial Technological Development effects. The technology spin-offs generated are likely to differ substantially in nature from the technology spin-offs of, for example, the DRIVE transport telematics programme, or investment in ‘fast ferries’ by operators on denser routes. Whilst it may be possible to generalise at a qualitative level about the types of spin-offs which are possible, we believe that to quantify the potential benefits to European society arising from an individual TEN project would require a substantial research project in its own right. The possible transmission mechanisms alone are multifarious (and, by the nature of technology development, difficult to predict), the benefits are likely to be highly diffuse and the beneficiaries hard to identify.

2.4.2 For these reasons, we recommend that the user of EUNET is given the option to include Technology Development, Implementation of the Single Market and/or External Dimension in the MCA. In cases where it is the judgement of the user that one or more of these objectives may be affected by the project, it will be necessary to develop an appropriate impact indicator *for that project*, which would then be included in the MCA in the usual way.

2.4.3 The full recommendations and further guidance on these optional impacts are set out in Chapter 8 Other Policy Synergy.

2.5 Implications for Appraisal

2.5.1 In general we can say that projects have ‘outcomes’ or ‘impacts’, which may contribute to (or detract from) achievement of the policy objectives against which the project is being appraised.

2.5.2 The EUNET assessment method (WP1 Deliverable D10, 1998) is a hybrid CBA/MCA method and as such is partly an objectives-led assessment (the MCA stage) and partly a microeconomic analysis guided by the single objective of social welfare maximisation (the CBA stage). However, the CBA and the MCA share the appraisal principle of comprehensiveness - thus the objectives led assessment (MCA) should consider whether projects contribute to *each* relevant objective of the investing organisation, whilst the economic appraisal (CBA) should be comprehensive across all significant effects of a project and across all affected groups. Taking this comprehensive approach, we would expect the EUNET assessment tool to address all the relevant objectives of EU transport policy, and within WP4 we would seek to provide a consistent set of impact measures for each objective, applicable across all projects as far as reasonably possible. As we have indicated above, this has led us to suggest the following set of impacts in relation to the EU Trans-European Networks - subject to review in the light of current European appraisal practice (Chapter 3).

Table 2.1: Indirect Socio-Economic Impacts Arising from Objectives

Objective	Impacts
Strategic Economic Development	Output Employment Land Use
Strategic Mobility and Social Dimension	Strategic Mobility 1 Strategic Mobility 2
Technology Development, Implementation of the Single Market, and External Dimension	Other Policy Synergy (optional impacts)

3. Current Appraisal Practice

3.1 Treatment of Indirect Impacts

3.1.1 Information on the approach taken to indirect socio-economic impacts in current national-level appraisals was obtained for all countries. We begin by posing the questions “Are indirect impacts always considered in appraisal?” and “Where they are treated, what approaches are taken?”.

3.1.2 In answer to the first question, Denmark and Sweden do not examine these effects at all. The UK COBA method includes only land use and relationship to policies and plans. Otherwise all countries consider some of the impacts listed in Table 1.1. Table 2.1 in Appendix I showed for each member state which impacts are included in current appraisals (on at least one mode). On the second question - “what approaches are taken?” - there is a wide range amongst the 15 countries. Germany and Spain adopt a monetary valuation approach. Belgium, the Netherlands and Greece include indirect impacts in the MCA, and there are many other approaches - varying by impact.

3.1.3 Table 3.2 gives a description of the analysis which is undertaken in each member state for indirect impacts overall. For illustrative purposes, three of the methods are then presented in some further detail in Appendix V below (taken from the German, Italian and Dutch appraisal procedures).

Table 3.2: Appraisal Methods for Indirect Impacts

Country	Appraisal Methods
Austria	Two sets of spatial evaluation criteria are used: firstly, agreement with spatial plans - urban development plan, landscaping and land use plan - and secondly, change in accessibility, including the accessibility of regional centres, of residential and business locations and of factory sites. The latter is measured using a weighted average of potential travel time saved from the associated residential/ business locations. The two indicators can be incorporated into an MCA. In principle, these criteria are applicable to projects on all modes within the Austrian Federal Transport Plan.
Belgium	In Belgium, formal appraisal methods are used in the roads sector to rank schemes. Six ‘indirect socio-economic’ criteria are included in the MCA, which typically has 29 criteria in total: • direct/indirect value added by the road transport sector (based on an input-output analysis); • employment (in 1991, for every 100 employees in the road haulage sector, purchases by that sector from other sectors are estimated to have led to another 49 full time job equivalents); • targeting specific industries (projects which require as inputs advanced technologies are scored more highly - assessment is by an expert panel - this appears to match the seventh EU transport objective listed in Chapter 2); • labour input (works in urban areas are scored more highly than inter-urban projects);

	• conformity to the sector plan; and • services for industrial, commercial or leisure areas (extent of improvement in accessibility). All MCA impacts are scored on a five point scale from 1 (least favourable) to 5 (most favourable). In the CBA, a zero shadow price of labour is used for the entire construction period and the first 10 years of operation. In Flanders only, Economic Impact Assessments are carried out in addition to the MCA and CBA. These assess macro-economic impacts, focusing on operating profits and employment.
Denmark	None.
Finland	In addition to the core CBA approach (the 'Socio-Economic Feasibility Calculation'), a 'Supplementary Study of Impact on Regional and Social Structures' is required. This incorporates a range of effects: • land use effects; • population; • employment development; • zoning; • regional structure. A separate study examines economic development impacts on the national and municipal economy, starting with the project investment cost.
France	Economic development is the second of seven objectives given for transport projects in the national evaluation guidelines (Sectretaire d'Etat de Transports, 1995). No guidance is given on measurement, but effects considered should include: • spatial redistribution; • development potential, eg. tourism and employment.
Germany	Within the Federal Transport Infrastructure Plan (FTIP) cost-benefit analysis, "spatial benefits" include employment change during both construction and operation phases, regional structure benefits, contribution to international trade (quality of cross-border links). Using a process which takes into account the % structural unemployment in a region, the benefit-relevant labour cost is calculated. The German system is highly-developed and of particular interest - it is described in some detail in Appendix V below.
Greece	Only in special cases (if a "special investigation" has been required). There is no standard method. "Qualitative and quantitative changes in employment" may be estimated. Distribution of GNP may be considered.
Ireland	In the national guidelines, the view taken is that inclusion in CBA will involve double counting (DKM Economic Consultants, 1994). Appraisal of projects for the EU Operational Programmes is a separate issue. Employment creation and "economic and social cohesion" are explicit goals and analysis of potential project impacts is required (although outside the CBA). It is noted that a 'HERMES' model has been proposed to estimate macro-economic impacts.
Italy	The 'Handbook for the Appraisal of Projects of the Italian Public Administration' recommends that for economies that are not in full employment, indirect and induced effects must be considered, including

	multiplier effects on production and consumption. The methodology for appraising and quantifying economic effects is set out in considerable detail in the appraisal study for the Malpensa 2000 airport upgrade project, see Appendix V. Some 'shadow prices' are used in CBA, set in co-operation with the Ministry of the Treasury, the National Statistical Bureau and the Central Bank, not just because market prices are affected by indirect taxation, but also because the value given by National authorities to macroeconomic variables such as employment, value added or foreign currencies is different from the market value.
Luxembourg	No appraisal conventions.
Netherlands	Spatial planning impacts of the scheme appear in each of the MCA priority models for road, public transport and inland waterways. Appendix V give further details.
Portugal	Although Portugal generally lacks standardised appraisal methods, the Portuguese airport operator ANA has recently undertaken a study of alternative locations for a new airport. The study considered four groups of effects including 'Social and environmental effects' - this included subjectively-assessed impacts on the economic development of the region. Another case study raised during the data gathering was the extension of the Lisbon Metro for Expo '98. This appraisal included the predicted gain in values of state-owned land near the metro within the CBA. A proposed tax on the capital gain to private property owners in the area was also included. Other socio-economic effects were in a qualitative fashion and contributed to the justification of the investment - eg. employment, economic development, economic and social cohesion.
Spain	The Spanish evaluation methodology is set within the planning process for the National Infrastructure Plan (PDI), and includes a financial, an economic and a social analysis. The social analysis is distinctive in being based on considerations of equity and the avoidance of social exclusion, and not on efficiency. The analysis therefore covers any potential effects of the project on: • the vertical distribution of wealth; • the geographical distribution of GDP; • the split between consumption and investment and the potential effect on distribution between current and future generations; • employment creation. For some modes, the social analysis is carried out on a monetary CBA basis, with values for employment generation and equity weights for higher, medium and lower income groups in the overall CBA calculations.
Sweden	None.
UK	In trunk road appraisal (the COBA cost-benefit analysis), view taken is that at the national level these are not significant in comparison with the primary effects of any scheme. No analytical treatment is given. The Standing Advisory Committee on Trunk Road Assessment are currently reviewing these procedures (see SACTRA 1998). The method for local schemes (Challenge Funding approach) is more sophisticated. It is recognised that transport infrastructure often forms part

	of a wider regeneration package. Forecasts of site development, employment impacts and changes in output are acceptable within the appraisal (qualified by an assessment of displaced activity). Additional generated trips then contribute through the direct impacts to economic benefits within the CBA. Employment impact may be reported alongside the NPV.

3.1.4 Considering the methods of each member state as described above, we conclude that:

- treatment of indirect socio-economic effects is uneven: output and employment are the most commonly-included impacts in this category. Other impacts are included in less than half the member states, and even then in widely divergent forms
- social considerations and equity are of explicit concern in a small number of countries, either between regions, or between income groups, or both;
- Cost-Benefit Analysis for indirect socio-economic impacts is attempted only in Germany and Spain: both monetise employment effects, Germany also monetises a regional equity indicator (based on regional output per capita - see Chapter 7), whilst Spain applies equity weights for high, medium and low income groups in the appraisal (again see Chapter 7);
- Multi-Criteria Analysis is in wider use for indirect socio-economic impacts, being used in Austria, Belgium, Greece and the Netherlands.

3.1.5 Overall, these conclusions appear to support the adoption of the set of impacts defined in Chapter 2: we therefore proceed on this basis.

3.2 Three Case Studies

3.2.1 Three methodologies which are of particular interest as examples of the alternative analytical systems in use are the following - each is presented in detail in Appendix V:

- *Case Study 1 - The German Approach to Regional Economic Benefits*
- *Case Study 2 - Malpensa Airport - Appraisal of Indirect Socio-Economic Effects*
- *Case Study 3 - Dutch Priority Models*

4. Economic Development

4.1 Introduction

4.1.1 Implicit in the sixth EU transport objective ‘Strategic Economic Development’ (see 2.3 above) is the idea that investment in new or upgraded transportation systems can influence the economic performance of European regions and potentially of the EU as a whole. The same idea is embodied in numerous project appraisal methods at the national level, where economic development impacts are given an explicit place in the appraisal framework and in some cases a standard method exists for their estimation.

4.1.2 The objective of this Chapter is to provide common guidelines within which to consider these potential economic development impacts of Trans-European transport initiatives. We do not shirk the question of whether in some cases there may be no impact, or indeed the regional impact may be negative. This is addressed in the next section (4.2). Nor do we seek to replace the existing standard national approaches to economic impact assessment - for a project developed at the national level it is possible that an assessment on this basis will be available and if so, it may make more sense to re-interpret the findings than to start again from nothing. Furthermore, the methodology chosen for forecasting of output and employment effects in a particular region will depend heavily on the types of data already in existence (input-output tables, employment multipliers, etc). Therefore, the aim here is to set out the relevant principles so that either an existing assessment or a fresh analysis can be admitted into the EUNET assessment on a common basis.

4.2 Conceptual Basis for Secondary Benefits

4.2.1 Transport economists have demonstrated (Mohring and Williamson, 1969; Dodgson, 1973) that under perfectly competitive conditions, the standard measures of user benefit in transport CBA capture *completely* the benefits to the economy as a whole arising from a network improvement. These user benefit measures are classed as Direct Impacts in EUNET - ie. travel time savings, VOC savings, accident reduction, and so on. There are then no additional “secondary benefits”.

4.2.2 The assumptions underlying perfect competition, in the strict microeconomic sense required by this result, are that the market features:

- many buyers
- many sellers
- perfect information
- instantaneous trade

4.2.3 That these assumptions are violated in many real-world labour and product markets is well documented (eg. Layard, Jackman and Nickell, 1991; Michie and Grieve Smith, 1994). Once substantial unemployed labour resources and imperfectly competitive product markets are acknowledged, we cannot rely on the above result to guarantee that the conventional user benefit measures are adequate. Instead, it becomes necessary to understand the link between transport investment and economic development. We then need to consider whether there may be any “secondary benefits” over and above the direct user benefits. A conceptual basis for secondary benefits is needed.

4.2.4 The basis for much current European practice in economic impact assessment is the Keynesian principle of effective demand (Keynes, 1936, Chapter 3) and its application to the theory of income and employment as follows.

4.2.5 The principle of effective demand, put simply, states that the level of output in the macroeconomy will be determined by the sum of the expenditure plans of different sections of society (plus, in an open economy, the planned expenditure by ‘foreign’ residents on domestic output). The equilibrium level of output, Y*, will be given by:

$$Y^* = E = C + \overline{I} + \overline{G} + (\overline{X} - M) \qquad (1)$$

where E is aggregate expenditure

C is aggregate consumption

I is aggregate investment

G is government expenditure

X is the total value of exports, and

M is the total value of imports.

Bars indicate that I, G and X are fixed outside the model.

4.2.6 Assuming that consumption and imports are linear functions of domestic disposable income, Y_d, we get:

$$C = \overline{C} + cY_d$$
$$M = \overline{M} + mY_d \qquad (2)$$
$$Y_d = Y - tY$$

where c is the marginal propensity to consume out of Y_d,

m is the marginal propensity to import, and

t is the marginal rate of taxes on income.

4.2.7 Substituting equations (2) into equation (1) gives:

$$Y = k\,(\overline{C} + \overline{I} + \overline{G} + \overline{X} - \overline{M})$$

where

$$k = \frac{1}{1 - (1 - t)(c - m)}$$

k is the *multiplier*.

4.2.8 The multiplier is the ratio of the final change in income to the initial injection of expenditure in the Keynesian system. Provided that there are some unemployed resources - ie. the equilibrium level of income Y* is less than the full-employment level of income Y_f - total output and income are free to grow in response to any injection of effective demand. For example, suppose there is an increase in export demand from X_0 to X_1. If sufficient unemployed resources exist domestically, national income will rise $k(X_1-X_0)$.

4.2.9 Regional multiplier analysis is simply the application of the above system to the regional economy, treating the 'study' region as the 'domestic' country and all other regions as 'foreign' countries to which the study region is linked by trade flows of exports and imports. Y becomes the gross output and Y_d the disposable income of the region. X becomes exports from the region and M becomes imports to the region, and so on. k becomes the *regional income multiplier.*

4.2.10 The variable *(c-m)* now takes on some significance as the marginal propensity to consume goods produced within the region. Table 4.1 shows how the value of (c-m) affect the level of the regional multiplier for different levels of the tax rate.

Table 4.1: The Regional Income Multiplier and the Marginal Propensity to Consume Goods Produced within the Region

Marginal propensity to consume goods produced within the region (c-m)	Tax rate (t) 0.10	0.20	0.30
0.1	1.10	1.09	1.08
0.2	1.22	1.19	1.16
0.3	1.37	1.32	1.27
0.4	1.56	1.47	1.39

Source: Armstrong and Taylor (1978), p236

4.2.11 The size of the regional multiplier is affected empirically by the size of the region in relation to the whole, a larger circular area drawn around a smaller circular area typically having a higher marginal propensity to consume goods produced within it - ie. greater self-sufficiency in production - and a lower marginal propensity to import. By the same reasoning, a small city is likely to have a lower income multiplier than a large city.

4.2.12 The calculation of the multiplicand - the expenditure injection or withdrawal - can also be complicated (Armstrong and Taylor, 1978), by the existence of significant import components in the expenditure itself. For example, if construction of a highway in a particular region requires raw materials, plant or labour to be purchased from outside the region, that part of the investment 'leaks' immediately from the region as imports.

4.2.13 The relevance of the above analysis is that it outlines a process through which, in principle, transport investment in a region could give rise to impacts *outside the transport sector.* It is possible that these could, under conditions of imperfect competition and unemployed resources, have welfare implications not captured by the transport sector analysis of a conventional transport CBA, although it should be stated immediately that the micro-economic analysis of these impacts is in general rather undeveloped. The work of Venables for the UK Standing Advisory Committee on Trunk Road Assessment (SACTRA, 1998) represents one recent development in this direction: Venables uses computable general equilibrium models to consider the backward and forward linkages between the transport sector and the rest of the economy, and stresses imperfect competition arguments in suggesting that there may be an additional benefit to producers from transport improvements, over and above the conventional CBA user benefit measures - ie. in short there may be "secondary benefits".

4.2.14 Furthermore, it should be noted that the above does not imply that investment in transport infrastructure to or within a peripheral region will necessarily have a positive effect on output within that region, even though the multiplier effect of the initial investment itself will be positive. To see this, consider a simple model with two regions and one mode of transport. Suppose that a road is built from peripheral region A to central region B, which reduces transport costs between them. Given the reduced cost of transport, businesses optimising their location may choose to relocate either from A to B or from B to A depending on a range of factors including the size of the two potential markets and the availability and cost of the necessary factors of production. This simple model is sometimes used to argue in favour of building links to peripheral regions on the grounds that there are pools of unemployed (and skilled) labour in these locations which employers would seek to utilise if access to the major markets (in the central region) were easier and less costly. However, it is also possible that firms currently located in the peripheral region, finding that the peripheral region is now more accessible from the centre, would seek to move their activities closer to the larger potential market in the central region, thus switching output and employment *away* from the region which was intended to benefit from the new link. In the regional multiplier model, the marginal propensity to import, m, would be increased and regional output, Y, would fall. There is, in this sense, a "two-way road" - secondary benefits could be either positive or negative. The balance between these two (and other) influences on regional output can only be determined for the individual project by empirical study.

4.2.15 The argument in Paragraph 4.2.14 is presented in terms of the effects of transport costs on regional output via the prices of goods. An important contributor to this is via the effects of transport costs on the supply of a pool of qualified labour to particular locations and hence on the quality of that pool (economies of agglomeration). It is possibly the effects on labour costs and availability and the way in which this is transmitted between labour and firms (the wage equation debate) which determines the nature of locational competition in high quality service sectors such as financial services, and is critical to the results of particular studies such as those discussed below in Section 4.3.

4.2.16 To summarise, then:

- Keynes' principle of effective demand provides a conceptual basis for a causal linkage between transport investment and output in the wider economy at an aggregate level;
- regional multiplier analysis is the direct practical application of this principle, although the same effects can be analysed through the analytical system of input-output analysis;
- microeconomic models and evaluation methods specifically for transport investment are still under development, however in the following section we will show ways in which other models - notably input-output analysis - have been adapted to the task of economic impact assessment for transport projects at the national level in Europe, with the aim of providing guidance for the development of the assessment tool within EUNET.

4.3 Current Appraisal Practice

4.3.1 We have already reviewed at length the current approaches to output and employment within the wider review of indirect socio-economic impact assessment in Chapter 3 and have focused on two specific approaches in the first and second case studies in Appendices V.

4.3.2 We therefore take this opportunity first to give an overview of some of the different methods used at national level, then to introduce two studies of the economic impact of TEN expenditure at a European level in order to compare methodologies and draw any lessons for the EUNET Trans-European Network appraisal method.

4.3.3 Overall, around half of the member states (seven out of 15 - see Table 3.1) currently attempt to forecast employment impacts in a quantitative fashion. Of these, four have used **input-output analysis**: Germany has the standardised and rigorous approach using Input-Output tables described in Appendix D (PLANCO et al, 1993), whilst Spain and Italy have both used Input-Ouput analysis to assess the employment impacts of major airports, and Belgium has used Input-Output analysis to estimate employment, but in a specific sector - road haulage - which limits applicability.

4.3.4 The technical basis of input-output analysis is well known and set out in, for example, Leontief (1985). It is distinctive in focusing on the inter-sectoral linkages within the economy - building a complete regional model allows the analyst to predict effects of any change in the system on the regional economy (eg. an injection of expenditure in a particular sector - say additional tourism in the event of a new airport being constructed). The model also makes it possible to calculate the employment effects (direct, indirect and induced - these are defined below) associated with any change in the level of output, and to estimate the effect of changes in productivity in particular industries.

4.3.5 In general, input-output (I-O) analysis is vulnerable to certain criticisms both generally and in the transport appraisal context: some of the principal problems are that:

- accurate modelling for a single model year requires enormous quantities of data, preferably based on current fieldwork, since all the inter-sectoral linkages must be specified - this makes I-O analysis extremely costly (eg. in a 100 sector model, there are 100*100 =10,000 intersectoral linkages to be specified, although a proportion of these will be zero in practice);
- the technical coefficients (which relate the inputs to each sector to that sector's ability to produce outputs - ie. a simple constant-returns-to-scale representation of the production technology) may in practice be unstable over time - this significantly limits the ease with which I-O models can be used for the forecasting of future output and employment changes;
- the role played by transport in firms' cost bases can be surprisingly small and hard to identify by direct survey methods (eg. Halcrow Fox, 1995) making it more difficult to investigate the impact on production of changes in transport costs; and
- for Trans-European Networks, the relevant international or inter-regional I-O model with the appropriate sector and spatial disaggregations would be needed - in general, it is doubtful whether this could be expected to be available in advance for any particular TEN project appraisal.

4.3.6 However, the Regional Economic Model in EUNET WP6 overcomes the first and last of these difficulties by being designed specifically for the EUNET assessment. Further information is given in the WP6 Deliverable.

4.3.7 Only Italy among the member states refers specifically to its use of **regional multiplier analysis** in current transport appraisal, although others infer it in their approach to estimating employment consequences of increased expenditure, and their general treatment of induced effects. The conceptual basis of the regional income multiplier was described in Section 4.2. The resulting employment effects are typically calculated using aggregate ratios of employees to the total value of output (alternatively, sector-specific ratios can be inferred from an input-output model, or, as in the German method employment specifically in transport investment projects).

4.3.8 The three conventional classes of output and employment effect and their interpretation in terms of regional multiplier analysis are the direct, indirect and induced effects. Although definitions vary slightly between countries, a typical classification would be:

- direct effects

  - these fall into two groups: direct effects during the *investment period* consist of the investment expenditure itself and the associated employment (eg. expenditure on labour, materials, energy, etc. and employment in engineering and construction); and direct effects during the *operating period* consist of expenditure on operation and the associated employment (again labour, materials, energy, etc., now financed through revenue and subsidies, and employment in operating the transport service - drivers, infrastructure maintenance staff, management, etc);

- indirect effects

  - indirect effects occur in sectors supplying intermediate goods and services, or raw materials, to the project (eg. suppliers of aviation fuel or catering services to an airport);

- induced effects

  - induced effects occur when the owners of factors employed in providing the project or in supplying it (ie. the factors directly and indirectly employed) spend a proportion of their incomes on goods and services in the wider economy - this is tantamount to a 'second round' injection of expenditure into the economy, from which multiplier effects can be calculated using the regional income multiplier k (see 4.2.9) if only aggregate data is available, or sectoral multipliers if there is an input-output model.

4.3.9 In order to make a reasonable estimate of these effects, a careful assessment is required of the various categories of direct and indirect expenditure, as well as data on the relevant employment:output ratios and a means of estimating the induced effects, whether through aggregate multipliers or through I-O analysis.

4.3.10 To give a balanced picture it should be noted that Finland has recently begun recommending that economic multiplier effects should not, as a rule, be included in a socio-economic feasibility calculation, although this appears to a consequence of standardising appraisals on a CBA basis, which cannot readily accommodate such effects given the current state of the art. Other member states rely on a range of unspecified economic impact assessment techniques.

4.3.11 Turning to the European Union-level experience of economic impact assessment, the following studies may be of particular relevance to EUNET:

- Dr Rana Roy (1995), Lost and Found: The community component of the economic return on the investment in PBKAL, European Centre for Infrastructure Studies Report, Rotterdam;

- CEC DGII Economic and Financial Affairs (1997), *The Likely Macroeconomic and Employment Impact of Investments in Trans-European Transport Networks,* Commission Staff Working Paper, Brussels.

4.3.12 Although only the latter of these two studies is strictly an economic impact assessment, they are related in that the latter is dependent upon the results of the former (in that it extrapolates them to the whole T-TEN programme). The ECIS report is also of interest because it claims to provide a solid methodology for calculating the economic value to the Union, as distinct from the Member States taken individually, of cross-border transport projects, and because identifies a potential omission from the economic appraisal if such a project is appraised as the sum of national parts.

4.3.13 The purpose of the ECIS report was to calculate *ex ante* the economic value (on a conventional Cost-Benefit Analysis basis) of the Paris-Brussels-Köln-Amsterdam-London (PBKAL) high speed rail project. The innovation mentioned above was the inclusion of benefits to foreign resident international passengers when travelling over the 'home' country's improved section. This was shown to increase the internal rate of return on the project from 6.5% to 8.9% (excluding the French section, which had already been built) - sufficient to pass with a test discount rate of 8%. It will be important to ensure that for international traffic the EUNET assessment tool takes this item of benefit into account.

4.3.14 The DGII Working Paper takes the results of the analysis further by extrapolating the PBKAL rate of return to the other T-TEN projects and then inputting the investment costs (demand side effect) and transport cost reductions (supply side effect) into the multi-region business cycle and growth model QUEST II. In order to complete the analysis, a number of assumptions are made, including the assumptions that:

- the other 13 'priority' T-TENs (CEC, 1996) would yield 70% of the economic rate of return of PBKAL, whilst the additional Outline T-TENs (CEC, 1994c) would yield 40% of this rate;
- network effects of completion of the entire 'priority' or 'outline' network would then increase these project-specific rates of return by around 40% and 200% respectively, leading to overall a rate of return approximately equal to PBKAL's for the T-TEN programme as a whole, either the 14 'priority' TENs or the greater number of 'outline' projects;
- this is equivalent to a 0.05% higher value of Total Factor Productivity in the corporate sector after 15 years;
- a substantial part, but not all, of the increased labour productivity is realised as increased real wages rather than increased output ;
- T-TENs recover two thirds of the investment costs through user charges, the remainder through government transfers - this has implications for the extent of crowding-out of alternative investment in the QUEST model.

4.3.15 The conclusions of the analysis are that for the 14 'priority' T-TENs alone:

- there will be an additional 700,000 person-years of employment over the 10 year construction period, calculated using the EUROSTAT 1985 Input-Output Table sectoral input-output multipliers and EUROSTAT data on employees per ECU of expenditure in each sector;
- total GDP gain by the year 2030 would be 560 billion ECU (representing an economic IRR of around 11%);
- long term permanent employment would rise by between 130,000 and 230,000 jobs (or at least 570,000 jobs if workers could be

persuaded to take a greater share of the labour productivity gain as additional employment rather than higher wages).

4.3.16 Amongst the interesting implications of the DGII paper for the EUNET methodology is that the calculation of the direct, indirect and induced employment effects of the T-TEN projects as a whole during the investment period, has been calculated using publicly available EUROSTAT input-output tables and employment:output ratios. Another interesting aspect is the use of the QUEST model to model the effects in the capital market and labour market (crowding-out and wage changes) as part of the overall macroeconomic system. Whatever forecasting model the EUNET user chooses to use for output and employment, these financial and labour market constraints should be borne carefully in mind.

4.4 Practical Implementation in EUNET

4.4.1 Two separate stages can now be distinguished within the assessment of economic development impacts:

- forecasting, and
- evaluation.

4.4.2 In the hybrid CBA/MCA system of EUNET, evaluation need not necessarily mean monetary valuation. Instead, it may be taken to mean the selection of appropriate impact measures and the inclusion of those measures within the MCA part of the assessment tool (Work Package 1). Before moving on to discuss forecasting, we next consider which of these two evaluation approaches is more appropriate for economic development impacts - and hence determine what type of impact is to be forecast.

4.5 Evaluation

4.5.1 There are in principle two possibilities, either:

i) an **objectives-led** approach to appraisal (MCA)

- we know that the EU transport objectives in this area are ‘Strategic Economic Development, ie. regional economics, spatial planning considerations,etc’;

- the review of current appraisal methods has identified output and employment as the key regional economic indicators - in principle these could move in opposite directions (if, for example, a transport improvement facilitated industrial consolidation, which then led to an increase in productivity so that regional output rose whilst employment fell);

- therefore output and employment could be included as two separate indicators in the Multi-Criteria Analysis;

- land use will be dealt with separately (Chapter 6).

...or,

ii) a **microeconomic** approach (CBA)

- this would estimate the secondary benefits arising from the transport project

- in theory, CBA has the potential to ensure *no double counting*

4.5.2 However, there are several problems with the second approach at present, some more fundamental than others, which would considerably reduce its credibility:

- the linkage between forecasting models of the macro-economy and microeconomic evaluation measures has not yet been developed, partly because the methods of modelling macro-economic effects of transport improvement projects are themselves in their infancy (the QUEST application (CEC, 1997) for example represents a “first tentative estimate” of the consequences of T-TENs);
- it is doubtful whether there exists a CBA methodology suitable for transfer between countries as yet: the German and Spanish methods both involve a certain number of country-specific assumptions and require country-specific data;
- furthermore, the alternative cost of creating an additional job is not necessarily related to its opportunity cost, which is the theoretically consistent basis for evaluation;
- there is a fundamental theoretical difficulty that CBA is an efficiency analysis with serious potential limitations in the field of economic growth and changes in output and employment (Cheung, 1993; De Brucker et al, 1995).

4.5.3 Consequently, we recommend the MCA approach, with two impacts: output and employment.

4.6 Forecasting (with Further Implications for Evaluation)

4.6.1 Looking at the forecasting stage, and bearing in mind our aim (as explained in the Introduction to this Chapter) of providing generally applicable guidelines rather than a single, rigid method, we outline in the following paragraphs some of the desirable characteristics of forecasting methods, given the lessons from recent experience described in the preceding sections. Note that in practice most of these points have both forecasting and evaluation dimensions.

4.6.2 The forecasting methodology should offer:

- a clear definition of the study area so that, referring back to the multiplier-type analysis above, it is absolutely clear within what boundaries a certain economic development response is projected (eg. “the regional income multiplier for NUTS2 Area ‘West Yorkshire’ is 1.47”);

- an explicit statement of the mechanisms and linkages by which changes in the transport sector are being taken to impact on the wider economy, eg. through an input-output table, or through a regional multiplier system, etc, so that the analysis could be replicated if necessary;
- careful consideration of *additionality* and *displacement* - the former being the extent to which the output and employment are greater in the Do-Something than in a realistic Do-Minimum scenario (ie. consider to what extent it is the transport project which is responsible rather than other factors), the latter being the extent to which employment and output which are additional to the region in question have been displaced from other regions;
- careful consideration of the effects in the capital market and labour market (crowding-out and wage changes) as a consequence of large projects, whatever forecasting model is used; and
- a clear separation of effects within the investment period vs. the operating period, and of direct, indirect and induced effects where possible.

4.6.3 For a particular appraisal, forecasts would be generated for the Do-Something and Do-Minimum scenarios. The impact would be calculated as the difference between the two forecasts. Weighting would take place through the assessment tool's own weighting system - REMBRANDT or an alternative.

4.7 Recommendations

Definitions

4.7.1 There are one or two remaining issues over the appropriate definitions of output and employment.

4.7.2 Firstly, what is the appropriate national accounting definition of Output? For consistency between countries, we define output in terms of Gross Domestic Product (EUROSTAT definition) in ECU, converted at the EUROSTAT yearly average ECU conversion rate for 1995.

4.7.3 Secondly, what is the time frame? In order to achieve consistency between projects, we recommend that the increment in output for the year 2020 should be estimated. This would be within the appraisal period for any project with a 20 year operating period opening between 2001 and 2020, although projects opening after 2015 would have a relatively limited period to build up demand. If for any reason forecasts for the year 2020 are unavailable, the appraiser must make assumptions about the growth of output over time in both the Do-Minimum and Do-Something scenarios.

4.7.4 For employment, the first question is 'what is an employed person? - full time or part time? - does voluntary work count as employment - are those on government training schemes "in work"?'. Again, for simplicity and consistency, we adopt the EUROSTAT definition.

4.7.5 The time frame issue should be treated in the same way for employment as for output.

4.7.6 We also need to define the study area, ie. the area for which we wish to estimate the impact. This should be the EU as a whole. Disaggregation of results by country may also be provided, although the MCA is unlikely to operate at such a level of spatial disaggregation.

4.7.7 To emphasise, we are concerned with changes in output and employment. If the output of the analysis - say a feasibility study conducted outside EUNET - is an estimate of output and employment, need to review the method to ensure that additionality and displacement have been given proper consideration.

Measures

4.7.8 For this impact, we are interested in net employment and output, so the measures should be:

- additional output - in ecu per annum in the year 2020;
- additional employment *net of displacement* (ie. with displaced jobs deducted) - in thousands of additional jobs (full-time equivalent) in the year 2020.

4.7.9 In order to move from the above to points on an MCA scoring scale, a range will need to be set for the scoring scale within WP1 according to the upper and lower bound estimates of the potential output and employment effects for the pool of projects being appraised. This task would be the responsibility of the appraiser and should be undertaken after careful consideration of the pool of projects being compared within the MCA and the likelihood that further projects, with different levels of these effects, may be added at a later date.

4.7.10 In order to take into account the differential effect, in relation to policy, of employment impacts in high versus low unemployment regions, it would be appropriate for the scoring scale to distinguish the Objective 1, 2 and 5 areas eligible for assistance under the Structural Funds from other areas. A differential scoring scale analogous to that suggested for Landscape impacts could be used to allow employment created in high unemployment areas to score more highly. The decision over whether to retain the units of output (bn ecu) and employment (000s additional FTE employed) in the MCA, or whether to transform the units onto an abstract scoring scale, eg. -5 to +5, is an interesting issue, but one which is the preserve of Work Package 1.

4.7.11 Employment should not be given a monetary value - there is no consistent basis and there are some doubts over whether alternative cost is a good proxy for opportunity cost of labour.

4.7.12 Finally, it is important given the inclusion of these indicators that shadow prices on labour are *not* used since to do so would involve double-counting the benefits arising from the direct employment impacts of the project (‘direct’ in the sense of Paragraph 4.3.8).

5. Land Use

5.1 Introduction

5.1.1 Firstly, there is a definitional issue to be resolved here over the difference between ‘Land Use’, ‘Land Take’, ‘Land Amenity’ and ‘Land and Property’, all of which are covered by the final recommendations of this Work Package. ‘Land and Property’ appeared in the initial list of Direct Impacts (Part II, Table 1.1) and is included as one component within the final definition of Investment Costs:

- land and property costs - including the cost of acquiring land needed for the scheme (and any associated properties), compensation payments necessary under national laws and the related transactions and legal costs (Appendix II, Table 1.1.

5.1.2 ‘Land Take’ is discussed in Appendix III. This would be another monetary variable to be included where possible, which would reflect the difference between the costs included under Investment Costs and the opportunity cost of the land. The two might differ as a result of for example distorted farmland prices under the Common Agricultural Policy, or the effects on market prices of compulsory purchase or property speculation.

5.1.3 ‘Land Amenity’ is quite separate from the market value of land, particularly where access is free, eg. footpaths through the countryside, and reflects recreational value derived from actually having access to the land taken by the project. The recommendation is that this be included in EUNET through the Multi-Criteria Analysis, and a scoring scale is provided in Appendix III, Table 6.1.

5.1.4 Finally, ‘Land Use’ is distinguished from the above as:

- wider impacts on land use *resulting from* the direct and environmental effects such as reduced travel times (positive) or severance (negative).

5.1.5 Potential land use impacts include:

- changes in patterns of residential and commercial land use
- changes in zoning / land designations
- changes in use of former agricultural land following severance
- changes in the overall regional structure

5.1.6 Any of the above may have implications for population, employment and energy consumption - ie. there may be feedbacks into other impacts.

5.1.7 In order to make an assessment of the land use changes likely to follow a particular project, there is a need for a) forecasts of the changes and b) a basis for evaluating these changes. The following section describes current practice amongst the EU members states as reported in the WP4 data gathering exercise.

5.2 Current Appraisal Practice

5.2.1 Austria includes two criteria in its appraisal framework relating to the spatial structure of the area, each with more than one sub-criterion:

1. Accordance with Spatial Structure
    - agreement with urban development plan
    - agreement with landscaping plan
    - agreement with land use plan
2. Modification of Accessibility
    - accessibility of regional centres
    - accessibility of dwelling and working sites
    - accessibility of factory sites

5.2.2 The former appears to relate to land use in the sense described above, whilst the latter is first and foremost an accessibility criterion - see Chapter 6. Each of the sub-criteria for the former is assessed in terms of goals achievement - ie. the extent to which a particular project contributes to the achievement of explicitly stated policy goals. A substantial positive contribution earns a high score for the project; a negative contribution acting *against* the policy earns a low score. The weight attributed to Accordance with Spatial Structure in the overall evaluation is determined by 'expert' judgement.

5.2.3 Finland has a formal planning process, and appraisal framework, which is used by agencies covering road, rail, sea and air investments. A part of this process is the preparation of 'supplementary studies' (supplementary to the core CBA calculations), including one entitled 'Impact on regional and social structures', which contains an assessment of effects on:

- population;
- employment development;
- zoning, and
- the development of the regional structure.

5.2.4 In Greece, the following 'land use' effects are measured and included in the MCA:

- "Intensity of habitation" (Population/Area)
- "Employment Indicator" (Employments/Area)
- "Intensity of Agricultural Land Use" (Number of Agricultural Machines in an Area)
- "Energy Consumption" (Energy Consumption/Population)

5.2.5 The Dutch approach is to rank projects within a pool according to their consistency with national planning aims (see also Chapter 3). Scores are allocated according to a project's relative performance and the criterion ('Physical Planning' or 'Spatial Policy Targets') is then weighted using a fixed weight built into each priority model. The weight itself varies, from 16% in the public transport priority model to 5% in the roads priority model. The types of policy targets with which consistency is being assessed include:

- suburbanisation/commuting;
- growth centres and towns;
- structure of large urban districts;
- traversing of open spaces/zoned areas;
- opening up development areas.

5.2.6 Lastly, in the UK, a descriptive assessment is included in the Framework for trunk road schemes, focusing on:

- the need to replace land formerly used by the community (Public Open Spaces)
- the impact of the scheme on planning authority land use designations
- an agricultural assessment which may include changes in the type of farming, effects on irrigation/drainage,etc.

5.2.7 To conclude, only five countries deal explicitly with land use effects. The central concern appears to be the interaction of the scheme with land use planning policy:

- to what extent does the scheme accord with policy?
- to what extent will the scheme force changes in zoning policy?

5.2.8 This does not lend itself to monetary valuation. However, it does offer a useful basis for an MCA criterion, once adapted to the Trans-European Network situation. The following sections set out the proposals.

5.3 Definition

5.3.1 In line with current appraisal practice, and to complement the land-related impacts already included under the Direct and Environmental categories, we define the Land Use impact as:

- extent to which the project conforms (or conflicts) with land use policy.

5.3.2 We define conformity in terms of:

- the extent to which types of development likely to be encouraged by the project conform to the existing (or an equally acceptable alternative) land use plan -eg. if residential development is likely to be encouraged, does this fit with the planning authority's zoning of that locale? Or if commercial development is likely to be encouraged, are the sites which will become more attractive to developers zoned for the types of development which is expected.

- the extent to which *dis*couragement of some types of development likely to follow by the project is in conformity with the existing (or an equally acceptable alternative) land use plan - eg. if severance arising from a project is likely to discourage local commercial of residential development in an area, does this fit with the relevant plan (eg. is the area zoned for recreational purposes or conservation?; is there a plan to limit population growth, or the reverse?); and

- extent to which localised changes in zoning enforced directly by the project itself are acceptable to the planning authority - eg. if the project involves construction of an airport and associated services (eg. terminal retail, hotels), does the land use change to 'transport' and 'services' conform with plans and zoning?

5.3.3 Double counting of benefits and disbenefits already included elsewhere in the appraisal should be avoided - for example, severance of residential from commercial locations and implications for local journeys should **not** be included since it is already included under Severance. However, if this severance is expected to lead to future changes in development patterns in contravention of the area plan that would be highly relevant to this Land Use impact.

5.4 Measure

5.4.1 Given that land use planning takes place at various levels in the planning hierarchy in each member state, it is proposed that the measure of land use impact for the MCA take the form of an average weighted by population of scores attributed *to each authority whose planning area is likely to be affected.*

5.4.2 The steps involved in calculating the measure would be as follows:

i) identify areas likely to be affected by land use change;

ii) identify responsible bodies;

iii) compare land use plans with anticipated qualitative effects;

iv) score each plan area (ie. each authority) according to the following scoring scale:

Table 5.1: Scoring Scale for Planning Area A

Score	Scale Point Definition
+2	Strong positive conformity with the land use plan
+1	General conformity (some minor or localised conflicts)
0	Mixture of conformity and conflict within Area A - on balance neutral
-1	Some significant areas of conflict with the land use plan - on balance project conflicts with land use plan
-2	Strong conflict with land use plan (and few or no parts of the planning area for which the project can be said to make a significant positive contribution to implementation of the plan)

v) take an average of the scores recorded, weighted by the population of each planning area, giving a single score for the project as a whole.

5.4.3 In order to ensure that the average is not biased toward zero (neutral), it will be important to define clearly *only those areas where a land use change is expected* at step (i). Within these areas, scoring will necessarily be subjective in the absence of a land use model, however the scoring scale given in Table 5.1 offers a consistent basis across projects. Consistency is likely to be further enhanced if there is consistency of *appraiser* between projects, since this would bring a single interpretation of the scoring scale to bear on the judging process.

5.4.4 For major infrastructure projects, we *would* expect the use of a land use and transport interaction (LUTI) type model, such as MEPLAN or DELTA. This would assist considerably with the analysis at step (i).

5.4.5 Finally we note that it would preferable for the appraiser to seek the views of the relevant planning authorities, and ideally seek their agreement with the judgements made.

6. Strategic Mobility

6.1 Current Appraisal Practice

6.1.1 Accessibility and regional/social equity are addressed by just four countries' national appraisal methods.

6.1.2 In Austria, accessibility of regional centres, development sites and so on, is measured as a weighted average time consumption according to the following formula:

$$e_i = \sum_j E_j t_{ij} \Big/ \sum_j E_j$$

where e_i is the accessibility of point i from all points j

t is journey time, and

E_j is assumed to be a measure of trip ends at j.

6.1.3 The result is included in the MCA, where there is a risk of double counting with the Efficiency criterion, which aggregates actual travel time savings.

6.1.4 The German appraisal framework regards accessibility as the potential saving of travel time, and so brings the two together, with time savings as the measure and accessibility the title of the impact. Time savings are calculated in a way that has much in common with the rest of Europe - see Appendix II Chapter 2.

6.1.5 However, the German framework has an additional impact called Regional Structure Benefits, which is added to the CBA calculations and is defined as follows:

$$NR_3 = b(NB_1 + NB_2 + NB_3 + NE + NR_1 + NR_2)$$

where NR_3 is the total benefit from spatial structure advantages in DM per year

b is a Regional Differentiation Factor (see below)

NB_1 is total benefit from standing cost savings

NB_2 is total benefit from operating cost savings

NB_3 is total benefit from cost changes due to volume shifts

NE are benefits from improved accessibility (ie. travel time)

NR1 are the monetised employment effects see Appendix C

6.1.6 The factor b is derived from the gross value added per inhabitant in the year 2010 (as an indicator of the regional welfare level) using the following procedures:

Regions of the former Federal lands

Scaling of the regional welfare indicators on factors between 0.1 and 0.3. To ensure that only regions with a significantly below-average welfare level benefit from preferential treatment, said treatment was restricted to the 20 regions recording the lowest gross value added per inhabitant, ie. to approximately 25% of the total population of the former Federal lands.

Regions of the new Federal lands

Scaling on factors between 0.2 and 0.4, covering all regions. The higher weighting as compared to the Federal lands takes account of disparities that will continue to exist in the "catch-up phase" as well as welfare discrepancies that will also not have disappeared completely in the year 2010.

6.1.7 The Netherlands take a similar approach to Germany on accessibility: the CBA contains an Accessibility impact, which in practice is measured using total time savings. However, the Dutch priority models do not include separate regional equity indicators.

6.1.8 Finally, the Spanish evaluation methodology includes a financial, an economic and a social analysis. The social analysis is distinctive in being based on considerations of equity and the avoidance of social exclusion, and not on efficiency. The analysis therefore covers any potential effects of the project on:

- the vertical distribution of wealth;
- the geographical distribution of GDP;
- the split between consumption and investment and the potential effect on distribution between current and future generations;
- employment creation.

6.1.9 For some modes, the social analysis is carried out on a monetary CBA basis, with values for employment generation and equity weights for higher, medium and lower income groups in the overall CBA calculations. The values for the latter given in the Spanish rail evaluation manual (Ministry of Public Works, 1996) are:

Table 6.1: Spanish Equity Weights for Cost Benefit Analysis

Income Group	**Equity Weight in CBA**
Higher income	0.84
Medium income	1.00
Lower income	1.21

6.2 Treatment in EUNET

6.2.1 In EUNET, issues of regional accessibility, peripherality, equity and social cohesion, including definitional and measurement issues, are being addressed by Work Package 5 'Indicators of Regional Accessibility and Social Cohesion'. WP5 is expected to produce three outputs:

- two MCA indicators, and
- a MapInfo GIS output at NUTS2 level of spatial disaggregation.

6.2.2 The two MCA indicators will be calculated for each project, reflecting the improvement as a result of the project in accessibility and social cohesion. Each indicator will give a single value for Europe as a whole. Both will be calculated as the difference between the Project Scenario and the Do-Minimum Scenario, measured as a percentage improvement, and the results will be transferred to the MCA stage of the assessment tool where matching weights will be generated. Further definition of the two indicators will be provided by the forthcoming WP5 Deliverable.

7. Other Policy Synergy

7.1 Recommendations on Definition and Measurement

7.1.1 In our discussion of the EU transport objectives in Chapter 2. For Objectives 7, 8 and 10, Technology Development, Implementation of the Single Market and External Dimension, we took the view that the impacts will be project specific. For this reason, we recommend that the user of EUNET is given the option to include Technology Development, Implementation of the Single Market and/or External Dimension in the MCA. In cases where it is the judgement of the user that one or more of these objectives may be affected by the project, it will be necessary to develop an appropriate impact indicator *for that project*, which would then be included in the MCA in the usual way. Weights would be generated within the assessment tool software using the REMBRANDT (or alternative) system (see Work Package 1, Deliverable D10 (Beuthe et al, 1998)). In order to provide as much consistency as possible between appraisals, we suggest that:

- the 'study area' for any quantification of total benefits be the European Union as a whole, with EU residents as the beneficiaries;
- the indicator be designed to reflect the *difference* between clearly defined Do-Something and Do-Minimum scenarios;
- once a scoring scale has been chosen for a particular impact (eg. a seven point scale from +3 (strong positive impact)...0 (neutral)...-3 (strong negative impact)), and the points on the scale defined, then for consistency the same scale should be used across all affected projects; and
- the titles Technology Development, Implementation of the Single Market and External Dimension should be used, with the project specific impact as a subtitle, eg. "Technology Development (Marketable Road Tolling Technology)".

7.1.2 Methods which may be appropriate to the assessment of these impacts, in general, include:

- direct market research (eg. surveys of potential final users of new technology);
- specialist investigation/market assessment;
- assessments of commercial exploitability.

7.1.3 The following are examples of types of projects where these optional MCA impacts might be relevant:

Technology Development

- Train à Grand Vitesse (HSR); ATT-ITS systems (see EC DGVII, 1995b? for further guidance on evaluation methods); subsidies to Airbus

Single Market

- EU investment programmes in bridge strengthening, or harmonised electric rail voltages

External Dimension

- TEN projects linking the EU with the Baltic States, Eastern Europe, Switzerland, Africa, the Americas or Asia.

7.1.4 Finally, for these three objectives, we would caution that the comparative assessment of projects is fraught with problems, and that care will be needed. Some of the principal difficulties likely to be encountered are the following:

- the standard modelling software within EUNET (under WPs 5 and 6) will probably not provide outputs relevant to these policy objectives - supplementary studies will be required to forecast impacts;
- there is a lack of both theoretical and practical evidence within the transport appraisal paradigm for these effects - wider, project-specific investigations will be required to identify effects, transmission mechanisms, groups affected and the magnitude of the effect; and
- distinguishing the benefits arising from an individual TEN project from the overall benefits of the policy (or new technology) as a whole will be a formidable challenge - eg. it will be necessary to identify not just the benefits from development of TGV technology as a whole, but the benefits from its implementation in a particular corridor.

7.2 Weighting of Optional Impacts in the MCA

7.2.1 It is anticipated that the WP1 assessment tool will incorporate user-defined impact weights, which gives the system as a whole considerable flexibility: provided that any additional 'optional' MCA impacts are included at the weight-generation stage, they can be built-in to the MCA assessment on a common footing with the other, pre-defined impacts. The 'pairwise comparisons' weighting method is described in WP1 Deliverable D10, Chapter 3. Its final implementation in EUNET will be set out in WP1 Deliverable D16 “Decision Analysis Report and Prototype” (forthcoming).

APPENDIX VI - PARTNERS' INVOLVEMENT IN WP4 DATA GATHERING

Table A1: Gathering and collation of information on the impacts of transport

Country	Information gathered by	Information collated by
Austria	ICCR	PLANCO
Belgium	FUCAM	ITS, Leeds
Denmark	The Technical University of Denmark	ITS, Leeds
Finland	LT Consultants Ltd	ITS, Leeds
France	INRETS	ITS, Leeds
Germany	PLANCO	PLANCO
Greece	NTUA	NTUA
Ireland	ITS, Leeds	ITS, Leeds
Italy	Gruppo Clas	Gruppo Clas
Luxembourg	FUCAM	ITS, Leeds
Netherlands	ITS, Leeds	ITS, Leeds
Portugal	Gruppo Clas	Gruppo Clas
Spain	Gruppo Clas	Gruppo Clas
Sweden	Technical University of Denmark	ITS, Leeds
United Kingdom	ITS, Leeds	ITS, Leeds

APPENDIX VII - **STANDARD ECONOMIC SERIES**

Examples of the ECU conversion rates, price indices used are given below.

Official Annual ECU Exchange Rates

	1ECU =	
	1992	**1995**
AUS	14.21	13.18
BEL	41.59	38.55
DEN	7.81	7.33
FIN	5.81	5.71
FRA	6.85	6.53
GER	2.02	1.87
GRE	247.03	302.99
IRE	0.76	0.82
ITA	1595.51	2130.14
NRL	2.27	2.10
POR	174.71	196.11
SPA	132.53	163.00
SWE	7.53	9.32
UK	0.74	0.83

Source: EC DGII

Eurostat Consumer Price Index (General)

	1985=100	
	1992	**1995**
AUS	120	131
BEL	117	125
DEN	127	134
FIN	137	143
FRA	123	130
GER	115	125
GRE	308	427
IRE	125	133
ITA	147	168
NRL	112	120
POR	207	241
SPA	145	176
SWE	148	166
UK	141	158

Source: Eurostat Basic Statistics 1996

Taxes linked to production and imports minus subsidies, as % of GDP at market prices

	1995
AUS	13.6
BEL	10.2
DEN	14.3
FIN	11.5
FRA	12.6
GER	11.2
GRE	11.4
IRE	11.3
ITA	9.8
NRL	10.3
POR	12.4
SPA	7.8
SWE	9.6
UK	13.1

Source: Eurostat Basic Statistics 1996