METHODES D'EVALUATION ECONOMIQUE DES PROJETS ROUTIERS DANS LES PAYS MEMBRES DE L'AIPCR

ECONOMIC EVALUATION METHODS FOR ROAD PROJECTS IN PIARC MEMBER COUNTRIES

CONTENTS

PREFACE

The 1995 Strategic Plan of PIARC defined value for money as a topic area.

One of the strategies from this topic area is to bring together results of different studies concerning the impact of investment on economic development, the location of economic activity and traffic (including any social disbenefits). The aim is to inform about international experience and to improve the prediction of the impacts of the projects.

In order to accomplish the above, this study was conducted as a questionnaire survey of all member countries of C9 in 1997, supplemented with information from other available sources e.g. publications and reports. The data contained in this reported therefore is as for 1. October 1997 unless otherwise stated in graphs and tables.

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1. INTRODUCTION

This study has been commissioned by Committee C9 on Finance and Economic Evaluation. The ultimate objective is to compile information from published sources, including existing surveys, and to make recommendations, if possible, on specific and general basis. The following goals have been agreed upon:

a) to assemble information for each participating country on the methodology for economic evaluation of road projects, the elements of cost and unit costs;

b) to analyse and evaluate the differences between the various methods of assessment, to assess the range of cost elements with view of making recommendations for further developments.

The potential for benefits that may exist in assembling information on economic evaluation methods used in member countries and the possible opportunity for agreement on a common framework for economic evaluation was envisioned. It was, however, recognized that the latter aim might prove difficult in practice. Because there has generally been little dissemination of information on economic evaluation methodologies between member countries, this project was expected to provide an opportunity for obtaining data and discussing the methods in the context of member countries with a view to better decision making.

Compiling information on methodologies used in the different member countries was considered to be useful in the following way. Those countries that consider their methodologies as failure may learn from the successful ones. Those who have difficulties in quantifying or estimating the values of different factors may learn from those who have been successful. Compiling and publishing this type of information will therefore contribute towards a more efficient use of public funds in the member countries.

The study was conducted as a questionnaire survey of all member countries of C9 supplemented with information from available sources. For those countries that did not respond to the questionnaire, information has been obtained entirely from other published sources. The available sources comprised mainly of publications from the various countries and notably a report, EURET/385/94, commissioned by European Commission DG VII. The latter report provides a description of objectives and sets out appraisal methods and values used in EU member countries.

This report is organized as follows. Chapter 2 gives a brief description of the major methods that may be applied to evaluate road projects. Chapter 3 summarizes the methods for valuing impacts as practiced in member countries. Chapter 4 gives a summary and comparison of existing frameworks of impact assessment in member countries. The potential for harmonization within member countries is briefly discussed in chapter 5 while chapter 6 gives some recommendations on a general basis.

Finally, caution must be taken when interpreting data and comparisons presented in this report. First, the data reported here are as for 1st October 1997 or as stated in graphs and tables. Some of these data may have been reviewed in the mean time. Second, comparisons made between countries are only meant to illustrate the magnitude of variations in absolute terms. One should be aware that the values reported may have been derived through different methods in the member countries, and in many circumstances will contain different components.

2. METHODS OF ECONOMIC EVALUATION

Any rational decision-making process involves weighing up the advantages and disadvantages of a policy action. The ways in which these advantages and disadvantages are compared vary according to the type of decision rule or framework that is used. The process of weighing up advantages and disadvantages to decide whether a project is desirable or not, is known as project evaluation - also sometimes referred to as project appraisal or project assessment. The methods of evaluation are the main subject of this chapter.

The main aim is to give a brief description of the major methods of evaluation that may be applied. We begin in section 2.1 with why evaluations are necessary. In section 2.2, we describe the major evaluation methods that exist in the literature. Finally in 2.3, we describe the measurement methods used to quantify the indicators that describe the effects of an investment.

When reference is made in this chapter to a project, the term is being used in a broader sense. Consequently, it may refer to the construction of a new road infrastructure, but could equally well mean a road maintenance measure, a road management measure, such as changes in fares policy or the introduction of a traffic management scheme, or indeed an integrated strategy as a whole[1].

2.1. The need for and purpose of economic evaluation of road projects

Evaluation or appraisal has been described as a process of investigation and reasoning designed to assist decision-makers reach an informed rational choice.

The decision whether to invest in a road project, and if so, under what constraints results from the weighing up of a number of different, and sometimes sharply conflicting objectives. Economic evaluation is one way of assessing these factors. The economic evaluation aims at providing the decision makers with an estimate of economic costs and benefits over time of any project that are related to either the continuity of existing projects without any modifications (Do-nothing), or the continuing of projects with modifications which were expected anyway (Do-minimum).

There are several reasons for conducting economic evaluation of road projects. The first and the most fundamental rests, wholly or partly, on the concept of economic efficiency. Test of economic efficiency rests on the valuation of all costs and benefits of a project in monetary terms. A project is said to be economically efficient if the benefits measured in monetary terms exceed the costs. The most efficient project is that for which the difference is the greatest.

[1] C.A Nash " Economic and environmental appraisal of transport improvement projects" in C. O´Flaherty (eds.): *Transport Planning and Traffic Engineering*

Economic evaluation described in this manner is, however, a partial technique. It does not measure all the costs and benefits in monetary terms. This limited but important role of economic evaluation has been criticized by many governments. As a result, some governments have ensured that environmental objectives and concerns are given full weight alongside with the monetary costs and benefits of road schemes.

Thus it may be stated that the aim of economic evaluation is simply to obtain information which in turn helps to guide policy and investment decisions towards the achievement of certain objectives. In this respect, the purpose of the economic evaluation method is to meet the following criteria [2]:

a) it should promote the efficient use of resources;
b) it should be able to test whether schemes conform to or advance decision makers' objectives;
c) it should demonstrate to the public and the decision makers that important decisions have an adequate technical basis;
d) it should be consistent in approach, ensuring that common standards are applied and are seen to apply;
e) it should help in understanding the incidence of impacts;
f) it should establish a control mechanism to which decentralized decision makers must conform;
g) it should be comprehensive in terms of the different kinds of impacts of the investments;
h) the technique employed for economic evaluation should be best suited to the particular circumstances of appraisal.

An elaboration of the points above follows below.

a) *Promoting efficient use of resources*

An efficient (economically) use of resources is achieved when it is impossible to make one person or group in a society better without making another group worse off. In other words, if a project is undertaken which would make everyone better off, the project would serve to promote economic efficiency. An evaluation procedure that takes account of this will be promoting economic efficiency. It, however, must be added that an evaluation procedure, whether qualitative or quantitative or a combination of the two must strive to be exhaustive in terms of the issue that it seeks to address. It must also consider the foreseeable effects on people and the environment both in the short and the long term, not only in relation to specific locality but also in the context of global policy choices.

[2] Cost-Benefit and Multi-Criteria analysis for New Road Construction, DOC EURET/385/94 final report April 94 R&D Unit. DG VII. COMMISSION OF THE EUROPEAN COMMUNITIES-DIRECTORATE GENERAL FOR TRANSPORT

b) *Conformity with the decision makers objectives*

In order to make a rational choice, the decision maker must know whatever he/she is trying to achieve. The starting point for any project evaluation should therefore start with a statement of the objectives that are being pursued. Hence the second objective of an evaluation must be to test whether proposed schemes/strategies conform to these objectives.

c) *Technical quality and consistency*

Sound technical analysis is a prerequisite for ensuring that decisions are robust. The evaluation procedure must be consistent in order to ensure that projects can be compared.

d) *Transparency*

All assumptions made within the analysis must be transparent and the decision should be open to scrutiny. Transparency ensures accountability of decision makers.

e) *A help to understand the incidence of impacts*

In addition to the economic efficiency aspect, investment decisions will have implications for different groups in society. The objective of the evaluation, then, is to ensure that the evaluation acts as an aid to the understanding and assessment of the incidence of impacts.

f) *Control mechanism for decentralized decision making*

This objective points to the fact that an evaluation procedure establishes a control mechanism to which any decentralized decision-maker must adhere, that is: repeated applications using the same methodology should lead to similar outcomes whoever performs the analysis or makes decision.

g) *Comprehensiveness*

The evaluation must aim to cover all feasible impact areas in a clear comprehensive manner so that the effect of projects which are different can be judged on an adequate basis.

h) *Suitability to the circumstances of appraisal*.

Finally, the evaluation procedure should be best suited to the particular circumstance within which the evaluation takes place. The limitations and implicit assumptions should be explicitly stated.

To sum up, the need for economic evaluation is to promote efficient use of resources, be able to test whether projects conform with both social and economic objectives, ensure a balanced treatment of all impacts and to enlighten the public and the decision makers on the incidence of impacts. In addition, it is required that the evaluation procedure should be consistent, comprehensive and as transparent as possible to foster accountability.

It should be supplemented here that, within the transport sector, economic evaluation may be used to assist decision making at different hierarchical levels and this may affect the choice of an evaluation procedure. The levels of hierarchy exist in terms of:

- allocating resources to the transport sector
- strategic allocation within the transport sector (road, rail, water, air, etc.)
- priorities within a given budget (e.g. road budget)
- the choice of an appropriate design option for a particular scheme or project.

Making the choices named above may require a mixture of political assessment, economic and technical or operation evaluation. At the top of the hierarchy, political assessments have a tendency to dominate while in making design choices technical assessment or operational criteria tend to dominate. While political and technical evaluations are always needed for road investment decisions, the requirement for economic evaluation is less clear-cut. A strong argument for performing economic evaluation, however, is that it helps to assess, in a systematic manner, the benefits and costs of alternative expenditures. It therefore provides an explicit check on value for money, either at project or programme level.

It may therefore be concluded that there is a strong case for using some form of economic evaluation at all levels of hierarchy of decision making.

2.2. Types of economic evaluation methods

Any rational decision-making process weighs up the advantages and disadvantages of a policy action. The ways in which these advantages and disadvantages are weighed and compared vary according to the type of the decision rule or framework that is used. There is however, a four-step procedure that is common in all decision rules:

(i) defining gains (advantages) and losses (disadvantages) according to some objectives,
(ii) listing advantages and disadvantages,
(iii) measuring gains and losses in the same unit or different units
(iv) by using explicit weights of importance (e.g. money value) or implying such weights ex post, decisions are made on the basis of i) to iii).

There is a large number of systematic frameworks that are advocated and used in many countries. The types of frameworks widely advocated and which we will concentrate on in this section are:

a) Cost-Benefit Analysis (CBA)
b) Cost Effectiveness Analysis (CEA)
c) Multi-Criteria Analysis (MCA)
d) Risk - Benefit Analysis (RBA)
e) Environmental Impact Assessment (EIA).

a) Cost-benefit analysis

Cost-benefit analysis (CBA) measures as far as possible, the costs and benefits of a policy or action. Since the resource cost of policies or actions are invariably in money terms, comparison in cost-benefit analysis is undertaken by measuring benefits in money units. There are two fundamental features in CBA. First, it forces the analyst to list the pros and cons of any policy or action. Second, the listing must reflect some goal. It is common that the ultimate goal in CBA is that of increasing the society's well-being. This implies that anything contributing to gains in the society is a benefit and anything detracting from it is a cost. In CBA, care has to be taken to neither double-count nor to count as a benefit to society a simple transfer from one member of the community to another. However, such a transfer will be relevant when considering and understanding the incidence of impacts mentioned section 2.1.

The basic rule in CBA can be formulated as follows:

$$NSB = B - C > 0 \qquad (1)$$

Where NSB is net social benefits, B is the benefit and C is cost. The basic rule above implies that a policy is desirable if the net social benefit is positive i.e. benefits greater than costs. Since benefits and costs may occur at a later time after a project has been realized, time is readily introduced into (1) above as:

$$NPV = \sum_{t=0}^{T} (B_t - C_t) \bullet (1+r)^{-t} \qquad (2)$$

Where NPV is the net present value of net social benefits, Bt the benefits in year t, C_t costs in year t, T the time horizon and r the rate of social discount. The rule then is that the net present value of social benefits be greater than zero. There are three theoretical justifications for discounting:

- that people are generally becoming better off hence place less weight on given benefit over time (i.e. the social time preference);
- that resources devoted to a particular project should at least earn as high return as they would have elsewhere (i.e. the capital rationing argument);
- to ration scarce resources financial resources in the sector (i.e. the capital rationing argument).

Argument (2) is usually adopted by government agencies and other lending agencies.

Several decision rules have been developed in CBA. The simplest of them is to undertake all projects where the net present value (equation 2 above) is positive. Other important rules that have been proposed include the Internal Rate of Return (IRR); which is defined as the discount rate which would produce a NPV equal to zero i.e.

$$\sum_{t=0}^{T}(B_t - C_t) \bullet (1+i)^{-t} = 0 \qquad (3)$$

Where T, B_t and C_t are as previously defined and i the internal rate of return. Critics of internal rate of return point to the fact that IRR is a solution to polynomial equations with many roots which cannot always be sorted out.

A second decision rule which is also frequently used is the benefit-cost ratio (B/C). The simplest benefit-cost ration is defined as:

$$\frac{B}{C} = \frac{\sum_{t=0}^{T} B_t(1+r)^{-t}}{\sum_{t=0}^{T} C_t(1+r)^{-t}} \qquad (4)$$

The decision rules that B/C be equal to or greater than one is acceptable. Another specification of benefit-cost ratio which takes account of capital as a scarce factor is to take the ratio; net present value (NPV) to capital costs as follows:

$$\frac{B}{C} = \frac{NPV}{C_{capital}} = \frac{\sum_{t=0}^{T}(B_t - C_t) \bullet (1+r)^{-t}}{C_{capital}} \qquad (5)$$

The formulation above assumes that capital costs are distinguishable from operating costs.

Another simple but useful index in CBA is the so-called first year rate of return (FYRR). In comparison to the other indices, a FYRR is much less demanding as data is only needed for the opening year:

$$FYRR = \frac{B_1}{C} = \frac{\sum_{i=1}^{I} B_{1i}}{C} \qquad (6)$$

Where B_1 is the stream of benefits in the opening year, B_{1i} is benefit component no. i, I is the number of benefit components taken into account, and C is the sum of discounted construction costs. The FYRR shows how worthwhile a project is in the first year. It should be noted, however, that the applicability of FYRR is related to the issue of timing. The year in which the project achieves a FYRR equal to the discount rate is the year for which the NPV is maximum; this year is the optimal starting date for the project under two conditions,.

These conditions are:

- the benefits are always increasing with the years (which are generally the case)
- the NPV must be always discounted at the same reference year

b) Cost-Effectiveness Analysis

Cost effectiveness deals with benefits that are not easily quantified or for which there are no easily defined money units. There is thus, no formal rule for determining whether a policy is desirable or not. The principal aim of CEA is to obtain a money-based index that is helpful in comparing alternatives with the same general type of objective. Such an index can be obtained as follows:

$$\text{Cost Effective Index} = \frac{\text{Units that measure consequence}}{\text{Cost in monetary units}} \qquad (7)$$

Thus a project with the highest index is preferred. For example it may be decided to spend $K on reducing the rate of accidents along a corridor. Let now H be the number of units that measure the consequence in non-monetary terms. If there are several ways of achieving accident reduction, the one with the highest value of H/$K (or the lowest value of $K/H) is to be preferred.

Although there exist real situations where CEA has a significant role to play in decision making, it does not indicate whether a policy is worthwhile or not. However, if a decision is already made to invest in a project, CEA is an important procedure for ensuring the rational use of limited resources. Another strength of CEA is that it may overcome resistance from decision-makers to the idea of money valuation of benefits. It should, however, be noted that once the decision-makers make the decision on the basis of CEA, then they have implied a money value. CEA is in this way a variant of CBA.

c) Multi-Criteria Analysis

Multi-criteria analysis (MCA) takes into account both the effects that are valued in monetary terms and other effects considered to be of interest. In relation to CEA, multi-criteria analysis tackles the problem of several effects arising from a policy which CEA cannot. Since effects of a policy cannot be added together directly because of the lack of a common unit (which would be money in the case of CBA), MCA places a weighting factor on the individual effects. If, for example, reduced accidents were more important than gains in scenic beauty, then they would be weighted with a higher factor. The various benefits may then be summed up in their weighted form. For example, if benefits are accident reduction (A) scenic beauty (S) and savings in travel time (T), and their respective weighting is a, s and t, then the overall benefit is B´, where:

$$B' = aA + sS + tT \qquad (8)$$

The weights are in fact prices since they reflect the relative importance of each of the objectives. They are, however, derived in a number of ways: by asking experts; by asking individuals and by asking decision-makers. It should be observed that the resulting B´ can be assessed as the cost effectiveness index shown in (7) as B´/C (where C is the cost in monetary units). The comments concerning CEA are therefore also applicable to this approach. Multi-criteria analysis is more complex than the general description given here.

The main advantage of multi-criteria analysis is that it incorporates the multiple objectives that decision-makers generally have, and if the weighting factors can be derived, it enables diverse objectives to be integrated. When compared to CBA, the fundamental difference is that MCA recognizes that economic efficiency is not the sole objective of a policy.

d) Risk-Benefit Analysis

The application of decision rules to risky events has led to the emergence of Risk Benefit Analysis (RBA). RBA is nothing other than CBA in the context of a risky event. To see the formal equivalence, consider a transportation project that will increase the level of pollution and hence the risk of being sick. The risk of such a policy is the number of people being sick due to the increased pollution. The benefits of “no action” are the avoided costs of cleaning the pollution. We can therefore compare the risk with benefits to give us “*risk-benefit analysis*”. The similarity with CBA is that RBA takes the number of sick people to be the cost and the foregone resource cost to be the benefit.

e) Environmental Impact Assessment

The practice of EIA typically requires the identification and measurement of impacts of any action where those impacts may be adverse or beneficial. EIA pays particular attention to the environmental consequences of a policy action. Typically, alternatives to the policy are also shown. Impacts may also be valued in monetary terms, in fact many EIA practices include CBA within their wider frameworks. The objectives which determine gains and losses are often unclear and in relation to CBA, entail double counting. Furthermore, there is no aggregation rule and decisions are made on the basis of inspecting the matrix of impacts. The advantages of EIA are similar to those of MCA. It allows for objectives other than economic efficiency to be taken into consideration in an explicit manner.

The relationship between cost-benefit analysis and multi-criteria analysis

As we will see later, cost-benefit analysis, multi-criteria analysis or a mixture of the two are the most frequently used methods for assessing the impacts of road projects. The distinction between the two approaches is sometimes vague and in many instances may be a matter of semantics rather than substance. It is therefore important to comment on their relationship.

The simplest and perhaps most meaningful definition that will be pursued here is found in the United Nations Seminar on International Transport Investment (1987) which suggests:

"The primary difference between the two methods is that in cost-benefit analysis, the analyst attributes the weights to the various objectives and is responsible for the aggregation of the project's effects, whereas in multi-criteria analysis the decision maker gives the weights to the objectives and is involved in the final evaluation phase"

It should now be clear that both techniques assess the effects of investment in relation to a base situation, and that both are applied to a wide range of projects and that they differ in the treatment of impacts. Both techniques are applicable to most types of projects. The appropriateness of each technique depends, however, on the relative availability of information on value indicators, i.e. whether or not impacts can be monetized. In cases where agreed monetary values are available for the majority of impacts, the cost-benefit analysis may have a relative advantage over the multi-criteria analysis, and vice versa, in cases where monetary values are not available. It should therefore be apparent that the method to choose will depend on the objective of the analysis and the nature of the impacts to be assessed. In many circumstances, where some and not all impacts can be valued in monetary terms, a hybrid of the two techniques may be called for. A hybrid technique may overcome the disadvantages of the two techniques while maintaining their advantages.

Summary of evaluation methods

This chapter has described the most central evaluation methodologies that are used in practice. Each methodology has its advantages and weaknesses. The debate concerning which methodology to choose, however, seems to be misplaced as the methodologies do not seem to compete with each other. For example, risk and uncertainty are easily integrated in CBA and CEA rules. Which procedure to use seems to be determined by the problems of monetary benefit estimation. This is the fundamental reason for choosing one procedure rather than another.

To sum up, one may conclude that there is a spectrum of approaches to the economic appraisal of road projects. At one extreme lies the purely multi-criteria analysis which employs weights from a variety of sources which contain a large degree of subjective assessment. At the other extreme lies the purely cost-benefit analysis which exclusively employs monetary valuation and has generally more objective and explicitly defined criteria. Which approach to choose will therefore depend on the objective of the analysis, the nature of impacts to be assessed and the hierarchical level of decision making as outlined in chapter 2. In many circumstances, it is appropriate to form a sort of hybrid framework. Such a framework may overcome the disadvantages of each framework while at the same time takes care of the advantages of each.

3. METHODS OF VALUING IMPACTS

In order for physical measure of impacts to be comparable, they must be valued in common units. It is of a great advantage if as many impacts as possible are valued in the same unit of measurement. This provides a standard by which projects can be compared. In turn, it results in consistency of evaluation and provides an opportunity for greater efficiency in decision making. Monetary unit is undoubtedly the best measure in this respect. It should be noted, however, that this is merely a device of convenience rather than the implicit statement that money is all that matters. Markets generate the relative values of all traded goods and services as relative prices: prices are therefore very useful in comparing resources used in road construction with working hours saved, not only because both are made comparable, but some indication of their scarcity is provided. Prices carry valuable information.

This chapter describes, in a brief manner, methods used to evaluate impacts normally considered in economic evaluation frameworks within the transport sector. There are several ways of valuing impacts depending whether the impact is market traded or not. These can be categorized into the following four groups:

- Impacts for which prices exist in the market
- Impacts for which prices can be imputed from quasi-market observation

- Impacts that are best indicated by using weighting techniques
- Impacts which are best indicated by using qualitative descriptions.

3.1. Impacts for which prices exist in the market

In a free market, under certain conditions, an economically efficient allocation of resources will be achieved by the activities of the producers and consumers freely buying and selling goods and services. In a perfectly operating market economy, only goods for which consumers will be willing to pay for will be produced, and prices will be equal to the marginal cost of production. In such a market, the resources values of goods will be reflected in their prices.

It follows that, wherever competitive markets are operating freely, market prices are an appropriate measure of cost or benefit of transportation projects.

There are, however, circumstances where markets are distorted e.g. through monopolies, regulation or failure to internalize external effects. In such cases it is necessary to take these distortions into account in order to maintain consistency. An adjustment commonly undertaken is to remove taxes meant for revenue purposes, from cost as these represent a transfer to the government rather than a cost to the economy as a whole.

If, however, an element of the tax represents a pollution charge, justified as a price for a scarce resource, it would be appropriate to treat that element as part of the resource cost and not as a transfer to the government.

To summarize, market based prices provide very useful indicator values of impacts which, if suitably adjusted for market distortions, should be used in economic evaluation of road projects.

3.2. Impacts for which prices can be imputed from quasi - market observations

There are many costs and benefits of transport projects (time saving; pain and grief resulting from accidents; environmental effects, etc.) which do not have a direct market price. However, for some of these impacts, values can be imputed or inferred from observed or stated human behaviour. The principal methods normally used are the following:

- revealed preference (RP)
- hedonic pricing (HP)
- travel cost method (TCM)
- stated preference (SP)
- contingent valuation method (CVM)
- replacement cost method
- dose -response method

(i) Revealed Preference (RP)

Revealed preference methods rely on finding a market in which people reveal the value they attach to the attribute in question in terms of willingness to pay for it or accept compensation for its loss. RP method implicitly assumes that individuals know the value of the good in question and are aware of the effect on their utility that an increase or a decrease in the good in question would bring. Revealed preference has been applied widely in the transport sector for example, in the valuation of travel time. The approach has been used to try and discover what people are willing to pay to save time. The most popular case is that of choice of travel mode, where people may have a choice between two modes, one of which is faster and more expensive than the other one. If a model gives an estimate of the probability with which a person chooses one mode of transport rather than the other as a function of journey time, money cost and any other relevant quality difference, the relative weight attached to time and money can be used to estimate that person value of time.

Revealed preference is useful but has also its weaknesses. In the example above, it is necessary to find cases where such trade-off really exists and are perceived and understood by representative cross-section of the population. To estimate the value of time to a reasonable degree, samples running into thousands are needed and the data usually has to be collected specifically for this purpose by means of a questionnaire.

(ii) Hedonic pricing (HP)

Hedonic pricing is a form of revealed preference analysis. Its main preposition is that the price of a good is related to its characteristics and that thus the consumers' preference for attributes of a good can be inferred from consumption decision. HP is mostly used in the context of house price models to derive amenity/environmental benefits associated with a particular area. The approach is to estimate the relationship between house prices and the environmental characteristics of houses while controlling for other factors such as the physical characteristics of the house and its accessibility. The estimated effect on price of the environmental factors such as the level of noise and air pollution are often taken as some sort of mean valuation of the characteristics in question, although more complex methods may be applied.

The HP approach has several shortcomings. For instance, as usually applied, it assumes a perfect market in which buyers with perfect knowledge can obtain any combination of characteristics they wish. At best it can only be used to value attributes experienced in the home and where people correctly perceive the effects themselves. Thus it is likely to be more appropriate in valuing noise nuisance rather than valuing the health impacts of air pollution. Furthermore, HP has limited application where housing is rented and cannot provide the values held by people who are not the consumers of the particular housing market. Moreover, there is no clear relationship between willingness to pay, as is normally indicated by sales prices, and the social costs or benefits. Data requirements are also very high and there may be problems in finding suitable sample population.

(iii) Travel cost method (TCM)

The travel cost (or the Clawson method) approach by contrast to the HP method is only applicable for valuing the benefits of visiting facilities. It solely relies on estimating a demand curve relating the frequency of visits to the travel cost involved. TCM has been used in transport sector to provide estimates of the impacts to recreational sites that are severed or damaged due to road construction.

Again there are some limitations with TCM. The most obvious is that most leisure trips are multipurpose, and it may not be clear to what extent the cost incurred is due to visiting a single facility, such as beach or stretch of woodland, or due to the other components of the trip. TCM is a partial technique in that it only measures the benefit people get from visiting sites rather than the value the site may hold in terms of scientific research or people's willingness to pay to preserve it.

(iv) Stated preference (SP)

An alternative to finding markets in which people reveal their valuation by the choices they make, is to use surveys to ask them about hypothetical decisions. Such hypothetical methods are normally referred to as stated preference. In recent years, SP methods have taken over from revealed preference as the dominant method used in overcoming valuation problems in benefit-cost analysis. In some contexts, such as the value of time saving, the reason is cost effectiveness. By asking respondents to choose between a number of hypothetical alternative pairs of options, estimates may be obtained of the relative value they attach to different attributes of the options with much smaller and therefore cheaper samples than if revealed preference data were used. In revealed preference survey, only one response is obtained per respondent. In addition, the questions in SP may be formulated to yield maximum information, and problems such as multicollinearity may be avoided. A second reason for preferring stated preference is that uncertainty about perception may be reduced by the provision of information, for instance, journey times and costs of alternative modes of transport. Stated preference exercises have now become the dominating technique used for valuing the human cost of accident, value of time and valuing the environment.

As stated earlier, stated preference exists in a number of different forms, the most popular being Contingent Valuation Method (CVM) as discussed below.

(v) Contingent Valuation Method (CVM)

Contingent Valuation method has become popular, especially in the environmental field. CVM involves actually asking direct questions about an individuals “willingness to pay” (WTP) to achieve or to avoid a particular result such as to reduce the level of noise nuisance in given area or to protect a forest from destruction. This method is attractive, because in principle it can be used to value almost anything, regardless of whether it can be quantified or not, or if it has been experienced or not. With the aid of CVM it appears possible to quantify almost all externalities in the transport sector.

There are, however, problems, with SP and CVM. The main weaknesses of these approaches are that the data obtained represents the individuals’ statement of what they would do in hypothetical situations. One way of overcoming the problem is to present respondents with situations that are as realistic as possible. The problem is larger in a badly designed survey than in a well designed one. Another problem is that what people say and what they do are often very different.

(vi) Replacement cost method

The cost of replacing goods which have been damaged or destroyed by a particular impact can be used as a proxy for the benefit to society of eliminating certain externalities resulting from road investments. An example could be the planting of trees to replace those felled during construction. A weakness of the replacement cost method is that replacement may not actually take place. In such a case, the replacement cost is a poor guide to the loss of benefit.

(vii) Dose-response relationship

This method involves obtaining money values of pollution via dose-response relationship. Two stages are involved. First, the general relationship between physical damage and level of pollution is identified. Second, the specific level of pollution is used to estimate the physical damage. Multiplying by the price per unit of damage gives the cost of pollution. Dose-response has been used in studying metal corrosion, vegetation damage and the effects of pollution on public health. The problem with dose response is that the data requirement is high and there are problems of interdependence between causal variables. Furthermore, there are doubts as to whether the alternative costs fully reflect the cost of the externality.

3.3. Impacts that can best be indicated by using weighting techniques

Another approach to determine impact values is to derive values directly by assigning weights for each impact, stating the impact relative importance to all other impacts under consideration. The weights are derived in a number of ways: by asking experts; by asking individuals; and by asking decision-makers. There are several techniques under this category generally termed multi-criteria. These categories include lexicographic approaches, consensus-maximizing approaches, aggregational techniques, graphical techniques and concordance techniques. Common to these techniques hence their advantages, is that they try to overcome the basic problem which occurs when alternative schemes have to be evaluated using a range of apparently non-comparable criteria. They seek to describe the diverse scheme impacts in similar terms so that trade-offs and comparisons can easily be made. The techniques reduce the information about impacts to a set of single score numbers or grand index and determine the best solution or produce a complete or partial ranking of alternatives following a series of pairwise comparisons. The advantages of these methods are similar to those discussed in chapter 2 under multi-criteria methods.

3.4. Impacts which can best be indicated by using qualitative descriptions

Impacts that belong to this category are divided into two groups: (1) those that mainly cannot be valued because no adequate study of the possible effects exists and (2) those where valuation might be wrong in principle because they are irreplaceable or their effects may be irreversible.

For those in-groups (1), impacts can be dealt with by expert opinion. In the second group, it may be inappropriate to place a monetary value, especially the environmental ones. The importance of some environmental assets may lie in their uniqueness and therefore cannot be substituted. The use of monetary evaluation in such a case may be pointless. To the decision-makers trade-offs should be described.

Whenever these types of impacts arise they are best dealt with by explicit description and/or measurement in physical terms rather than valuation in monetary terms. A set of rules and procedures determining what has to be described, the level of detail and the bodies to be consulted, is however, necessary.

An example of this approach is the so-called *Leitch framework* in the Design Manual for Roads and Bridges, Department of Transport, UK.

Summary of methods of evaluating impacts

This chapter has presented the state-of-the-art of monetary and non monetary techniques used in valuing impacts. In principle methods exists for valuing all the costs and benefits of road investments. However, all have their problems and the reliability of most of them is open to discussion and criticism. Yet a number of points may be mentioned. The usefulness of monetary evaluation techniques in relation to the environmental impacts in particular, depends upon the extent to which the effects of impacts are perceived by the individuals. The advantage with the monetary evaluation methods as compared to the non-monetary methods is that the monetary methods are transparent and can easily be communicated into political debates whereas pure non-monetary methods, such as weighting, may not. An additional argument for emphasizing monetary evaluation is that it facilitates comparison between socio-economic valuation of schemes and financial evaluations.

The basis for evaluation of the impacts, however, should be to exploit the strengths of a range of approaches while ensuring an acceptable level of compatibility between them. Furthermore, the methods chosen for evaluating impacts should be seen in the light of the objectives with evaluations and the decision making process.

4. SUMMARY AND COMPARISON OF EXISTING FRAMEWORKS IN MEMBER COUNTRIES

This chapter reviews the different frameworks used for economic evaluation of road projects in the member countries. The objective of this section is not to describe each framework in details but to present an overview of similarities and differences between them. Drawing on information gathered, it considers methods of evaluation (section 4.1) objectives and scope of application (section 4.2), overall approach to project comparison (section 4.3), range of criteria included in the methodologies (section 4.4), methods used to derive monetary values (section 4.5) and a comparison of value of indicators (section 4.6). In section 4.7 methods for evaluating impacts not valued in monetary terms are summarized. Section 4.8 summarizes the extent to which monetary values are accepted in the various countries.

However, caution is necessary when interpreting results presented section 4.6. The values presented are derived through different methods in the member countries, and in many circumstances will contain different components. Direct comparison is therefore not always possible.

4.1. Methods of evaluation

In all frameworks studied, economic evaluation methods play an important part when road schemes are appraised. Benefit-cost analysis supplemented with other forms of assessment, particularly environmental impact assessment, plays a part in all frameworks. As an example, the framework of the United Kingdom is benefit-cost analysis in which most indicators are given monetary values, although it is supplemented with environmental impact assessment. The Norwegian framework has benefit-cost analysis as its core while indicators not measurable in monetary terms are assessed qualitatively. The Israeli framework entirely has only benefit-cost analysis although the evaluator has the option to address issues that are not quantifiable in monetary terms. The framework in the Republic of South Africa adopts benefit-cost analysis methodology in which all indicators are given monetary values.

The methods used in the different member countries may be classified according to a general categorization developed in conjunction with the EURET/385/94 report which was commissioned by European Commission DG VII. Table 4.1 below presents this categorization for the different member countries.

Table 4.1: Categorization of methods in member countries

Conventional benefit-cost analysis	Broader framework with emphasis on benefit-cost analysis	Broad framework with emphasis on multi-criteria	Mainly multi-criteria with limited Cost-Benefit analysis	No particular framework or framework varies with state or province
Israel Finland Sweden South Africa Portugal* Spain* New Zealand	Czech Republic Germany UK Norway Switzerland Denmark Australia Greece	France*	Belgium* Netherlands	Canada USA

* Classification from EURET/385/94 report is assumed.

As shown in Table 4.1, the framework for Norway, United Kingdom, Australia and Germany is described as broad framework in which emphasis is placed on the outcome of the benefit-cost analysis. Methods of evaluation used in Israel, Finland and Sweden, on the other hand, employ the benefit-cost analysis.

Canada and the United States do not apply any standardized method for economic evaluation of road projects. The method of evaluation varies between states or provinces, although the benefit-cost analysis is widely employed. The most distinguished member countries in terms of methods are Belgium and the Netherlands. These countries use conventional multi-criteria techniques. In multi-criteria techniques, weights are applied to the various criteria to produce a common single measure for the purpose of project comparison. It should be noted, for France, Belgium and Netherlands, that the benefit-cost analysis is one of the criteria taken into account in multi-criteria analysis. In France, the method is being revised, the cost-benefits analysis being completed by a survey of monetized impacts and of non-monetized impacts.

Note that most European countries, either as member states of the European Community or as member of the European Economic Area must, under directive 85/337, produce an environmental impact statement for any large road projects.

4.2. Objectives and scope of application

In most countries, infrastructure projects are constructed through public funds. Exceptions exist, e.g. in Norway, a certain proportion of road infrastructure is financed through tolls and fuel taxes. Nevertheless, most infrastructure is provided without any profit motives. This implies that factors, other than more conventional commercial measures of expected profitability are required as an indication of the social worth of projects.

A common objective for the economic evaluation of road projects in most member countries is that such evaluations are necessary for preparing a set of feasible alternative plans for road investments and to assist decision-makers in selecting the most desirable projects from a pool of projects.

Although there is a great variation with respect to the area of application of the methodologies in member countries, evaluation methodologies can be classified according to the following categories of purposes:

i. Assessment of road maintenance and operations
ii. Ranking of mutually exclusive alternatives, i.e. selecting the best alternative

iii. Selecting schemes to be included in the road programme
iv. Defining national transport policy (comparing road projects to other modes of transport).

(i) above involves assessing the economic benefits of maintaining and operating existing roads. In addition to the methodologies named above, another method, known as life cycle cost analysis principles, may be used to assess road maintenance and operations. The life cycle cost analysis involves minimizing the costs of providing a given standard of maintenance during the service life of a road. In some cases, especially when evaluating different maintenance options, road user delays for different options are calculated and included in the analysis.

Ranking mutually exclusive projects in (ii) occurs when two or more projects are interdependent i.e. projects are alternative solutions. For example, two bridge projects for the same fjord crossing. Another type of decision where economic evaluation may be used concerns the prioritization problem i.e. (iii) above. This involves the selection of a group of projects from a larger pool of projects. This type of decision is affected by the limits of an investment budget for the planning period. A fourth type of decision, (iv) above, concerns defining national transport policy. Here road investments may be compared to other modes of transport and the mode with best merit is selected.

In Norway and in the United Kingdom, the principal reasons for economic evaluation are according to i), ii) and iii) above. In the Czech Republic, economic evaluation is used for purposes i) and iii). In Denmark, Finland, France and Germany the economic evaluations are used for the purpose ii) and iii). In Sweden and Israel, evaluations are used for all the purposes listed above. In Canada, the evaluation methods employed are generally used to evaluate the economic worth of some but not all road projects, and the methodologies may vary from province to province. In the United States, the objective of economic evaluation varies by state and may include none or all the categories listed above. In Australia, economic evaluation is used to prioritize discretionary projects on an economic basis and to demonstrate that the total programme of road projects provides a real economic benefit. Given the climatic diversity and size of Australia, pure economic evaluation alone is not seen as sufficient to determine the appropriate priority of projects.

4.3. Overall approach to project comparison

Overall approach to project comparison may vary between member states depending on the framework of evaluation used. In those countries where benefit-cost analysis techniques play a part, the overall approach to project comparison is similar and resembles those found in textbooks. Alternatives for the same project are compared against a “Do nothing” or a “ Do-minimum” option. This refers to the existing road traffic network, although it may include minor cost improvements when feasible.

Cost estimates include all capital expenditures and provisions for future maintenance of the network, both for the "do something" and "do minimum" alternatives. Benefits calculated in monetary terms are assessed for a given appraisal period which may vary between countries at a discount rate, which also may vary.

Projects or project alternatives are ranked according to some indicator for project worth e.g. net present value, benefit-cost ratio, etc. For countries that use a broader framework than conventional benefit-cost analysis, indicators for economic worth are used in addition to the impacts that cannot be calculated in monetary terms. Table 4.2 below, gives some information on the indicator of the project, the appraisal period and the discount rate used in each country.

As can be seen from the table, there is a great variation in all variables between countries. The shortest appraisal period is 15 years (Israel) while the longest is 40 years (Sweden). Note, however, that Sweden does not calculate residual value of capital while Israel does. The discount rate varies from 3% in Germany to 15% in the Republic of South Africa.

Although the indicators shown above are used for project ranking, it should be noted that a project’s unquantified environmental benefit is also given consideration. In the case of the United Kingdom, for example, schemes and options with negative net present value are rejected unless the unquantified environmental benefit of the scheme are judged to outweigh this difference between costs and benefits. In Australia, projects are screened for strategic fit, assessed on economic terms, then evaluated taking into account social and environmental objectives, often in an unquantified manner.

Table 4.2: Indicator for project worth, discount rate and appraisal period

	Indicator for project worth	Discount rate	Appraisal period	Residual value of capital calculated
Germany	benefit-cost ratio	3%	30	no
Sweden	benefit-cost ratio	4%	40	no
Belgium*[m]	net present value	4%	30	no
Netherlands*[m]	net present value	4%	30	no
Finland	benefit-cost ratio	6%	30	yes
Spain*	benefit-cost ratio	6%	30	no
Denmark*	first year rate of return	6%	30	_
UK	benefit-cost ratio	6%	30	no
Israel	net present value	7%	15	yes
Australia	benefit-cost ratio	7%	30	no
Norway	benefit-cost ratio	7%	25	yes
Portugal*	net present value	8%	20	no
France*[m]	first year rate of return	8%	_	_
New Zealand	benefit-cost ratio	10%	25	yes
South Africa	benefit-cost ratio	15%	30	no
USA[a]	benefit-cost ratio	7%	40	yes
Switzerland	_	_	_	_
Italy*	benefit-cost ratio	_	_	_
The Czech Republic	benefit-cost ratio	_	_	no
Canada (Quebec only)	net present value	7-10%	30	no

* values from EURET 385/94 report
[a] Different indicators within the benefit-cost analysis are used, in most cases the benefit-cost ratio itself
[m] The basic framework is the multi-criteria analysis where the results of the benefit-cost analysis is one of the criteria
_ implies that information was not available at the time of writing

Source:
Questionnaire survey of member countries and EURET 385/94 report

4.4. Range of criteria included in the methodologies

The benefit-cost analysis methodology only includes criteria valued in monetary terms. Nevertheless, it is widely used by member states as a partial or primary evaluation technique. It is recognized by member states that there are several criteria which are not valued in monetary terms or even quantified in any other unit. However, the majority of criteria in all the frameworks studied are related to socio-economic impacts and hence form the core of the benefit-cost analysis. These impacts may be grouped into the following general areas (EURET/385/94):

- transport and economic efficiency,
- safety,
- environmental protection and improvement.

Transport efficiency typically includes travel savings, vehicle operating costs, maintenance costs and investment costs. Safety mainly includes accident costs, while environmental protection and improvement involves impacts such as noise nuisance, air pollution, visual intrusion etc. The range of impacts included in the methodologies may also be divided into two categories: those that are valued in monetary terms and those that cannot and hence are described qualitatively. Table 4.3 below provides an overview of impacts in the two categories as practiced in most frameworks.

Table 4.3: Range of impacts included in frameworks by category

Impacts valued in monetary terms	Impacts described in words or qualitatively
Travel time savings Accident costs Vehicle operating costs Road maintenance costs Investment costs Delay caused by maintenance work Noise nuisance* Local air pollution	Air quality** Cultural heritage and monuments Disruption due to construction* Ecology and nature conservation Landscape effects Land use Effects on pedestrians and cyclists Water quality and drainage Geology and soil Outdoor recreation

*Not all frameworks value this in monetary terms
** some components may be valued in monetary terms

The degree to which all the above impacts are included in frameworks varies a great deal between member states. Norway, Sweden, Germany, Netherlands, Belgium and the United Kingdom include most of these impacts in their frameworks.

Some frameworks, such as that of Sweden, include other real impacts - notably related to stress, comfort and general well being of drivers. In France, comfort is also considered in the framework.

Another important factor included in some frameworks is regional impact. In Norway, Sweden and the United Kingdom, regional impacts are considered taken into account through travel time savings and vehicle operating costs. They are hence not considered independently, but as a distributional impacts.

4.5. Methods used to derive monetary values

The methods used to derive monetary values of an impact will, of course, depend on the impact being evaluated. Different member states may use different methods of deriving values depending on the objectives. Objectives for deriving values have not been investigated in this study. It is assumed that the objectives are used in the impact assessment of road projects.

For some impacts, more than one method may be used to derive monetary values. One example is time savings, where time savings outside the course of work may be valued using stated preference techniques while time savings in the course of work are derived using opportunity cost principles. Different components of accidents costs are also valued in this manner e.g. material damage is valued using market values while loss of life is valued using both market values and stated preference technique to measure willingness to pay to avoid accidents.

The different methods for deriving monetary values are grouped as follows:

- Impacts traded in a market - resource costs
- Non-traded impacts - revealed preference, stated preference, implicit valuation, ad hoc procedures.

The material collected reveals that some countries choose to derive values with methods that are typical for non-traded impacts, even though the impact is traded in the market. A summary of observed practices in the different countries is given in Table 4.4 below. It should be noted that all countries value travel time savings, accident cost, vehicle operating costs, maintenance costs and investment costs in monetary terms.

Table 4.4: Summary of observed methods for deriving monetary values

Impacts	Method for deriving monetary values
Travel time savings:	
Business travels	Resource cost (Opportunity cost)
Other travel	Stated preference, revealed preference
Accident costs:	
Fatality	Stated preference, Loss of production
Injury	Stated preference and opportunity cost
Material damage	Resource costs
Vehicle operating costs:	
Fuel	Resource costs
Maintenance costs	Resource costs
Garage costs	Resource costs
Road maintenance	Resource costs
Investment costs	Resource costs
Pollution:	
Local air pollution	Stated preference
Noise nuisance	Stated preference, Hedonic method
Barrier effects	Stated preference

4.6. Comparison of value of indicators

It is of interest to compare values of indicators between countries. In section 4.5, we stated that most countries value travel time, accident costs and vehicle operating in monetary terms. From the collected information, it is possible to compare these values between most countries. Sections 4.6.1 and 4.6.3 below summarize the main results.

4.6.1. Value of time

Figure 4.1 compares the value of time for business travel in the framework of member states. The values shown were almost always derived using the opportunity cost approach. There are, however, three exceptions. Swedish and Spanish values are derived from stated preference studies. In the framework of South Africa, the value of time, regardless of income group, status as worker or non-worker or travel purpose, is considered to be reflected by the Gross Domestic Product (GDP) per capita. The value of time per hour per person is then found by dividing GDP per capita by total numbers hours in a year.

An overview of values by travel purpose used in the different countries is provided in Table 4.5 below. As indicated, values are expressed in 1997 ECU except where mentioned. For the United States, we have used the average values calculated from a range of values used in different states.

It should be noted that there are several countries that do not differentiate values by travel purpose.

The variation in values for business travel ranges from 2.0 to 24.35 ECU with an average of 16.10. The Czech Republic has the lowest value while Norway has the highest. The range of values for to/from work and other travel purposes is from 0.50 to 18.65 ECU. Again, the Czech Republic has the lowest value while Belgium has the highest.

	Déplacement d'affaires	De et vers le lieu de travail	Autres buts	
République tchèque	2,00	1,50	0,50	The Czech Republic
Afrique du Sud	5,45	5,45	5,45	South Africa[d]
Allemagne	5,64	4,23	2,82	Germany
Espagne[c]	9,47	9,47	9,47	Spain[c]
France	11.24	11.24	11.24	France
Nouvelle-Zélande	12,50	4,10	4,10	New Zealand
Canada (Québec uniquement)	-	6.13	4,29	Canada (Quebec only)
Portugal	15,43	2,50	2,50	Portugal
Suisse[a]	15,50	15,00	14,50	Switzerland[a]
Royaume-Uni	16,70	4,10	4,10	UK
Pays-Bas[b]	17,35	17,35	17,35	Netherlands[b]
Israël	18,00	1,75	1,75	Israel
Italie[b]	18,28	18,28	18,28	Italy[b]
Belgique[b]	18,65	18,65	18,65	Belgium[b]
Etats-Unis	18,79	8,89	8,89	USA
Finlande	20,80	5,80	4,60	Finland
Australie	21,04	8,60	8,60	Australia
Suède	22,20	4,70	4,00	Sweden
Danemark	22,25	6,09	5,01	Denmark
Norvège	24,35	8,00	8,10	Norway
Max.	24,35	18,65	18,65	Max.
Min.	2,00	1,50	0,50	Min.
Moyenne	17,35	6,11	5,23	Average

[b] Chiffres cités dans le rapport EURET 385/94. Valeurs basées sur PIB 1990 par tête de la population active / *Figures from EURET 385/94 report. Values are based 1990 GDP per capita of the working population*
[c] Valeurs moyennes par heure véhicule citées dans le rapport EURET 385/94 et exprimées en ECU 1990 / *Average values per vehicle hour from EURET 385/94 report and expressed in 1990 ECUs*

Tableau 4.5
Valeur du déplacement en fonction de son but exprimée en ECU 1997 par heure véhicule (Les valeurs sont exprimées en ECU 1997, sauf mention contraire)

Table 4.5
Value of travel according to its purpose expressed in 1997 ECU per vehicle hour (Values are given in 1997 except where mentioned)

4.6.2. Accident costs

The information collected makes it also possible to compare accident costs. Table 4.6 provides values by casualty type for frameworks from different member countries.

Accidents values are derived on the basis of three types of costs: (1) direct finance costs to those concerned; (2) loss of output to those killed or injured and; (3) cost associated with « grief, pain and suffering» resulting from death or injury. The most commonly used methods for valuation are given in section 4.5 (see Table 4.4).

As is seen in Table 4.6, figures from several countries were not available. The variation in accident costs for the countries from which data was available is large. This variation is better visualized in figures 4.2 to 4.4.

It must be noted that the precise definition of what constitutes a fatality, serious or slight injury is most likely to differ between countries. This might be one explanation for the large variations observed. Another possible explanation is the approach used for valuation in each individual country.

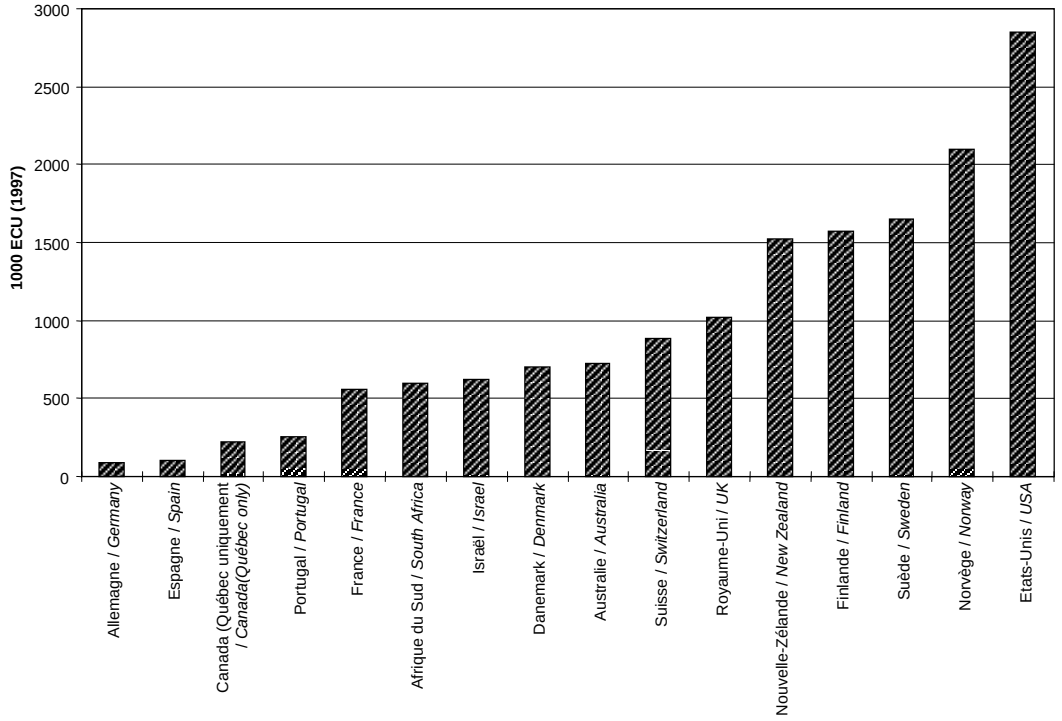

Figure 4.2
Comparaison des valeurs dans le cas d'accidents mortels

Figure 4.2
Values of fatality for different countries

Considering valuation of material damage shown in figure 4.3, Republic of South Africa has the highest valuation and the variation by countries is well pronounced. The same trend is also visible in serious casualties where USA has the highest valuation (see figure 4.4).

4.6.3. Vehicle operating cost

Vehicle operating costs are universally given monetary values. The components will normally include fuel/oil consumption, tyre wear, vehicle maintenance and depreciation. There are some variations in the precise definition of these cost components between member states.

Since most of the components depend on factors such as geography, age of vehicle fleet and fuel/oil prices, vehicle-operating costs will naturally vary by country. The magnitude of this variation is shown in Figures 4.5. and 4.6

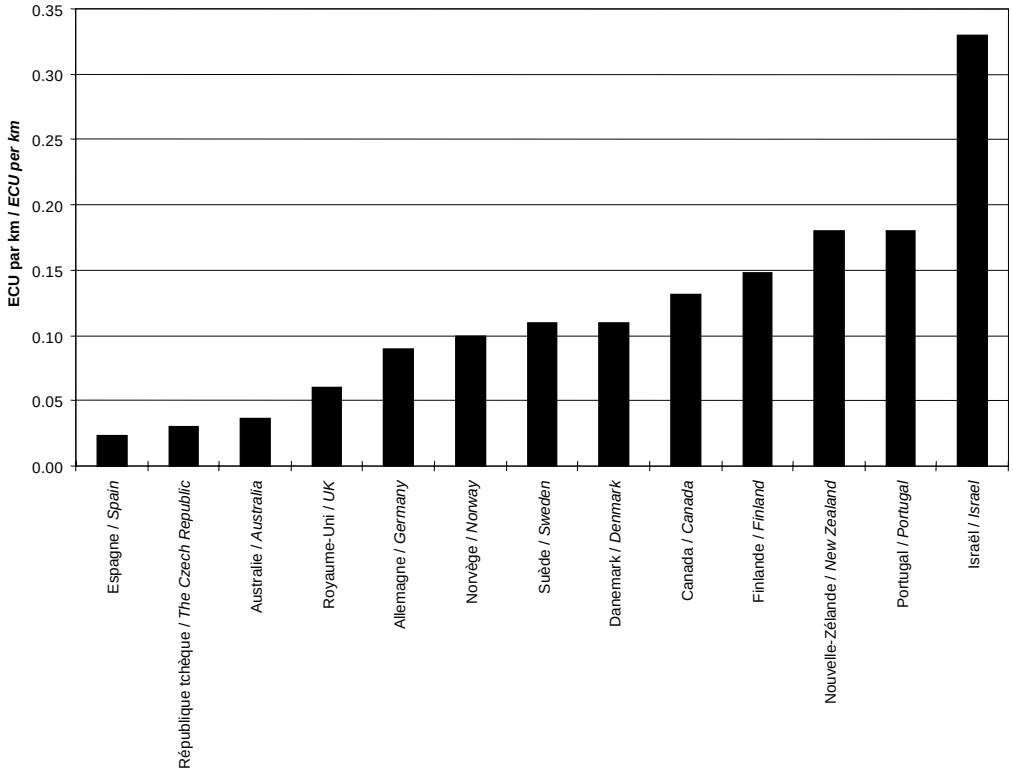

Figure 4.5
Comparaison des coûts de fonctionnement des véhicules par km (véhicules privés)

Figure 4.5
Vehicle operating costs per km. (private vehicles)

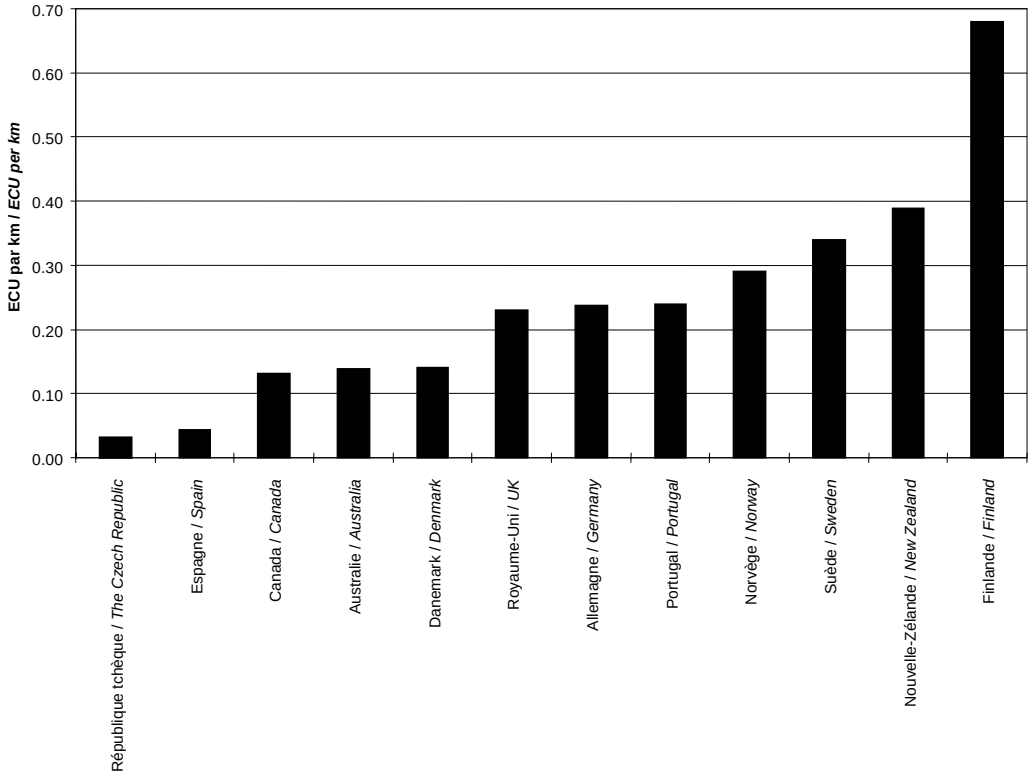

Figure 4.6
Comparaison des coûts de fonctionnement des véhicules par km (véhicules lourds)

Figure 4.6
Vehicle operating costs per km. (Heavy vehicles)

4.6.4. Environmental impacts

The manner in which the environment is valued varies a great deal between countries. A number of countries including Germany, Norway, Sweden, Denmark and Finland value some of their environmental impacts in monetary terms, while countries like Great Britain and South Africa do not. The methodologies and environmental factors are very different from country to country and a direct comparison is difficult. An overview of the environmental factors valued in monetary terms is given Table 4.7.

Table 4.7: Environmental impacts valued in monetary terms

Impacts	Finland	Norway	Sweden	Denmark	Germany	New Zealand
Noise nuisance	yes	yes	yes	yes	yes	yes
Local air pollution	yes	yes	yes	yes	yes	yes
Visual intrusion	_	_	_	_	_	_
Ecological impact	_	_	_	_	_	_
Disruption impacts	_	_	_	_	_	_
Effects on Agriculture	_	_	_	_	_	_
Landscape Effects	_	_	_	_	_	_
Wildlife impacts	_	_	_	_	_	_
Barrier effects	_	_	yes	yes	_	_

"_" indicates values not valued in monetary terms

As the Table shows, noise nuisance and local air pollution are most frequently valued in monetary terms. The actual values attributed to these impacts are derived from very different sources and the rules of measurement differ a great deal. In Table 4.8 below, the values and techniques used to derive monetary value for noise nuisance for a group of countries is given.

4.7. Methods for evaluating impacts not valued in monetary terms

Impacts not valued in monetary terms are mainly environmental factors. There are different practices in the different countries. In the current UK methodology, no attempt is made to value any environmental impacts in monetary terms. Rather, the environmental impacts are frequently set out in a matrix form known as the *Leitch framework*.

In the Leitch framework, there is a variety of measures in different units, viz. physical measures, number of houses as well as verbal descriptions. In the Norwegian approach, impacts are evaluated on a subjective scale indicating the net effect as positive or negative relative to the "Do-minimum" case. The Norwegian approach is a standardized procedure used throughout the country. In France and the Netherlands, all impacts are considered within a multi-criteria framework. Most countries including Finland, Denmark, Sweden, South Africa, New Zealand and Australia have no particular frameworks for evaluating this group of impacts. However, all countries do give verbal descriptions of such impacts.

Table 4.8. Value of noise nuisance and techniques of deriving them

	Finland	**Norway**	**Sweden**	**Denmark**	**Germany**	**New Zealand**
Technique	Resource costs	Stated preference	Revealed preference and hedonic pricing	Hedonic pricing	Mitigation cost	Stated preference, revealed preference
Unit of measurement	Per inhabitant suffering from noise nuisance, per year	Per expected change in dBA per person, per year	Per person per dBA per year	Per dwelling (SBT index) per dBA, per year	DM / regular air pollution per inhabitant Equivalent	Per dB per property
Unit value	915	Variable: 50% improvement is equivalent to 1720 ECU per person per year	121.2 (dBA=58)	4,597.86	24.103	1,100

4.8. Acceptance of methodologies and monetary values

An impression that emerges from member countries is that methodologies are widely accepted despite some criticism relating mainly to certain aspects of evaluation. An example of criticism that emerged from many countries concerns the valuation of travel time. Estimation of travel time savings from stated preference surveys seem to present many difficulties because many road users find it difficult to accept that small time savings can be provided reliably.

4.8.1. Correlation between prioritized projects and indicators of project worth

The correlation between prioritized projects and indicators for project worth varies between countries. In Norway and Sweden the correlation is found to be weak, while the United Kingdom has a good correlation. In countries where correlation is weak it is often argued that there are many other important *non-monetized* impacts that must be taken account of in prioritization. Furthermore, it is argued that many investment decisions are political decisions.

5. POTENTIAL FOR HARMONIZATION WITHIN MEMBER COUNTRIES

The potential for harmonization may be divided into two categories:

(1) potential for harmonizing evaluation methods for impacts
(2) the potential for harmonizing the overall economic evaluation methodology.

There is clearly an advantage to be gained by any attempt to harmonize valuation methods. Harmonization will allow consistent evaluation of international projects and may assist in the optimum allocation of funds within common communities like the EU. For the non- European members, harmonization with the European methods and methodologies may improve the valuation methods due to a wider scientific consensus. The values of impacts can also be harmonized although these may be allowed to vary by regional characteristics.

The harmonization of methodologies depends on several factors which were discussed in chapter 2. Among the factors determining the choice of evaluation methodologies is the level of hierarchy at which the decision to invest in road infrastructure is being made and the objectives being pursued.

In the frameworks of different countries, it was observed that objectives and decision-making policies are different in the different states. Harmonization may require that the objectives be the same. It should be observed however that the potential for harmonization is closely related to the ways in which impacts are valued.

The Committees' recommendation is that the best way to increase the potential for harmonization is a continued co-operation at the scientific level on methods for deriving the values to be used in economic evaluation.

6. CONCLUSIONS AND RECOMMENDATIONS

This study has assembled information for each participating country on the methodology for economic evaluation of projects in the transport sector. The intention has been to draw recommendations for further work on a general basis.

The major findings of the study are:

1. Member states use methods which vary between pure benefit-cost analysis and pure multi-criteria analysis. In all the methodologies, there is a considerable degree of valuing impacts in monetary terms

2. The objective with economic evaluation in member countries is that such evaluations should assist in one or more of the following:

   i) Assessment of road maintenance and operations
   ii) Ranking of mutually exclusive alternatives, i.e. selecting the best alternative

   iii) Selecting schemes to be included in the road programme
   iv) Defining national transport policy (comparing road projects to other modes of transport)

3. Overall approach to project comparison varies between member states depending on the framework of evaluation used. In those countries where benefit-cost analysis techniques play part, the overall approach to project comparison is similar and resembles those found in textbooks where the benefit-cost ratio is used as the ranking criteria.

4. The impacts included in all frameworks studied may be grouped into the following general areas:

   - transport and economic efficiency
   - safety
   - environmental protection and improvement

   There are very few countries that value environmental impacts in monetary terms.

5. The methods used in each individual country to derive monetary values are diverse. For some impacts, more than one method may be used to derive values. This explains the variation in values of impacts between countries

6. An impression that emerges from member countries is that methodologies are widely accepted despite some criticism relating mainly to certain aspects of evaluation. The correlation between prioritized projects and indicators for project worth varies among countries.

Following the findings above, the recommendations for further development are as follows:

I. To enhance the quality of decision making the full economic impact of projects should be evaluated along with those impacts where it is impossible or undesirable to reflect them in monetary terms. Member countries should strive to take into consideration as many economic impacts as possible to provide a valid economic evaluation of road projects.

II. While it is recognized that it is impossible, and in some cases undesirable, to value all impacts in monetary terms, member countries are urged to value impacts in monetary terms where possible. The advantage with the monetary evaluation methods as compared to the non-monetary methods is that the monetary methods are transparent and can easily be communicated into political debates, while pure non-monetary methods such as weighting, may not. An additional argument for emphasizing monetary evaluation is that it facilitates comparison between socio-economic valuation of schemes and financial evaluations.

III. The use of the benefit-cost assessment has implicit assumptions about not only consumer preferences now, but about consumer behaviour and preferences in the future. Accordingly the sensitivity of project evaluation with respect to discount rates and implied future behaviour should be made clear to the decision makers.

IV. For the impacts that cannot be valued in monetary terms there is an urgent need to develop a stringent methodology for evaluation that ensures that impacts are seriously taken into consideration in the decision making process. There is also a need to develop ways of comparing these impacts with those that are valued in monetary terms.

V. Member countries should develop strategies for marketing economic evaluation methods to the decision makers. This is necessary due to the lack of use in the actual decision making.

VI. There is a need for expressing the economic evaluations and impact assessments in terms that can be understood by the public at large. This will enhance the public understanding of the importance of economic evaluations.

VII. A weakness of the cost benefit analysis in decision making concerns transparency. Decision-makers do not see the built-in valuations and weightings in the calculations. Member countries should therefore carry out a sensitivity analysis to illustrate how changes in the input variables affect the results of the evaluation.

VIII. There is need for co-operation between member countries in developing monetary values of impacts, especially environmental ones. Some member countries have also monetary values for goods in freight transport. Sharing experiences on such issues would be beneficial for other member countries.

IX. Member countries should consider expanding the area of application of benefit-cost analysis to include e.g. traffic management systems and maintenance. This would improve our knowledge of the profitability and expenditure allocation of alternative activities within road agencies.

A general recommendation is that there is a need for continued co-operation in developing methodologies of economic evaluation. One area where such co-operation should be enhanced is in valuing the environment.

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8. ANNEX

8.1. Letter to Members Countries represented within C9

Norwegian Public Roads Administration
Directorate of Public Roads
Our contact - Direct line
James ODECK -+47 22073674

Our date	Our references
1996-12-20	96-6182

DEAR MEMBERS OF WORKING GROUP C9

Subject: Survey on the economic evaluation methods for road projects in member countries

Committee C9 on Financing and Economic Evaluation has commissioned a study entitled “Compile information on published sources, including existing surveys and make recommendations in respect of externalities on specific and general basis”. The ultimate objective is to summarize practices in the member countries and to draw up recommendations for further development of economic evaluation methods and models of member countries. Compiling information on methodologies used in the different member states can be useful in that countries may learn one another and thereby improve their methods. Compiling and publishing this type of information will therefore contribute towards a more efficient use of public funds in the member countries.

In order to accomplish the above mentioned, Committee C9 needs your response to the attached table of questions. To aid you in responding to the questionnaire, a response from the Norwegian Public Roads Administration is attached. Thus your response should include the following:

- A short description of the economic method of evaluation used in the member country as requested in table 1. The response should follow the attached procedure of the Norwegian Public Roads Administration.
- Filled-in tables 2 through 5.

The results of the survey and recommendations made will be published in a PIARC report. The descriptions from each member country will therefore be part of the report as annexes.

Kindly return your response to the address below not later than February 15th 1997.

Kjell Haaland, Norwegian Public Roads Administration
P.O.Box 8142 Dep N-0033 OSLO.

Yours sincerely,

Kjell Haaland - KH/GLI

8.2. Questionnaire

The following questionnaire which forms the basis of this report was sent to all member countries of C9.

Table 1: Questions on economic method of evaluation in member countries

Question	Description
1. Methods of evaluation	A description of the methodologies used for evaluation i.e. whether the cost-benefit analysis, the Multicriteria analysis, etc.
1.1 Objectives and scope of application	Description of the areas in which the methodology is applied i.e. intermodal level, competing project selection of the same mode and/or selection of alignments, and evaluation of global schemes.
1.2 Overall approach to project comparison	Full description on how comparisons of projects are undertaken.
2. Range of criteria included in the methodologies	A list and definition of all the factors included in the methodologies and e.g. travel time savings by travel purpose, vehicle operating costs, accidents costs, environmental factors etc. It must be stated whether the indicator is valued in monetary terms or not.
2.1 Methods used to derive monetary values for each impact	E.g. market prices, contingent valuation etc.
2.2 Methods used to evaluate impact not measured in monetary terms	E.g. threshold levels
2.3 Current unit values of impact measured in monetary terms	E.g. cost of accident, value of time in local currency and in ECU.
3. Value indicator for project worth	E.g. first year rate of return, net present value
3.1 Current discount rate, cost of funds and evaluation period	In percentage as determined by the central authorities. Evaluation period in years.
4. Acceptance of the values and the methodology	A description of the extent to which the monetary values and methodology are accepted as a good practice by the decision makers and the public at large.
4.1 Correlation between prioritized projects and indicators for projects worth	What can be said about the correlation? Good, bad (?).
4.2 Role of non-monetized impacts in the decision making process.	What role does the non-monetized impacts play in the decision making process? Are there any observed trade-offs between the monetized and non-monetized impacts in the decision making process?

Table 2: Range of criteria included in the methodology and valued in monetary terms.

Impacts valued in monetary terms
Travel time savings
Accident costs
Noise nuisance
Local air pollution
Maintenance costs
Investment costs
Residual value of capital
Vehicle operating costs

Table 3: Range of criteria included in the methodology but valued in non-monetary units or described verbally

Impacts valued in non-monetary units or described verbally

Table 4: Methods for deriving values for monetized impacts

Impacts valued in monetary terms	Method of valuation
Travel time savings	
Accident costs	
Noise nuisance	
Local air pollution	
Maintenance costs	
Investment costs	
Residual value of capital	
Vehicle operating costs	

Table 5: Current values or impacts valued in monetary terms

Impacts	Unit of measurement	Unit value in local currency (1996)	Unit value in ECU (1996)*
Travel time savings			
Accident costs			
Noise nuisance			
Local air pollution			
Maintenance costs			
Investment costs			
Residual value of capital			
Vehicle operating costs			

Table 6: other economic indicators

Indicator	Value
Rate of discount	
Evaluation period of projects	
Cost of collecting funds through taxation	

* PLEASE. STATE THE EXCHANGE RATE OF ECU TO THE LOCAL CURRENCY

8.3. Evaluation methods in Norway
Applications of the Norwegian Public Roads Administration

Response to questionnaire survey from PIARC Committee C9 on economic evaluation methods in member countries.

Method of evaluation

The mandatory method used for economic evaluation of road projects in Norway is the benefit-cost analysis. The benefit-cost analysis is, however, only part of a wider impact assessment comprising factors that can be valued monetarily and factors that cannot be valued in monetary terms. Thus, before a project is included in a project pool for ranking, local impact assessment is carried out in order to select the best alternative.

At the project ranking level those factors that are not quantifiable in monetary terms are also presented using a systematic procedure to ensure that decision makers take account of them.

Objectives and scope of application

The key objective of the benefit -cost analysis in the Norwegian road sector is to prepare a set of feasible alternative plans for road investment and to assist decision makers in selecting the most desirable projects from a pool of projects.

The area of application of the benefit-cost analysis is at three levels as follows:

1. comparison of road project alternatives
2. ranking of competing road projects in a pool of projects
3. comparison of road projects against other competing modes.

The benefit-cost analysis as part of a wider impact assessment, is most commonly used for the purpose of level 1 and 2 above. Currently, however, the benefit-cost methodology is being developed so that it can hopefully be used for the purpose of level 3.

The benefit-cost analysis is not used for evaluating global schemes. Neither for the so-called global environmental factors included in the analyses of road projects.

Overall approach to project comparison

Project comparisons are carried out at two levels. The first consists in comparing the alternatives of the same project, while the second compares different competing projects of a pool.

When comparing different alternatives of the same project, a reference alternative normally called “Do-Minimum” is defined. The “Do-Minimum” option refers to the existing road and traffic network against which alternative improvements can be evaluated. It is simply a description of the situation on the existing network assuming the normal trend without any new road construction. All the proposed alternatives are then compared to the “Do-Minimum”. The impacts valued in monetary terms are calculated and discounted over a 25-year period with an interest rate at 7%. If the net present value i.e. the difference between net benefits and project cost, is positive then the alternative is considered economically worthwhile. However, the proposal is only made if the impacts not quantifiable in monetary terms are considered so small that they do not offset the sign of the net present value.

When ranking projects from a pool at the national level, those with positive net present values are considered economically worthwhile. When choosing the most desirable among them the benefit-cost ratio is used as the choice criteria. Again this is only so if the sum of impacts not quantified in monetary terms, evaluated subjectively, are considered so small that they do not offset the net present value.

Range of criteria included in the methodology

The range of criteria included in the methodology may be divided into two categories: those that are valued in monetary terms and those that are either described verbally or in some other physical units. The impacts valued in monetary terms are included in the benefit-cost analysis and form the basis for calculating the net present value and the benefit-cost ratio. The two categories of impacts form the total impact assessment.

The range of criteria may be grouped as follows:

Impacts valued in monetary terms	Impacts valued verbally or in other units
Travel time savings	Impacts on:
Accident costs	- Outdoor recreation
Noise nuisance	- Natural environment
Local air pollution	- Cultural monument
Maintenance costs	- Cultural environment
Investment costs	- Landscape
Residual value of capital	- Agriculture and fishing
Vehicle operating costs	- Geo and Water resources
	- Land use
	- Visual intrusion
	- Ecology
	- Regional development

Methods used to derive monetary values

The methods used to derive monetary value for impacts depend on which impact is being valued. Broadly speaking impacts can be divided into two categories: impacts that are traded in the market and non-traded impacts. The former consists of those impacts of which their monetary values can be observed in the market i.e. resource cost. The latter consists of those impacts of which their monetary value cannot directly be observed in the market but must be derived either through surrogate markets or by using interview techniques to measure how many people are willing to pay or to accept.

The methods for deriving values for each impact that enters the benefit-cost analysis are shown in the table below:

Impacts valued in monetary terms	Method of valuation
Travel time savings	Stated preference studies; willingness to pay
Accident costs	Most components by resource cost, loss of welfare by stated preference studies - willingness to pay.
Noise nuisance	Stated preference studies - willingness to pay
Local air pollution	Stated preference studies - willingness to pay and compensation acceptable
Maintenance costs	Resource cost
Investment costs	Resource cost
Residual value of capital	Resource cost
Vehicle operating costs	Resource cost

Method used to evaluate impacts not measured monetarily

These impacts are evaluated individually on a subjective scale indicating whether the net effect is positive or negative. For evaluating each of the impacts, a standardized procedure for evaluation has been developed. The procedure is as follows:

1. Description of actual situations and characteristics stating the qualities and values of the particular area of influence;
2. Qualitative and verbal description of the magnitude of the impacts;
3. Overall assessment of the importance of the impacts.

The overall importance of change in impacts due to the project is described by using a gliding scale comprising plusses (++) and minuses (--). The scale has nine intervals ranging from very negative (----) to very positive (++++). Thus the end result states the degree to which change in a particular impact is positive, neutral or negative. In addition the degree of change is described verbally. A procedure has, however, not yet been developed to sum them up so that they can be weighed against those that are evaluated in monetary terms.

Current values of impacts valued in monetary terms

The current values of impacts valued in monetary terms are presented below.

Impacts	Unit of measurement	Unit value in NOK (1996)	Unit value in ECU (1996)*
Travel time savings:	Per light vehicle hour (Vh)		
Business trips		198.20	24.35
To/from work trips		65.10	8.00
Others(leisure etc)		65.90	8.10
Average light vehicle	Per bus hour (Bh)	85.50	10.50
Average bus		425.50	52.30
Vehicle operating costs	Per light vehicle Km.(Lvkm.)	0.86	0.10
	Per heavy vehicle (Hvkm)	2.42	0.29
Accidents costs	Per personal injury accident (Pa)	2.421	0.30 million
Noise Nuisance	Per expected change per person per year	Variable; example: a 50% improvement in noise nuisance is equivalent to 14,000 NOK per person per year	Variable; example: a 50% improvement in noise nuisance is equivalent to 1,720 ECU per person per year
Local air pollution	Per expected change per person per year	Variable; example: a 50% improvement in local air pollution is equivalent to 48,000 NOK per person per year.	Variable; example: a 50% improvement in local air pollution is equivalent to 5,900 ECU per person per year.
Construction costs	Total construction costs	Variable	Variable
Maintenance and operating costs	Annual operating and maintenance costs	Variable	Variable

The way in which values for noise nuisance and local air pollution enters the analysis is as follows: first the “do-something” alternative is compared to the “do-nothing” alternative and the difference in noise nuisance and/or local air pollution is calculated in percentages per person affected. The monetary value assigned to the reduction will then depend on the percentage reduction. The greater the reduction, the higher the monetary value assigned to the percentage reduction. As an example, a 50% reduction in noise nuisance per person will be assigned a value of 14,000 NOK per person per year, whereas a 70% reduction will be assigned a value of 20,000 NOK per person per year. In cases where there is an increase in noise nuisance or local air pollution higher values are assigned. As an example, a 50% increase in noise nuisance per person is assigned a value of 22,000 NOK whereas a 70% increase is assigned a value of 25,000 NOK. The values for noise nuisance and air pollution are calculated for the whole analysis period, discounted and included in the analysis.

* ECU = 8.14 NOK

Value indicator of project worth

The basic value indicator used in assessing projects is the net present value (NPV). In selecting projects from a pool under financial constraints, the benefit-cost ratio defined as net present value per NOK invested is used.

Current discount rate, cost of collecting funds through taxation and evaluation period

The current rate of discount is at 7%. Costs of collecting funds through taxation are not included in the analysis. The evaluation period is 25 years while the physical life of a road project is assumed to be 40 years. This implies that the residual value of capital is calculated for the 15 remaining year.

Acceptance of monetary values and the methodology

The methodology is widely accepted by practitioners as a good practice in documenting the socio-economic profitability of road projects. Formally, the methodology is recommended and adopted by the Ministry of Transport and Communication for use in the road sector. There are, however, critics that several factors are not quantified in monetary terms to make it a good tool for ranking projects.

Acceptance of the methodology may imply acceptance of the monetary values. In the case of Norway, monetary values used in assessing road projects are discussed thoroughly by experts before they are recommended. Thus among experts the values are generally accepted. There are, however, some debates in newspapers or other forums where people express their disagreements with some of the values used. This concerns mostly value of time and cost of accidents.

Correlation between prioritized projects and indicators of project worth

Several studies have shown a poor correlation between prioritized and the benefit-cost ratio. However, the correlation seems to be improving meaning that the decision makers are taking the results of economic evaluation more and more seriously.

Role of non-monetized impacts in the decision process

There is no documentation available on the influence that non monetized impacts may have on the investment decisions that are made. However, in cases where the Parliament chooses projects with negative net present values, an argument often given for doing so is that the non-monetized impacts are considered to be great and positive.

To date, no trade-off between the non-monetized and monetized impacts has been analyzed.