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Subject:

ECONOMIC EVALUATION METHODS FOR ROAD PROJECTS IN PIARC MEMBER COUNTRIES – Summary and Comparison of Frameworks

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PREFACE

PIARC has a goal of improving the performance of road administrations in the provision, operation and management of their road infrastructure and its use in accordance with international best practice. Economic evaluation methodology is one of a number of topics being addressed under this goal. One of the strategies is to document and analyse economic evaluation methodology used by PIARC member countries and international financing agencies to provide information on international experience leading to improved forecasting of project impacts and improved decision making.

Information on the economic evaluation frameworks used by PIARC member countries was originally obtained by questionnaire survey in 1997/98 and reported in a previous report[1]. A new expanded survey was undertaken in 2001/02 to bring the previous work up to date.

This latest survey and reporting has been carried out by a working group of PIARC Committee C9 on Finance and Economic Evaluation comprised of:

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The working group thanks the members of Committee C9 for the information presented in this report and their cooperation and also acknowledges the assistance of Mr Allan Kennaird, consultant from New Zealand, in helping to draft this report.

[1] Economic Evaluation Methods for Road Projects in Members Countries – Compiled Information on Existing Methodologies, PIARC Committee C9, October 1997

CONTENTS

ABBREVIATIONS

AADT	Average Annual Daily Traffic
BCR	Benefit Cost Ratio
CAPM	Capital Asset Pricing Model
CBA	Cost Benefit Analysis
CEA	Cost Effectiveness Analysis
CVM	Contingent Valuation Method
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EU	European Union
FIRR	Financial Internal Rate of Return
IFI	International Friction Index
IRI	International Roughness Index
IRR	Internal Rate of Return (sometimes called Internal Rent)
EMME/2	Equilibre Multi-Modal 2 - Transportation Network Modelling System
FYRR	First Year Rate of Return
GAM	Goal Achievement Matrix
GDP	Gross Domestic Product
HDM-4	Highway Development and Management System, Version 4
HERS	Highway Economic Requirements System (USA)
HGV	Heavy Goods Vehicle
HP	Hedonic Pricing
LCCA	Life Cycle Cost Analysis
MAIS	Maximum Abbreviated Injury Scale
MCA	Multi-Criteria Analysis
NO_x	Oxides of Nitrogen
NPV	Net Present Value
PMS	Pavement Management System
PV	Present Value
RBA	Risk Benefit Analysis
RCM	Replacement Cost Method
RP	Revealed Preference
SP	Stated Preference
TCM	Travel Cost Method
VE	Value Engineering
VOC	Vehicle Operating Costs
VOT	Value of Time
WB	World Bank
WTP	Willingness to Pay

ECONOMIC EVALUATION METHODS FOR ROAD PROJECTS IN PIARC MEMBER COUNTRIES

Prepared by

PIARC COMMITTEE C9

EXECUTIVE SUMMARY

PIARC Committee C9 on Economic and Financial Evaluation has prepared this report to present an up to date description and analysis of the methodologies used by PIARC member countries and international agencies for economic evaluation of road projects, the range and valuation of the impacts considered, and how the evaluations are accepted and used in decision making processes. The methodologies covered by this report are, in general, those used for evaluating capital investments at the project level. This work is an expansion and update of a 1997/98 PIARC survey and report on the same topic.

This report does not cover generic information on the purpose of economic evaluation, methods for economic evaluation, merits of the various evaluation methods, and methods of valuing impacts. That information is covered in the earlier report referred to above and in more detail in many other publications.

The report considers the purpose and scope of evaluations in member countries, including how the evaluation assists government policies and decision making.

Methods of evaluation adopted by member countries are reviewed. There is a wide range of methods used. Almost all countries use Cost Benefit Analysis (CBA) in some form as a component of the evaluation, often in conjunction with Multi-Criteria Analysis (MCA), or with an environmental or socio-economic analysis. Some countries use Life Cycle Cost Analysis (LCCA) to select pavement type.

The range of impacts (elements of cost and benefit) included in road evaluations are tabulated for PIARC member countries that have responded. All countries include road user time costs, vehicle operating costs and most include accident costs in their evaluations. In nearly all countries these benefits are monetised. Externalities are often not monetised.

Estimation methods for valuing road user and other impacts are tabulated, and the process used by each country for including social and environmental impacts and other externalities in the evaluation framework is documented. There is a wide range of approaches.

Cost and benefit unit values for road user impacts are tabulated and compared graphically, and for environmental impacts they are tabulated. The unit values vary significantly between countries. The economic indicators (NPV, BCR, IRR, FYRR, etc) used to measure the worth of a road project are listed, together with the discount rates and evaluation periods.

The theoretical and practical application of methods to address uncertainty and risk are also briefly reviewed. Most countries use sensitivity analysis to test the effect of, at least, a few variables. Canada uses simulation techniques for risk analysis and Australia is developing such techniques, while some LCCA programs in the USA use risk simulation techniques.

Methods for project option selection and for project-to-project comparisons are documented. While almost all countries use some form of economic evaluation to select alternatives, options and project components, political and funding considerations have significant influence on prioritisation of projects for implementation. There is a range of approaches to environmental and social impacts in these decisions.

Acceptance of the evaluation framework by politicians, officials and the public, including correlation between indicators of project worth and project implementation are considered in this report. There is an increasing interest in project evaluation methodology and the way that impacts are valued and presented. The valuation of environmental and social impacts continues to be questioned, and road administrations are increasingly consulting with interested or affected parties.

Changes from the previous report are noted. The UK has significantly widened its evaluation methodology to present information on environmental and social impacts and to cover other transport modes. Other countries are also widening their evaluation methods and moving towards MCA presentations. WTP is increasingly used for valuing various impacts and there is a trend towards use of lower discount rates. Increasing attention is being given to uncertainty and risk.

Guidelines from international agencies are briefly summarised for comparison, and reference is made to evaluation methods used in developing countries.

Some recommendations are given for further work, particularly that CBA continue to be developed to include all significant impacts; that member countries co-operate in developing monetary values; that the methodology be expanded to cover all land transport modes; and that more attention be given to use of quantitative risk analysis.

1. INTRODUCTION

1.1 Purpose

The purpose of this report is to present an up to date description and analysis of the methodologies used by PIARC member countries and international agencies for economic evaluation of road projects, the range and valuation of the impacts considered, and how the evaluations are accepted and used in decision making processes. The objective is not to describe each framework in detail, but to present an overview of similarities and differences leading to improved forecasting of project impacts and improved decision making.

1.2 Background

PIARC Committee C9 on Economic and Financial Evaluation is one of four technical committees working within Strategic Theme 4 of the PIARC Strategic Plan. Under Strategic Theme 4, PIARC has the goal of improving the performance of road administrations in the provision, operation and management of their road infrastructure and its use in accordance with international best practice.

Economic evaluation methodology is one of a number of topics being addressed by Committee C9 in its 1999-2003 work programme. This work is an expansion and update of a 1997/98 survey and report entitled "Economic Evaluation Methods for Road Projects in Members Countries – Compiled Information on Existing Methodologies" commissioned by PIARC Committee C9 [ref. 1]. The expansion and update is intended to highlight changing demands for economic evaluation by member countries in this topic area since 1997.

Project planning and project economics are increasingly affected by environmental issues; various aspects of sustainability, including those of a financial, environmental, economic, social, and political nature; equity; and participation. Economic analysis must facilitate the analysis of these additional issues whilst maintaining the basic focus on economic viability. Because of these changing demands, this report gives particular attention to:

a) Inclusion of externalities, environmental and other intangible factors

b) Sensitivity testing and evaluation of risk

c) How economic evaluation assists project selection and other decision making processes.

A questionnaire on the use of economic evaluation methods was sent to members of the PIARC C9 committee in 2001. This report is based on the responses received to the questionnaire together with information from published papers and guidelines of international agencies.

1.3 Scope of Report

Areas covered in this report include:

- Purpose and scope of evaluations in member countries, including how the evaluation assists government policies and decision making
- Methods of evaluation adopted by member countries
- Range of impacts included (elements of cost and benefit)
- Estimation methods for road user costs and benefits
- Estimation methods for other costs and benefits, including methods of including social and environmental impacts and other externalities
- Cost and benefit unit values
- Discount rate and analysis period
- Economic indicators (NPV, BCR, IRR, FYRR, etc)
- Treatment of uncertainty and risk
- Methods for project option selection
- Methods for project-to-project comparisons
- Acceptance of the evaluation framework by officials and public, including correlation between indicators of project worth and project implementation
- Changes from the previous report
- Guidelines from international agencies
- Recommendations for further work.

This report does not address the use of economic evaluation methodology in development of network level strategies and corridor management strategies. Instead it concentrates on project level evaluations. The methodologies covered by this report are, in general, those used for evaluating capital investments. In theory, similar processes can be used for evaluating road maintenance activities, traffic management schemes, or transportation strategies.

This report does not cover generic information on the purpose of economic evaluation, methods for economic evaluation, merits of the various evaluation methods, and methods of valuing impacts. That information is covered briefly in chapters 2 and 3 of the original report referred to above and in more detail in many other publications such as "Cost-Benefit and Multi-Criteria Analysis for New Road Construction" [ref. 2] published by the Commission of the European Communities, Directorate General for Transport, the World Bank "Handbook on Economic Analysis of Investment Operations" [ref. 5], and the Asian Development Bank "Guidelines for the Economic Analysis of Projects" [ref. 6].

2. SUMMARY OF FRAMEWORKS IN MEMBER COUNTRIES

2.1 Responses

Responses to the 2001 questionnaire survey were received from the following countries:

- Australia
- Canada
- Czech Republic
- Denmark
- France
- Germany
- Hungary
- Japan
- Mexico
- Netherlands
- New Zealand
- Norway
- Portugal
- Switzerland
- Sweden
- South Africa
- United Kingdom
- United States of America

2.2 Purpose and Scope of Evaluations

The purpose of economic evaluation is addressed in a generic manner in Section 2.1 of the original PIARC report (1997). It is noted there that economic evaluation may be used to assist decision making at different levels and that this may affect the choice of evaluation procedure. The purpose of economic evaluation is also addressed in the first paragraph of the World Bank's "Handbook on Economic Analysis of Investment Operations", which states "the main purpose of economic analysis is to help design and select projects that contribute to the welfare of a country". It goes on to point out that it is most useful when used early in the project cycle, and very limited when used solely as a single figure hoop through which projects must jump once prepared.

The World Bank Handbook lists ten questions that an economic analysis should answer:

a) What is the objective of the project?

b) What will happen if it is implemented, and what if it is not?

c) Is the project the best alternative?

d) Are there any separable components, and how good are they separately?

e) Who are the winners and losers?

f) Is the project financially sustainable?

g) What is the project's fiscal impact?

h) What is the project's environmental impact?

i) Is the project worthwhile?

j) Is this a risky project?

Many PIARC member countries recognise the need for an evaluation framework that takes account of all relevant factors, and which can be used for policy and strategy development as well as project decisions. They are addressing this in different ways.

Evaluations of road projects in Australia are done at both the Commonwealth (Federal) and State/Territory level. The evaluations are intended to quantify social, economic and environmental impacts to provide a sound basis for investment decisions and government budget processes. Broad socio-economic studies, focusing on sustainable development outcomes, are being undertaken as part of the state planning process.

Economic evaluation of road projects in Canada is done mainly for selection of options. Project priority is often dictated by funding constraints.

In the Czech Republic, project evaluations are used for both project option selection and for project priorities within the road mode. A common methodology for road and rail is being developed. Economic evaluation is also used for schemes and strategies.

Evaluations of road projects are carried out in France to first decide whether to proceed with a project, and then to choose between project options, including what and when to build.

Evaluations in Germany are done to assist selection of priority projects for the Transport Investment Plan.

Hungary uses economic evaluation to select project options, to rank projects, to assist investment decisions, and to support submissions for EU co-financing.

As well as selecting the most viable alternative treatment for a road section, evaluation of road projects in Mexico is used for global schemes and strategies, e.g. study of a trunk road corridor.

In the Netherlands, the most extensive evaluation of road projects occurs at the planning stage where alternative solutions are considered. Options typically include a "zero-option", use of public transport, and an option that is most beneficial to the environment. Alternative project specifications and ways of increasing road capacity are also evaluated. The evaluation is intended to identify impacts for discussion and as input to the final political decision.

In New Zealand CBA is the primary indicator for deciding central government funding for road infrastructure projects. Prior to 2002 projects had to have a BCR greater than 4.0 to get funding. From 2002 this requirement was modified and now factors that reflect the government transport priorities are considered alongside the BCR, while analysis of incremental costs and benefits is used to choose between project options.

In Norway the key objective of economic evaluation of road projects is to prepare a set of feasible alternative plans for road investment and to assist decision makers in selecting the most desirable projects. This covers both comparison of project alternatives and ranking of competing projects. CBA methodology is being developed to allow comparison of road projects with other transport modes. CBA is not currently used for evaluating global schemes.

Portugal uses economic evaluation to select project options. The main goal is completion of the main and complementary road networks. Economic evaluation is not decisive but complements other decisions.

In South Africa, economic evaluation of road projects is used to select project options, prioritise competing projects, and for global road network strategies.

Sweden conducts a common planning and evaluation exercise every four years covering all transport modes, with an essential focus on integration of modes. Strategic road planning is guided by five political goals:

- Accessibility
- Acceptable quality for the road system
- High level of road safety
- High environmental standards
- Encouragement of regional development.

In Sweden economic evaluation is an essential tool for deciding on the projects that should be included in the 10-year plan, which is updated every 4 years. It is also used at the project feasibility level, e.g. for choice of route in a road corridor.

Switzerland does not normally use economic evaluation for road projects. The main thrust is to identify projects to:

- Complete the motorway network
- Develop and remodel motorways
- Supplement the motorway network.

In the United Kingdom, evaluation is used to prioritise transport projects against 5 key government objectives:

- Protection of the environment
- Improvement in safety
- Support for sustainable economic activity and obtaining good value for money
- Improvement of access to facilities
- Integration of transport with other government policies.

The United Kingdom evaluation methodology is employed for projects, strategies and plans. The methodology is multi-modal.

In the USA the application, scope and rigor of economic evaluations varies significantly by state. Most states apply some form of economic evaluation for pavement type selection and for capital projects not derived from pavement, bridge or other management systems. Much of the evaluation process is a requirement of Federal or state legislation. Transportation projects (other than maintenance and rehabilitation) are required to be in a fiscally constrained transportation plan and transportation improvement programme, and must be certified as being in conformity with a state plan for meeting air quality standards. Any project or activity receiving Federal funds or approvals must undergo analysis of a comprehensive set of social, economic and environmental impacts. It is this wider analysis that influences selection of a particular project or project alternative. In addition, many states measure economic development impacts of road projects, e.g. employment, personal income, and tourism, for land use planning and other local purposes.

2.3 Methods of Evaluation

Section 2.2 of the original report briefly described the main methods of economic evaluation:

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)

Cost benefit analysis is the process of analysing costs and benefits of a project or proposal compared with a base case (either the existing situation or a "do minimum" option), in monetary terms.

Cost effectiveness analysis is sometimes used for comparing projects or alternatives where the outcome (benefit) is measured in non-monetary units. If there are benefits to a number of outcomes, then these are weighted and reduced to a single measure. This is called weighted cost effectiveness. Costs are always in monetary units. The process is described in chapter 8 of the European Commission report [ref 3].

Multi-criteria analysis uses both the impacts that have monetary values together with other impacts that are in non-monetary terms. MCA uses weighting of individual impacts to give an overall index for the project or proposal.

Risk benefit analysis is similar to CBA but with explicit allowance for risk. This is described further in section 2.9.

There are various forms of environmental and social impact assessment. Some impacts can be valued in monetary terms and some not. Some EIA include the result of CBA as one measure.

There is a surprisingly wide range of methods used by PIARC member countries for evaluation of road projects. The results of the 2001/02 survey are categorised in Table 2.1. Almost all countries use Cost Benefit Analysis (CBA) in some form as a component of an evaluation, often in conjunction with Multi-Criteria Analysis (MCA), or together with an environmental or socio-economic analysis. This indicates the need for an evaluation framework that takes account of all relevant factors.

Some countries use Life-Cycle Cost Analysis (LCCA) to select aspects of the project design, e.g. the pavement type. This type of analysis compares the cost streams of different strategies, including future maintenance and rehabilitation treatments. Typically, the strategies being compared are assumed to generate equal benefits. If road user effects (vehicle operation and travel time costs) are taken into account, then this is in effect a mini form of CBA.

Internationally there appears to be a general thrust to extend the traditional CBA to include additional factors. This mainly involves determining monetary values for environmental and social impacts. This is discussed further in section 2.5.

Table 2.1: Categorization of Evaluation Methods in Member Countries

	CBA	CBA + MCA	MCA	Other (EIA, socio-economic, input/output, etc)
Australia		✓		✓
Canada		✓		✓
Czech Republic	✓		✓	
Denmark	✓			✓
France		✓		✓
Germany	✓			✓
Hungary		✓		
Japan		✓		
Mexico	✓			✓
Netherlands	✓		✓	✓
New Zealand	✓			
Norway	✓			✓
Portugal		✓		
South Africa	✓			✓
Sweden		✓		✓
Switzerland	✓		✓	
UK	✓		✓	✓
USA	✓			✓

Australia uses CBA as the primary tool for evaluating road projects, but some projects are also subject to a broad MCA to take other factors into account. The methodologies at the Commonwealth and State levels are similar but not identical.

Canada uses both CBA and MCA for projects, but also uses input/output modelling to evaluate the impact on employment, and LCCA in evaluating pavement options.

The Czech Republic uses CBA based on HDM-4 calibrated for local conditions. MCA is used in special cases.

Denmark uses CBA supplemented by an environmental analysis to include water, ecology, land use, vegetation, animal, cultural asset, visual and other impacts.

France uses CBA for monetary valued effects plus MCA to take account of accessibility, employment, induced economic effects, compliance with local strategies and other effects that can influence choice. The mix depends on the stage of the study and the characteristics of the project. A full socio-economic assessment is used in the development of national strategies. Further information on the evaluation methodologies of transportation projects in France is given in a paper by E Quinet (ref. 10).

Germany uses CBA plus a non-monetary assessment of special effects and a non-monetary ecological risk analysis. Other decision criteria may also be used, including interdependencies between projects, national importance, network aspects and inter-modal linkages. Further information on the evaluation of infrastructure investments in Germany is given in a paper by W. Rothengatter (ref. 10).

Hungary uses CBA, based on COBA[2], and multi-criteria analysis.

Japan employs a kind of MCA supplemented by CBA methods and by quantitative or qualitative evaluation. Further information on the evaluation methodologies of transportation projects in Japan is given in a paper by H. Morisugi (ref. 10).

Mexico uses CBA, complemented by socio-economic analysis for non-monetary parameters.

In the Netherlands, the most common evaluation method is to list the characteristics of alternatives against prescribed criteria. These characteristics may be either measured or described. Sometimes a MCA is used and CBA is used for very large investments.

Prior to 2002 New Zealand used CBA exclusively for evaluation of road infrastructure projects. In 2002 this approach was modified to retain CBA as the primary indicator but with other factors taken into account at the high level decision making phase. All monetised parameters are included in the CBA, including some environmental parameters have been ascribed standard monetary values, such as noise and CO_2.

Norway uses CBA as part of a wider impact assessment, while Portugal uses CBA sometimes accompanied by MCA.

In South Africa the road project evaluation method is essentially CBA. On a network level, final project selection is based on optimisation, with the objective function being either minimisation to total transport costs, or maximisation of the area under the curve of a composite index. LCCA is used to take account of both agency and road user costs. Environmental Impact Assessments are carried out on all capital intensive road projects.

Sweden uses CBA complemented by a form of MCA, with impacts summarised in an Appraisal Summary Table (AST), to assess achievement of the political objectives for transport. Performance indicators are also used to describe the impacts.

The United Kingdom has made significant changes over the last 5 years in the methodology used to evaluate road projects. An MCA approach is now used with impacts summarised in an Appraisal Summary Table (AST), which is used to assess achievement of the

[2] COBA is a cost benefit analysis computer program, used for economic evaluation of road schemes, designed by the UK Department for Transport.

government's transport objectives. Impacts do not have explicit weights. Decision makers judge whether proposals offer good value for money. The AST draws on CBA and EIA results together with supporting analyses of distribution and equity, affordability and financial sustainability, and practicality and public acceptability. Transport user costs and benefits are estimated using an updated multi-modal version of the COBA programme. Information on the UK evaluation methodology is given in a paper by R. Vickerman [ref. 10] found on the UK Department for Transport's website (www.dft.gov.uk).

Evaluation methods in the USA vary significantly from state to state. All states have pavement, bridge and/or other management systems in place, some of which can select an optimum mix of maintenance and rehabilitation activities based on BCA and CEA. Only a minority of states currently make use of the management systems to develop multi-year optimised or prioritised plans for road asset preservation, and in most cases these analyses do not consider user costs or benefits. An asset management approach to road infrastructure is being promoted. This incorporates economic assessment of trade-offs between alternative investment options, both at the project level and the network or system level, and uses this information to help make cost-effective decisions and resource allocations. As part of this initiative, the US Federal Highway Administration has developed the Highway Economic Requirements System (HERS), which is used to investigate the relationship between investment levels and the condition and performance of the national highway system at the network level. The HERS model uses an incremental BCA approach for selection of optimum treatments. Further information on methods for evaluation of transportation projects in the USA is given in a paper by D. B. Lee Jr [ref. 10].

Various states in the USA frequently use LCCA to select the pavement type for rehabilitation. Most states use BCA and qualitative information on economic impacts for at least some capital projects. The states must also apply Value Engineering (VE), which considers project life-cycle costs, to all federal aid highway projects on the national highway system with an estimated cost of 28 million euro or more. Finally, environmental, social, and budgetary impacts of transportation projects must be addressed under Federal requirements for planning and environmental assessments.

2.4 Range of Impacts Included

Road projects have a range of impacts, depending on the type of project. As well as changes to vehicle operating costs, travel time costs and accident costs, there can be a range of environmental and social impacts that are considered. Environmental impacts can sometimes be addressed by including mitigation measures in the project design. Where an impact cannot be mitigated there is an attempt in some countries to value the impact and include it in the economic analysis, while in other countries there is a more subjective consideration of these factors. More recently, some evaluations are making allowance for road users' emotional and psychological preferences, e.g. driver and passenger comfort (passing opportunities, smooth roads, wide roads, etc) and network reliability.

The range of impacts included by PIARC member countries in economic evaluations for road projects is shown in Table 2.2. In the table, regional air pollution mainly refers to NO_x but can include other effects, and global air pollution refers to CO_2. The range of impacts included by member countries, to some extent, reflects the range of purposes for which economic evaluations are used by these countries.

Most countries include road user time, vehicle operating costs and accident costs in their economic evaluations. In nearly all countries these benefits are monetised. Externalities are very often not monetised. The most usual externalities to monetarise are noise and air-pollution. The ways that non-monetary impacts are included are described in section 2.6 of this report. The cost of land, project investigation, capital, maintenance, and operational costs are included with the monetised values by most countries.

Table 2.2: Range of Benefit Impacts Included (M: Monetised N: Not monetised Blank: Not Included)

BENEFITS	Australia	Canada	Czech Republic	Denmark	France	Germany	Hungary	Japan	Mexico	Netherlands	New Zealand	Norway	Portugal	South Africa	Sweden	Switzerland	UK	USA
Travel time	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M		M	M
VOC	M	M	M	M	M	M	M	M	M		M	M	M	M	M		M	M
Accident	M	M	M	M	M	M	M	M	N	N	M	M		M	M		M	M
Reliability					M		N				N	N			N		N	N[3]
Congestion	M			M	N		N			N	M			M	N			N
Comfort					M		N	N	N		M	N		M	N		N	
Noise	N	M	M	M	M	M	N	M		N	M	M		N	M		N	N
Vibration	N		N				N			N	N	N						N
Air pollution - Local		N	M	M	M	M	N	M	N	N	M	M		N	M		N	N[3]
Air pollution - Regional	N			M	M	M	N	M	N		N	M			M			N[3]
Air pollution - Global	M	N		M	M	M	N	M	N		M	M			M		N	N
Dust nuisance	N					M	N				M	M			M			N
Water pollution	N		N				N		N		N	N		N	N		N	N
Ecological impact	N		N			N	N	N	N		N	N		N	N		N	N
Visual impact	N		N			N	N				N	N		N	N		N	N
Community severance	N		N			M	N		N		N	N		N	N		N	N
Access to services	N		N		N		N		N			N		N	N			N
Employment impact	N	M	N		N	M	N		N			N		N	N			N
Agriculture impact			N				N		N			N		N				N
Mitigation/Clean-up		N				M	N		N		N	M		N	N		N	N
Strategic	N					N	N		N		N	N		N			N	M
Urban functioning	N		N			N	N		N			N		N	N			N
Urban renewal						N	N					N			N		N	N
Defence							N					N						N
Barrier and risks				M														
Toll					M				M					M				
Other			N[4]		M/N[5]	M/N[6]	M/N[7]			N[8]	N[9]					N[10]	N[11]	

3 Parameters are monetised in the FHWA HERS model
4 Protection of landscape, harmony with the landscape, labour force demand, loss of land
5 Variation of net receipts of operators of alternative modes (M), economic induced effects on non-transportation enterprises (N), coherence with local decision maker's strategies (N)
6 Effects from modal shits, improved international transport links and induced traffic, access to sea ports and airports (all monetised), and spatial effects (not monetised).
7 Time costs on a given road section (M), traffic situation (N), presumptions for future changes in the network (N)
8 External security, animals, effects on landscape, archaeology
9 Productivity gain, sites of cultural value
10 Regional structural politics and protection of minorities.
11 Option values

Table 2.3: Range of Cost Impacts Included (M: Monetised N: Not monetised Blank: Not Included)

COSTS	Australia	Canada	Czech Republic	Denmark	France	Germany	Hungary	Japan	Mexico	Netherlands	New Zealand	Norway	Portugal	South Africa	Sweden	Switzerland	UK	USA
Land	M	M		M	M	M		M	M	M	M	M	M	N	M		M	M
Investigation/design	M	M	M	M	M	M	M	M	M		M	M	M	M	M		M	M
Capital	M	M	M	M	M	M		M	M		M	M	M	M	M		M	M
Maintenance	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M		M	M
Operational	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M		M	M
Residual value	M	M	M		M	M		M	M		M	M	M	M	N		M	M
Other	M[12]	N[13]				M[14]				M[15]								M[15]

[12] Administration costs
[13] Costs of deicing and roadmarkings
[14] Compensation for ecological effects and replacement of environmental assets
[15] Mitigation of environmental impacts (e.g. noise reduction)

Table 2.4: Methods Used for Deriving Monetary Values

	Travel Time (Business)	Travel Time (Non-business)	Congestion	VOC	Maintenance	Accidents	Noise	Air Pollution
Australia	Resource	WTP	WTP	Resource/Market		WTP/Resource		
Canada	Salaries	Salaries		Market	Market	WTP/Resource	Market	
Czech Republic	Resource	Resource		Market	Market	Resource	Special	Mitigation
Denmark	Market			Resource	Market	Resource/WTP	WTP	WTP
France	Market	RP/Tutelary		Market	Market	Tutelary	Hedonic/ Mitigation	Health Damage
Germany	Resource	WTP		Resource	Resource	Lost Production/ Resource	WTP/ Avoidance Cost	Resource
Hungary	Resource/ WTP	Resource/ WTP		Resource	Resource	Resource		
Japan	Wage Rate	Wage Rate		Market		Market/Insurance	Hedonic	Intergov./EU value
Mexico	WTP/Market	WTP/Market		Market	Market			
Netherlands								
New Zealand	Resource	WTP	WTP	Resource	Resource	WTP/Resource	Hedonic	Mortality (local) Damage (global)
Norway	Resource	WTP/SP		Resource	Resource	Resource/ WTP/SP	SP/WTP	SP/WTP (local)
Portugal								
South Africa	WTP	WTP	WTP	Resource/Market	Market	Resource		
Sweden	Alternative Cost/WTP	WTP		WTP/Market	Market	Resource/WTP	Hedonic	Loss of Earnings/ WTP (local) Shadow (regional/global)
Switzerland								
UK	Market	Equity/WTP		Market	Market	WTP		
USA	Opportunity	WTP		Resource	Resource	Resource/WTP	Hedonic	Resource

Resource: Resource costs
Market: Market price
WTP: Willingness to pay
Opportunity: Opportunity costs
RP: Revealed preference

Table 2.5: Monetary Values of Parameters

	VOT (Cars) euro/vehicle/h	VOT (Trucks) euro/vehicle/h	VOC (Cars) euro/vehicle-km	VOC (Trucks) euro/vehicle-km	Fatal Injury euro	Non-fatal Injury euro	Noise euro/person/year	NO_X euro/tonne	CO_2 euro/tonne
Australia	5.2 (non-work)[16] 16.5 (work)[15]	17-20 (rural) 19-27 (urban)	0.10	0.37 – 0.60	728,000	7,700 to 184,000			
Canada	8.6	14	variable (~0.26)		1,660,000				
Czech Republic	2.8 (non-work) 8.2 (work)	6.6	0.15	0.60 – 0.68	231,000	8,600 to 85,100			
Denmark	6.6 (leisure) 8.5 (commuting) 31.5 (work)	38.2	0.11	0.16 – 0.28	1,124,000	31,700 to 116,000	7,200/SBT[17]	3273	41
France	10 – 35	40	0.11	0.36	1,061,000	23,000 to 155,000	variable[18]	0.001 - 0.03/km cars 0.006 – 0.29/km HGV	103
Germany	6.5 (non-work) 30.9 (work)	25.3 – 30.9	0.13	0.28 – 0.36	1,250,000	3,790 to 86,700	58/dBA	387	217
Hungary	4.0 (non-work) 5.2 (work)	4.9			136,000	2,000 to 9,300			
Japan	31.8	28.8 – 44.4	0.10	0.21 – 0.31	284,000	5,500 to 98,000	22,000/dBA/km	27,200	21
Mexico	2.0 (drivers) 1.2 (passengers)		0.16	0.41 – 0.99					
Netherlands	4.6-6.6(non-wk) 23 (work)	26							
New Zealand	3.5 (non-work) 12 (work)	3.5 (non-work) 10 (work)	0.08	0.14 – 0.45	1,320,000	6,000 to 137,000	33/dBA		13
Norway	9.6 (leisure) 6.7 (commuting) 22.3 (work)	42.6	0.12	0.37	2,850,000	81,000 to 812,000	1,320	1,930	13
Slovenia	5.1 (leisure) 3.8 (commuting) 14.6 (work)	4.3 – 8.6	0.04	0.14 – 0.25	590,000	6,100 to 49,300			

[16] Per occupant
[17] Noise nuisance index - change in noise nuisance (number of dwellings affected and noise level)
[18] Value calculated by m^2 of dwelling, variable according to noise level, example: 6.91 euro/m2/year for 70 dB(A)

Table 2.5 cont…

	VOT (Cars) euro/vehicle/h	VOT (Trucks) euro/vehicle/h	VOC (Cars) euro/vehicle-km	VOC (Trucks) euro/vehicle-km	Fatal Injury euro	Non-fatal Injury euro	Noise euro/person/year	NO_X euro/tonne	CO_2 euro/tonne
South Africa	2.5 (leisure) 6.7 (work)	1.6 (leisure) 4.8 (work)	0.20	0.51 – 1.27	46,500	1,800 to 8,000			
Sweden	9.3	25.2	variable[19]		1,900,000	22,600 to 346,000		2,700-8,000	226
Switzerland	4.5 - 23	26							
UK	11.6 (nonwork)[20] 32.8 (work)[20]		0.10[20]	0.14 – 0.48[20]	1,775,000	15,300 to 199,000			
USA	20,8	28.3	0.15	0.15 – 0.49	3,641,000[21]	16,200 to 280,900		1,120-2,580[23]	

Table 2.6: Monetary Values of Parameters (2002)

	Comfort euro/vehicle-km	Tolls euro/vehicle-km	Congestion euro/vehicle/h	Dust Nuisance euro/km/year	Employment Effects	Barrier & Risks
Denmark						1,501/BRBT[22]
France	0.055	0.07 - 0.14				
Germany					13,000/Generated Job	
New Zealand	0.015 - 0.07		2.5 - 3.0	22 – 132		
South Africa		0.015 – 0.035				
Sweden						
USA				2,500/tonne[23]		

Note: Where the countries listed in Tables 2.5 and 2.6 supplied the values in their domestic currency, the values were converted to Euro using an average exchange rate for 2002. Any values that were expressed in years prior to 2002 were updated to 2002 using an average inflation factor of 1.5% per year.

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[19] Takes account of purchase price, tires, labour, fuel, and for trucks, driver's salary and vehicle utilisation.
[20] The values are from Transport Economics Note (ref. 9) and the 2003 update of the COBA manual. VOC values are for an average speed of 80 km/h.
[21] US DOT recommended value for use in evaluating regulations and capital investments.
[22] Barrier effect and perceived risk index.
[23] Values used in national HERS model. Project level values are specific to location.

2.5 Estimation Methods for Monetary Costs and Benefits

Monetary values can be assigned to impacts if:

a) Prices exist in the market; or

b) Prices can be imputed from quasi-market observation

The previous PIARC report (Section 3) described how market prices need to be adjusted for market distortions before being used in economic evaluations, and also described the principal methods for imputing prices.

The range of methods used to derive monetary values by PIARC member countries is shown in Table 2.4. Denmark has derived a monetary value for the barrier and risk effect using WTP. France has used revealed preference for valuing comfort and reliability, and market prices for tolls and variation in net receipts of operators of alternative modes. Germany uses alternative costs for valuing employment generation. New Zealand uses WTP for driver and passenger comfort, while Sweden uses WTP and loss of earnings for dust nuisance.

2.6 Methods for Including Non-Monetary Impacts

There is increasing recognition of the need to include environmental, ecological and social impacts, and to a lesser extent road users' emotional and psychological preferences, in evaluations of road projects. Impacts for which monetary values are not available can be included in an evaluation framework in a number of ways, which are briefly described in sections 3.3 and 3.4 of the previous PIARC report.

The non-monetary impacts (identified in Tables 2.2 and 2.3) are included in the evaluation framework of PIARC member countries as shown in Table 2.7.

Table 2.6: Inclusion of Non-Monetary Parameters

	Method of Inclusion
Australia	In addition to CBA, a MCA is undertaken using values developed through consultative mechanisms with community participants and input from experts. Techniques like Goal Achievement Matrix and other spreadsheet-based techniques are used.
Canada	MCA (environmental mitigation and/or clean-up, winter de-icing, and road marking), input/output model (global air pollution).
Czech Republic	Vibration and ecological impact, water pollution, agriculture impact and landscape harmony are included by using mitigation/protection costs. Other impacts are included in a MCA using value functions assessed by experts.
Denmark	Normally only the monetised impacts are used in the economic analysis. Environmental impacts are sometimes monetised as a higher construction cost. Environmental impacts are evaluated in a separate environmental analysis.
France	Separate analysis is undertaken and indicators are derived for congestion, accessibility, direct and indirect employment, economic induced effects on non-transportation companies, and compliance with local strategies.

	Method of Inclusion
Germany	Ecological risk, spatial development and connectivity, and urban improvement are included in separate non-monetary analyses by giving projects a weighting on a 1 to 5 scale for each parameter.
Mexico	Non-monetary parameters are included in a socio-economic analysis. The parameters include: cities/towns connected by the road; potential jobs; access to services; population growth, density and migration; economic development; environmental damage; and reduction in accidents. Water pollution, ecological impact, visual impact, and environmental mitigation are included in an environmental impact assessment.
Netherlands	Non-monetary parameters are usually just described. These include: noise; vibration; air quality; safety; security; animals; landscape; and archaeology.
New Zealand	Prior to 2002 a ranking procedure was used for valuing non-monetary parameters – the impact of the parameter on the BCR was estimated and a back calculation used to quantify the value of the impact, which was then checked for reasonableness. From 2002 the BCR is calculated using the monetised parameters and non-monetised factors are then considered alongside the BCR when prioritising projects for funding. Issues relating to the native Maori people are considered outside of the expanded CBA framework.
Norway	Non-monetary parameters are ranked on a scale ranging from 4 minuses to 4 plusses and included in the wider impact assessment. There is no trade-off between monetised and non-monetised impacts.
Sweden	MCA and performance indicators are used to include non-monetary values. Water pollution, ecological impact, visual impact, and environmental mitigation are included in an environmental impact assessment. Community severance, access to services, employment, and urban renewal impacts are described verbally. Driver and passenger comfort is based on the IRI value, congestion is represented by the average speed compared to the speed limit, and reliability is related to standards. Improved functioning of urban areas is only considered at the strategic level.
UK	MCA is used to include non-monetary parameters. Townscape, heritage, water, journey ambience, biodiversity, transport interchange are rated on a 7-point scale plus qualitative comment. Landscape is rated on an 8-point scale with qualitative comment. Access to transport is rated on a 7-point scale without comment. Community severance is rated on a 4-point scale. Integration with land use and other government policies is rated on a 3-point scale. Noise impact is assessed as the reduction in the number of people annoyed, plus qualitative comment. Local air quality uses the weighted number of properties where air quality is improved plus qualitative comment. Physical fitness is the change in the number of cyclists and pedestrians making journeys of more than 30 minutes. Option values are assessed by identifying the group of transport services that are the cause of additional or reduced option value, the nature of the change in service, and whether option value is gained or lost. The size of the population affected plus monetary value is obtained if possible. There is on-going research to assign monetary values to more impacts, particularly noise and carbon emissions.
USA	States vary in the degree to which they monetise costs and benefits. Separate environmental and/or developmental analyses are usually also completed. Environmental and social impacts identified in environmental analysis are not evaluated or compared using formal criteria or trade-off analysis. Environmental and developmental impacts are presented for information of decision makers. Where adverse impacts are identified, mitigation is required to avoid, minimise, or compensate. Costs of mitigation become part of the project costs.

2.7 Monetary Values

The monetary values for different parameters and impacts are shown in Tables 2.5 and 2.6. In Figures 2.1 to 2.12 below, the values used for vehicle operating costs, accident costs and travel times are compared in graphical form. This helps to identify and highlight the differences in these values between the member countries.

Figure 2.1: Variation in Value of Vehicle Operating Costs for Cars

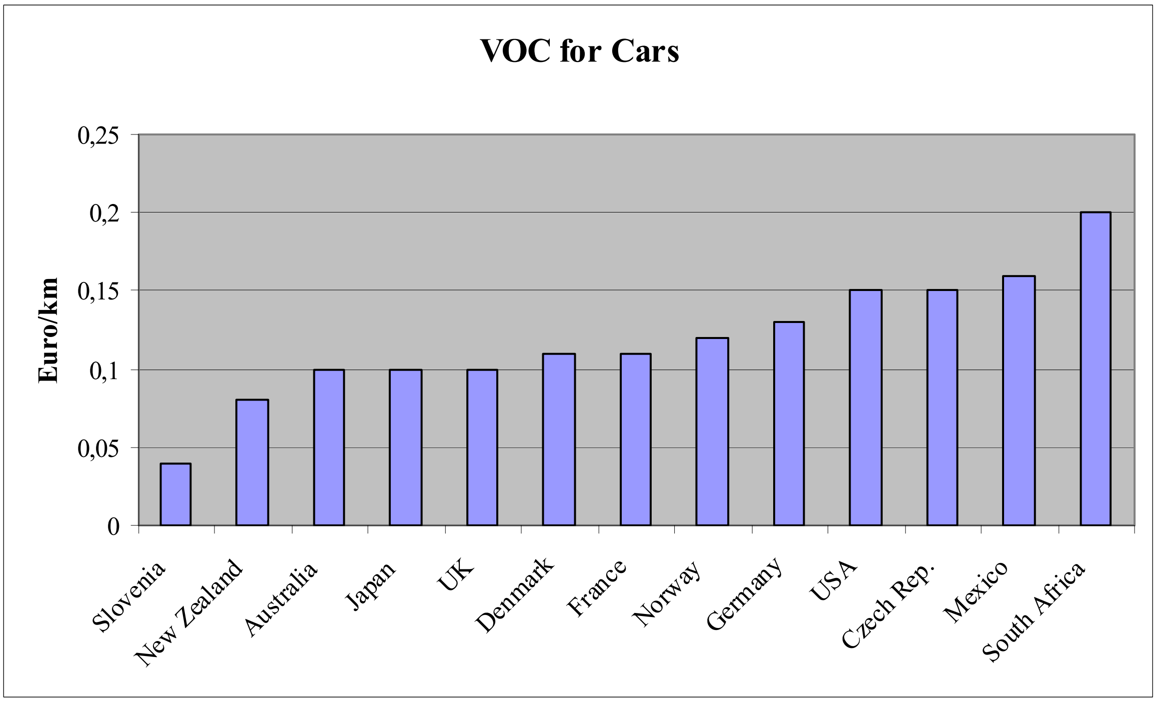


Figure 2.2: Variation in Value of Vehicle Operating Costs for Light Trucks

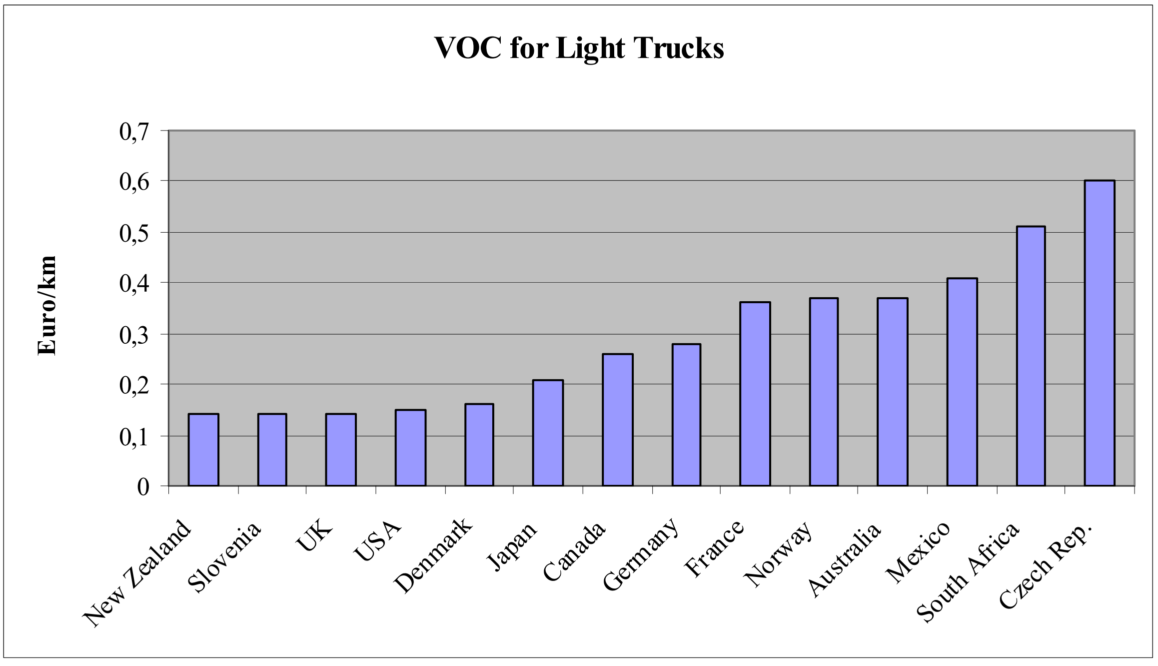


Figure 2.3: Variation in Value of Vehicle Operating Costs for Heavy Vehicles

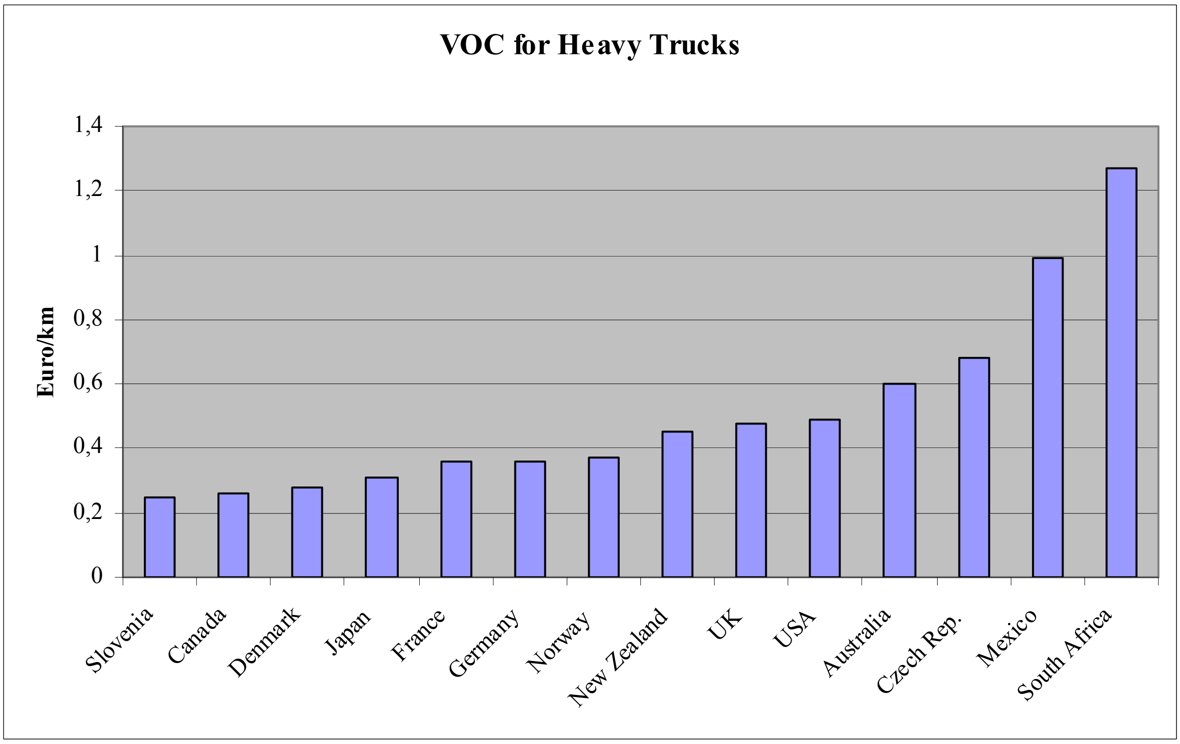


Figure 2.4: Comparison of Vehicle Operating Costs for All Vehicles Combined

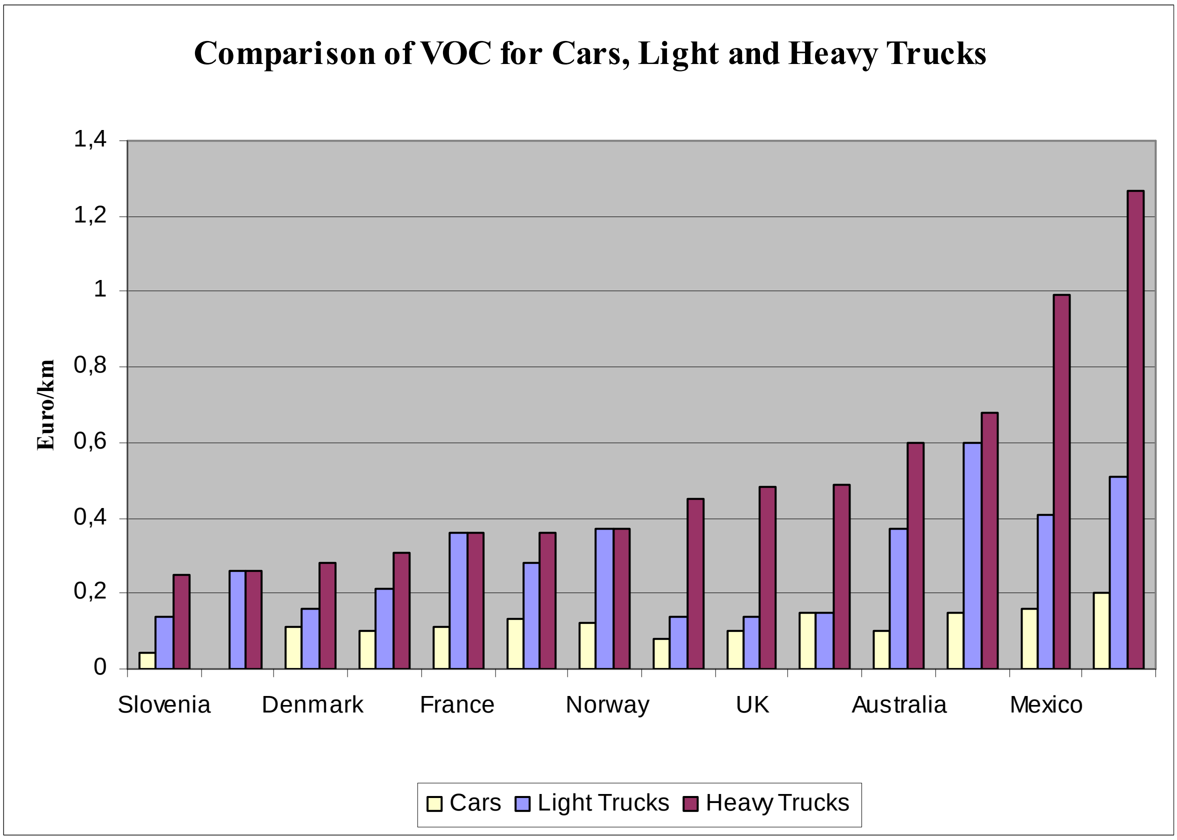


Figure 2.5: Variation in Cost of a Fatal Injury

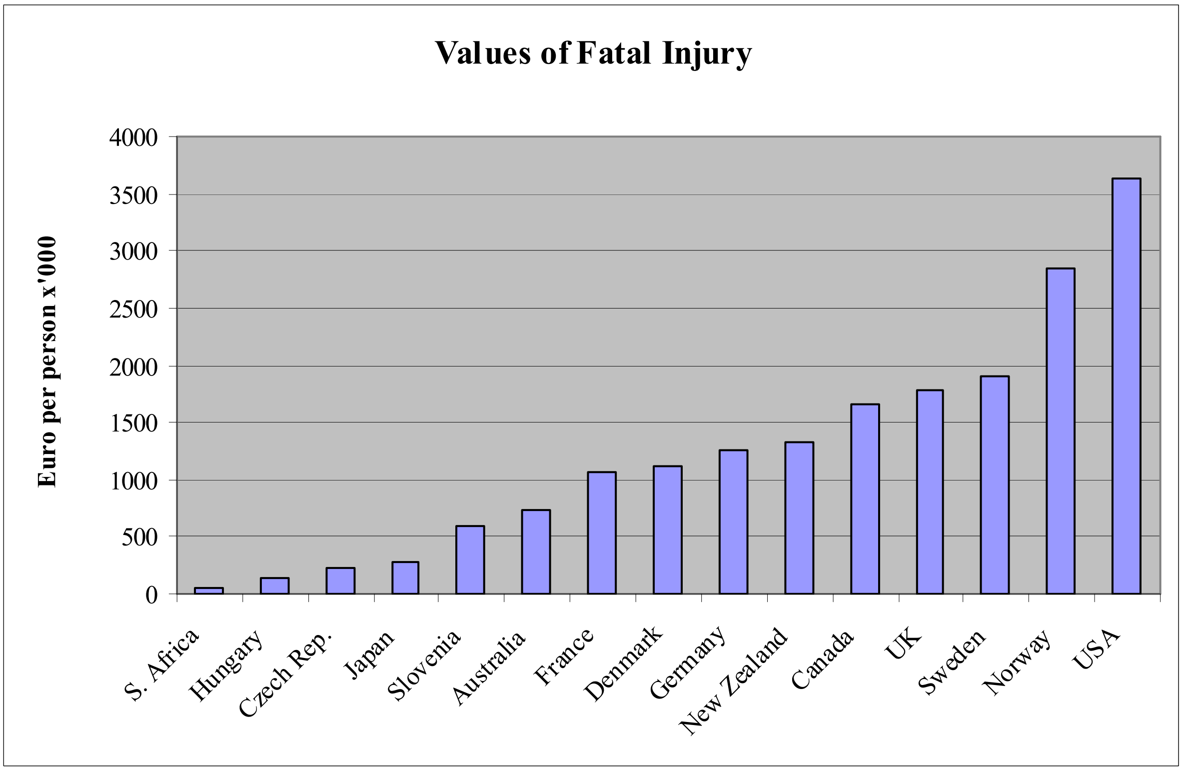


Figure 2.6: Variation in Cost of a "Serious" Injury

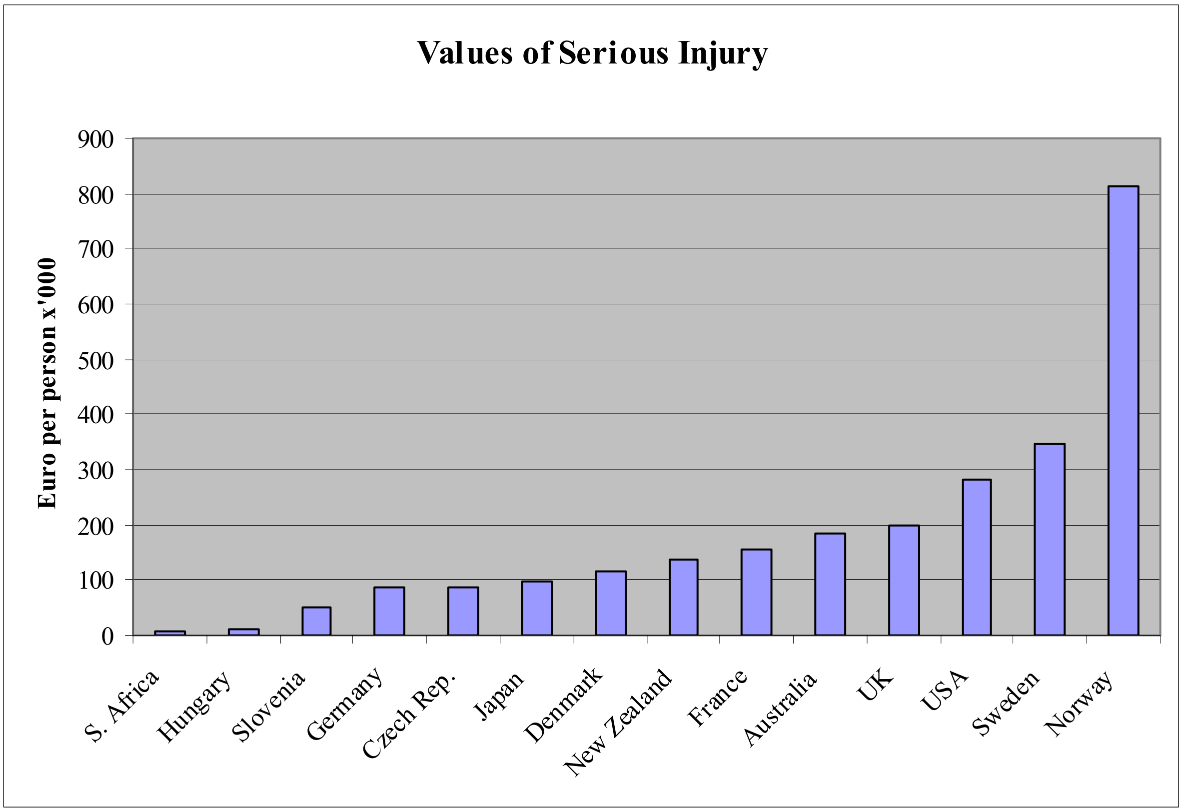
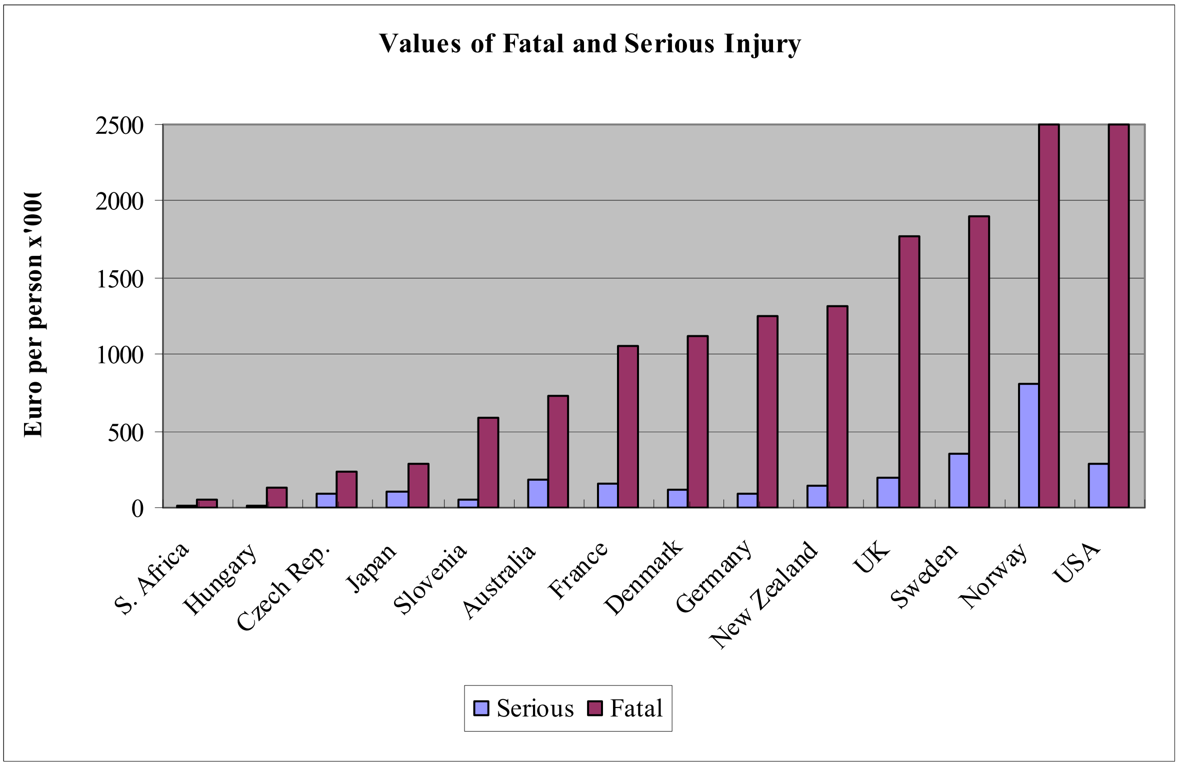


Figure 2.7: Comparison of Cost of Fatal and Serious Injuries



Note: the values of fatal injuries for Norway and USA are higher than shown in this figure - they have been capped for the purpose of this illustration.

Figure 2.8: Variation in Cost of a "Minor" or Less-Serious Injury

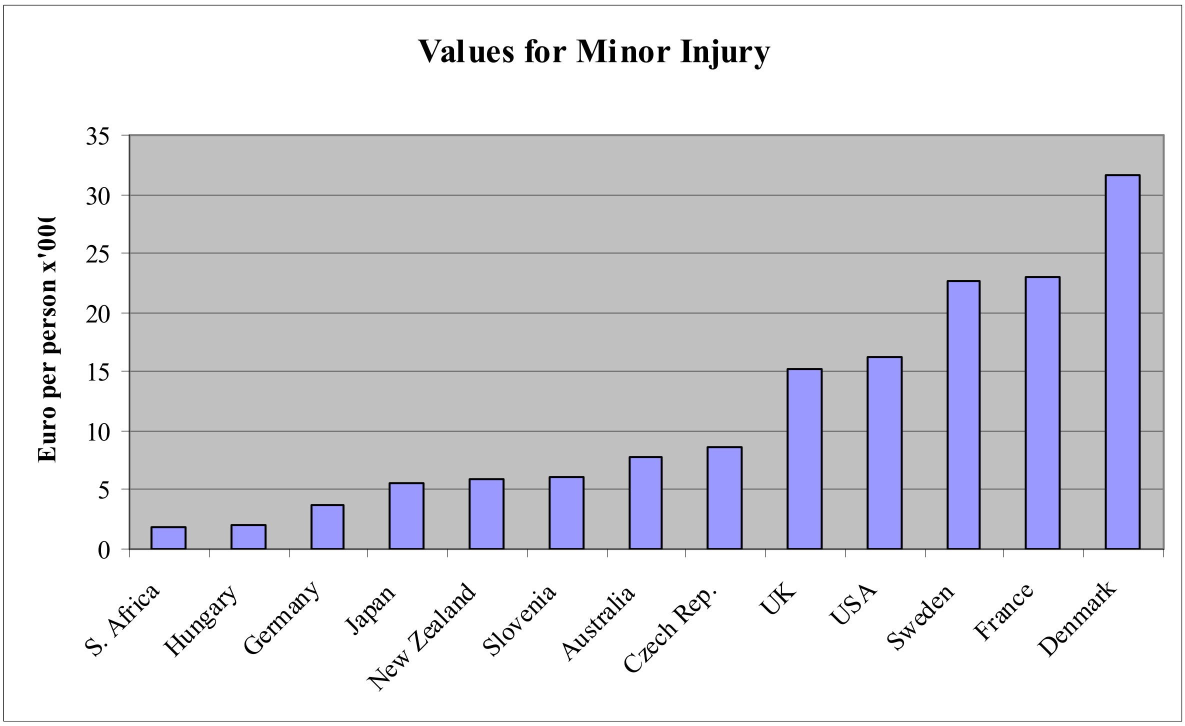


Figure 2.9: Variation in Values of Working Time for Car Users

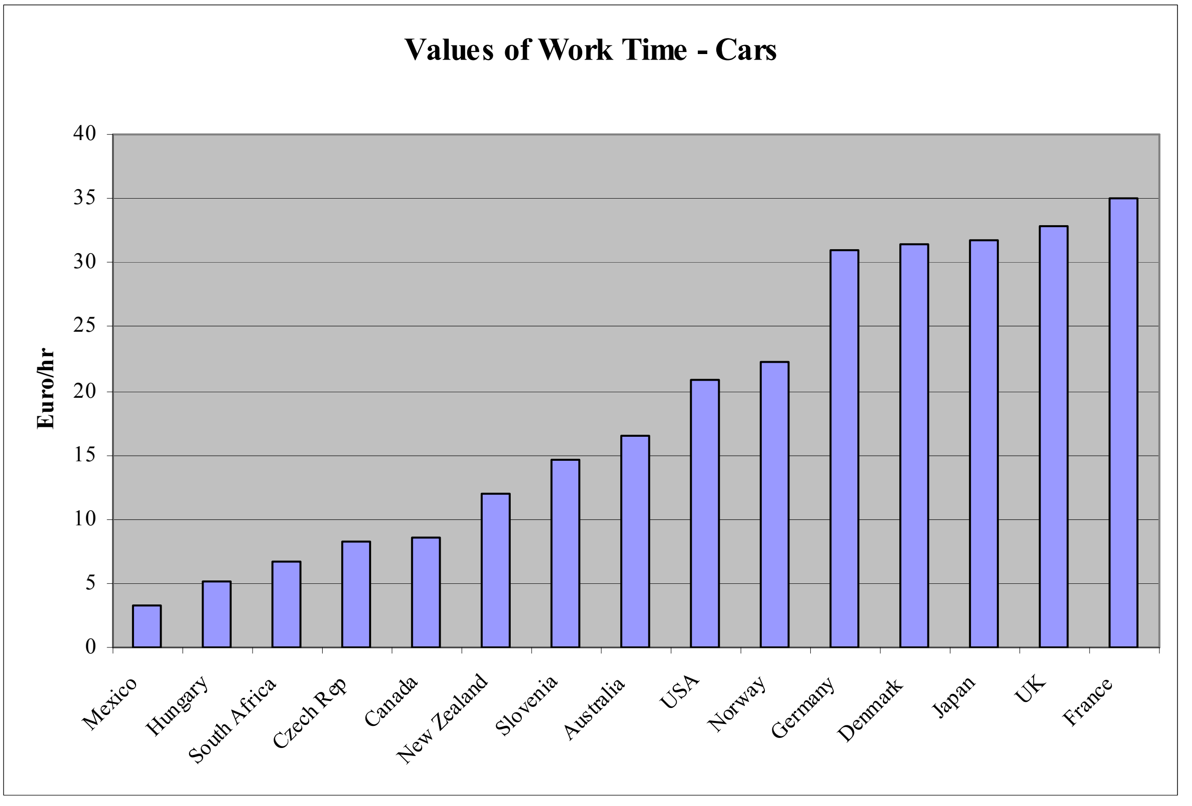


Figure 2.10: Variation in Values of Non-Work Time for Car Users

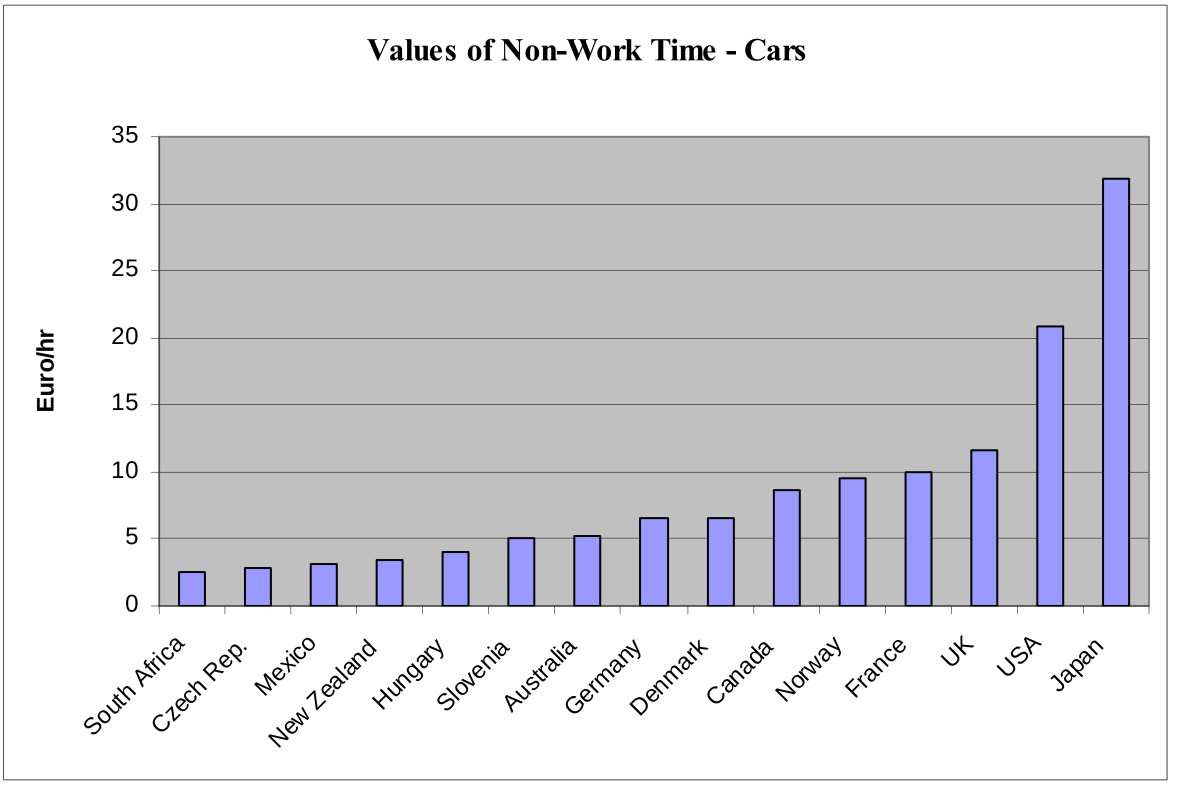


Figure 2.11: Comparison of Work and Non-Work Values of Time for Car Users

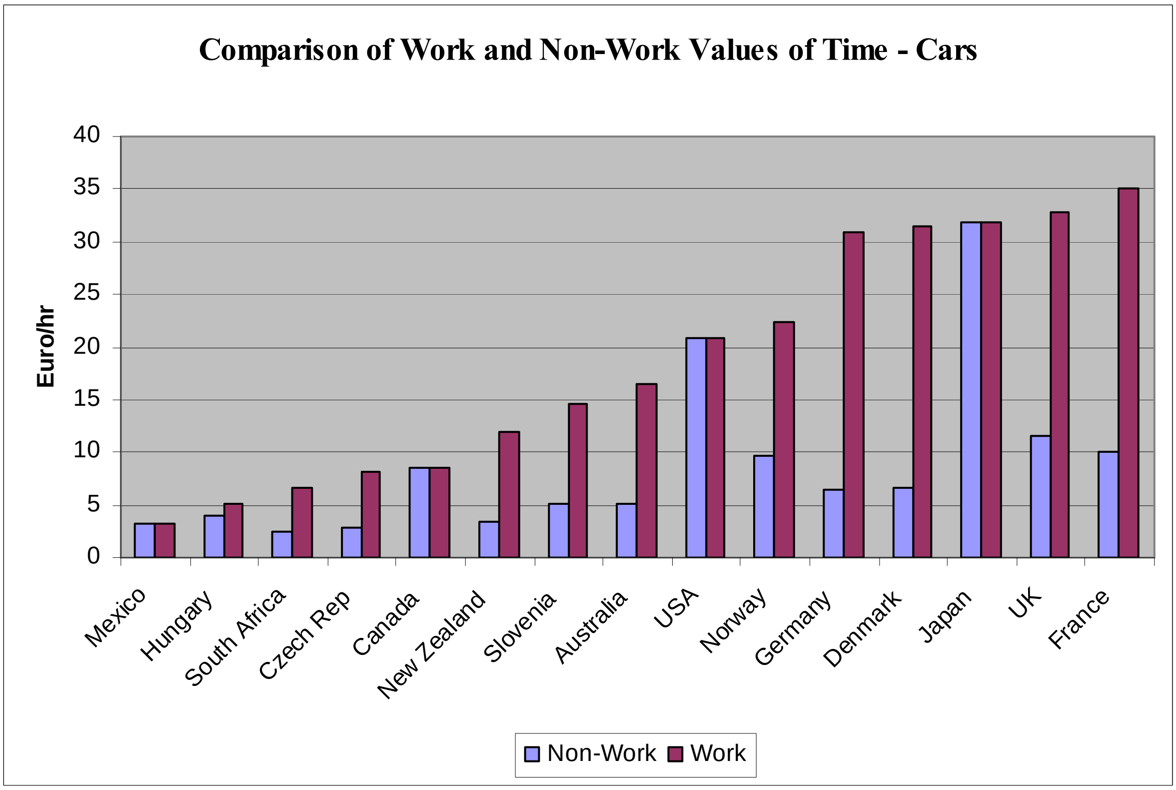
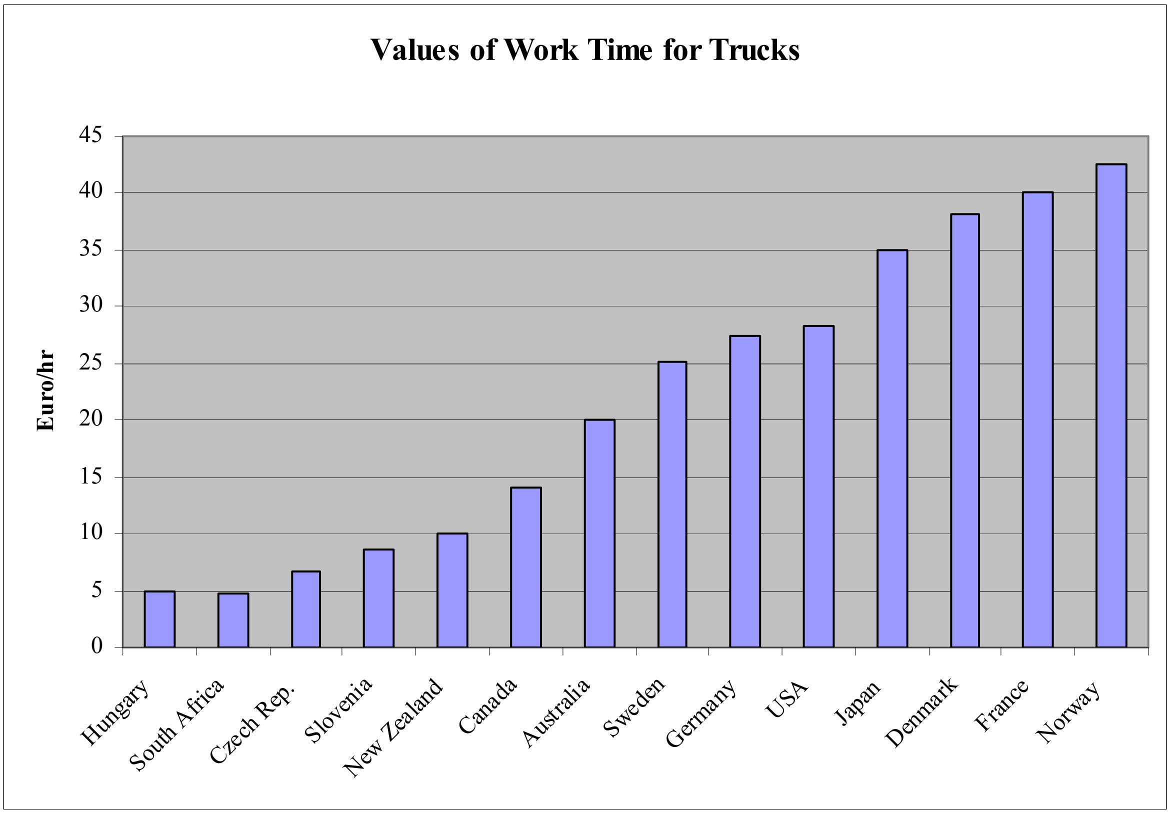


Figure 2.12: Variation in Values of Work Time for Trucks



2.8 Economic Indicators and Inputs

The Net Present Value (NPV) of a project, which is the Present Value of benefits minus the costs, is the principal measure of economic worth in many PIARC member countries.

Some countries use Internal Rate of Return (IRR), sometimes called Economic Internal Rate of Return (EIRR), as the measure of economic worth. IRR is the discount rate that results in a zero NPV for the project. If the IRR equals or exceeds the discount rate, then the project's NPV will be positive. There are a number of difficulties with the IRR criteria. If the net benefits of the project are such that there are net benefits in every year, then the IRR does not exist. Also, multiple IRRs can arise if a project's net benefits change sign during the evaluation period.

When it is necessary to prioritise projects within a constrained budget, the Benefit Cost Ratio (BCR), which is Present Value of benefits divided by the Present Value of costs, is often used. Selecting projects of decreasing BCR ensures that maximum benefits are obtained for a given budget. Sometimes NPV/Cost is used for this purpose, where Cost relates to the constrained budget. A similar approach is needed when choosing between mutually exclusive options or alternatives. The usual indicator for this purpose is incremental costs and benefits, expressed as an incremental BCR.

First Year Rate of Return (FYRR) is used in some countries for determining the best start date for a project. FYRR is usually defined as the project benefits in the first full year following completion of construction divided by the project costs over the evaluation period.

The economic indicators of project worth used by PIARC member countries, plus the discount rate and analysis period, are shown in Table 2.7.

Table 2.7: Economic Indicators and Inputs

	NPV	BCR	IRR	Other (FYRR, Financial Indicators, etc)	Discount Rate	Evaluation Period (years)
Australia	✓	✓			6 - 7%	20-30
Canada	> 0	> 1			5 -10%	20-50
Czech Republic	> 0	✓	> 7%		7%	20-30
Denmark	> 0		> 6%	✓	6 -7%	30
France	>= 0	✓	>= 8%	✓	8%	30
Germany	✓	✓			3%	varies
Hungary	> 0	> 1	> 6%		6%	30
Japan		> 1			4%	40
Mexico	> 0	> 1	> 12%	FYRR > 12%	12%	30
Netherlands		✓			4%	30
New Zealand		> 4		FYRR > 35%	10%	25
Norway	> 0	> 0	> 5%		5%	25
Portugal	✓	✓	✓	FYRR	3%	20-30
South Africa	✓	> 3	> 15%		8%	20-40
Sweden	high				4%	15-60
Switzerland						
UK	✓	✓			6%	30
USA	✓	✓	✓		3 - 7%	varies

✓ Indicator used but no value specified.

New Zealand uses the BCR, which includes time savings, vehicle operating cost savings, accident savings, comfort benefits, frustration relief and CO_2 changes, as the first indicator of project priority. The final decision of project prioritisation is based on information on the BCR combined with consideration of a project meeting the Government's priorities for reducing severe congestion, improving public transport, promoting walking and cycling, assisting regional development, and improving road safety. FYRR is also used as an indicator of optimal timing for a project.

Norway uses NPV/Cost for ranking competing projects and FYRR for timing of projects.

South Africa uses NPV/Cost in optimisation and also IRR.

Fulfilment of political goals is used in Sweden as an indicator as well as NPV.

The UK determines indicators for: PV cost to government; users NPV; private providers NPV; public providers NPV; other government NPV; as well as BCR.

In the USA, states may adopt any or all indicators of project worth, e.g. NPV, BCR or IRR, or may use qualitative factors. Federal agencies are required to use a 7% real discount rate for evaluation of Federal funded investments, but a lower rate, currently ranging from 1.6% to 3.2% (depending on the time frame), is allowed for cost effectiveness analysis. States typically use a discount rate of 3% to 5%. The policy guideline for the evaluation period is that should be long enough to capture long-term differences in discounted life-cycle costs among competing alternatives.

2.9 Treatment of Uncertainty and Risk

Economic indicators for a project are normally calculated using the most likely values of the parameters incorporated in the cost and benefit streams. Future values are often difficult to predict and there will, therefore, be some uncertainty about the results of project evaluations. The effects of varying the calculated values should be investigated, particularly for larger projects.

Sensitivity analysis is a simple technique to assess the effects of adverse changes on a project. It involves changing the value of one or more selected variables and calculating the resulting change in the economic indicators. The extent of change in any selected variable can be determined using post-evaluation and other studies of similar projects. Changes in the variables should be assessed one at a time in order to identify the key variables. Possible combinations of changes can also be assessed. Sensitivity analysis should be targeted to project parameters that are numerically large or for which there is considerable uncertainty.

The results of the sensitivity analysis can be summarized in a sensitivity indicator and in a switching value. A sensitivity indicator compares the percentage change in a parameter with the percentage change in a measure of project worth, e.g. the NPV or BCR. A switching value identifies the percentage change in a parameter for the NPV to become zero, the IRR to fall to the cut-off rate, and the project decision to change. Where percentage changes in the parameter cannot be measured, e.g. for delays, simply the percentage change in the NPV can be presented.

Sensitivity analysis, involving consideration of a range of values for significant parameters, is routinely done for road projects in Australia, Canada, Czech Republic, France, Japan, Mexico, Netherlands, New Zealand, Norway, Portugal, South Africa, Sweden, and the UK. Germany uses three traffic forecast levels but there is no other consideration of uncertainty and risk. Sensitivity analysis in Norway mainly deals with changes in investment cost, traffic growth rate and discount rate. Portugal checks the effect of changes in traffic volumes and investment cost. Instability in traffic growth is the main parameter checked in Sweden, while the UK considers high and low traffic growth forecasts.

Quantitative risk analysis associates a probability of an occurrence with different values of key parameters and specifies correlations between parameters. When such parameters are varied simultaneously through a random selection of outcomes, a frequency distribution for the economic indicator can be produced showing the probability that the project is not acceptable. Decision makers can then compare the scale of net benefits from different projects with their riskiness in selecting an individual project or a portfolio of projects. Quantitative risk analysis can be carried out for large and marginal projects, or for projects where there is considerable uncertainty about a key variable.

Normally computer simulation techniques are required to generate the underlying distributions and calculate the expected value of the economic indicator. In Monte Carlo simulation the project is implemented hundreds or thousands of times using specified probability distributions to give an average result and probability distribution for the economic indicator.

There is increasing use of qualitative risk assessment and risk management in Australia, and processes are being developed that use simulation techniques to evaluate risk and uncertainty.

In Mexico, risks are given a rating on a range 0 to 4. Risks assessed include: completion date; cost; achievement of outcomes; and delays from permissions and authorisations.

New Zealand’s approach to risk includes development and implementation of risk management plans for higher priority risks. Risk analysis is a requirement for all projects costing over 1.5 million euro and for those projects designed to reduce or mitigate risk.

Similarly in the USA, risk analysis is generally reserved for more expensive projects, or projects perceived at the outset to be especially subject to uncertainty or controversy. The results of the analysis can be presented together with recommendations on what actions to take or which variables to monitor during implementation and operation. However, individual states use a wide variety of mechanisms, e.g. pavement warranties, to manage risk.

2.10 Methods for Project Option Selection

Selection of options is part of the project design process. A comparative evaluation of the costs and benefits of mutually exclusive alternative options is usually required. If the alternatives have differences in benefits or service quality, then incremental benefits and costs need to be considered, usually in an incremental BCR analysis.

If the benefits are similar for all the alternatives, e.g. the ride quality is essentially the same for all pavement types and the associated maintenance/rehabilitation strategies, then the evaluation can concentrate on the stream of costs over the evaluation period. Sometimes this is called Least Cost Analysis (LCA). Whereas, LCCA is often used to select a particular project component, e.g. the pavement type, rather than project option.

Where the benefits or outcomes are not measured in monetary terms, CEA can be used for comparing alternatives. If there are benefits to a number of outcomes, then these are weighted and reduced to a single measure. This is called weighted cost effectiveness. Cost effectiveness ratios must always be used with caution, because the most cost effective alternative may not be economically justified.

LCCA, MCA and CBA are all used in Canada for selection of project options, depending on the type of project.

The Czech Republic uses HDM-4 CBA outputs (NPV and IRR) plus MCA, for assessment of project alternatives.

Denmark has previously used FYRR but is changing to NPV and IRR for project option selection. Traffic is usually modelled using the EMME/2 transportation network modelling system.

Selection of options for road projects in France starts with economic evaluation but political and environmental acceptability have an increasing effect as the project progresses.

In Mexico, a number of economic indicators (NPV, BCR, FYRR, IRR) are used to help select the final project option for recommendation to the parliament.

Option selection in the Netherlands does not only depend on costs and benefits, but also on political preferences, available budget and practical considerations. The latter can favour traffic management options because they are relatively easy and quick to implement.

New Zealand uses an evaluation of incremental costs and benefits for option selection. The target incremental BCR is set in advance of an evaluation being undertaken (e.g. a target incremental BCR of 3.0 was used for the 2002/03 year).

In Norway, project alternatives are evaluated by a local impact assessment, of which BCR is part. However, the final choice of project option is more dependent on local preferences than on economic analysis.

States in the USA increasingly use LCCA to select among mutually exclusive means to accomplish a transportation objective, e.g. pavement type selection for rehabilitation. Results of planning exercises and environmental assessments are often critical to option selection.

2.11 Methods for Project-to-Project Comparisons

The main purpose for project-to-project comparisons is to rank or prioritise projects for funding, either in the short-term or for longer term planning, usually because there are limited funds available for all the potential projects.

In Australia, projects are generally prioritised within a funding constraint and projects with a low BCR are usually not funded. Prioritisation is often not strictly objective, with criteria other then BCR used to subjectively prioritise competing projects. Project priorities are also influenced by higher level strategic outcomes.

CBA is used in Canada for selection of competing projects within the same mode. MCA is also used to include any non-monetised parameters.

In Denmark, the separately assessed environmental impacts are taken into account when deciding whether to implement a road project and can mean that a project with lower economic return is preferred.

In Germany projects are selected on the results of CBA plus non-monetary weightings and are then considered by the local and federal politicians. Once the list of projects for the federal road network is agreed the Federal Transport Infrastructure Plan (which is undertaken roughly every 10 years) is submitted to parliament and the approved Plan becomes an Act of Parliament. This means that the agreed projects cannot be changed by future politicians except for exceptional reasons.

Prioritisation of road projects in Hungary is significantly influenced by politicians.

In Japan, CBA is used for acceptance or rejection of the project. Prioritisation depends on MCA allowing for social factors and the importance of implementation.

In Mexico BCR and IRR are used to prioritise projects. Projects are selected on the basis of evaluation results (CBA plus non-monetary weightings) together with input from political aspects.

The Netherlands has recently developed a CBA approach for selection of competing projects or projects involving alternative modes.

In New Zealand, projects are initially prioritised for central government funding based on the BCR and then the Government's stated transport priorities are considered alongside the BCR, which may result in a re-ranking of the prioritised projects..

Project prioritisation in Norway takes account of all parameters, including BCR and non-monetised effects, all of which are included in a local impact assessment.

In Portugal decisions on which project proceeds are based more on the plan to complete the main and complementary road networks than on economic evaluation.

2.12 Acceptance of the Evaluation Framework

In Australia, public involvement with the development of objectives, criteria and weightings for the evaluation framework leads to acceptance of the evaluations by communities and key decision makers. There is increasing use of public consultative forums to obtain sign-off on priorities. Where projects have both high BCR values and high rankings from MCA, project implementation usually occurs within short timeframes.

In Canada economic evaluations are increasingly being used by government decision makers, and are mandatory when the federal and provincial governments jointly fund a project. However, funding availability often overrides the priorities indicated by economic analysis, and the general public is generally not aware of the methodologies used.

In the Czech Republic evaluation methods are accepted as good practice by government and other public authorities, and there is a good correlation between indicators of project worth and project implementation.

In Denmark, economic evaluations have a high acceptance as an indication of priority, but political decisions can over-ride this.

Japanese government decision makers and officials accept, and require, a CBA for a project, expanded or modified if necessary to include amenity, environment and equity balance considerations.

Likewise in Mexico, economic evaluation methodologies and values are well accepted by government decision makers. About 70 percent of highly ranked projects are implemented. Political considerations and trunk network completion quite often override the economic ranking.

Public consultation for road projects in the Netherlands often leads to disagreement on the weighting of impacts, particularly with regard to the mitigation of negative impacts, and therefore to changes to the project. High priority from evaluation, even when supported by CBA, does not guarantee implementation.

In New Zealand CBA and the monetary values used are accepted by public agencies and officials. Prior to 2002 there was an almost 100 percent correlation between the indicator of project worth (the BCR) and project implementation. This is partly due to the institutional arrangement for central government funding of road projects, which limits political input to high level policy and strategy. Since 2002 the process has been modified, with the BCR used as the initial indicator of project priority but with other factors considered alongside. There is an ongoing debate about the development of an improved framework for project selection.

In Norway the economic evaluation and the monetary values are widely accepted by practitioners. The monetary values were discussed thoroughly by experts before being included in the Norwegian evaluation procedures. There is some criticism that several factors are not quantified in monetary terms and there is some public disagreement with some of the values used – mostly the value of time and cost of accidents. In the past, there has been a poor correlation between the BCR and the final ranking of projects, but the correlation seems to be improving.

In South Africa the methodology and monetary values used are accepted. However, there is debate on the value of travel time. About 85 percent of implemented projects are economically viable. The other 15 percent are done in order to combine adjacent road sections to make an efficient project; to recognise socio-economic considerations not included in the economic analysis; for strategic network development; or for specific material or construction technical reasons.

In Sweden government decision makers at a strategic level readily accept CBA evaluation. Opinion is more divided at a municipal level. In general, the public is not aware of how road projects are ranked and selected, but there is some awareness among interest groups. There is a good correlation between implemented projects and projects with high indicators of worth. Exceptions are mainly for political reasons. The Swedish National Road Administration is working continuously to improve the methods and tools to better describe the consequences and impacts of road projects.

The evaluation methodology used in the UK enjoys general public acceptance. Consultation with key stakeholders is an integral part of the process. The theoretical basis of the monetary values is long established and the values are widely accepted. MCA is extensively used with a high degree of political involvement in the final choice of projects to be funded. Research shows that the decision makers take non-monetary impacts into account.

In the USA, states and the public are generally receptive to applications of economic methods to highway investment decisions in the USA. Many states have legislation that requires reporting of what is bought with public funds, how spending decisions are made, and what is achieved. The FHWA promotes the adoption of improved economic methods as part of its Asset Management initative.

2.13 Changes from Previous PIARC Report

Some countries have made significant changes to their project evaluation methodology in that last 5 years. In some cases, e.g. the UK and Sweden, the methodology has been extended to encompass multi-modal effects and apply to multi-modal projects. Other countries, including the Czech Republic and Norway are considering developing a common evaluation method for road and rail.

Australia, Portugal, and Sweden were all listed in the previous report as using conventional CBA. These countries now use a combination of CBA and MCA. The UK has shifted further toward the MCA approach to better present the wide range of impacts being considered and to relate project outputs to government transport objectives.

Where changes have been made these have mainly been to widen the evaluation framework to include additional environmental and social impacts. There has been little change in the range of impacts that are monetarised and included in the CBA. New Zealand has valued some aspects of road users' emotional and psychological preferences, e.g. driver and passenger comfort (passing opportunities, smooth roads, wide roads, etc) and network reliability.

Generally non-monetarised impacts are increasingly being presented to assist decision makers, in either a quantified or qualified manner, usually together with CBR results, often in an MCA type framework.

There has been some change in the methods used for deriving monetary values, particularly for accident costs. WTP is now used far more widely than it was previously, particularly for establishing values of statistical life.

Lower discount rates are now being used in many countries, e.g. the UK 6% instead of 8%; Portugal 3% instead of 8%; Canada 5-10% instead of 10%; and South Africa 8% instead of

15%. The European Union has recently issued advice that 3% should be used by countries in the Union for project evaluation purposes.

Increasingly attention is being given to uncertainty and risk as practical methods of risk analysis are developed in the international community.

Overall, there is an increasing interest in economic evaluation of road projects by politicians, the public and road administrations. This has resulted in questioning of the valuations used and extension of the evaluations to encompass more of the impacts of road projects. There is increasing consultation by road administrations with outside interests on the evaluation methods and the valuations used. Political and funding considerations continue to have a major influence on project priorities in some countries.

3. INTERNATIONAL GUIDELINES AND COMPARISONS

A number of international agencies, including the World Bank (WB) and multilateral development banks such as the Asian Development Bank (ADB), have documented internationally accepted principles and detailed guidelines for economic analysis of projects where they finance the project in whole or in part. These international guidelines, together with more detailed information on the actual practices of economic evaluation, can assist road administrations identify opportunities for improvement in their own evaluation practices.

Recent developments by these international agencies have placed greater emphasis on sustainability issues, including financial, environmental, economic, social and political.

3.1 World Bank

The following is summarised from the WB Operational Manual (ref. 4). The Bank requires an economic evaluation of investment projects and an environmental assessment. The economic evaluation and environmental assessment are presented as components in a wider Project Appraisal Document, which covers all aspects of project design, evaluation, financing, management, and monitoring. Guidance on project economic evaluation is provided in the Handbook on Economic Analysis of Investment Operations (ref. 5).

The WB evaluates investment projects to ensure that they promote the development goals of the borrower country. NPV is the basic criterion for a project's acceptability. Mutually exclusive designs are investigated by comparing the project design with other designs involving differences in such important aspects as choice of beneficiaries, types of outputs and services, production technology, location, starting date, and sequencing of components.

If the project is expected to generate benefits that cannot be measured in monetary terms, the analysis: (a) defines and justifies the project objectives, reviewing broader sectoral or economy-wide programs to ensure that the objectives have been appropriately chosen; and (b) shows that the project represents the least-cost way of attaining the stated objectives.

The WB assesses the robustness of the project with respect to economic, financial, institutional, and environmental risks. Aspects checked include: (a) whether the legal and institutional framework either is in place or will be developed during implementation to ensure that the project functions as designed; and (b) whether critical private and institutional stakeholders have or will have the incentives to implement the project successfully. Assessing sustainability includes evaluating the project's financial impact on the implementing/sponsoring institution and estimating the direct effect on public finances of the project's capital outlays and recurrent costs.

The economic evaluation includes a sensitivity analysis taking into account the possible range in the values of the basic variables and assessing the robustness of the project's outcome with respect to changes in these values. The analysis estimates the switching values of key variables and the sensitivity of the project's NPV to changes in those variables (e.g., delays in implementation, cost overruns, and other variables that can be controlled to some extent).

The economic analysis also examines the project's consistency with the WB's poverty reduction strategy.

The WB requires environmental assessment (EA) of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable, and thus to improve decision making. The breadth, depth, and type of analysis for the EA process depend on the nature, scale, and potential environmental impact of the proposed project. EA evaluates a project's potential environmental risks and impacts in its area of influence; examines project alternatives; identifies ways of improving project selection, siting, planning, design, and implementation by preventing, minimizing, mitigating, or compensating for adverse environmental impacts and enhancing positive impacts; and includes the process of mitigating and managing adverse environmental impacts throughout project implementation. The WB favours preventive measures over mitigatory or compensatory measures, whenever feasible.

The WB EA process takes into account the natural environment (air, water, and land); human health and safety; social aspects (involuntary resettlement, indigenous peoples, and cultural property); and trans-boundary and global environmental aspects. It also takes into account the variations in project and country conditions; the findings of country environmental studies; national environmental action plans; the country's overall policy framework, national legislation, and institutional capabilities related to the environment and social aspects; and obligations of the country, pertaining to project activities, under relevant international environmental treaties and agreements. EA is initiated as early as possible in project processing and is integrated closely with the economic, financial, institutional, social, and technical analyses of a proposed project.

It should be noted that the objectives of the WB, and its relationship with its clients, means that the economic evaluation of transport projects performs a rather different role than it does in a typical national administration. The Bank is not concerned with ranking of projects, either within or across sectors, but rather with establishing that an individual investment represents sensible use of resources within the particular country.

3.2 Asian Development Bank

The ADB uses a project evaluation framework and techniques similar to those of the WB. The project framework integrates the evaluation of the economic, environmental and social effects as illustrated in Figure 3.1.

An EIA is required for large or environmentally sensitive projects.

Projects are evaluated against multiple criteria:

a) Relevance – to the country development strategy and to strategic objectives

b) Efficacy – achievement of project outcomes

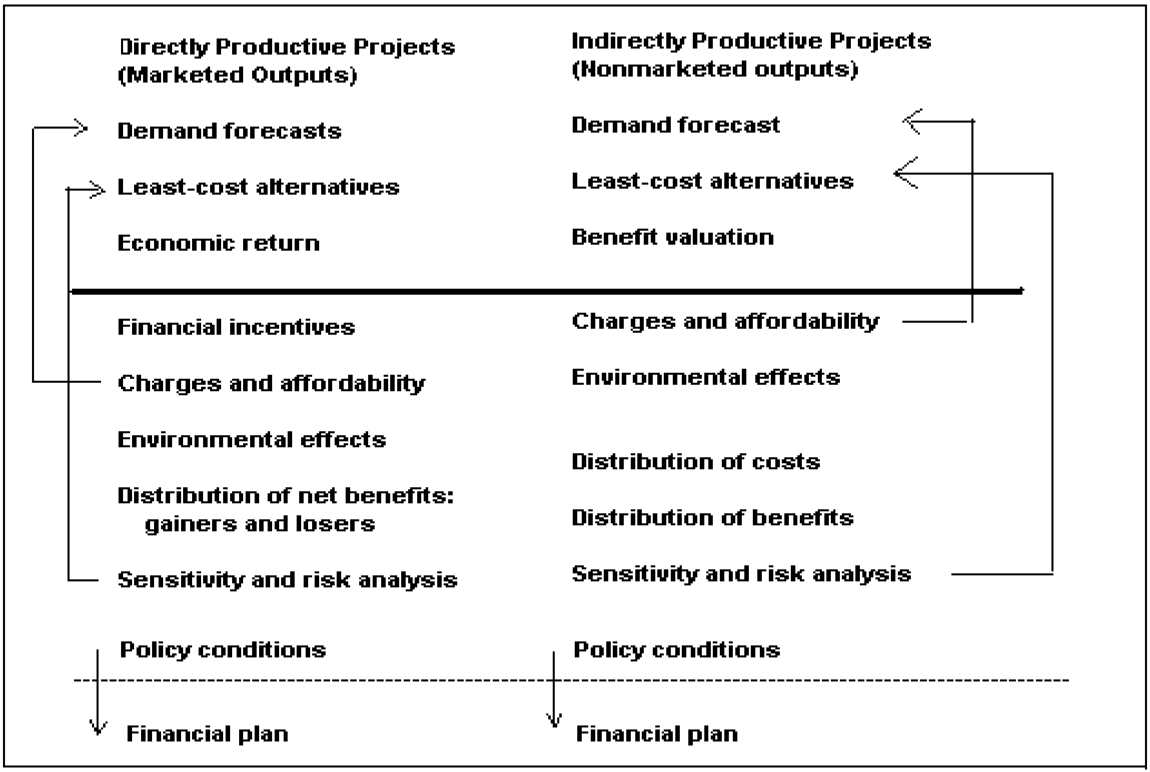
c) Efficiency – EIRR and FIRR values, cost effectiveness of project outputs

d) Sustainability – continuing demand, cost recovery, maintenance policy and procedures, finance and skills, commitment to the project, effect on environment and resources, community participation

e) Institutional development and impacts – laws and procedures, norms and practices, institutional arrangements, impacts on poverty, the environment, social organisation, political developments

Usually the above criteria are each given relative weights and a rating (0 – 3), so that an over weighted rating can be presented in a Project Appraisal Report.

Figure 3.1: ADB Framework for Economic Evaluation



The ADB has produced Guidelines for the Economic Analysis of Projects [ref. 6]. This includes methodology for integrating the costs and benefits of environmental changes in economic analysis. It is noted that the environment is increasingly being treated as a form of natural capital resource. NPV with and without project environmental impacts is used as decision criteria. The ADB discount rate is 10% – 12%. Sometimes a lower rate is used in a sensitivity analysis to check longer-term environmental impacts.

3.3 European Union

Requirements for Financial and Economic Evaluation of Development Projects are given in a European Commission publication [ref. 3]. Information on transport project appraisal in EU member countries is given in a paper by A.L. Bristow and J. Nellthorp [ref. 10]. One clear trend reported is that EU countries are moving towards developing consistent multi-modal evaluation techniques, in place of techniques that just applied to roads. The report notes that there is a high level consensus as to the direct impacts that should be included in CBA, but valuations are different where no market values are available, e.g. time and accident costs. There is also a degree of consensus on which impacts should be included in environmental impact assessments, but less agreement on the appropriateness of monetary valuation.

3.4 Developing Countries

Information on evaluation of road projects and programs in developing countries is given in a paper by A. Talvitie (ref. 10). The paper describes the evaluation method commonly used by road administrations in developing countries, including for World Bank supported road projects and programs. Some emphasis is given to institutional aspects.

3.5 International Comparisons

International comparisons of transport project appraisal are made in a paper by H. Nakamura and a paper by Y. Hayashi and H. Morisugi (ref. 10). The second paper covers: institutional arrangements in the transport sector; the system of transportation project evaluation; and the primary project evaluation tools.

4. RECOMMENDATIONS FOR FURTHER WORK

The previous report recommended that:

a) As many impacts as possible should be included in economic evaluations of road projects.

b) Impacts be valued in monetary terms where possible.

c) A stringent evaluation methodology be developed to ensure that impacts are compared and are seriously considered in decision making.

d) PIARC member countries develop strategies for marketing economic evaluation methods to decision makers.

e) Member countries co-operate in developing monetary values for impacts, especially environmental impacts.

Some progress has been made on a) and c), particularly in the UK. In some countries there appears to be a move away from determining monetary values for environmental and social impacts. While it is recognised that this saves discussion and challenge to the values used, this is opposite to the approach advocated by international agencies such as the World Bank and the Asian Development Bank.

This report recommends that PIARC member countries:

a) Continue to refine and develop CBA and MCA methodologies.

b) Co-operate in developing monetary values for environmental and social impacts, and methods for their inclusion in project evaluation.

c) Expand the project evaluation methodologies to cover all land transport modes.

d) Give more attention to use of quantitative risk analysis for projects with significant risks or which are controversial.

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