

## Cost-benefit analysis of road safety measures

### Summary

Traffic and transport budgets, national ones as well as regional ones, should be calculated as optimally as possible. That is why it is essential to be able to assess a variety of measures well and compare them with each other. This is possible when a cost-benefit analysis is used. This method provides support when, for example, determining policy plans and budgets, or prioritizing and phasing investment options. Cost-benefit analyses have already often been used in the Netherlands and in other countries. However, the experiences with using them for road safety measures are still limited. The SWOV guideline *Cost-benefit analysis of road safety measures* offers a practical overview of the various sections of a cost-benefit analysis and indicates how the method can be applied to road safety measures.

### Background

During the last few years, many measures to improve road safety have been studied. In order to be able to choose between them it is advisable to assess them unambiguously. Besides taking the road safety effects into account, the mobility (i.e. exposure) and environmental effects must also be examined. As government budgets in general decline, a choice between various investments often has to be made for example, between safety, accessibility, or liveability. Because of increasing decentralization, these choices have to be more often made at the regional level. This leads to increasing investment independence. There is, therefore, a need for a clear framework for integrally weighing a variety of measures. The method that is suitable to do this is the social cost-benefit analysis. During the last few years, this method has been applied to all infrastructural projects of national importance. They are also often used for this in other countries. However, the experiences with the cost-benefit analysis (CBA) for road safety measures are rather limited. For this SWOV, together with the research and advice agencies ECORYS and CE, has developed a guideline (Wesemann & Devillers, 2003). This fact sheet contains a summary of this report.

### What is a cost-benefit analysis used for?

In a CBA the welfare effects of an investment, for example in road safety, are determined. This means that a CBA answers the question of whether an investment's benefits exceed the costs. Not only are the financial aspects studied, but also issues as safety, emissions, and congestion. In this way, a CBA makes it possible to make statements about the social return of an investment. An overview of social costs and benefits can serve as basis for prioritizing separate measures or measure packages (combinations of measures). In addition, CBA is used to weigh off investments in various policy areas. Such choices are necessary when making policy plans, fixing the national budgets, and prioritizing or phasing investment options. A CBA is useful in this because it involves summarizing a great deal of information in a rational framework. However, this leaves the responsibility of the decision maker unimpeded. Other considerations than those processed in the CBA can also play a role in the eventual choice. Examples of this are ethical and legal considerations.

A CBA can be used for a variety of purposes. These determine the amount of detail needed. What is known as a simplified CBA is suitable for exploring a problem and formulating alternative investment options. A simplified CBA provides an indication of the costs and benefits based on already available information. The likely alternatives can then be subjected to a thorough CBA in which additional and more detailed information is gathered. The thorough CBA is needed to make a final choice of alternatives.

A cost-effectiveness analysis (CEA) can sometimes be sufficient for prioritizing road safety measures. This analysis only examines the road safety effects (e.g. casualty saving) and investment costs. A CEA is thus only suitable if no important side effects are anticipated. Measures can be ranked with it, based on the costs necessary to save one casualty.

### **For who is a cost-benefit analysis useful?**

A CBA can be carried out at various levels. The social effects are determined for a municipality, region, or country. It is also possible to attribute social effects to the actors involved. In this way, a picture emerges of the costs and benefits for each actor. This can be important for support of measures and any budgetary consequences. It can, therefore, be a useful instrument for all parties involved in deciding about investments, especially national and regional governments. The guideline designed by SWOV is meant for these parties, and for research and advisory organizations that carry out CBAs of road safety measures.

### **How does a cost-benefit analysis work?**

When carrying out a CBA, the most important aspects are:

#### *Comparing alternatives*

In a CBA, the welfare effects, i.e. the social costs and benefits, of the situation with the measure (the project alternative) can be compared with the situation that would develop without the measure (the null alternative). The null alternative can be the autonomous development or continuation of the current policy.

#### *Costs and effects*

In a CBA of road safety measures, three categories of effects can be distinguished: effects on safety, mobility, and environment. Safety involves limiting material damage, medical costs, production loss, immaterial damage, settlement costs, and traffic jam costs (see also SWOV fact sheet [Road crash costs](#)). Mobility effects consist of changes in travel time and travel costs. Environment costs consist of changes in emissions and noise nuisance. In a CBA, the effects of measures are compared with the costs such as those for changing the infrastructure or vehicles (implementation costs) and maintenance and enforcement (operational costs). In the case of measure packages, we must of course take overlapping and cost savings into account when combining measures.

#### *Monetarizing effects*

In a CBA, the effects are expressed in terms of money as much as possible. This is called monetarizing. Some effects can be monetarized using market prices, for example, medical costs and business travel times. For effects with no market price, other valuation methods have been developed, such as the contingent valuation method (CVM) or the hedonic pricing method (HPM). The CVM uses surveys to determine a monetary value of, for example, road safety's immaterial costs (see also SWOV fact sheet [The valuation of human costs of road deaths](#)). The HPM uses, for example, house prices to monetarize effects. In this way, the 'price' of noise nuisance is determined by the price difference between houses in areas with a lot and little noise nuisance. Effects that can absolutely not be expressed in terms of money are included as a *reminder* item in the overview of costs and benefits. For example, this applies to landscape effects of a new infrastructure. If possible, additional (quantitative) information about the effect is given so that they can be included in the definite decision. The *Additions to the Guideline OEI* (MoT & Ministry of Economic Affairs, 2004) recommends presenting an overview of the effects of more common units (such as the number of casualties or the amount of carbon monoxide) as well as the overview of monetarized effects.

#### *Time aspects*

Project and null alternatives are compared over a longer period, e.g. 10 or 20 years, depending on the effectiveness duration of measures. The costs and effects are discounted to the first investment year, using a discount rate. This involves weighing the effects during a period of years, by which those effects that occur later weigh less than those that occur earlier. By calculating what is known as the present value of costs and benefits in this way, measures with different effectiveness durations can still be compared with each other. An official discount rate of 2.54% has been fixed for government projects.

A CBA uses scenarios to estimate the size of effects in the course of time. The scenarios describe future developments in, for example, demography and economics. Recently four new scenarios that can be used in CBAs were developed in a study carried out by the Netherlands Bureau for Economic Policy Analysis (Janssen et al., 2006).

### *Return calculations*

If the costs and the monetary value of all effects for a particular period have been determined, the social return is then calculated. Usual criteria for this are the balance and the ratio of the discounted value of benefits and costs. Based on these criteria, measures or measure packages can be compared. Finally, it is often useful, and also usual, to examine uncertainties in a CBA's results. This can be done by testing the extent to which results are sensitive to uncertainties in, for example, effect and cost estimates, and in valuation of effects. Depending on the type of uncertainty, various methods can be used in order to take this into account, such as increasing the interest rate with a 'risk premium', or a sensitivity analysis (MoT & Ministry of Economic Affairs, 2004).

### **What are cost-benefit analyses used for in the Netherlands?**

In the Netherlands, the importance of using CBA for an integral assessment of policy measures has now been recognized for some time, especially when it concerns infrastructure. In 2000, a guideline was written about carrying out social CBAs of infrastructural projects. This is known as the EEI guideline; short for the Economic Effects Infrastructure (CPB & NEI, 2000). Since then, all large infrastructural projects of national importance have been assessed according to this guideline. This has led to a large number of analyses, e.g. the extension of Schiphol Airport, Maasvlakte 2, the Zuider Zee Railway, and the introduction of road pricing policy ('A Different Way of Paying for Road Use'). In addition, the method was used on smaller scale projects such as the light rail link from Gouda to Leiden.

The EEI guideline and several of its applications were assessed (BCI, 2002) which has led to changing its name to Infrastructure Effects Overview and a number of additions to it.

### *Attention for road safety*

In the original EEI guideline road safety still received insufficient attention. In the immediate future, an addition to the original guideline will be published which pays attention to safety effects, among which road safety effects. This addition will contain recommendations, guidelines, and core data for measuring and valuing of road safety effects in a CBA of infrastructural projects. In the Netherlands the number of CBAs on road safety measures still is limited. Specifically, there have been some studies into the costs and benefits of measures aimed at lorries and transport companies (e.g. Langeveld & Schoon, 2004).

### **What are cost-benefit analyses used for in other countries?**

There has also been an increased interest in CBAs in other countries. Guidelines for carrying out CBAs are available in the United States, a number of European countries such as Great Britain, France, and Germany, and in various other countries. At the EU level, there also is a guideline available (European Commission, 2003). For transnational projects guidelines were developed in the European project HEATCO (Bickel et al., 2006). Various survey studies have shown that the CBA is often used in various European countries, especially for infrastructural projects (for example, see Bristow & Nellthorp, 2000). The CBA is mainly used for selecting and prioritizing projects. The number of CBAs is also increasing in Europe. Not only are they carried out for new EU member countries, but also for trans European projects, such as various railway projects and the Galileo satellite project.

### *Cost-benefit analyses for road safety*

In the meantime, a number of CBAs have been carried out abroad for road safety measures. CBAs play an important role in various programmes of the European Commission. In the ESCAPE and PROMISING programmes, CBAs have been drawn up using the same method for extra police control on speeding, alcohol, and seatbelts (Elvik, 2000) and for 20 specific measures for vulnerable road users (TRL, 2001). The IMMORTAL project contains a CBA of measures against alcohol use and of an eye test when renewing a driving licence (Vlakveld et al., 2005). In all these studies, the effects on mobility and environment are being monetarized as well as the safety effects. The goal of the ROSEBUD project has developed a practical applicable method for cost-benefit and cost-effectiveness analyses of road safety measures, based on existing knowledge and experience and after consulting users. This project has also made CBAs for road safety measures in different countries (Winkelbauer & Stefan, 2005)

Elvik & Amundsen (2000) have assessed 64 Swedish road safety measures and 4 measure packages with a CBA. In addition, two recent European Commission guidelines were assessed for

their costs and benefits in 15 European countries (ICF Consulting, 2003). These are guidelines for enforcement of speeding, alcohol, and seatbelt use and enforcement of rules and regulations for lorries and busses. These studies also include mobility and environmental effects besides the road safety effects.

### What are the results of cost-benefit-analyses?

The ultimate result of a CBA is an overview of costs and benefits and the social return of alternatives. As many items as possible are monetarized. *Table 1* shows the social costs and benefits of two measure packages that were analysed in Elvik & Amundsen's Swedish study. Before the packages were compiled, the costs and benefits of the separate measures were determined. The first package is based on the Swedish long term Vision Zero. The second package called 'Cost-benefit' only consists of measures whose separate benefits were greater than their costs. These two project alternatives were compared with the null alternative in which no extra measures were included. The period under consideration is 2002-2011.

	'Vision Zero' Package	'Cost-benefit' Package
<b>Benefits:</b>		
Accidents	15,953	9,295
Travel time	-16,150	-332
Vehicle operation	-283	230
Environment	469	470
Induced traffic	-891	42
<i>Total benefits</i>	<i>-904</i>	<i>9,704</i>
<b>Costs: *</b>		
Investment	18,022	4,870
Operational	12,207	1,362
<i>Total costs</i>	<i>30,229</i>	<i>6,232</i>
<b>Profitability:</b>		
Benefits-costs balance	-31,133	3,472
Benefits-costs ratio	-0.03	1.56
*) Elvik & Amundsen also include welfare losses for taxes as costs. This (unusual) cost item has been excluded in this table.		

Table 1. Example of a cost-benefit overview of two measure packages in Sweden in € million (1999 price level) (Elvik & Amundsen, 2000, SWOV version).

*Table 1* shows that the Vision Zero package delivers the greatest safety benefits. Also the environmental effects are positive. On the other hand, there are considerable negative mobility effects (especially an increase in travel time) and the costs are greater. This results in a negative benefits-costs balance of € 31 billion. In the alternative 'Cost-benefit' package, the benefits of improved road safety are smaller than in Vision Zero, but the mobility and environmental effects are collectively positive and the costs smaller. This results in a positive benefits-costs balance of €3.5 billion.

Apart from providing an overview of costs and benefits and social return, a CBA usually contains a lot of information about alternatives, effects, and scenarios. This information often comes from other studies such environmental impact assessments and studies for design/layout and scenarios.

### What are the results of the SWOV guideline?

The SWOV guideline is the result of a methodical preliminary study that was carried out in 2002 (Wesemann & Devillers, 2003). The method is used in, for example, the Regional Road Safety Explorer, which is an instrument that can be used to calculate the costs and benefits of local and regional road safety measures. This instrument will be used for carrying out regional CBAs.

**Publications and sources**  
**(SWOV reports in Dutch have an English summary)**

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