

## Cost-benefit analysis of road safety measures

### Summary

Traffic and transport budgets, national ones as well as regional ones, should be spent as optimally as possible. It is therefore essential to be able to make a good assessment of a variety of measures and compare them with each other. This is possible when a cost-benefit analysis is used. This method provides support when, for example, deciding on policy plans and budgets, or prioritizing and phasing investment options. Cost-benefit analyses have already been used frequently in the Netherlands and in other countries. However, the experiences with using them on road safety measures are still limited.

### Background and content

During the last few years, many measures to improve road safety have been studied. 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 have generally been reduced and regional budgets have increased, a choice between various investments must often be made: for example between safety, accessibility, or liveability. There is, therefore, a need for a clear framework for integrally assessing a variety of measures. The method that is suitable for this purpose is the social cost-benefit analysis (CBA). This fact sheet indicates when and for whom a CBA can be useful. The different parts of a CBA are described as well as the application of the method to road safety measures. SWOV Fact sheet [Utilization of information on costs and effects](#) discusses how information about costs and effects can be used in decision making.

### 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 like safety, emissions, and congestion. This way, a CBA allows making statements about the social return on 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, a 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 here because it summarizes a great deal of information in a rational framework. However, this leaves the responsibility of the decision maker unimpeded. Other considerations than those included in the CBA can also play a role in the eventual choice. Examples 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 that are required to save one casualty.

### Who is a cost-benefit analysis useful for?

A CBA can be carried out at various levels. The social effects can for instance be 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.

## 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 after application of the measure (the project alternative) are compared with the situation that would develop without application of the measure (the null alternative). The autonomous development or continuation of the current policy can be used as the null alternative.

### *Costs and effects*

In a CBA of road safety measures, roughly three categories of effects can be distinguished: effects on safety, mobility, and environment. Safety involves limiting material damage, medical costs, production loss, human costs, 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. Sometimes, public health effects are also taken into account; for example, the health effects of measures that stimulate or discourage cycling. In a CBA, the effects of measures are compared with the costs such as those for changing the infrastructure or vehicles (implementation costs) and for maintenance and enforcement (operational costs). In the case of measure packages, we must, of course, take into account overlap and cost savings due to combining measures.

### *Monetizing effects*

In a CBA, the effects are as much as possible expressed in terms of money. This is called monetizing. Some effects can be monetized 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), the conjoint analysis method (CA), or the hedonic pricing method (HPM). The CVM and CA use surveys to determine a monetary value of, for example, human costs of road crashes (see also SWOV Fact sheet [The valuation of human costs of road deaths](#)). The HPM uses, for example, the housing market to monetize effects. The 'price' of noise nuisance can, for example, be determined by making use of the price difference between houses in areas with much and with 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. This for instance applies to landscape effects of a new infrastructure. The *Additions to the Guideline OEI* (Ministry of Transport & Ministry of Economic Affairs, 2004) recommend presenting an overview of the effects in more common units (such as the number of casualties or the amount of carbon monoxide) in addition to the overview of monetized effects.

### *Time aspects*

Project and null alternatives are compared over a longer period, e.g. ten or twenty years, depending on the duration of effectiveness of measures. The costs and effects are discounted to the first investment year, using a discount rate. This means that the effects are weighed over a number of years, and that those effects that occur later weigh less than those that occur earlier. This way the so-called present value of costs and benefits is calculated and measures with different life spans can still be compared with one another. An official discount rate of 2.5% has been determined for government projects.

A CBA uses scenarios to be able to estimate the size of effects in the course of time. The scenarios describe future developments in, for example, demography and economics. Four scenarios that are often used in CBAs in the Netherlands were developed in the study *Welfare, Prosperity and Quality of the Living Environment* (Janssen et al., 2006).

### *Return calculations*

When the costs and the monetary value of all effects for a particular period have been determined, the social return is calculated. The usual criteria 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 customary, 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

discount rate with a 'risk premium', or a sensitivity analysis (Ministry of Transport & 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 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 OEEI guideline; short for the Research programme on 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 resulted in a number of large analyses, e.g. the extension of Schiphol Airport, Maasvlakte 2, the Zuiderzee Railway, and the introduction of road pricing policy ('Different Payment for Mobility'). In addition, the CBA method was used on smaller scale projects such as the light rail link from Gouda to Leiden and infrastructural measures to improve the accessibility of The Hague.

An assessment of the OEEI guideline (BCI, 2002) has led to the name being changed into Overview Effects Infrastructure (OEI) and a number of additions to the guideline.

#### *Attention for road safety*

In the original OEEI guideline road safety still received little attention. However, in the immediate future an addition to the OEI guideline will be published which pays attention to safety effects, including road safety effects. This addition will contain recommendations, guidelines, and data for measuring and valuing road safety effects in a CBA of infrastructural projects.

SWOV, in cooperation with the research and consultancy companies ECORYS and CE, has developed a guideline that gives a practical overview of the components of a CBA and indicates how the method can be used for road safety measures (Wesemann & Devillers, 2003). The CBA method is used, for example, in the Regional Road Safety Explorer (VVR-GIS), an instrument for calculating effects, costs and benefits of regional packages of measures (see also SWOV Fact sheet [VVR-GIS 3.0: support for investment decisions](#)).

The number of CBAs of road safety measures still is limited in the Netherlands. One of the few examples is a recent CBA of Sustainable Safety measures that were taken in the period 1998-2007 (Weijermars & Van Schagen, 2009). This showed that the benefits of these measures were around four times the amount of the costs. Furthermore, some studies have been carried out 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. The EU level also has a guideline for the application of CBAs (European Commission, 2003). For transnational projects guidelines were developed in the European project HEATCO (Bickel et al., 2006). Different studies have shown that a CBA is often used in various European countries, especially for infrastructural projects (e.g. Bristow & Nellthorp, 2000) and that it is mainly used for selecting and prioritizing projects.

Furthermore, the number of CBAs is increasing in Europe. Not only have CBAs been carried out for new EU Member States, but also for trans-European projects, such as various railway projects and the Galileo satellite project.

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

A number of CBAs of road safety measures have now been carried out on the European level and in countries other than the Netherlands. In a few countries the costs and benefits of large measure packages have been determined. For example, in Norway four measure packages and 45 separate measures were evaluated using a CBA (Elvik, 2007), and in Switzerland a CBA of road safety measures taken in the period 1975-2007 was set up (Wieser et al., 2010). Furthermore, in European projects CBAs were used for various separate measures, such as:

- measures against driving under the influence of drugs (Veisten et al., 2011);
- intelligent vehicle systems (Baum et al., 2008);
- measures against drink driving;
- an eye test when the driver's licence is renewed (Vlakveld et al., 2005);
- extra police enforcement for speed, alcohol and seat belts (Elvik, 2001); and
- specific measures for vulnerable road users (TRL, 2001).

In addition, two potential European Directives were created for enforcement concerning speed, alcohol and seat belt use and for enforcement of regulations for heavy goods vehicle traffic and buses, evaluated on the basis of social costs and benefits in fifteen European countries (ICF Consulting, 2003). Within the ROSEBUD project methods were developed for cost-benefit and cost-effectiveness analyses of road safety measures that can be applied in practice. These methods are based on existing knowledge and experience and on consultation of users. Within this project CBAs of road safety measures in different countries were also made (Winkelbauer & Stefan, 2005). Most studies do not only take safety effects into account, but mobility and environmental effects as well. The CBAs show that the benefits of investments in road safety often exceed the costs (see for example ROSEBUD, 2005).

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

The final result of a CBA is an overview of the costs and benefits and the social returns of alternatives. As many items as possible are monetized. *Table 1* shows the social costs and benefits of two measure packages that were analysed in Elvik's Norwegian study (Elvik, 2007). Before the packages were compiled, the costs and benefits of the separate measures were determined. The package 'Optimal use of road safety measures' consists of measures of which the individual benefits were estimated to be higher than the individual costs. The package 'Strengthening present policy' is an intensified continuation of measures that are already being taken in Norway. These two project alternatives were compared with the null alternative in which these measures are not applied. The period under consideration is 2007-2020.

	Package 'Optimal use of road safety measures'	Package 'Strengthening present policy'
<b>Benefits:</b>		
Road safety	10.042	8.471
Travel time	-816	1.591
Transport costs	184	-240
Environment	121	-17
Public health	66	80
Increase of mobility	8	70
<i>Total benefits</i>	<i>9.604</i>	<i>9.953</i>
<b>Costs:</b>		
	6.472	11.042
<b>Profitability:</b>		
Benefits-costs balance	3.132	-1.088
Benefits-costs ratio	1,48	0,90

Table 1. Example of a cost-benefit overview of two measure packages in Norway in million euros. The costs and benefits in the table are those as compared to the null alternative in which these measures are not applied (price level 2005; Elvik, 2007, edited by SWOV).

*Table 1* shows that the 'Optimal use of road safety measures' package has higher safety benefits than 'Strengthening present policy'. However, the latter package has favourable mobility aspects, which (among others) results in the benefits for both packages being approximately equally high. The costs of 'Optimal use of road safety measures' are lower, which gives a more favourable benefit-cost ratio: the benefits are 1.5 times higher than the costs and this package is therefore responsible for a positive balance of more than 3 billion euro. 'Strengthening present policy', however, has a negative balance of 1 billion euro and a benefit-cost ratio that is lower than 1.

In addition to an overview of costs and benefits and social returns, a CBA usually contains a lot of information about, for example, alternatives, effects, and scenarios. This information is often taken from other studies, such as design studies, environmental impact reports, and effect and scenario studies.

## Conclusions

Cost-benefit analysis is a useful instrument aiding decision making on investments in road safety. It provides a rational framework for information on costs, effects and benefits of (packages of) road safety measures, and provides us with insight into the social returns of investments in road safety.

## Publications and sources

(SWOV reports in Dutch have an English summary)

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