Cost-benefit analysis of a sustainably safe road traffic system

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D-97-17

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Contribution to the conference 'Traffic Safety on Two Continents', Lisbon, Portugal, September 22-24, 1997

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Leidschendam, 1997
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Report documentation

Number:	D-97-17
Title:	Cost-benefit analysis of a sustainably safe road traffic system
Subtitle:	Contribution to the conference 'Traffic Safety on Two Continents', Lisbon, Portugal, September 22-24, 1997
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Project number SWOV:	75.705
Client:	This research was funded by the Dutch Ministry of Transport and Public Works
Keywords:	Cost benefit analysis, cost, safety, traffic, statistics, evaluation (assessment), Netherlands.
Contents of the project:	In this report it is shown, using cost-benefit techniques, that for different variations of estimates, investments in a sustainably safe road traffic system are profitable from a societal point of view.
Number of pages:	10 p.
Price:	Dfl. 12,50
Published by:	SWOV, Leidschendam, 1997

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Summary

About 2% of the Dutch gross domestic product is taken up by the material costs of road accidents. This amounts to more than 9,500 million Dutch guilders (1993). When one would take into account the immaterial costs as well, the total costs to society would be even higher: more than 12,000 million guilders.

It has been estimated that the overall number of accidents can be brought down to about 20% of the current level, when one would strictly apply the principles for a sustainably safe road traffic system, both with respect to the network as a whole, as to the design of the roads and crossroads of that network.
This would mean rebuilding of a considerable part of the network, adding up to an estimated 60,000 million guilders. Although this could be spent over a longer period (e.g. 30 years), and although it should be possible to cover this for a large part from the existing budgets for investments and maintenance, this still is a huge sum of money.

On the other hand the gains for society would be considerable as well, as the total yearly costs of road accidents would be brought down through this investment.

In this presentation it is shown, using cost-benefit techniques, that for different variations of these estimates, investments in a sustainably safe road traffic system are profitable from a societal point of view.

This paper is based on research commissioned by the Netherlands Transport Research Centre (AVV) of the Dutch Ministry of Transport and Public Works, reported by Poppe & Muizelaar (1996); with other contributions reported by Hasselbeke & Ros (1996) and KPMG-BEA (1996).

Inhoud

1. The total costs of traffic accidents

The total costs of traffic accidents for the society as a whole can be determined in different ways. For this study the results of a macro-economic approach have been used. This is more fully described by Muizelaar, Matthijsen & Wesemann (1995). Different categories have been discerned. This has been done in such a way that material costs attributable to traffic accidents could be determined from publicly available sources. Simultaneously the categories have been chosen such that they give a complete picture of the total costs without overlaps.
The macro-economical approach ensures that not only the costs related to registered accidents are covered, but the actual total costs as well. This also means that care must be taken when relating the total costs to the number of accidents or casualties!

The total costs can be divided into material and immaterial costs. Firstly the material costs will be described.

1.1. Material costs

The material costs were divided into the following categories.

- Medical costs; all medical costs caused by the accidents, also those in later years (discounted towards the year of the accident).
- Gross potential loss of production; the contribution a person could have made in production if he or she would not have been killed, or temporarily or permanently disabled. In reality this potential contribution will be somewhat lower, since not everybody participates continuously in the production process. However, if one should want to correct for this, one should also introduce a reliable estimate for the rate of participation. And one should take into account friction costs, related to the replacement. It is termed the gross loss since production is not being corrected for the future consumption of a killed person. This consumption can be seen as one of the elements of the immaterial part of future life. If one would correct for this element, the full immaterial costs should be taken into account. In the initial estimates this was not done. More about this later.
- Material damage; damage to cars etc., and all other costs to be paid by the party responsible for the accident (usually covered by the insurance).
- Handling; costs made by police, ambulance, fire-brigade, etc.
- Congestion; the part of the total costs of congestion (loss of valuable time, etc.) attributable to traffic accidents.

1.2. Immaterial costs

One also has to consider the immaterial costs. The immaterial costs cover the suffering, the loss of enjoyment of life in the case of disabilities, the loss of a fellow person, etc.
Initially these costs were not included in the estimates. This was due to the fact that this estimate should be comparable to the estimates in a previous study. For the purpose of this study, where the societal effects were being considered, this was felt to be inadequate. There was however no estimate for the immaterial costs in the Netherlands available. A comparison of studies in several other countries showed a more or less fixed relation

between the material costs and the immaterial costs (Koornstra, 1995). This made it possible to include an estimate for the immaterial damage as well.
This made it necessary however to introduce a correction for the difference between the gross and the net potential production loss.

1.3. Overview of the estimates

In *Table 1* the different categories and the final estimates are given.

Category of costs	Total costs (in millions of Dutch guilders, for 1993)
Medical costs	440
Gross potential loss of production	4,346
Material damage	4,188
Handling costs	303
Congestion	250
Total material costs	9,527
Immaterial costs (taking into account the gross/net correction for the potential loss of production)	2,826
Total	12,353

Table 1. *Different categories of costs and the final estimates.*

The total material costs alone amount to 2% of the total Dutch gross domestic product. This percentage is almost the same as shown in a comparable study executed ten years ago.

2. The costs and the effects of a sustainably safe system

2.1. Key figures of a sustainably safe system

An estimate has been made of the total costs related to the realisation of a sustainably safe road traffic system. For the main categories of roads and areas it has been envisioned what changes in physical implementation would finally be reached. The notion of a sustainably safe system, and its consequences for infrastructure, have been described elsewhere (e.g. Wegman & Elsenaar, 1997).
This description leads to an estimate of the related investment costs, including the costs related to more education and information, more enforcement, etc.
From the changes in physical implementation it could also be determined what categories of accidents would be affected and in what sense.
In combination with the non-infrastructural measures it was possible to make an estimate of the overall reduction in accident numbers as well.

After all two scenarios have been developed. A 60 billion guilders scenario would lead to an approximately 80 percent reduction in accident numbers. When the total costs would reduce to 30 billion guilders, the reduction would be approximately 60%.
For both scenarios a transition period of thirty years has been considered reasonable and reachable. An analysis of the current yearly expenditure of the different authorities (in investments and in maintenance) shows that it is possible to find a large part of the 30 or 60 billion guilders within the current budgets, during such a period (Hasselbeke & Ros, 1996).

2.2. Reductions and serioiusness of accidents

In the framework of this study these overall numbers have been refined, by discerning the casualties into different categories of seriousness: killed, hospitalized, and other casualties (based on registered numbers).
Regarding the effects on the number of accidents, a reduction of 80%, respectively 60%, for all categories has been taken as an upper level for the effect of a sustainably safe traffic system.
One could argue that, taken the nature of the measures envisioned in the notion of a sustainably safe system, these reductions would primarily act on the fatal accidents. This is because they focus on reduction of speed and reduction of differences in speed and mass. We applied the rule of thumb for the relation between speed and the seriousness of an accident: for fatalities speed to the fourth power, for hospitalized speed to the third power, for other casualties speed squared, and speed in itself for accidents with only material damage. Taking 80, respectively 60% for fatalities, we arrived at lower reduction levels for the other categories and took these as a lower level for the overall effect.

The costs of traffic accidents have also been divided into costs attributable to the different categories of seriousness. For this purpose the framework developed by Elvik (1996) has been used.

2.3. Fixed and variable costs

A final refinement related to the division into fixed and variable costs. The gains of introducing a sustainably safe system should come from the reduction of the costs of traffic accidents. Still, a reduction of the number of casualties in any year will not result in an immediate proportional reduction of costs in the following year. Many organisations will still act on the 'level' of the previous year: we have to reckon with fixed costs on the short term. The available material did not give much information to make this distinction, so the division rests on estimates. The medical costs have been estimated to be a fixed part of 70% during the first ten years, the material damage is estimated to be fixed for 30% during these ten years. The other costs are considered fully variable, and after the first ten years all costs are considered variable.

3. The benefits for society

The benefits for society can be determined by executing a cost-benefit analysis on the numbers described in the previous paragraphs. This results in a measure for the societal cost-effectiveness of the proposed scheme.
Within this analysis we have different options:

- with or without the immaterial costs;
- an upper level estimate (reduction levels equal for all categories of casualties) or a lower level estimate (reduction levels differentiated);
- a 60 billion guilder scheme with 80% reduction or a 30 billion/60% reduction scheme.

As said before, the transition period was set on 30 years. This is also the economical lifespan of most investments in infrastructure. Therefore, the period covered by the cost-benefit analysis was set on thirty years as well. The costs and benefits for each year have been discounted towards the first year with a nominal interest rate of 4% (this is the rate the Ministry of Traffic and Public Works uses when evaluating major projects in infrastructure).
We set the total expenditure for each investment to the first year, and supposed that all gains would be effective from the next year onwards. This of course is not a true representation of reality, but it does hardly make any difference for the cost-effectiveness that is being computed.

When we consider only the material costs, and take the lower level for the reduction levels, the cost-effectiveness is 6% for the 60-billion scheme, and 9% for the 30-billion scheme. This lower level for the cost-effectiveness thus lies clearly above the comparison rate of 4% the Ministry applies.
This means that also if one chooses a higher nominal interest rate, the net cash value will still be positive.
In other societal cost-benefit analyses it is customary to consider also the immaterial costs. When this is done, still using the lower reduction levels, the cost-effectiveness would rise to 12, respectively 16%.
Would one apply the upper reduction level, then a cost-effectiveness of 14% and 22% would be reached.
Finally it should be stressed that these levels of cost-effectiveness have been computed by only considering the effects on traffic safety. The kind of investments in infrastructure we are dealing with, will also have positive effects on noise levels, environmental quality, and aspects of mobility.

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