SWOV Fact sheet

Road crash costs

Summary
Road crashes result in all sorts of social costs, such as medical costs, production loss, human costs, material costs, settlement costs and traffic jam costs. Research into road crash costs and their trends are carried out quite regularly. In 2003 in the Netherlands the costs were € 12.3 billion, or 2.6% of the Gross National Product. Insight into these costs is used for policy preparation and assessment, and makes it possible to compare costs with those in other areas. Another important use is for cost-benefit analysis. This uses the costs of each crash or casualty saved to judge road safety investments. The research method of road crash costs has improved greatly over the years, for example by including human costs.

Background
In the Netherlands in 2005 there are 817 fatalities and more than 18,000 in-patients. Besides there is a much larger average annual number of crashes resulting in less severe injury or with material damage only (MDO). This results in all sorts of social costs, such as medical costs and production loss. Improving road safety has priority in mobility policy, mainly because of such social costs (VenW, 2004). Both in the Netherlands and in other countries research is regularly being carried out into the size of these crash costs as well as into cost trends. The first study in the Netherlands was done in 1985 (McKinsey, 1985). Commissioned by the Transport Research Centre (TRC), SWOV carried out the first update of this study in 1995, in which various aspects of the method were improved (Muizelaar et al., 1995). Since then, SWOV and TRC periodically study crash costs in the Netherlands. Over the years the method has been improved further, for example, by including human costs and traffic jams due to crashes. Similar developments also took place in other countries.

What is the purpose of road crash costs research?
Information about the size and development of road crash costs is important to policy and research for two reasons. In the first place, this information is regularly used to prepare and assess the national road safety policy, like the realization of the *Mobility Memorandum* (VenW & VROM, 2004). This information is also useful for comparing road safety policy with other policy areas. These can be other sectors within traffic and transport or outside, e.g. environmental policy, public health or other safety issues. Information about the social costs provides insight into economizing possibilities and can be used for setting policy priorities. International comparisons of road crash costs are also made. Secondly, information about the costs of road crashes is used in cost-benefit analyses (see SWOV Fact sheet *Cost-benefit analysis of road safety measures*). These use the costs per crash or per casualty to express the road safety policy effects in terms of money. For example, in the Overview Effects Infrastructure (OEI), guidelines often used for cost-benefits analyses in the Netherlands, core road crash cost data was used (Eijgenraam et al., 2000). Such research is also carried out to price mobility. Traffic costs estimates are meant to determine the extent to which current pricing policy is efficient and which improvements are possible. CE Research and Advice Consultants (CE, 2004) and the European Conference of Ministers of Transport (ECMT, 1998) studies deal with this. These studies also examined other traffic costs than those of crashes, especially costs of infrastructure, environment and congestion.

Which types of costs exist and how should they be measured?
In 1994, an extensive international comparative study was published about the way in which 14 European countries determine crash costs: the COST 313 project (Alfaro et al., 1994). The report made recommendations about the categories of costs that should be studied and how each one should be measured. In brief, this resulted in five main categories (Elvik, 1997), each with its own measuring methods:

1. *Medical costs.* These result from the treatment of casualties, e.g. costs of hospital, rehabilitation, medicines and adaptations for the handicapped. These costs have to be determined by the 'restitution costs method'. All countries do this in practically the same way.

2. *Production loss.* These costs result from the temporary or permanent disability of the injured, and the complete loss of production by fatalities. These costs have to be determined by the 'human capital method', which determines the value of the production that would have been realised by the casualties if they had not been injured or killed. This is also done in more or less the same way in all countries. However, important differences can occur: some countries also put a value on domestic work, and some countries correct the production loss of fatalities for their consumption loss (Elvik, 1995).
3. *Quality of life loss* of casualties and their families and friends ('human costs' or 'human losses'). These are the human costs through suffering, pain, sorrow and loss of the joy of living. We recommend determining these costs with one of the 'willingness-to-pay methods'; these determine the amount of money people are prepared to pay to relieve human suffering. In general, most countries recognize this cost category, but the ways of calculation differ widely, and only a few countries use a willingness-to-pay method. The willingness to pay for a reduction in the chance of dying also involves calculating the economic value of consumption loss. If this is also part of the production loss, the willingness-to-pay must be corrected for this to avoid counting it twice.
4. *Material costs.* These costs result from damage to goods such as vehicles, freights, roads and fixed roadside objects. For this the 'restitution costs method' is recommended. This is done everywhere in the same way.
5. *Settlement costs.* These costs result from the settlement of crashes and the resulting expenses incurred by organizations such as the fire brigade, police, law courts and insurers. Also the 'restitution costs method' for this is recommended. This is already generally used.

This situation in 1994 is mainly the result of knowledge about valuing 'imponderables': cost elements for which there are no market prices. Elvik (1995) distinguishes four phases in this development of valuation since the 1950s: it was only during the last phase in the 1980s that a number of countries began to value 'human losses' based on a willingness-to-pay method. This approach is, theoretically, very well justifiable. However, empirical research of the willingness to pay for traffic risk reduction is complicated and only provides results with many uncertainties. Since 1994 an increasing number of countries nevertheless use a willingness-to-pay method (see SWOV Fact sheet *The valuation of human costs of road deaths*). This was sometimes accompanied by improvements in this method.

How are the crash costs measured in the Netherlands?
Nowadays, SWOV and TRC carry out crash costs research according to the recommendations of the COST 313 report in practically all aspects in which a sixth category was added viz. the costs resulting from traffic jams. These are caused by loss of time due to traffic-jams resulting from crashes. In the Netherlands, the 'real' numbers of crashes and casualties were used, i.e. allowing for those crashes and casualties that were not registered.

1. *Medical costs.* Various data sources are used, including statistics of Statistics Netherlands (CBS) and the hospitals' National Patient Register. The latter contains, for example, the average number of days that a casualty is hospitalized, the average costs per day of hospital or nursing home treatment and the annual number of ambulance trips.
2. *Production loss.* This is the potential loss of production, i.e. the monetary value of the contribution somebody would have made if he/she had not been injured or killed. Here, it does not matter if the individual casualties actually were employed before the crash, or would have been employed in the future. In the case of fatalities, the total value of the production over the lost productive years is estimated and weighed over those lost years. Until now, no allowance has been made for unpaid work, such as domestic or voluntary work. However, the consumption loss of fatalities is included in the production costs.
3. *Quality of life loss.* To determine the human costs a survey was held in the Netherlands about the amount of money people are willing to pay for a particular reduction in crash rate (De Blaeij, 2003). What is known as the 'Value Of a Statistical Life' (VOSL) was used to calculate the human costs. The VOSL is corrected for the consumption loss of those killed, because it has already been included in the category production loss (Wesemann et al., 2005).
   Little is known yet about the human costs of non-fatal injury; only Great Britain has carried out such a study (Hopkin & O'Reilly, 1993). Based on this, the human costs per in-patient are estimated at 10% of that of a fatality.
4. *Material costs.* The estimation of these costs uses insurance data, such as damage claims paid, and estimates of the damage not claimed and the damage not covered by third party policies.
5. *Settlement costs.* Among other sources, CBS statistics and insurance data are used to estimate these costs.

6. *Traffic jam costs.* Research data is used to determine the total traffic jam costs and the share of lost time due to crashes. This share was in 1997, the last year for which the sum was calculated, about 13% (NEA, 1998).

The first study into the crash costs in the Netherlands (McKinsey, 1985) also determined the prevention costs, such as those for measures and research. They are, however, not included in crash costs, as they are meant to prevent crashes.

What are the crash costs in the Netherlands?
In 2003, the last time such research was carried out, the total crash costs amounted to € 12.3 billion. The largest categories in 2003 were human costs (€ 5.5 billion), and material costs (€ 3.8 billion), whereas the production loss and settlement costs (each € 1.3 billion) also had a large share (see *Table 1*).

Cost category	1997	2000	2003
Medical costs	182	192	232
Material costs	2,647	3,250	3,866
Settlement costs	834	1,055	1,262
Production loss	1,290	1,441	1,294
Traffic jam costs	88	100	125
Human costs	5,206	4,957	5,549
Total	10,248	10,995	12,327

Table 1. *Social costs of road crashes (€ million, current prices). Source: AVV, 2006.*

The costs between 1997 and 2003 rose by 20%. If, however, an inflation correction is made, the increase in costs is extremely limited: 1%. There are large differences between the various cost items. The settlement costs and material costs rose by 50% because of, among other things, the rise in the price of new cars. The production loss increased in the beginning, but between 2000 and 2003 they again declined because of a declining number of traffic casualties being included in the Disablement Insurance Act, and an increase in determining how disabled a casualty is. The human costs only slightly increased because of a reduction of the number of casualties (AVV, 2006).
What is also known is how the costs are distributed among casualty and crash severities, and how much the costs per casualty or crash are. The majority of the costs can be attributed to crashes resulting in in-patients (€ 4.7 billion), MDO crashes (€ 3.9 billion) and, to a lesser extent, the road deaths (€ 2.6 billion). The costs of crashes with Accident & Emergency (A & E) department patients or casualties with less severe injuries are relatively low (€ 0.8 billion and € 0.4 billion respectively). Between 1997 and 2003 the costs of deaths and in-patients declined almost proportionally with the number of casualties, whereas the costs of crashes with hospital A & E patients increased in spite of the number of casualties declining (*Table 2*). This is also expressed in the large increase in the costs per A & E patient. The explanation for this is that the cost items that increased the most (material costs, and settlement and traffic jam costs) have a relatively large share. The costs per death were the highest (€ 2.4 million).

Casualty severity	Number of casualties		Costs		Costs per casualty	
	2003	1997-2003	2003	1997-2003	2003	1997-2003
Deaths	1,088	-12%	2.640	-12%	2.427	0%
In-patients	18,600	-8%	4.655	-9%	0.249	-1%
A & E	97,000	-10%	767	12%	0.008	25%

Table 2. *Number of casualties, and costs by crash seriousness and per casualty in 2003 (in € million), and the 1997-2003 development (excluding inflation). Source: AVV, 2006.*

In a recent study (AVV, 2006) the calculation method was changed for various items so that the results are not really comparable with data from previous publications. The most important alterations

are the calculation of human costs and of production loss. In the new calculation the human costs are based on the results of recent VOSL research in the Netherlands (De Blaeij, 2003). More detailed data on disability, in particular for partial disability was used for calculating production loss (Kramer, 2006). The human costs, therefore, were about twice as high as was previously assumed and production loss was a lot less.
No study has been made of the costs in more recent years. Based on the casualty numbers in 2004 and 2005, costs per casualty and inflation numbers we can provide an indication for the costs in these years. *Table 3* shows, for both years, the number of deaths, in-patients and A & E patients. These numbers were then multiplied by costs per casualty from *Table 2*. Besides these, the Statistics Netherlands (CBS) data was used to correct for inflation by using their consumer price index. The costs of less severe injury and MDO crashes were calculated by only correcting for inflation, seeing as there was insufficient reliable data about the real number of casualties and MDO crashes. The total costs, according to this method, amount to about € 12 billion in both 2004 and 2005 (*Table 3*). The rapid decline in the number of deaths during recent years has led to a relatively small decrease in costs. The most important reason for this is that the number of in-patients, that constitute a large part of the total costs, have declined a lot less rapidly.

Crash seriousness	Number of casualties		Costs (€ billion)	
	2004	2005	2004	2005
Fatal	881	817	2.2	2.0
In-patients	18,100	17,700	4.6	4.5
A & E	92,000	89,000[1]	0.7	0.7
Light injury	Unknown	Unknown	0.4	0.4
MDO	Unknown	Unknown	4.0	4.0
Total	Unknown	Unknown	11.9	11.7

[1] Estimation based on the number of registered A & E patients in 2005 (10,546; source: National Road Crash Register) and the registration rate in 2004 (11.8%; source: Injury Surveillance System & National Road Crash Register).

Table 3. *Number of casualties and crash costs by crash seriousness.*

In 2003 the costs of road crashes amounted to 2.6% of the Gross National Product (GNP). This percentage declined between 1997 and 2000 from 3.0 to 2.6 and has remained stable since then. A comparison with other social costs also gives a better insight into the relative amount. The costs due to direct time loss caused by (all) traffic jams on the main road network were in 2000 for example, 'only' € 0.6 billion (AVV, 2004). If the costs of people avoiding traffic jams (detour, another time of day and such) are also included, the traffic jams costs are about twice as high (Koopmans & Kroes, 2004; AVV, 2004). If traffic jams on the secondary road network are included, the approximate costs are estimated at € 2 - 2.5 billion (Annema & Van Wee, 2004). The total costs of traffic jams are probably even slightly greater because what are not included are the costs of unreliability of journey duration, and indirect costs such as environmental effects. The environmental costs of road traffic are estimated to be considerably higher: more than € 6 billion (CE, 2004). These refer to the costs of air polluting emissions, CO2 emissions and noise nuisance. So, compared with other traffic related costs, the road crash costs are high.

The € 11 million test
For the 1997-2001 road safety programme, the European Commission introduced what is known as the € 1 million test (Commission of the EC, 1997). This is a rough rule of thumb to judge the return of road safety measures. The estimates show that each traffic fatality costs € 1 million, so each measure is economically justified if it costs less than € 1 million for each fatality saved. The estimate of € 1 million is based on the total costs of € 45 billion for *all* crashes in Europe in 1995 (including fatalities, injured and MDO crashes) and on the number of fatalities that year (45,000). However, this calculation only used the registered crashes and the 'hard' economic costs (medical costs, production loss, material costs and settlement costs). If the unregistered crashes and human costs were included, the cost per fatality would be € 3.6 million (ETSC, 1997). This sum is a lot larger because the total costs are much higher, whereas the number of fatalities remains the same, as practically all fatalities are registered.
The test is in fact a quick way of conducting a cost-benefit analysis. However, it is limited because only the number of fatalities saved is taken into account, and the side effects on, for example, environment and mobility, are not allowed for. SWOV recommends only using this method in the

Netherlands if there is no time and money to carry out a cost-benefit analysis for the effects of all measures. However, the amount per fatality needs to be actualized using (recent) Dutch data. Using the ETSC method, a calculation made for the Netherlands results in € 11.3 million per fatality in the year 2003. Explanations for this difference with the € 3.6 million for the EU are the higher human costs, the greater productivity (and thus production loss), inflation and a greater material damage by renewing the total number of cars on the road with more expensive ones. There is also a lower ratio of fatalities to injured in the Netherlands, so that the total costs are attributed to a relatively small number of fatalities. Differences in the calculation methods of some cost categories probably also contribute to the difference.

International comparison

Many countries do research into crash costs and there are various international comparative studies. A sound comparison requires sufficient knowledge about the following: Have the same cost categories been studied? Have the same measuring methods been used? Is the data used of a comparable quality?

The COST 313 study provides outline answers to the first two questions. With exception of the human costs and their measuring methods, the fourteen countries used the same cost categories and measuring methods. In spite of this, determining the production loss (by putting a price on unpaid work and correction for consumption loss of those killed) can still result in large differences (Elvik, 1995). COST 313 did not answer the question whether the data was of a comparable quality. Answering this question is practically impossible because of the large number of divergent sources used for these studies. However, one of the comparative studies (Elvik, 2000) investigated whether the cost estimates referred to all crashes, i.e. also MDOs and crashes not registered in official statistics.

In the light of all this, the results of these studies must be used carefully. In addition, at the very least, a distinction should be made between countries that do and those that do not include human costs. Elvik (2000) compared the costs of eight European and four non-European countries. All these countries had estimated human costs in one way or another. The data of the eight European countries referred to just one year in the 1990-1997 period. For these countries their costs, including human costs, varied from 1.3% to 3.2% of GNP (an average of 2.1%). Excluding human costs, this was 0.5% to 2.8% of GNP (an average of 1.3%).

Trawén et al. (2002) studied the costs per fatality in nine European and two non-European countries. They show that the average cost in these countries had increased by about 70% in the period 1990-1999. Among other matters, this increase can be attributed to changes in calculation methods and adding cost categories such as human costs. Although the costs and methods begin to resemble each other more, large differences remain between the estimates in the different countries. This is made clear by an overview of costs per casualty in ten European countries that was made for the *Road Safety and Environmental Benefit-Cost and Cost-Effectiveness Analysis for Use in Decision*-Making (ROSEBUD) project (Hakkert & Wesemann, 2005). For the five countries (besides the Netherlands) that included human costs, the costs per fatality ranged between more than € 1.9 million in Switzerland to € 3.0 million in Norway (price level 2002). The costs per severely injured ranged between € 169,000 (Switzerland) to € 474,000 (Norway).

Is subsequent research being carried out?

The idea is that TRC also in the future periodically will carry out studies of road crash costs, together with SWOV. Where necessary and possible, attention shall be paid to methodological improvement, for example determining the human costs of non-fatal crashes. A supplement to the OEI guideline will soon be published that describes how safety should be included in a cost-benefit analysis of infrastructure projects. Based on crash cost data, this supplement will make recommendations about valuing road safety effects.

Conclusions

In 2003 the road crash costs in the Netherlands were € 12.3 billion, or 2.6% of the Gross National Product. Insight in these costs is important for preparing and assessing (road safety) policy. The research methods into crash costs have improved greatly over the years, for example, by also including the human costs of death and injury.

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