Cost-benefit study concerning car front impact requirements to increase the crash-safety of pedestrians and cyclists

Final report

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L.T.B. van Kampen
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SWOV Institute for Road Safety Research, The Netherlands

SWOV Institute for Road Safety Research
P.O. Box 170
2260 AD Leidschendam
The Netherlands
Telephone 31703209323
Telefax 31703201261

Executive summary

In The Netherlands, the traffic safety of pedestrians and cyclists, has been a major concern for many years. Though both the annual number of pedestrian casualties and cyclist casualties have decreased during the past 10 to 20 years, as in almost all European countries, Dutch policy aims at further reducing these numbers. The proposed measure, introducing tests regarding the front-end of cars, is strongly supported by the Dutch Ministry of Transport, since it is expected that both pedestrians and cyclists will benefit.
In order to establish a stronger (international) base for this purpose, the Dutch Ministry of Transport has agreed to have SWOV carry out a cost benefit study on the subject, of which the general design should be comparable to similar studies, already carried out by TRL (UK) and BASt (Germany), in order to compare results.
In this report, the Dutch cost benefit analysis, carried out by SWOV, is described.
The scope of the problem is derived from Dutch national accident data. The annual number of casualties, relevant to the problem of collisions with car front-ends, is at least 6500 (pedestrians and cyclists). Nearly 200 of these casualties were killed, while 1900 were hospitalized. It is certain that the remaining number of other injured (slightly injured) is in reality far greater than the 4400 registered casualties, due to the problem of under-registration.

In another part of the study, gross costs pertaining to casualties have been calculated. This resulted in a 1991 value of average costs per fatality of about 900,000 guilders (415,000 ECU's); the costs per hospitalized are about 115,200 guilders (53,000 ECU's); costs per slightly injured are 28,800 guilders (13,300 ECU's).

Expected effectiveness of the proposed measure has been derived from indepth accident data, following the model used in the BASt-study, mentioned before.

Using this effectiveness data, as well as the cost data and the national accident figures, Dutch benefits of the proposed measure have been calculated, their total number being more than 750 casualties spared (of whom 11 fatalities, 263 hospitalized). In 1991 money value, these annual benefits amount to 24,800,000 ECU's.
These benefits are the result of the compliance of new cars to the proposed measure. Assuming that each year, some 500,000 new cars, complying to the measure, replace the same number of older cars, the cost per new car may be up to 50 ECU's, in order to keep a positive cost-benefit ratio. In view of extra cost-expectations for new cars, complying to the measure as reported in the TRL-study, mentioned above, this means that a positive ratio of benefits over costs of 3:1 is feasible.
It is concluded that implementation of the proposed measure will be of great benefit for The Netherlands.

Contents

1. Introduction

The study, presented in this report, has been carried out on behalf of the Dutch Ministry of Transport, Public Works and Water Management, Transport Research Centre (AVV). Traffic safety of vulnerable road users, such as pedestrians and cyclists, has been a major concern for many years and the Dutch Ministry of Transport is committed to the further improvement of their safety.
This report covers a Dutch cost-benefit study concerning proposed changes of Directive EC/74/483, based on EEVC-activities (WG10). The changes of this international directive aim at improving the crash-safety of pedestrians in case of collisions up to 40 km/hour with (new) cars, by demanding compliance to different impact test requirements concerning the cars' front-end.
More specifically, three different tests are proposed, concerning:
- bumper
- bonnet leading edge
- bonnet top.

The injury criteria are such that the majority of serious injuries of adult and child pedestrians up to collision speeds of 40 km/hour are prevented. Some additional effectiveness is expected for collision speeds over 40 km/hour.
In the Dutch situation, beneficial effects are also expected for cyclists. For this reason both pedestrian and cyclist accident data will be used in this study.
The first two tests aim at reducing serious leg injuries (both lower and upper leg) of pedestrians.
The bonnet top test (excluding the area of the upper windscreen frame and the windscreen itself) aims at reducing fatal and serious head injuries of pedestrians, both adults and children.

To calculate benefits of these provisions in terms of fatalities and serious injured saved, and translate those savings in terms of money, reliable (in-depth) accident and cost data will be used, as well as more general national data on these subjects. Costs of implementation of the measure, specifically costs to be invested to improve the car front-end, are not calculated.

This Dutch study may be seen as the third in a series of cost benefit studies on the same subject. The other two have been already published and were carried out, respectively by TRL (Lawrence et al., 1993) and BASt (Bamberg & Zellmer, 1994); in this report these important studies will be simply referred to as, respectively, the TRL-study and the BASt-study.

In the next chapter, the Scope of the Problem, based on Dutch national accident data is given, and the overall design of the further study is explained.

SWOV gratefully acknowledges the support of Frau Bamberg, Mr Gläser and Mr Zellmer from BASt (Germany) who provided in-depth data on accidents ('Otte-data'); the advice from Prof Wismans and Mr Janssen from TNO, especially regarding the calculation of effectiveness; the

advice of Mr Van Wees of one of the major Dutch insurance companies, regarding the use of the data and the calculation of costs.

The study was carried out by SWOV under supervision of representatives of the Ministry of Transport: Mr Huijbers from the Transport Research Centre (AVV) and Mr Ammerlaan from the Department of Road Transport (RDW).

2. Scope of the problem and study-design

2.1. Accident data

In this chapter, Dutch national accident data are used to describe the scope of the problem and to show developments during the last few years. Some remarks concerning their validity and completeness are in order. Dutch national accident data are police based and are processed by the Transport Research Centre (AVV), Department for Statistics and Data Management. These data will be referred to as VOR-data.
They have excellent quality as far as some typical accident, vehicle, road and casualty information is concerned. They are far from complete and almost certainly not representative for the overall Dutch accident situation. In The Netherlands, it is found that the completeness of the registration (i.e. the number of registered injury accidents compared to the expected real number of injury accidents) is decreasing over the years. This has been established by comparing national hospital registration (based on a 100% complete registration of hospitalized persons) with national accident registration (based on police data). During the last 10 years the completeness of police based injury accidents decreased from about 80% to less than 70% (SWOV-studies). However, for accidents involving motor vehicles, as is the subject of this study, completeness appears to be better than average. Therefore, national accident data on hospitalized casualties, used in this study, are regarded as almost complete and representative as are in fact the national data on fatal accidents.
For accidents of lower injury severity than resulting in hospitalization (slightly injured), the completeness of the registration is supposed to be even far less than the 70%, mentioned for hospital data.
However, in order to be able to carry out benefit calculations regarding this group of lightly injured, the official data will be used, bearing in mind that benefits, calculated for this group, are a considerable underestimation of the real benefits.

2.2. Development of the problem (1989-1992) and accident details (1991)

Table 1 in Annex 1 shows a very clearly decreasing trend with respect to the numbers of Dutch casualties (for both pedestrians and cyclists) resulting from collisions with car front-ends.
The numbers for 1992 indicate that the decreasing trend may have stopped (further discussion on this subject is carried out in para. 5.2).

The next tables from Annex 1 show some relevant accident details, also exclusively relating to collisions between car front-ends and pedestrians or cyclists. The year 1991 is used, mainly because in both TRL- and BASt-studies, this year has been used and because insurance-based cost data were available for that year.

The first of these tables (Tables 2a and 2b) show the distribution of casualties according to area (inside or outside the built-up area).

Interesting but understandable is that the number of casualties outside the built-up area is considerably lower than inside built-up areas.

For cyclists the percentage is 15%, for pedestrians 8%.
However, looking at the injury-severity distributions, we see that the outcome of accidents is far worse on locations outside built-up areas.
For cyclists, the relative number of fatalities outside built-up areas is five times greater than inside (8% against 1.6%). For pedestrians the difference is even greater (25.7% against 2.5%), a factor 10!.
It is reasonable to suppose that the differences are due to the greater driving and collision speeds outside built-up areas.

Tables 3a and 3b show more in detail the distribution of casualties according to point of contact on the front of the car. Most of the casualties are supposed to have contacted the centre section of the front of the car.

Finally, Tables 4a and 4b show the age(group) distribution of the casualties, indicating that severity of outcome increases with increasing age (group).
The number of younger casualties is clearly greater for pedestrians than for cyclists.

2.3. Overall design of the study

The report contains four parts, including this chapter about the scope of the problem and the design:
• Basic problems to be solved in the case of cost benefit studies are the question of costs regarding the different categories of casualties: what are the (economic) costs of one fatality, one seriously injured (hospitalized) and one slightly injured casualty; this part is described in Chapter 3.
• Next is the question of the effectiveness of the proposed measure in terms of casualties: how many casualties (fatalities, hospitalized, slightly injured) are involved and which proportion may be saved as consequence of the measure; this part is described in Chapter 4.
• Finally comes the question of the calculation of annual national benefits against costs of implementation of the measure, described in Chapter 5.

Relevant parameters, for which both accident data and cost data were to be found, are ideally:
- type of collision (car vs pedestrian; car vs cyclist)
- collision speed (especially under or over 40 km/hour),
- contact point on car front (especially bumper, bonnet leading edge, bonnet top),
- individual injury (head injury, leg injury, other injury)
- injury severity (preferably in AIS-categories; otherwise fatal, serious, slightly),
- age group (under 15, over 15).

Since only part of this ideal detail is available in both national accident data and national cost data, alternative data sources have been sought and found:
As in the TRL- and BASt-studies, detailed accident data from the 'Otte-sample' were used, kindly provided by BASt.
As far as cost data are concerned, the required detail was hopefully to be found in insurance data, kindly made available by one of the major Dutch insurance companies.
It was thought that through combinations of these detailed data with gen-

eral data, necessary to produce national annual benefits and costs, the proper approach was found to ultimately calculate the cost-benefit ratio of the proposed measure.

At the same time, it was understood that even after using detailed data, considerable loss of information would take place in the translation to national levels.

A Dutch approach regarding effectiveness was developed, specially aiming at the specific bicycle problem in this country. This is discussed further in Chapter 4.

As far as possible, an overall design has been used, giving maximum comparability with the results of the two other cost benefit studies.

3. Cost calculations

3.1. Design of the cost-study

Costdata, normally used in cost benefit calculations, are based on economic costs of accidents.
The data often are generalized costs for all types of accidents and all types of road user. Results of this type of study, regarding Dutch national costs of traffic accidents and casualties, are available and will be used as main source.
Since the purpose of this study is to calculate costs for a specific type of accident and specific categories of road user (pedestrians and cyclists), insurance data were used to gather additional information, especially aiming at possible cost-differences between cyclists and pedestrians.
The insurance-study will be presented in Annex 2 of this report, while its main results will be described in the para. 3.4.

3.2. Type of data needed

Cost-categories, pertinent to the injury-problem of the casualties include:

Medical costs:
- emergency care
- hospital stay
- injury treatment
- medicine and applications
- transportation
- rehabilitation
- funeral

Production costs:
- loss of production (employer, society)
- loss of income (casualty)

Other costs:
- domestic help
- years of life lost (fatalities)
- grief ('pain and suffering')
- interest
- legal costs
- police costs

Material damage, normally an important cost factor, is not included in this study, since the proposed measure only aims at reducing injury (severity).

For the purpose of this study, these cost data would have to be available for the following accident conditions and parameters:
- pedestrians and bicycles hit by car front-end
- type of car damage (i.e. front-end of car, preferably distinction between bumper, bonnet leading edge, and bonnet);
- distinction according to injury area (i.e. brain, skull, leg etc);
- distribution according to injury severity (such as fatal, serious injury,

other (lower) severity);
- distribution according to collision speed (preferably below and above 40 km/hour);
- age and sex of casualty.

Such detailed data on costs of traffic accidents are not available in The Netherlands, nor in other countries, which means that considerable loss of information had to be accepted.

3.3. National cost data

Several Dutch cost studies regarding the national traffic safety problem have been carried out. In these studies all available national cost data from a variety of sources have been combined to estimate the gross national costs of traffic accidents. The costs per accident or casualty have been established, dividing the gross national costs by the number of accidents or casualties.
There are mainly two sources: SWOV and McKinsey.
The estimate of McKinsey (1985) of the total economic costs of traffic accidents is about 6 billion guilders, while the estimate of SWOV (1984) is nearly twice that amount.
In 1984, SWOV calculated economic costs of accidents, based on available (economic) data (Flury, 1984). The cost-level calculated in this study is comparable to the level of costs found in other international studies, based on economic data.
Three categories of costs were considered: fatalities, injured, and damage-only cases.

The costs-figures for these three categories were (in guilders of 1982):
fatality: 1,000,000 guilders
injured: 23,500 guilders
damage: 8,750 guilders

No further distinction was made for different severities of injured.

In terms of guilders 1991, these costs-figures have increased due to devaluation. Values 1991 would be at least:

fatality: 1,200,000 guilders
injured: 30,000 guilders
damage: 10,000 guilders

McKinsey (1985) calculated the national costs of traffic accidents, based on a wide variety of sources (among which insurance data). According to this study, the economic costs of traffic accidents amounted to 6 billion guilders (1983 value).
The costs per injured (regardless of severity) were estimated at 40,000 guilders (1985 value) and the costs per fatality were net 180,000 guilders and gross 750,000 guilders (1985 value). In terms of money-value 1991, these costs would have become about 48,000 guilders per injured and 215,000 guilders (net costs) or 900,000 guilders (gross economic costs) per fatality.

3.4. Discussion of cost results

Insurance data (presented in Annex 2)
Payments to pedestrian casualties and those to cyclist casualties, both hit by car front-ends, appear to be equal. Thus, no further distinction with respects to costs for these two groups has to be made.

Contrary to the expectation, payments for fatalities are not exclusively found in the higher costs-categories. In fact, it appears that payments for hospitalized casualties are as high as those for fatalities.
Another factor is the age distribution. As can be seen from Annex 2, Table 2, the proportions of children and elderly are relatively high, especially for pedestrians. Furthermore, as can be seen from Annex 2, Tables 9 and 10, payments for these two age groups are indeed less than for others. Among others, no payments for 'loss of income' are applicable, since either there is no income (children) or the income (pension) is not part of the claim.

Generally, costs based on payments to casualties of accidents, do not reflect all possible cost-categories and/or not all of the costs in a particular cost-category.
Payments to the very slightly injured however, may reflect most of the real costs, since almost no additional costs such as 'pain and suffering', loss of income etc., are applicable.

Macro-economic data
Dutch national economic cost data on the other hand, show a comparable level of costs of fatalities and seriously injured as found in other (foreign) studies in other countries.
Costs regarding fatalities are several times greater than for hospitalized and other categories of injured, due to the effect of loss of future production capability for employer/society and family (years of life lost).

The economic cost data derived from the SWOV-study, generally show a somewhat higher level than the McKinsey-based calculations.
Since the study of McKinsey, specially made for the Dutch Ministry of Transport, is still recognized as 'the standard' on the subject, we will use primarily the results of the McKinsey-study for our cost study. Therefore, as shown in the previous chapter, the cost per injured are 48,000 guilders and the gross costs per fatality 900,000 guilders (1991 level).

3.5. Calculation of costs per casualty

Available Dutch sources on economic costs of accidents and casualties, do not distinguish between different categories of severity of injury.
Since we need this distinction for our study (i.e. hospitalized and less severely injured), the following solution was reached, using both national and insurance-based cost data:

As shown in Annex 2, Table 8, mean-payments to hospitalized are more than twice as much as for ambulant treated, and more than seven times as much as for lightly injured. Payments to hospitalized are about four times as much as for both lower severity groups combined.

The McKinsey cost data per injured (48,000 guilders) were based on a number of some 90,000 casualties, of whom about 20,000 were hospitalized.

The costs for one hospitalized (H) and those for one other injured (O), are to be derived from the following formula:

$$\frac{(20{,}000 * H) + (70{,}000 * O)}{90{,}000} = 48{,}000 \text{ guilders,}$$

while we may derive the relation between H and O from the insurance data presented before, for instance in Annex 2, Table 8, which indicates that H is about 4 times greater than O (combining the two lower groups of severities).

Substituting H/O = 4 in the first formula gives:
O = 28,800 and H = 115,200 guilders.

In summary, the economic cost data to be used for the calculations in the cost-benefit analysis (Chapter 5 of this report) are:

fatality: 900,000 guilders (415,000 ECU's)
hospitalized: 115,200 guilders (53,000 ECU's)
lightly injured: 28,800 guilders (13,300 ECU's).

4. Effectiveness calculations

4.1. Design of the effectiveness-study

As mentioned in earlier parts of this study, the proposed front-end tests have been primarily designed to reduce fatal and serious injury of pedestrians. Since cyclists, especially those hit sideways, generally show the same type of collision-outcome as pedestrians (Van Oorschot & Janssen, 1987; Schoon et al., 1992), these too will benefit from the changes made to the front-end of cars resulting from the measure.
Differences between pedestrians and cyclists, such as a higher seating position of cyclists, the speed of the bicycle itself, cyclists hit head-on or from behind instead of sideways, may cause relative differences in effectiveness. This will be discussed in more detail in this chapter.

To calculate benefits in terms of fatalities and seriously injured saved, reliable accident data have to be used. In order to be able to compare the results with those of other studies, it was decided to develop an international design, in which in-depth data from Otte (Germany) were used. At the same time, a Dutch approach was built in, in order to acknowledge the typical Dutch aspects of traffic accidents, with emphasis on cyclists. The 'Otte-data' were kindly provided by the BASt for this specific purpose.

4.1.1. *Approach*

In order to calculate benefits of the proposed tests in terms of a decrease of the expected number of casualties and/or a decrease of their injury severity, a SWOV-approach was developed regarding the effectiveness of the proposed measure. Then, Dutch experts from TNO were asked to give their opinions on the subject and to help finalize the design.
In the final approach, the expected injury reducing potential of the proposed measure (especially aiming at reducing head/brain injury severity and leg injury severity) is seen as a function of injury-severity (AIS).

It is expected that the test requirements of the proposed measure are such that fatalities (AIS-5/6 injuries) will be prevented almost completely, under the condition that collision speed do not exceed 40 km/hour. This injury reducing potential of the measure will, of course, not stop at exactly 40 km/hour, so there still are benefits for casualties hit at higher speeds. On the other hand, even under 40 km/hour some of those with weaker bodies will still be fatally injured.
With regard to non-fatal injuries, the 40 km/hour limit is again supposed to be the upper limit. Contrary to what is expected for fatal injuries however, only part of the serious injuries will be prevented. In the first place, this is due to the fact that most of the (former) fatal injuries now become serious. In the second place, some of the (former) serious injuries will remain serious, though probably having a lower severity.
It is expected that the measure will not prevent casualties from being injured at all. That is to say that the effectiveness regarding minor injuries (AIS-1 and some AIS-2) is expected to be fairly low. Effectiveness regarding the higher severity categories (AIS-2/5) is expected to increase with

increasing injury severity, from fairly low to almost 100% for fatal injuries, though not necessarily in a linear way.
This theoretical concept of effectiveness, expected from the proposed measure, has been used to finalize the Dutch approach.

Fatalities
As far as fatalities are concerned, the Dutch approach is that all casualties now being fatally injured by relevant parts of the car front-end, will be spared, as long as collision speeds are not more than 40 km/hour. Effectiveness therefore is 100%.

Seriously injured and slightly injured
The Dutch approach for this group of seriously injured is, that injury-severity of each individual injury, relevant to the problem (that is caused by relevant parts of the car front-end), will decrease. In some instances the decrease will be more than one AIS-category, but the minimum is assumed to be one category. This conservative position will be applied to all injured, including those who were killed and whose injuries will be considered now as AIS-5 injuries.
The same approach was applied in the BASt-study, and is now adopted in the SWOV-study as well.
The calculation of the effect of decreasing the severity of each relevant individual injury by one AIS-category, has been thoroughly carried out in the BASt-study. Since SWOV has agreed to use the same source-data for the purpose of calculating effectiveness, the results of such calculations in case of the SWOV-study would have been the same as in the BASt-study. In the SWOV-study, however, the resulting effect-percentage (the proportion of relevant seriously injured to be spared) is considered a minimum value because of two reasons. One is already mentioned (the decrease of one AIS-category per relevant injury is regarded a minimum); the second reason is that this downshift will also result in a lower average injury-severity for the remaining group of seriously injured, while only the net effect (the remaining proportion) is calculated.
Effectiveness regarding slightly injured will be established along the same lines.

The above-mentioned approach is meant in principle for both pedestrian-casualties and cycle-casualties. However, as is stated before, SWOV will use a specific additional approach for cyclists, since it is found that the 'Otte-data', though valid for pedestrian-accidents, are less valid for the representation of Dutch cycle-accidents.

4.1.2. *Cyclists*

As mentioned above, effectiveness of the measure might be different for pedestrians and cyclists. The main reasons are:
- the different heights of the two groups with regard to the car front-end;
- the speed of the bicycle, causing the cyclists to miss relevant parts of the front-end more often than pedestrians;
- the different collision-modes of the car-bicycle configuration of which the most comparable with the car-pedestrian configuration (cyclist is hit sideways) is also the most common, representing about 70% of all contacts between cyclists and car front-ends (the other modes being: cycle rear-end contacts and cycle frontal contacts).

According to the 'Otte-data', used for the calculation of benefits in the

BASt-study, no cyclist-fatalities occur at collision-speeds of less than 40 km/hour. Consequently, no cyclist-fatalities would be prevented by the measure as indeed is concluded in the BASt-study.
It was thought that in the Dutch traffic situation, where cyclists are the most common mode of transport (there are 2.5 times as much cycles as cars in The Netherlands), the confrontations between cars and cyclists would lead to more collisions and different outcomes than found in the German situation in the Hannover Area, where the in-depth accident data have been gathered.
Accident statistics of both countries (as published by ECE, and also available in the international IRTAD-databank) show that the proportion of bicycle casualties in The Netherlands is about two times greater than in Germany.

In the following approach, cycle accidents are discussed in relation to pedestrian accidents, based on Dutch accident data.

Official accident statistics, already presented in Annex 1, show that in 1991 about 2.5% of all registered casualties of car-front-end-against-cycle-collisions are fatalities, compared to 4.4% of the comparable pedestrian-casualties.
In both groups the percentage of fatalities outside the built-up area is (far) greater than the percentage inside the built-up area. This can be readily understood, assuming that average collision speeds outside the built-up area are (far) greater than those inside the built-up area, leading to (far) greater collision-severities.
Since the legal speed limit inside the built-up area is 50 km/hour, it might be expected that a fair amount of these collisions, both with pedestrians and cyclists, had collision speeds under 40 km/hour. This also will be the case for a small share of the collisions outside the built-up area. In the Dutch approach is assumed that 'working area' of the proposed measure is mainly within the built-up area, though in some instances speeds of up to 40 km/hour may be applicable for accidents outside the built-up area.
In both groups (pedestrians and cyclists), the proportion of fatalities inside the built-up area is more or less the same (53-54% of all fatalities). Inside the built-up area, the numbers of fatalities divided by the numbers of hospitalized plus fatalities (a measure for the severity of the outcome) expressed as percentages are 6,3% for cyclists and 6,4% for pedestrians. The difference is considered relatively small.

These similarity leads to the assumption that in The Netherlands, the average collision speeds (inside the built-up area) of cycle-accidents and pedestrian-accidents are comparable. Since the Dutch accident data do not contain information about the actual collision speed, though they do contain information about the speed limit at the scene of the accident, this assumption can not be verified.
In view of the still existing differences between cyclists and pedestrians, already mentioned, and especially in view of the relatively large difference in outcome of collisions outside the built-up area (as illustrated by the national data in Annex 1), a conservative approach is chosen to find the appropriate effectiveness figure: it is assumed that effectiveness for cyclist-fatalities is half of the figure derived for pedestrian-fatalities.

With respect to non-fatal injuries, a similar approach is adapted and effectiveness in both casualty-groups will be put at half the effectiveness found for pedestrians.

4.2. Calculation of effect-percentages

In this paragraph, effect-percentages will be established according to the effectiveness-approach, described in the previous paragraph.
In principle, effect-percentages represent proportions of relevant casualties in a particular severity-group, using indepth-data. Relevant casualties are those out of all casualties (in the same severity-category) who will benefit from the proposed measure. Therefore, excluded are those who did not collide with cars. From the remaining casualties, excluded are those who were not hit by the relevant parts of the front-end. From the remaining casualties, excluded are those who did not have a collision under 40 km/hour.

1. Fatalities

Pedestrians
The effectiveness in preventing pedestrian-fatalities is 100% of the relevant casualties. This group, according to the 'Otte-data', represents 3.3% of all pedestrian-fatalities inside built-up areas, which is seen by BASt as the lower limit of the effect-percentage. The upper limit according to that study is 7.3%. In the Dutch study, an effect-percentage of 7% is chosen as the most appropriate, only to be applied to fatalities inside built-up areas.

Cyclists
Effectiveness for cyclists is 50% of the figure found for pedestrians. Therefore the effect-percentage is calculated at 3.5%, also only to be applied to fatalities inside built-up areas.

2. Seriously injured

Pedestrians
The effect-percentage with regard to seriously injured pedestrians is 10%, being a somewhat more than the percentage calculated in the BASt-study. This difference is explained in the previous paragraph.

Cyclists
Effectiveness for cyclists in this severity-range is put at half the figure found for pedestrians. The effect-percentage therefore is calculated at 5%.

3. Slightly injured

Pedestrians
The effect-percentage for slightly injured pedestrians is 7%. The figure calculated in the BASt-study is applicable only to casualties inside built-up areas. However, since casualties inside built-up areas represent almost 95% of all casualties in this severity-category, in the Dutch study the effect-percentage of 7% will be applied to all slightly injured casualties.

Cyclists
According to the Dutch approach, effectiveness for cyclists in this group is 50% of the figure for pedestrians. This effect-percentage therefore is 3.5%.

The following effect-percentages have been derived and will be used in the final cost-benefit analysis (next chapter):

	Pedestrians	Cyclist
Fatalities (inside built-up areas)	7%	3.5%
Seriously injured (hospitalized)	10%	5%
Slightly injured	7%	3.5%

5. Cost-benefit calculations

5.1. General design of the cost-benefit calculations

As stated earlier, no cost-estimates have been made regarding the implementation of the measure for car-manufacturers. The cost-benefit study therefore will concentrate on the number of casualties spared, and the economic benefits of this reduction in terms of money (ECU's). The cost-benefit ratio resulting from the implementation of the measure is positive (more benefits than costs) if the total costs of implementing the measure are less than the calculated money value of the benefits. Considering the number of new cars, relevant to the implementation of the measure, the implementation costs per new car could be calculated. This would indicate to what price-level manufacturers could made changes to the front-end. During the implementation period of the proposed measure (it may take 10 years to replace all existing cars with cars, complying to the new requirements), annual benefits are of course less than 100%. The annual cost-benefit ratio will quickly rise to its final position presented in the next part of this chapter.

5.2. Implementation aspects of the measure

In order to calculate cost-benefit ratio's of the proposed measure, several assumptions must be made regarding the the development of casualties in the (near) future as well as the development of the number of new cars and the total number of cars.

Implementation aspects

According to several recent studies regarding projected car ownership in The Netherlands in the next century, a further increase of car ownership is expected. Since a major cause of this type of development is (the unpredictable) economic growth, it may be doubted that such forecasting is fully realistic. Furthermore, Dutch national policy will definitely remain focused on actually discouraging car-ownership and car use, in favour of public transport and other, less energy- and space-consuming modes of traffic (such as cycling and walking). Another, even more important new aspect of Dutch national policy, is the creation of a fully sustainably safe traffic and transport system. This factor may also, though more on a long term base, influence the numbers of casualties, the numbers of cars, and even the type and severity of collisions between road users.
In view of these contradicting aspects, and to simplify further calculations, it is assumed that the growth in the number of cars is constant, and the total number of cars will remain at the current level of about 5,500,000 cars; and that the annual number of new cars will remain at the current level of about 500,000 or about 9%-10% of the total number of cars.

Trends in pedestrian-casualties

As has been clearly illustrated in the TRL-study, Europe shows a very definite downward trend regarding pedestrian-casualties during de previous

20 years (1970-1990). Though the annual decline is decreasing, a further decrease of the numbers of pedestrian-fatalities is expected.
More specifically, in The Netherlands this downward trend has been very much apparent, especially for the years mentioned above. The number of fatalities decreased at a fairly steady annual rate from 609 in 1970 to 144 in 1990.
Pedestrian-fatality figures from the years 1990-1993 point to a possible end of this downward trend:

Year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Fatalities	212	188	216	172	201	190	144	145	152	147

There is still no way to accurately predict future developments from previous developments, whatever the trends.
The best conclusion at this moment is that the 1991 figures used in the study so far, apparently would have been fair predictors for the two years to come (1992 and 1993) and 1991 figures and distributions will therefore be used for later years as well. The downward trend that existed at least up to 1990 will be neglected.
Apart from statistical developments and arguments, there are reasons to suppose that the current Dutch habits regarding walking (jogging!) tend to an increase of exposure of this group of road users, so the supposed end of the downward trend may in fact be caused by an actual increase of walking mileage.

Trends in cyclists-casualties

Fatality-figures for the last 10 years indicate that a downward trend for cyclists was apparent at least up to 1991, though with more irregular fluctuations than for pedestrian-fatalities:

Year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Fatalities	360	315	312	312	282	333	304	238	251	244

Here also, the downward trend may have ended. Though not intended, the current Dutch policy regarding cycling, aiming at discouraging car use through encouraging other traffic modes, may have stopped the apparent downward trend for cyclists as well as for pedestrians.
As for pedestrian-fatalities, also for cyclist-fatalities the year 1991 will be used for further calculations.
In case the trend actually is reversed from downwards to upwards, these figures give conservative results regarding the benefits to be calculated in the next chapter.

5.3. Calculation of national benefits

In the previous Chapter 4: Effectiveness calculations, benefits have been calculated and expressed in terms of the relative number of casualties (out

of the total number of casualties) that will be spared by the measure.
By applying these effectiveness-figures to national accident data of any given year (in this study the year 1991 is chosen), the national benefits of the measure in terms of casualties spared are apparent.
By applying the costs per casualty as calculated in Chapter 3: Cost calculations, benefits can be expressed in money values, (1991 ECU's).
These benefits, of course, would only be realized when all cars would have a changed front-end, complying to the criteria specified in the test requirements.

The total 1991 numbers of casualties to be used for the calculation of national benefits are according to VOR-data:

	Pedestrians	Cyclists
Fatalities (inside built-up areas)	86	149
Seriously injured (hospitalized)	1203	2878
Slightly injured	2263	9026

According to an average under-registration of more than 50% , the number of slightly injured (both pedestrians and cyclists) is far too low. Some under-registration may be expected for hospitalized.

	Effect (%)	Annual benefits (casualties)	Annual benefits (ECU's)
Fatalities			
pedestrians	7	6	2,490,000
cyclists	3.5	5	2,075,000
Seriously injured			
pedestrians	10	120	6,360,000
cyclists	5	143	7,579,000
Slightly injured			
pedestrians	7	158	2,101,400
cyclists	3.5	315	4,189,500

Table of benefits of the proposed measure (both casualties and ECU's, 1991) based on effectiveness data.

In terms of casualties, the total annual benefits amount to:

fatalities	11
seriously injured	263
slightly injured	473

In terms of money (ECU's, 1991), the total annual benefits amount to:

fatalities	4,565,000
seriously injured	13,939,000
slightly injured	6,290,000
Total	24,794,000

5.4. Calculation of the cost-benefit ratio

Considering the assumptions made in para. 5.2, and the calculated annual benefits from the previous table, the cost-benefit saldo can now be calculated.

The total annual benefits amount to 24,794,000 ECU's,
the number of new cars per year is 500,000,
the benefits per new car are then (in rounded figures):
24,794,000/500,000 = 49.6 ECU's per new car.

Investments (implementation costs) per new car may therefore not exceed this figure in order to keep a positive benefits to costs ratio. To keep a positive ratio of *for instance* 2:1 (benefits over costs), the costs per new car may not exceed 24.8 ECU's. To keep a positive ratio of 3:1, the costs per new car may not exceed 16.5 ECU's.
In view of the costs per car as calculated by IAD (UK) Ltd, reported in the TRL-study, this last cost-figure is feasible and a positive benefits over costs ratio of at least 3:1 is to be expected for The Netherlands.

There is scientific discussion about the use of net versus gross costs, a choice that greatly influences the benefits pertaining to fatalities. Calculations based on the far lower net cost per fatality (mentioned in para. 3.3) would still lead to a positive ratio of benefits over costs of more than 2:1, considering the same cost per new car as mentioned above.

6. Conclusions

The proposed measure with regard to intended changes of the car front-end will have a positive cost-benefit ratio in The Netherlands, if the costs of implementation remain under a level of 24,794.000 ECU's (1991 values) overall costs, or 49.6 ECU's per new car.
In view of the results of the IAD(UK)Ltd cost-study published in the TRL-report on this subject, it is concluded that a benefits-over-costs-ratio of at least 3:1 is expected.
Implementation of the proposed measure therefore will be of great benefit for The Netherlands.

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Annexes 1 and 2

Annex 1. *VOR-accident data (Dutch national accident data).*

Annex 2. *Insurance-based cost-study.*

Annex 1. VOR-accident data (Dutch national accident data)

Selection

National accident data of injury-producing accidents have been used. Selected are cases of collisions between cars and pedestrians and between cars and cyclists, both groups only as far as the front-end of cars were contacted.
Since only so called primary collisions were selected (in which reliable information about the two collision partners, covering about 90% of all cases), the numbers are conservative.

Casualties are divided into three categories:
fatalities, hospitalized and other injured (or slightly injured).
The latter group is considered to be less severe injured than the group of hospitalized. In terms of AIS-categories, fatalities have AIS-5 and AIS-6 injuries; hospitalized or seriously injured have AIS-2 to AIS-5 injuries; slightly injured have AIS-1 to AIS-2 injuries.

Development of the scope of the problem is showed, using the years 1989-1992.

	1989	1990	1991	1992
Cyclists o.w.				
fatalities	169 (3.0)	143 (2.7)	123 (2.6)	127 (2.6)
hospitalized	1651 (28.9)	1423 (26.4)	1260 (26.3)	1261 (25.7)
other injured	3882 (68.1)	3821 (71.0)	3417 (71.2)	3520 (71.7)
Total	5702 (100%)	5387 (100%)	4800 (100%)	4908 (100%)
Pedestrians o.w.				
fatalities	98 (4.7)	83 (4.0)	76 (4.4)	81 (4.7)
hospitalized	778 (37.5)	743 (36.2)	637 (37.0)	585 (34.1)
other injured	1201 (57.8)	1228 (59.8)	1007 (58.5)	1051 (61.2)
Total	2077 (100%)	2054 (100%)	1720 (100%)	1717 (100%)

Table 1. *Development of the number of pedestrian and cyclist casualties resulting from collisions against the front-end of cars; VOR-data 1989-1992.*

Severity (of injury)	Area Inside built-up area	Outside built-up area	Total
Fatal	66 1.38 53.66	57 1.19 46.34 1.61	123 2.56 8.01
Hospital	984 20.50 78.10 24.07	276 5.75 21.90 38.76	1260 26.25
Other	3038 63.29 88.91 74.32	379 7.90 11.09 53.23	3417 71.19
Total	4088 85.17	712 14.83	4800 100.00

Table 2a. *Cyclists.*

Severity (of injury)	Area Inside built-up area	Outside built-up area	Total
Fatal	40 2.33 52.63 2.53	36 2.09 47.37 25.71	76 4.42
Hospital	589 34.24 92.46 37.28	48 2.79 7.54 34.29	637 37.03
Other	951 55.29 94.44 60.19	56 3.26 5.56 40.00	1007 58.55
Total	1580 91.86	140 8.14	1720 100.00

Table 2b. *Pedestrians.*

Severity (of injury)	Point of contact (on car) 11 left front	12 centr front	13 right front	Total
Fatal	18	80	25	123
	0.38	1.67	0.52	2.56
	14.63	65.04	20.33	
	1.75	3.15	2.02	
Hospital	237	700	323	1260
	4.94	14.58	6.73	26.25
	18.81	55.56	25.63	
	23.10	27.57	26.15	
Other	771	1759	887	3417
	16.06	36.65	18.48	71.19
	22.56	51.48	25.96	
	75.15	69.28	71.82	
Total	1026	2539	1235	4800
	21.38	52.90	25.73	100.00

Table 3a. *Cyclists.*

Severity (of injury)	Point of contact (on car) 11 left front	12 centr front	13 right front	Total
Fatal	16	40	20	76
	0.93	2.33	1.16	4.42
	21.05	52.63	26.32	
	5.44	4.00	4.71	
Hospital	96	362	179	637
	5.58	21.05	10.41	37.03
	15.07	56.83	28.10	
	32.65	36.16	42.12	
Other	182	599	226	1007
	10.58	34.83	13.14	58.55
	18.07	59.48	22.44	
	61.90	59.84	53.18	
Total	294	1001	425	1720
	17.09	58.20	24.71	100.00

Table 3b. *Pedestrians.*

Severity	Age (of casualty)					
(of injury)	Unknown	Under 11	11-20 y	21-64 y	65+	Total
Fatal	0	4	23	41	55	123
	0.00	0.08	0.48	0.85	1.15	2.56
	0.00	3.25	18.70	33.33	44.72	
	0.00	0.76	1.46	2.03	8.35	
Hospital	5	141	350	503	261	1260
	0.10	2.94	7.29	10.48	5.44	26.25
	0.40	11.19	27.78	39.92	20.71	
	20.00	26.96	22.21	24.94	39.61	
Other	20	378	1203	1473	343	3417
	0.42	7.88	25.06	30.69	7.15	71.19
	0.59	11.06	35.21	43.11	10.04	
	80.00	72.28	76.33	73.03	52.05	
Total	25	523	1576	2017	659	4800
	0.52	10.90	32.83	42.02	13.73	100.00

Table 4a. *Cyclists.*

Severity	Age (of casualty)					
(of injury)	Unknown	Under 11	11-20 y	21-64 y	65+	Total
Fatal	0	13	5	29	29	76
	0.00	0.76	0.29	1.69	1.69	4.42
	0.00	17.11	6.58	38.16	38.16	
	0.00	2.18	1.73	5.38	10.25	
Hospital	4	225 82	173	153	637	
	0.23	13.08	4.77	10.06	8.90	37.03
	0.63	35.32	12.87	27.16	24.02	
	30.77	37.75	28.37	32.10	54.06	
Other	9	358	202	337	101	1007
	0.52	20.81	11.74	19.59	5.87	58.55
	0.89	35.55	20.06	33.47	10.03	
	69.23	60.07	69.90	62.52	35.69	
Total	13	596	289	539	283	1720
	0.76	34.65	16.80	31.34	16.45	100.00

Table 4b. *Pedestrians.*

Annex 2. Insurance-based cost-study

Introduction

It appeared that the major insurance companies have rather detailed computer based cost data on their individual cases, including both damage (to cars and other properties), injury and other costs relevant to car accidents.
It was decided to use available insurance data on cost-*payments* of specific accidents. It was understood that this type of cost data would not necessarily yield all relevant costs of these accidents, since in some cases the insurance company would not be fully liable, or since not all relevant costs would be claimed. Therefore, the cost data found at the insurance company could be regarded as an absolute minimum.

Description of the available insurance data

The relevant data in this cost-study are third-party-liability data.
Due to the current traffic laws in The Netherlands, pedestrians and cyclists hit by cars, may claim their damage and injury costs from the car owner, unless it is positively proven that the car owner was not at fault. In some cases only part of the costs may be claimed, since the driver of the car was only partly at fault (for instance 25%, 50% or 75%). To calculate the complete costs of these cases, the payments made by the insurance company have to be multiplied by a factor representing the inverse of that specific amount.

Though the cost data and some of the general accident data are available in computerized data files, some of the other relevant data are not.
These data have to be gathered from the original written forms, which are kept together in individual case files.
Such data include:
- type of accident (i.e. car front against pedestrian or cyclist)
- part of the car front-end involved (i.e. bumper, leading edge, bonnet)
- type of injury
- type of treatment/severity of injury (i.e. fatal, hospitalized or other)
- age and sex of victim.

The different sorts of costs (payments) available in the material studied are:
- medical costs,
- loss of income,
- grief payment (pain and suffering),
- domestic help,
- property damage (not relevant to this study),
- other injury costs,
- interest payment,
- reserve (estimated remaining costs as long as a case is not closed; mostly for loss of income and grief payments).

These costs (payments) were listed according to cost-category per individual case and will be presented as a total to minimize privacy problems of the insurance company.

Execution of the cost-study

Selection of relevant cases

For the purpose of comparability with the outcome of both other (German and British) cost-benefit studies, accident and cost data had to be gathered for the year 1991.

The total number of registered injury cases involving cars and either pedestrians or cyclists (as available in the data files of the insurance company) was 155 for the year 1991.

This was considered to be a sufficient number to carry out the cost-study and no other (more recent, and therefore more incomplete) data were used, although they were available.

Sequence of (data) steps

The following steps were carried out:

- All record numbers of individual cases, involving cars and pedestrians or cyclists were noted, using and selecting from the computerized data; this work was done by SWOV at the office of the insurance company.
- The individual records of these cases were then located in the appropriate departments of the insurance company. Many of these records were still active. This work was done by the insurance company.
- Using these individual files, SWOV selected those cases that complied to the following selection criteria:
  - only car front involved
  - victim either pedestrian or cyclist
- From these resulting relevant records, the following data per casualty were extracted by SWOV, separate for pedestrians and cyclists:
  - outcome of accident (fatal, hospital, other)
  - part of car damaged (bumper, bonnet, window)
  - side of bicycle hit (side, rear, front)
  - age and sex of victim
  - percentage of third party liability (100, 75, 50, 33, 25%)
  - relevant remarks concerning typical aspects of that specific case.
- These data were coded, according to a pre-coded list, on a hand-written form, by SWOV.
- Using the individual case-numbers of the same resulting relevant cases, the computerized data bank was entered again, to gather all different sorts of cost data.
- These data were added to the data already coded. This work was also done by SWOV at the office of the insurance company.
- The data on the handwritten forms were then put into a computer data file, at the office of SWOV.
- Computing and analysing of the data took place at SWOV.

Results of the cost-study

In the following tables the results of the work is presented, firstly with respect to the different accident parameters; secondly with respect to the cost data.

Accident data

The total number of relevant cases selected from the original 1991 sample is 111 (73 cyclists and 38 pedestrians) out of 155.

This means that 44 cases were not selected, all of these being bicycle accidents, in which the bicycle was not hit by the front-end of the car. In most of these cases the bicycles struck opened doors of the cars or the side of the cars. Of the 111 relevant cases, 5 are either too complicated (more than one casualty per case) or incomplete with respect to cost data. The remaining sample consists of 106 cases (70 cyclists and 36 pedestrians).

Outcome	Cyclists	Pedestrians	Total
Fatal	7 (10%)	4 (11%)	11 (10%)
Hospital	21 (30%)	13 (36%)	34 (32%)
Other	42 (60%)	19 (53%)	61 (58%)
Total	70 (100%)	36(100%)	106 (100%)

Table 1. *Outcome-category for cyclists and pedestrians (Insurance data 1991).*

Table 1 shows the numbers of the two groups of casualties according to their outcome-category. Some 10% of the selected casualties in both groups were killed.
This percentage is clearly higher than could be expected from the data of the official Dutch accident statistics (see Annex 1).

Age (years)	Cyclists	Pedestrians	Total
0-14	15 (21%)	14 (39%)	29 (27%)
15-64	37 (54%)	13 (36%)	50 (47%)
over 65	18 (26%)	9 (25%)	27 (26%)
Total	70 (100%)	36 (100%)	106 (100%)

Table 2. *Age-categories for cyclists and pedestrians (Insurance data 1991).*

Table 2 shows that large proportions of the total numbers in both casualty-groups are formed by children and elderly people.

Sex	Cyclists	Pedestrians	Total
Male	43 (61%)	18 (50%)	61 (58%)
Female	27 (38%)	18 (50%)	45 (42%)
Total	70 (100%)	36 (100%)	106 (100%)

Table 3. *Sex-categories for cyclists and pedestrians (Insurance data 1991).*

Table 3 shows that there is some difference between cyclists and pedestrians with regard to sex distribution. There are clearly more male casualties than female casualties in the cycle population as well as in the total casualty group.

Location of injury	Cyclists	Pedestrians	Total
Head	27 (29%)	12 (33%)	39 (37%)
Leg	14 (20%)	10 (28%)	24 (23%)
Other	29 (51%)	14 (39%)	43 (41%)
Total	70 (100%)	36 (100%)	106 (100%)

Table 4. *Location of injury for cyclists and pedestrians (Insurance data 1991).*

Head injuries (brain, face and skull) and leg injuries form the major separate categories of most serious injuries (Table 4). Other injuries include arm injuries, thorax injuries and spine/back injuries.

Cost data

In Table 5 and 6 all cost data have been combined into one group of payments (total payments), covering all relevant payment-categories. Only costs relevant to the problem of injury resulting from the collision with the car front-end are selected, which means that any payments with regard to property damage, either to the car owner or to the pedestrian (clothing) or cyclist (clothing and bicycle), have been neglected.

Total payments (guilders)	Cyclists	Pedestrians	Total
< 5.000	25 (36%)	11 (31%)	36 (34%)
5 - 10.000	15 (21%)	5 (14%)	20 (19%)
10 - 50.000	22 (31%)	17 (47%)	39 (37%)
50-100.000	7 (10%)	-	7 (6%)
> 100.000	1 (1%)	3 (8%)	4 (4%)
Total	70 (100%)	36 (100%)	106 (100%)

Table 5. *Total injury-payments (guilders) for cyclists and pedestrians (Insurance data 1991).*

Table 5 shows that in the majority of cases total payments were established at a level under 50,000 Dutch guilders, while 34% of the total stay under 5,000 guilders.

The differences in level of payments for the two casualty groups are not remarkable, therefore the casualty-groups will be combined.

It is necessary to know whether these figures are dependant on the severity of the outcome of accidents; this is shown in Table 6.

While the majority of the lower severity category ('Other') clearly belongs to the lower category of payments, emphasis for the hospitalized is somewhere in the middle payment-region. The distributions indicate that payments for fatalities are somewhat different from, but not higher than, payments for hospitalized (see also Table 8).

Total payments (guilders)	Cyclists and pedestrians Fatal	Hospital	Other	Total
< 5.000	3 (27%)	4 (11%)	29 (48%)	36 (34%)
5 - 10.000	4 (36%)	3 (9%)	13 (21%)	20 (19%)
10 -50.000	2 (18%)	19 (56%)	18 (29%)	39 (37%)
50-100.000	0	6 (18%)	1 (2%)	7 (7%)
> 100.000	2 (18%)	2 (6%)	-	4 (4%)
Total	11 (100%)	34 (100%)	61 (100%)	106(100%)

Table 6. *Total injury-payments (guilders) for cyclists and pedestrians (Insurance data 1991).*

In Table 7 and 8 the payment data are specified according to three categories: minimum, (arithmetic) mean and maximum.
This tables show again that the difference regarding level of payment between cyclists and pedestrians is small, as already indicated in Table 5.

Total payment level (guilders)	Cyclists	Pedestrians
Minimum	60	150
Mean	20.000	26.000
Maximum	140.000	150.000
Number of casualties	70	36

Table 7. *Total payment level (guilders) for cyclists and pedestrians (Insurance data 1991).*

Table 8, a seperate severity-category is introduced: out-patients. This category of casualties was treated in a hospital, though not admitted for a stay of longer than one day. The remaining category (lightly injured) treatment is based on other (non-hospital) provisions.

Total payment level (guilders)	Severity category (all casualties) fatal	hospital	out-patient	light
Minimum	2.200	2.500	500	60
Mean	32.500	38.000	16.000	5.000
Maximum	140.000	150.000	74.000	22.000
N=	11	34	31	30

Table 8. *Total payment level (guilders) for all casualties according to severity-category (Insurance data 1991).*

Table 8 clearly shows the relevancy of the new severity-category 'out-patients' since their payment level is far higher than for the remaining group 'light', while the mean payment level is about half the amount of the hospitalized and fatalities.

The difference regarding payments between fatalities and hospitalized is very small.

Tables 9 and 10 show the influence of age(-category) on level of payment:

Total payment level (guilders)	Age-category (all casualties) 0-14	15-24	25-44	45-64	>65
Minimum	340	1,000	2,830	3,250	60
Mean	16,180	21,250	25,400	40,400	14,100
Maximum	8,400	138,600	120,800	149,200	95,700
N=	29	18	16	16	27

Table 9. *Total payment level (guilders) for all casualties according to age-category (Insurance data 1991).*

Table 9 clearly indicates that (mean) payments for children and elderly are considerably lower than for other age-groups. The highest payment levels belong to age-category '45-64'.

Age-category	Severity category (all casualties) fatal	hospital	amb.tr.	light
0-14	6,040	33,662	8,440	3,275
15-24	70,540	23,970	12,750	5,260
25-44	120,800*	32,000	17,800	7,320
45-64	4,500*	72,800	30,200	8,000
> 65	18,100	29,600	24,500	3,700

* only 1 casualty per group

Table 10. *Mean payment level (guilders) for all casualties according to age-category (Insurance data 1991).*

Apart from irregularities in the group of fatalities, caused by low cell numbers, the pattern (shown in Table 10) is obviously the same as seen from Table 9: relatively low payments in both the youngest and the oldest age-groups compared to the others.

Additional information about payment data

Many of the cases used, are still waiting for final judgement and settlements. This is reflected in the separate cost category 'Reserve', in which category the remaining expected payments are calculated.
Though this category is part of the total costs presented, in some cases a larger final payment may exist than calculated.

The insurance cost data used, do not reflect all possible injury and accident costs since they are based on individual cases (micro-economic level) and not based on economic costs for society.
Further more, not included are those costs paid by other insurances for which no regress (or redress) is possible.

As far as *medical costs* are concerned, not included are:
- Costs paid by the Dutch AWBZ (national insurance covering all medicines, provisions such as artificial limbs, transport costs).

As far as *income-damages* are concerned, not included are:
- Costs paid by the Dutch AAW (minimum level insurance for all disabled workers).
- AOV-claims (disability-insurance, either for workers or for non-workers).
- Accident-insurance claims (costs paid by separate insurances, either for workers or for non-workers).

For fatalities, the following additional cost-categories are not included:
- Life-insurance payments.
- Next of kin pension-payments (except for ABP-payments: pensions to next of kin of civil servants).
- Payments based on AWW (national insurance for widows and orphans).

As far as *grief-payments* are concerned, not included are:
- Payments to next of kin of fatalities (in The Netherlands, contrary to other countries, no grief-payments for this purpose are considered; only in case of injury, grief-payment is applicable).

The influence of the costs-categories, not included in the data gathered from the insurance company, on the cost data presented, is obviously considerable, though no exact calculation of their magnitude can be made.

According to the insurance company, the 1991 payments for income-damages and grief, used in the study, appear smaller then usual.
This indicates that the sample used may be different from other years with respect to age-distribution and/or category of profession of the casualties.

All of the above mentioned factors point the same way: the insurance-based payment-data do not reflect all of the cost-categories nor all of the costs relevant to the problem studied in this project. Without further study, however, it is very difficult to ascertain the magnitude of this problem.