Faculty of Economics, Business Administration and Econometrics

5

SERIE RESEARCH MEMORANDA

Economic Evaluation of Safety Measures for Transport Companies

Sytze A. Rienstra
Piet Rietveld
Joke E. Lindeijer

Research Memorandum 1998-24

vrije Universiteit amsterdam

Economic Evaluation of Safety Measures

for Transport Companies

Sytze A. Rienstra'

Piet Rietveld[2]

Joke E. Lindeijer[3]

1) Netherlands Economic Institute
Transport Division
PO-box 4 175
3006 AD Rotterdam
The Netherlands
tel. x-3 l-lo-4538835
fax: x-31-10-4523680
e-mail:rienstra@nei.nl

2) Free University
Dept. of Spatial Economics
De Boelelaan 1105
1081 HV Amsterdam
The Netherlands
x-3 l-20-4446097
x-3 l-20-4446004
prietveld@econ.vu.nl

3) SWOV Institute for
Road Safety Research
PO-box 170
2260 AD Leidschendam
The Netherlands
x-31-70-3209323
x-3 l-70-3201261
lindeijer@swov.nl

Abstract

Measures to reduce material damage within companies may both increase the business economic performance of the company and traffic safety in general. In this paper the notion of whether such measures are economically feasible is investigated. Results are presented of a series of interviews among transport companies and of a postal questionnaire survey. Next, calculations are presented for three types of companies: a small family company, a large family company and a large formalised company. The main conclusions are that a successful introduction of measures is largely influenced by psychological and cultural factors. Especially in larger companies, substantial cost savings may occur due to an active material damage prevention policy, which will also have positive impacts on traffic safety in general.

1. Introduction

Damage reduction often receives scant attention from transport companies, despite the possibility that costs of damage cases are high. It is important to note that a damage case not only results in *direct* costs such as those of repair, but also in *indirect* costs: administration costs, costs for a temporary replacement of a truck, a negative image for a company, time costs of the driver and other employees, etc. Transport companies are often unaware of these high indirect costs. Insurance companies suggest that these indirect costs may on average be as high as the direct costs. Direct costs, with the exception of the known risk, are covered by the insurance company; this is not the case, however, for the indirect costs. In addition, companies that have a reduced damage frequency pay lower premiums than companies with a high frequency. Therefore, decreasing the number of damage cases may result in large cost cuts, which may be even larger than is directly shown in the company accounts.

If a company wants to reduce its damage costs it may implement a wide range of measures, but the introduction of these measures will, however, result in costs for the company. From an economic point of view, it becomes interesting to evaluate whether the cost savings are higher than the costs made after introducing the measure.

The costs of high damage rates are not only high for the companies, but also for all of society because of the connection with traffic safety. Insurance companies indicate that approximately 2% of the reported damage cases by transport firms are accidents that have slightly injured people, 1% have heavily wounded people, and 0.25% are fatal accidents. Heyer and Wouters (1996) also emphasise the societal advantages of fewer accidents; with every truck driver who is injured in an accident, there are on average, six persons besides the driver who are injured.

It can therefore be assumed that an active damage reduction policy will clearly have positive impacts on traffic safety in general. As a result, society will benefit from reducing the number of damage cases; this may be an important reason for governments to stimulate active damage prevention policies of transport companies.

The high internal economic and external costs of damage cases lead to the question of whether 'win-win' situations can occur, whereby companies can make profitable investments in damage reduction measures and traffic safety for society overall is improved. To analyse this, our paper presents some indicative analyses of the costs and benefits from a firm perspective. We are acutely aware that these measures will lead to reductions of both private and external costs of damage cases. We decide to focus on the private costs here, in order to discover the extent to which measures are profitable from a firm's standpoint. To find the necessary information for these analyses a variety of interviews were held and a postal questionnaire survey was sent to transport companies. The results of this empirical research will be discussed first, and afterwards the results of the calculations will be presented. For a more detailed analysis we refer to Lindeijer et al. (1997).

2. Results of the Interviews

Based on two interviews with an expert, 21 clearly identified measures have been investigated in the research. The beginning of the establishing of a damage reduction plan is the introduction of the so-called **'start model'.** This model consists of three parts:

- a formalised damage reporting system, with e.g., standardised forms and a fixed person to whom damage is to be reported;
- a computerised damage registration system, that uses a spreadsheet program or more sophisticated software;
- individual feedback to the driver (e.g., a short talk and discussion for every damage case).

This model should be introduced before other measures are introduced, because if a company has no insight into the location of problems and of those who cause high damage rates, it makes no sense to introduce measures. In addition to this start model, a wide range of measures have been identified, varying from damage prevention meetings, courses and training activities, sanction and bonus schemes (material and non-material), ABS-systems etc. (see also Figure 1 for the entire list).

Interviews with representatives of transport firms active in taking damage prevention measures lead to the following conclusions:

1. The **start model** (formalised damage reporting, computerised registration and individual feed-back) leads to large damage reduction percentages. Companies mention reductions of up to 50%, mostly depending on the damage frequency before the model is implemented. The following reasons for these reductions are:
   - the attention to damage prevention makes drivers more conscious about the costs of damage reduction and the need/necessity to pay attention to this;
   - the management of the company gains insight into the damage patterns, frequencies, etc., and is therefore better qualified to introduce effective measures;
   - because of the measurement activities sometimes individual drivers or cases attract attention. In one company for instance, 20% of the drivers was involved in 80% of the damage cases. By giving these drivers particular attention, the damage frequency was lowered dramatically. In another company, many accidents occurred at a specific crossing; by undertaking action there, the damage costs were significantly reduced.
2. The introduction of the start model results in a reduction of the number of damages as well as in lower **average costs per damage case.** One company reports that not the number of damages, but only the average amount per damage case was reduced.
3. Additional measures ▪ aside from the start model ▪ are often decided in an ad hoc way rather than after an analysis of possible benefits, costs and measures. These measures often aim to maintain the results at the current level by giving new attention to damage prevention. It is therefore difficult to give exact impacts of these measures.
4. The **company's culture** is often more important to the acceptance and introduction of measures than the monetary costs are. Companies still owned by the founder or his family ('family companies') mostly have an informal style. The management knows or assumes to know the drivers and is therefore reluctant to take measures which aim to influence a driver's manner or could be interpreted as criticism of the drivers. In such companies the director's opinion is the most decisive factor of the introduction of a measure. In more formalised hierarchical companies implementation is easier.
5. In many cases it is not the measure itself, but the **psychological impact** of a measure which is regarded as important. For example, a spirit of competition may develop between drivers to have lowest damage records. Also significant is that a measure be considered as 'fair' or 'reasonable'. Several companies emphasise the importance that a driver (or a small group of drivers) is responsible for his 'own' truck. The perceived attention of the management when

introducing measures and the publicity around damage reduction is extremely important for the successful implementation of a measure.

6. The **reasons** for starting with damage reduction plans are mostly found in the high costs. A threat of a premium rise by an insurance company is important in this respect, but so is a comparison of a company's own damage pattern with the national average, or a chaotic spiralling of control of damage costs. Some companies also mention image improvement as a reason for beginning with damage prevention.
7. **Technical** measures such as ABS-systems, a capsize warning system, and side protection are in almost all cases considered too expensive when compared with the expected cost reductions.

3. Results of the Postal Questionnaire Survey

To get a broader picture of the damage reduction policies of companies as well as the impacts of the selected measures, a postal questionnaire survey was sent to about 500 companies in 1997. The useful response rate was 132 companies (26%). A wide range of companies are included in the research population, varying from companies having transport as a main activity, to companies which primarily transport their own goods between plants or to customers. The size of the firms, the market in which they operate, and the type of goods carried also varies widely. Here we will present some main conclusions of the questionnaire.

Opinions regarding various measures

In Figure 1, the scores for the introduction of various measures are presented. The costs of the measures which have to be contracted out - driving skill test, safety course, tachograph analysis - are perceived to be high, while the first two are also quite difficult to introduce according to the respondents. The costs of technical measures - ABS, black box, extra side protection, trip planning - are also thought to be high. Sanctions and rewards (monetary, non-monetary), maintenance check, and the inclusion of damages as an item in the yearly individual assessment talk are regarded as relatively inexpensive.

Most measures receive scores between 3 and 4 (on a scale of 1-5, in which 1 is very negative and 5 is very positive: see Figure 1), in response to the resistance against any particular measure in the organisation. The differences between the measures are not very large. The same holds true for the perceived effectiveness of measures. Most measures get an average score between 3 and 4, which indicates that they are considered to be quite effective. The main exceptions are sanction- and reward systems, which are thought to be less effective than the other measures.

The set of measures most often implemented are the start model, extensive training of new employees by a company's personnel and a daily maintenance check. Training giving by a company's own personnel is considered as rather high, but this measure is nevertheless assumed to be effective. More than 10% of the companies state that individual feedback, computerised damage registration, selection of new employees based on their 'damage history', damage cases in the yearly individual assessment talks, and computerised trip planning are being implemented in 1997.

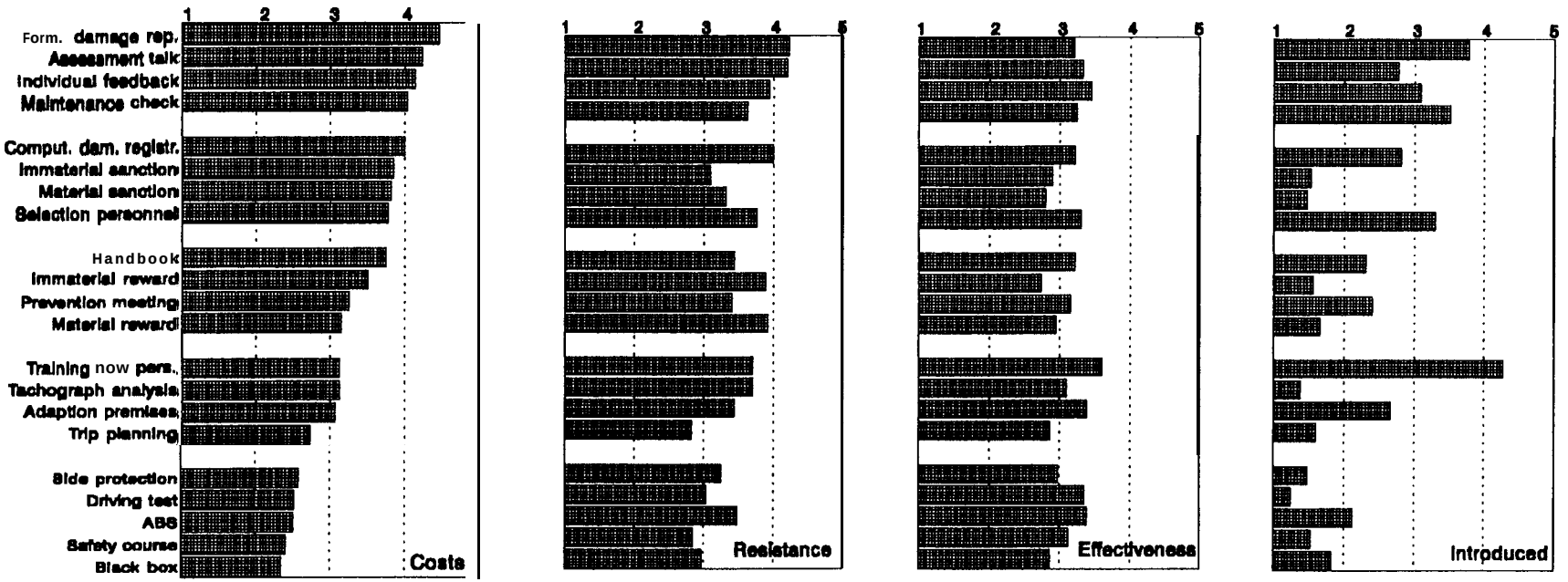

Figure 1 *Scores for damage prevention measures*

Note: Scores run from 1 to 5; 1 = very high costs, very much resistance, very ineffective, introduction 0%; 5 = very low costs, very little resistance, very ineffective, introduction 100%.

The costs of these measures are all perceived to be rather low (average score <2), with the exception of computerised trip planning. It must be noted that this measure is not considered as a damage reduction measure. It is also expected that these measures are relatively easy to introduce (besides trip planning). It is striking that a great number of companies have adjusted the routing on their own premises, and notably few companies have introduced sanction and reward schemes.

To analyse the scores in another way, a cost-effectiveness and a resistance-effectiveness index have been calculated based on the scores given. The cost-effectiveness index for example, is calculated by dividing the score for the perceived costs by the score for perceived effectiveness. These figures indicate the extent to which the perceived costs, effectiveness and resistance are related, and which measures are most attractive from both points of view: the higher the index, the more attractive is the measure. The scores are presented in Table 1.

Table I *Cost-effectiveness- and the resistance-effectiveness indices of damage reduction measures*

Measure	cost/ effectiveness	Resistance/ effectiveness	Measure	Cost/ effectiveness	Resistance/ effectiveness
Form. damage report	1.39	1.32	Prevention meeting	1.03	1.08
Material sanction	1.37	1.19	Tachogr. analysis	1.01	1.20
Immaterial sanction	1.33	1.07	Trip planning	0.95	0.99
Immaterial reward	1.28	1.42	Adaption premises	**0.94**	1.06
Indiv. assessment talk	1.27	1.26	Side protection	0.87	1.09
Damage registration	1.25	1.24	Training new pers.	0.86	1.03
Maintenance check	1.25	1.12	Safety course	0.77	0.91
Individual feedback	1.20	1.14	Driving test	0.75	0.90
Handbook	1.17	1.07	ABS	0.74	1.03
Selection new pers.	1.15	1.14	Black box	0.70	0.89
Material reward	1.06	1.33			

Note: A score above 1 indicates that this measure can be implemented at relative low costs/resistance compared to its effectiveness; a score < 1 means the opposite.

It can be concluded from observing the table above that the start model, sanction and reward schemes, the involvement of damage patterns in individual assessment talks, and maintenance check receive the highest score on the cost-effectiveness index. Technical measures (ABS, black box) and measures having to be contracted out (driving test, safety course) receive a low score. The results of the interviews (Section 2) confirm this finding.

From the resistance-effectiveness index it appears that sanction schemes will yield greater resistance than reward systems, although the first still score above ' 1' on the index. Technical measures (except the black box) are also easy to introduce, while measures which are based on participation of the company's own staff (maintenance check, feed-back) score relatively low on this index. The correlation between the cost effectiveness and resistance effectiveness is rather high (0.74): measures that tend to have a high cost effectiveness also tend to be perceived as highly resistance effective.

Other results

In addition to the questions related to the measures, some other questions have also been asked about the opinions of the respondents regarding damage prevention. Approximately 25% of the

respondents have established a damage reduction plan; most of these plans were written in the 1990s.

On average, the respondents have a positive attitude towards damage reduction policies. Only the statement 'damage reduction policies are too time consuming' is valued in a neutral way, but the respondents do not believe that 'it diverts the attention from other tasks', 'it has no impact' or that 'their organisation is too small'. Impacts such as 'lower absence due to illnesses', 'lower use of petrol' and 'a better working atmosphere' are however not supported.

Another question refers to the factors which are most important for a successful introduction of measures. Most weight appears to be attached to the involvement of the drivers and the management, followed by a continuous attention to damage reduction in the company. Somewhat lower - but still high - scores are given to the availability and enthusiasm of the employee responsible for damage reduction and the quality of the information provided to the drivers. The lowest scores - but still quite high - are for the support of the insurance company and the employers organisation.

Subgroup analysis

A subgroup analysis has been conducted to identify differences of opinion and to draw conclusions regarding the influence of characteristics of companies and damage prevention. The number of accidents and the relation with various characteristics of the company have been analysed through a regression analysis. The results are presented in Table 2.

Table 2 Regression analysis with average number of damage cases (per year per truck) as dependent variable

Subgroup	Coeff	Subgroup	Coeff
With prevention plan	0.50[3]	Bulk freight	-0.50[3]
		Light freight	-0.00
Fixed routes	-0.47[3]		
Variable routes	-0.24	Distribution transport[4]	
		Full loads[4]	
Number of trucks	0.00		
		constant	1.11[3]
Regional orientation	0.10		
R^2	0.36		

Notes: 1) Reference values: with prevention plan, both, international/national orientation, no specialisation, both.
2) n= 71
3) Significant at 5% level.
4) These variables have not been used in the final estimation, but were not significant in other specifications.

From this analysis it can be concluded that companies having a damage reduction plan have on average, more damage cases than companies without such a plan. Having many damage cases apparently results in preparing and introducing a plan but such a plan has not (yet) reduced the amount of cases below the average of all companies. Another effect may be that firms with a damage reduction plan have as a result a better damage registration and hence they report more damage cases.

Companies which usually use heavy trucks generally report fewer damages than companies transporting lighter and perishable goods. This may be explained by the notion that speed is more important in the second type of goods transport than in the first. On the other hand, distribution transport does not reveal more damage cases - but the correlation with the lighter goods and this

variable is high. Another result is that companies which primarily drive fixed routes encounter fewer damage cases than the companies driving alternate routes. It seems plausible that if a route is known fewer accidents are likely to happen.

The number of trucks has no significant impact in this multi variate analysis. This is noteworthy, since during the interviews it was often remarked that companies with many cars, and a more hierarchical and formal structure with less input from the drivers, often have a greater number of damage cases per truck. This also appeared from a more qualitative analysis of the data (see below). Apparently, however, this variable is correlated with other variables in the analysis, so that it has largely lost its explanatory power.

In Lindeijer et al. (1997) tables are presented on the views of various subgroups regarding the list of measures. We will only discuss the main conclusions:

- larger companies report more damage cases than smaller companies do;
- larger companies have introduced more measures;
- large companies value various measures differently from small ones; this may be due to cultural differences or introduction problems.

The above analysis is based on qualitative data concerning perceptions. To give a more precise indication of the costs and benefits of damage prevention measures, we made a selection of 10 promising measures mainly based on Table 1. In the remainder of the paper these measures will be discussed and the impacts, costs and benefits will be calculated. Before turning to the actual calculations, it is first necessary to define in further detail some companies for which these calculations will be made and give more succint indication of the impacts of various measures is given.

4. Company Types

From the interviews and the postal questionnaire it clearly appeared that the internal economic costs and benefits depend on specific characteristics of a company. It is therefore not possible to present general calculations applicable to each company. Three general company types are defined, and are more or less representative for all companies; each differs largely in size and company culture. To reduce the complexity of the analysis, no further distinction is made about other characteristics of a company, also because these characteristics are too specific and differ too much for individual companies. The companies are described as follows.

Company A: Small Family Company
Company A is a small family company managed by the founder or family of the founder. The company started with just one truck, and slowly grew; now there are many more drivers and members of the family work for the company. The company's culture is therefore very unofficial, problems are solved informally, and the employees know 'everything' about each other (driving style, driving behaviour, number of damages), but it is 'not done' to criticise colleagues. The involvement of employees within the company and management is very large. The company has 10 trucks and 10 drivers; more personnel are employed for other tasks. The damage frequency is quite low and is about 0.5 cases per truck/driver per year.

Company B: Large Family Company
Company B is a large version of Company A. The founder is the director of the company and also the informal company culture is still present. The company has however, grown considerably over time; therefore the social involvement and cohesion are smaller than in Company A. As a result, the damage frequency is higher. Company B owns 50 trucks and has 50 drivers. The damage frequency is 0.75 cases per truck/driver per year.

Company C: Large Formalised Company
Company C has an entirely different company culture: relations among employees are hierarchical and strongly formalised. Management does not know its employees very well, and there is an intermediate management level. The commitment of the drivers to the company is small; the same holds for the social cohesion of the drivers. The damage frequency on the other hand is rather high. The company owns 100 trucks and employs 100 drivers. The average damage frequency is higher than in the previous companies: 0.9 per truck per year.

5. Impacts of the measures

After the definition of the company types we now turn to the impacts - i.e. the level of damage reduction per measure - of a measure for each company type. Based on a literature review and supplemented with the results of the various interviews, it is possible to estimate the impacts of the selected measures per company. We will analyse the **maximum** effects: in practice, the effects are probably smaller because of implementation problems or specific features of a company.

The start model
From the interviews it was revealed that the introduction of the start model may result in a damage reduction of up to 50%. Furthermore, it appeared that giving individual feedback to the drivers is the most difficult to introduce, because it costs most time and causes the greatest resistance. As a consequence, this part of the start model is the least introduced.

Nevertheless, it may be assumed that the start model without the giving of individual feedback may also have a positive impact on damage reduction (see Chhokar and Walin, 1984). For pragmatic reasons, it is assumed then that the start model without individual feedback is followed by a reduction of the number of damages by 25%.

Due to the company culture and the fact that the management knows its personnel, it is however assumed that this model will have no impact in Company A. So the effects of 50% or 25% only hold for Companies B and C.

Damage prevention meetings, driving tests and reward/sanction schemes
Gregersen (1995) investigates the impact of behavioural measures on the reduction of damages. In this research, the largest impact is found for group discussions (54%; this is assumed to be the maximum impact of damage prevention meetings), followed by driving tests (34%) and reward schemes (lower, but no percentage is reported). Based on the research of Bruce et al. (1989), the impact of sanction and reward schemes is assumed to be 25%. The latter schemes should be adapted to the company's culture however; otherwise these will not be very effective and merely cause considerable resistance (Kipping, 1989).

Damage prevention meetings are designed to improve social cohesion, while both other measures may be assumed to compensate for the lack of commitment or social cohesion. Therefore, these measures are again assumed to have no impact in Company A, where these factors cause no problems.

Yearly assessment talks and tachograph analysis

As is the case with the driving tasks, these measures aim to influence and control driving behaviour. It is assumed then, that the impact of these measures is about as large as the impacts of the driving tests **(34%)** when these tests are repeated periodically (yearly). However, in many cases, these measures may only be introduced incidentally, for instance, after a serious damage case or accident. The measures acquire the character of a sanction; it is assumed therefore, that the incidental measures will have the same impact as sanction schemes (25%) do.

Selection personnel, maintenance check, drivers ' handbook

These measures do not impact at the individual level, but strive to influence the behaviour of the whole group of drivers. Therefore, there is only a general reduction impact, because the commitment of drivers increases. This effect will not be very important in practice as was frequently mentioned in the interviews: the maximum effect is said to be 2%. For a comparable measure, Twisk (1993) finds a similar effect.

In Company A the management has a good overview on damages per driver and knows their driving style; these measures are assumed to have no effect in company A. The management may also be well informed about new drivers in such a company.

We assume that a company in all cases introduces the start model. However, individual feedback is not introduced by all companies, so we will make calculations for both cases. Next, it is assumed that one of the other measures is introduced. The other measures therefore have an additional effect after the introduction of the get-started model.

6. Cost-benefit analysis for the distinct Companies

When calculating the costs of a measure, a distinction has been made between direct and indirect costs (see Section 1) as well as initial (once-only), fixed (yearly) and variable (depending on the number of damage cases) costs. Various assumptions have been made, e.g. regarding the time needed to implement the measure. These assumptions will certainly influence the outcome of the calculations. The main issues are:

- the method of ***implementation;*** what is the time needed to implement the measure, what are the investment costs (e.g., material), is contracting out or external advice necessary, etc.;
- the ***availability*** of resources; for example, can computerised registration use existing computers and software?, is there a maintenance unit?;
- to which extent ***do economies*** of ***scale*** occur? Measures with high fixed investment costs are more attractive for large rather than for small companies.

To calculate the benefits of the measures assumptions have to be made. Based on information provided during the interviews, the average cost per damage case is $1,500[1], of which 50% is repaid by the insurance company. For indirect costs, an amount of $750 per case has been added.

[1] The initial calculations were in Dutch guilders. Here an exchange rate of 1 USD = 2 DFL is used.

It is also assumed that a reduction in damages will be rewarded by the insurance companies by reducing the premium by 50% of the amount of money saved. In total, the benefit to a company of one less damage case is therefore $3.375. We will not elaborate here on the specific costs and benefits of the calculations, but instead present the results (Table 3).

Table 3 Benefit-cost balance of damage prevention measure. USD per year

Company / Measure	A	B+[1]	B-[1]	C+[1]	C-[1]
Start model	-/- 750	15,594	7,182	81,391	**39,493**
Sanctions and rewards	-/-186	17,568	20,380	**27,393**	42,580
Indiv. assessment talk	-/-80	17,885	20,698	**27,895**	43,082
Prevention meetings	-/-692	26,060	30,279	40,343	63,968
Driving test (incidental)	2,121	12,243	14,353	19,705	29,830
Driving test (periodical)	955	8,235	11,048	10,828	26,015
Tachograph analysis (inc)	2,194	12,206	14,173	19,980	29,329
Tachograph analysis (col)	2,188	13,781	16,594	20,688	35,875
Drivers' hand book	-/-185	1,037	1,037	1,225	2,913
Selection Personnel	J-32	1,248	1,248	1,371	3,058
Maintenance check	-/-634	-/-1,765	1,765	-/-4,655	42,967

Notes: 1) B- and C- have introduced the start model without individual feedback, B+ and C+ have introduced the model including individual feedback.

2) In the calculations it is assumed that the measure is the only one which is introduced in addition to the start model.

For Company B and C all measures are economically profitable except 'maintenance check'. The latter is caused by the large time costs: it is assumed that it takes two minutes per driver per day. In practice, however, these costs may not be perceived to be as high as these calculations indicate. Furthermore, the benefits of the drivers' hand book and the selection of personnel show the lowest benefits. For the other measures, the benefits are so high that other assumptions regarding the costs and benefits/effects will lead to positive results unless the assumptions differ widely.

Table 4 Benefit-Cost ratio of damage prevention measures (USD per year; maximum effects)

Company / Measure	A	B+[1]	B-[1]	C+[1]	C-[1]
Start model	--	8.86	5.46	28.73	15.78
Sanctions and rewards	--	25.6	**29.54**	22.15	33.88
Indiv. assessment talk	--	46.11	53.20	36.18	55.33
Prevention meetings		10.41	11.94	8.73	13.26
Driving test (incidental)	10.49	11.97	13.85	9.83	14.36
Driving test (periodical)	1.43	1.82	2.10	1.61	2.46
Tachograph analysis (inc)	15.63	11.58	11.93	11.21	11.73
Tachograph analysis (col)	3.19	4.06	4.69	3.59	5.84
Drivers' hand book	--	3.80	3.80	3.65	7.30
Selection Personnel	--	8.87	8.87	5.32	10.65
Maintenance check	--	0.44	0.44	0.27	0.53

Notes: 1) B- and C- have introduced tbe start model without individual feedback, B+ and C+ have introduced the model including individual feedback

2) In the calculations it is assumed that the measure is the only one which is introduced in addition to the start model.

3) The figures can be interpreted as follows: a yearly cost of $1 for introducing an individual driving test by company A generates $10.49 as benefit (less costs).

In addition to the balance of costs and benefits, it is also interesting to know what the return on investment is. This allows for a comparison with other investment possibilities and the yield of investing in damage reduction. It must be emphasised, however, that the calculations are based on maximum effects of a measure; in reality the benefits are likely to be smaller. The cost-benefit ratio is presented in Table 4.

It is important to note, that a combination of various measures will reduce the benefits: now it is assumed that the measure is the only one in addition to the start model. When more measures are introduced, the benefits will probably decrease.

From the calculation method it follows that the benefits for Companies B and C which introduced the start model without individual feedback benefit more from the other measures than the companies which do introduce individual feedback - the benefits of the start model are of course lower. This is caused by the larger impact of the full start model; therefore there are fewer damage cases 'left' for the other measures. But when both amounts are added up (i.e. of the measures and the start model), the total benefit is in all cases larger than with the limited start model.

For Company A many fewer measures appear to be profitable in an internal-economic sense. Some measures are assumed to have no impact whatsoever for this measure, and so there are no benefits included in the calculations. Only driving tests and tachograph analyses have an effect on the number of damage cases.

We would like to again emphasise that in the calculations maximum effects are assumed. However, the benefit-cost ratio clearly shows that when the impact is, for example, half as large (roughly resulting in 50% lower benefits) most measures are still profitable. The results are therefore quite robust.

Finally, it should be noted that the calculations are exclusively from a business perspective; therefore no impacts have been calculated on other road users. From the interviews it appeared that these accidents seldom occur per company, so that this does not play a role in the decision-making process of companies. However, these accidents will also be reduced; meaning that the benefits per measure are even higher.

7 Conclusions

From the viewpoint of costs and benefits damage prevention measures are mainly interesting to larger companies. Small companies, being the largest group, have a normally informal culture in which measures are less effective. Especially those measures for which no large investments are needed, which influence the behaviour of drivers, and need not to be contracted out are perceived as attractive by the transport companies. This is no surprise because the costs and the risks are quite low.

Final remarks must be given on the calculations presented above. The impacts of the measures are largely related to the way they are implemented. An assortment of subjective factors, such as the company culture and the involvement of the management play an important role in this respect. The calculations also assume a maximum effect; in practice, the actual effects will

probably be lower. But whenever the benefit-cost ratios are analysed, it can be concluded that when the effects are not maximal there will also be high benefits.

The study shows, that companies with an active damage reduction policy can achieve substantial benefits and operate in a more profitable way. Additional impacts may also be achieved:

- the atmosphere at the company may improve (e.g., more commitment from the drivers, fewer absences from illness), this may have positive impacts on the functioning of the company as well;
- the image of a company may improve because there is less bad news about it;
- there may be additional savings in maintenance costs because more careful driving styles are applied.

In this way positive and self reinforcing impacts may occur, thus resulting in high indirect benefits of damage prevention policies.

One of the most striking results of this research is that companies seldom register damage cases systematically; in even fewer cases individual feedback is given to drivers. Only by introducing the 'start' model will large benefits for a company result, mainly because of a cultural and psychological shift following from attention given to damage prevention, and possibly from giving solutions for specific cases. When introducing this so-called 'start' model, damage reductions of 50% are sometimes mentioned.

An important social benefit is that the number of accidents will reduce; consequently social benefits may even be larger than internal ones of the firm. This may be an important reason for governments to stimulate companies to attend to damage reductions, especially by encouraging the introduction of the get-started model may be an important step.

In conclusion, high benefits can be achieved especially in larger companies by implementing active damage reduction strategies. This may also result in an improvement of general traffic safety.

Acknowledgements

The research on which this paper is based has been funded by and carried out for the Traffic Research Centre (AW) of the Dutch Ministry of Transport. We thank Henk Roodbol for his useful comments during the execution of this project. We would also like to thank Ewoud Wesselingh (EVO) for his willingness to participate in various stages of the interview series. We thank EVO, TLN and KNV for their support in the questionnaire research. Finally, we wish to thank the interviewed companies for their consent to participate in this research.

References

Bruce-McAfee, R. and R. Winn, 1989, The Use of Incentives/Feedback to Enhance Work Place Safety, *Journal of Safety Research,* vol. 20, pp. 7-19.

Chhokar, J.S. and J.A. Walin, 1984, Improving Safety Through Applied Behavior Analysis, *Journal of Safety Research, vol.* 15, pp. 141-151.

Fokkema, H. J., *1990, Bedrijfsgewijze Aanpak Verkeersonveiligheid; Advies Inzake het Stimuleren van Veiligheidsgerichte Activiteiten binnen het Bedrijfsleven,* TT90-44, Traffic Test, Veenendaal.

Gregeresen, N.P., 1995, *Prevention of Road Accidents Among Young Novice Car Drivers,* no. 44, Linkoping University Medical Dissertations, Linkoping.

Heyer, T. and P.I.J. Wouters, 1996, *In-Car Electronica Zwaar Verkeer,* SWOV, no. R96-46, Leidschendam.

Ripping, A.M.C., 1989, *Beloningssystemen ter Bevordering van Verkeesveiligheid bij Bedrijven; Een Literatuurstudie,* Traffic Test, Veenendaal.

Lindeijer, J.E., S.A. Rienstra and P. Rietveld, 1997, *Voorbeeld van Bedrijfseconomische Kosten/Baten Schadepreventiemaatregelen,* SWOV/RE-VU report for AVV, SWOV, no. 97-42, Leidschendam.

Twisk, D.A.M., 1993, *Het Puntenstelsel en de Verkeersveiligheid,* no. R93038, SWOV, Leidschendam.