THE PROMISING CONTRIBUTION OF SUSTAINABLY-SAFE 60 KM/H-ZONES TO RURAL ROAD SAFETY IN THE NETHERLANDS

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ABSTRACT

The Sustainable Safety Programme in the Netherlands aims to reduce the number of injuries by 30% and the number of casualties by 40% in 2020, compared with 2002. To achieve this, the relatively unsafe network of minor rural roads (47,500 km; 250 traffic fatalities) is being dealt with. To this end, the water boards have changed about 4000 km of minor rural roads in connected areas into 60 km/h-zones using speed inhibitors (especially at intersections) and adjusting the division of the carriageway through painted road markers. The effect on the traffic safety was researched in 20 sub-areas (with a total road length of 850 km) by comparing a 5-year pre-change period with an average post-change period of almost 31/2-years. Additionally, a control study was done on 2100 km of comparable roads with a speed limit of 80 km/h in order to determine if the effects were attributable to the 60 km/h-zones. The previously expected decline of 10% to 20% in the number of traffic casualties has been achieved: the decline amounts to at least 19% with a statistical chance of 0.95. The decline occurs especially at intersections. The cost effectiveness of a simply design amounts to €11,000. This is much lower than the originally estimated €18,000.

KEY WORDS

EVALUATION / SAFETY / COST-EFFECTIVENESS / SPEED REDUCTION / MINOR RURAL ROADS

1. INTRODUCTION

Traffic accidents are a large social problem world wide. Economic losses from accidents can reach up to 2.5% of GNP [1]. According to the World Health Organization, 600,000 people die and 15 million are injured in road accidents each year [2]. A problem of this size deserves a world wide approach, both in countries with a relatively high number of casualties and in countries where important improvements have already been achieved in the last decades. The Netherlands is an example of a country with relatively favourable traffic safety figures: in 2004, 50 people per million inhabitants died in traffic (in comparison: the average for the European Union was 95 and for the USA 145). This relatively favourable position has mostly been achieved through a curative approach, in which the most dangerous points in the road network ('black spots') have been improved over a number of years. Because it was expected that this approach would not be effective enough to bring about a further decline in the number of traffic accidents with respect to future traffic growth, an innovative approach to traffic safety was chosen for in the 1990s: The Sustainable Road Safety Programme [3]. The innovativeness of the Sustainable Road

Safety concept is that traffic is seen as a system of rules, vehicles, infrastructure and traffic participants. Moreover, it is also assumed that the traffic participants have limited possibilities. Sustainable Road Safety aims at minimizing the number of casualties by applying a system in which:

- Vehicles offer as much safety as possible to passengers and to others in the case of a collision and are equipped with facilities that can ease the job of the driver.
- Traffic participants are adequately trained and, as key stone in the system, are adequately monitored;
- For the road network, function, form, rules and use are in agreement with one another by opting for three categories of roads.

This system utilizes a preventive approach in which preventing accidents is central. For the road network, this approach is based on the following three principles [4] [5]:

1. functionality of roads; road users should use the road as the road maintenance authority meant it to be used.
2. homogenity of traffic; striving for small differences in speed and direction of movement between traffic participants and small differences in mass and vulnerability;
3. predictable behaviour: the route choices and the manoeuvres have to be unequivocal for road users everywhere.

The programme Sustainable Road Safety is concerned with all roads, both within the built-up area (in cities and villages) and in the rural areas. In this contribution, we focus on the roads outside the built-up area and particularly on the minor rural roads. The aim of this contribution is to show what a structural area-oriented approach to the net of minor rural roads can mean for a cost-effective improvement of traffic safety.

This paper is structured as follows. First, we examine roads, traffic and traffic safety in the urban-rural areas (sec. 2), followed by a short consideration of the possibilities to improve traffic safety (sec. 3). Section 4 discusses a method to measure the effects of these measures as well as a large scale application of this method in the Netherlands. The results of the research and the most important conclusions are discussed in section 5, after which the paper is concluded with a short discussion (sec. 6).

2. RURAL ROADS AND TRAFFIC SAFETY

On the regional scale, the paved road network in the urban-rural areas can be divided into three hierarchical, connected categories: (1) primary roads, which include motorways, (2) secondary roads-arterial highways, and (3) minor rural roads. Primary roads connect a region with the (inter)national network and serve the through traffic over long distances. The secondary network connects the most important regional centres and opens up the larger places and the important recreation areas. The network of primary and secondary roads covers the country like rope netting. Within the mesh of this network, the local destinations are reachable via minor rural roads. For minor rural roads, a functional difference can be made between collector roads and access roads. Table 1 shows the road lengths and an indicative overview of the road and traffic characteristics of the paved road network outside the built-up area in the Netherlands.

Table 1 - Characteristics of minor and major roads outside built-up areas in the Netherlands [6].

	Minor roads		*Major roads*	
Scale of road network	Local		Regional	National
Road type	Access road	Collector road	Arterial highway	Motorway
Network characteristics				
Length (paved) [km]	47 652 [1)]		7 508 [2)]	2 291
Road characteristics [3)]				
Cross-section width [m]	5.5 – 9.5	6.5 – >10	± 20	± 40 – 60 [4)]
Pavement width [m]	2.5 – 4.5	4.5 – 6.2	± 7.5	2×(12 – 21) [4)]
Number of carriageways	1	1	1	2
Number of traffic lanes	1	1 or 2 [5)]	2	4, 6, 8
Traffic characteristics				
Volume [$\times 10^3$ vehicles d^{-1}]	0.1 – 1	0.5 – 5	2 – 25	20 – 200
Legal speed limit [km h^{-1}]	60/80 [6)]	60/80 [6)]	80/100	100/120

[1)] Road statistics do not allow for a specification of the local network by road type
[2)] Including 868 km arterial highway belonging to principal national routes (non motorways)
[3)] Profiles based on the Dutch concept of sustainable traffic safety
[4)] Based on a 2×2 and a 2×4 motorway respectively, total width including two verges of 5 m
[5)] For 2 lanes, a minimum pavement width of 5.5 m is required
[6)] Both limits are still in use. The legal limit has been 80 km h^{-1} since 1974, unless 60 is signposted. The latter is happening since about 10 years. Today, the lower limit is already the case for half of the Dutch rural minor road network.

The minor rural roads with a total length of about 47,500 are by far the longest type of road in the Netherlands. They are managed by the municipality (about 40,000 km) and water management boards (about 7000 km). Given the occurrence of mixed traffic (lorries, cars, bicycles and pedestrians) on these roads with one carriageway and frequently with only one traffic lane, it is no wonder that the risk of a traffic accident (expressed in chances of an accident per 10^6 vehicle kilometres) on minor rural roads is considerably higher than on primary and secondary roads: See Table 2.

Table 2 - Index numbers for the traffic safety of road types in 1995 [7].

Category of road	Casualty accidents per million motor vehicle kilometres	Victims per casualty accident	Casualties per million motor vehicle kilometres	Fatalities per 100 casualties
Motorway	0,05	1,49	0,07	4,41
Arterial highway	0,23	1,34	0,31	4,59
Minor road	0,51	1,26	0,64	4,86

The high chance of accidents in combination with the long length of and the frequently high traffic intensity on minor rural roads leads to, seen absolutely, a fair amount of accidents with traffic fatalities and injured who need to be treated in hospital: see Table 3.

Table 3 - Traffic fatalities and injured who needed to be treated in hospital in the Netherlands in 2005 according to road category; minor rural roads are marked in grey [8].

Category of road	Traffic fatalities			Injured treated in hospital		
	(1)	(2)	(3)	(1)	(2)	(3)
Motorway *)	3	129	132	96	1107	1203
Arterial highway	15	148	163	259	1277	1536
Minor road	231	224	455	4721	1947	6668
Total in the Netherlands	249	501	750	5076	4331	9407

(1) within the built-up area (2) outside the built-up area (3) total

*) Including about 868 km of other national roads within the category of arterial highways

From this table, it appears that two-thirds of the traffic fatalities and 46% of the injured that need to be treated in hospital occur outside of the built-up area. Taking into account all traffic fatalities, 30% occur on minor rural roads while this is 21% for injured that need to be treated in hospital. From these statistics, it can be concluded that the minor rural roads are not only relatively unsafe (per ridden motor vehicle kilometre, see Table 2) but that the absolute number of traffic casualties is high. An improvement of this situation with the help of the Sustainable Road Safety concept is, for the time being, especially aimed at mostly technical interventions on the road itself, in which the minor rural road is seen as a space to reside in and not as a traffic lane.

3. HOW TO IMPROVE RURAL TRAFFIC SAFETY

Speed measurements on minor rural roads show that the narrow through road widths do not hinder the high speeds of motorised traffic. Even the legal maximum speed of 80 km/h is often violated [9] [10]. High speeds are often given as the cause of an accident. Although more causes play a role in most accidents, it is certainly true that the consequences of an accident are more serious the higher the speed.

Because judicial measures are not enough for an effective speed management on minor rural roads, supporting, small-scale, technical interventions have long been sought after for individual stretches of road. A set of examples of these in which the use of diverse interventions is strongly connected with the width of the road pavement is described in [11]. These types of measures, however, still raise various objections: (1) they are curative in nature, without asking the question if the volume of traffic agrees with the road's function that has been ascribed to it by the road maintenance authority; (2) they are aimed at individual stretches of road, without considering the local cohesion in a network; (3) solving a problem on the one stretch of road can easily lead to the creation of problems on other, nearby stretches of road; (4) the separate measures have never been systematically evaluated for their effectiveness.

Homogeneity of traffic is the goal behind the concept of Sustainable Road Safety. Minor rural roads consist of one narrow carriageway for two-way traffic in which a mix of large and small, heavy and light vehicles occur. In addition to this, vulnerable traffic participants such as bicycles and pedestrians are also present. In the strictest sense, homogeneity can only be achieved in this case by separating the different groups of traffic participants. Because this is not a realistic option, homogeneity is approached by pursuing low driving speeds. With the introduction of the concept Sustainable Road Safety, a maximum speed of 40 km/h was originally set for minor rural roads. However, taking into consideration the large difference between the current limit of 80 km/h, a speed of 60 km/h has been chosen for the practical development of the zone.

Sustainable Road Safety on minor rural roads is implemented, as much as possible, in an area-oriented way. For this reason, all minor rural roads in connected areas are designated as so-called 60 km/h-zones. To begin with, this designation consists of placing zone-boards along all entrances, mostly in combination with a double stripe across the road. Because it is known from experience that additional measures are necessary to actually achieve the desired driver speed behaviour, the design of the road is also changed. At first this happens within a so-called simple design, where speed inhibitors such as speed humps and speed tables (raised levels at intersections) are placed at strategic places (especially at intersections and exits) The division of the carriageway is adjusted by means of painted road markings: instead of centre markings, edge markings are introduced, possibly in combination with non compulsory suggested cycle lanes (figure 1). A reduction of 10 to 20% in the number of traffic casualties is expected from the implementation of the simply designed 60 km/h-zones by the SWOV, the Dutch National Road Safety Research Institute [12].

Figure 1 – Zone sign at the entrance (see above photo) and the redesigned minor rural road within a 60 km/h-zone (bottom photo).

Water boards play a unique role in Dutch road management [13]. By now, they have already adapted almost two-thirds of the 7000 km of minor rural roads under their management to simple 60 km/h-zone. For the 40,000 km of municipal minor rural roads, no figures are known but these roads are also actively being changed to simple 60 km/h-zones. Here, the question naturally arises if the project yields the intended effect on traffic safety.

4. THE IMPACT OF MEASURES: HOW TO QUANTIFY THEM?

4.1. The method for assessing the 60-km/h zones

To answer the central question about the effect of the 60 km/h-zones, the Association of Water Boards has had an assessment method developed. The method is constructed in modules: see figure 2.

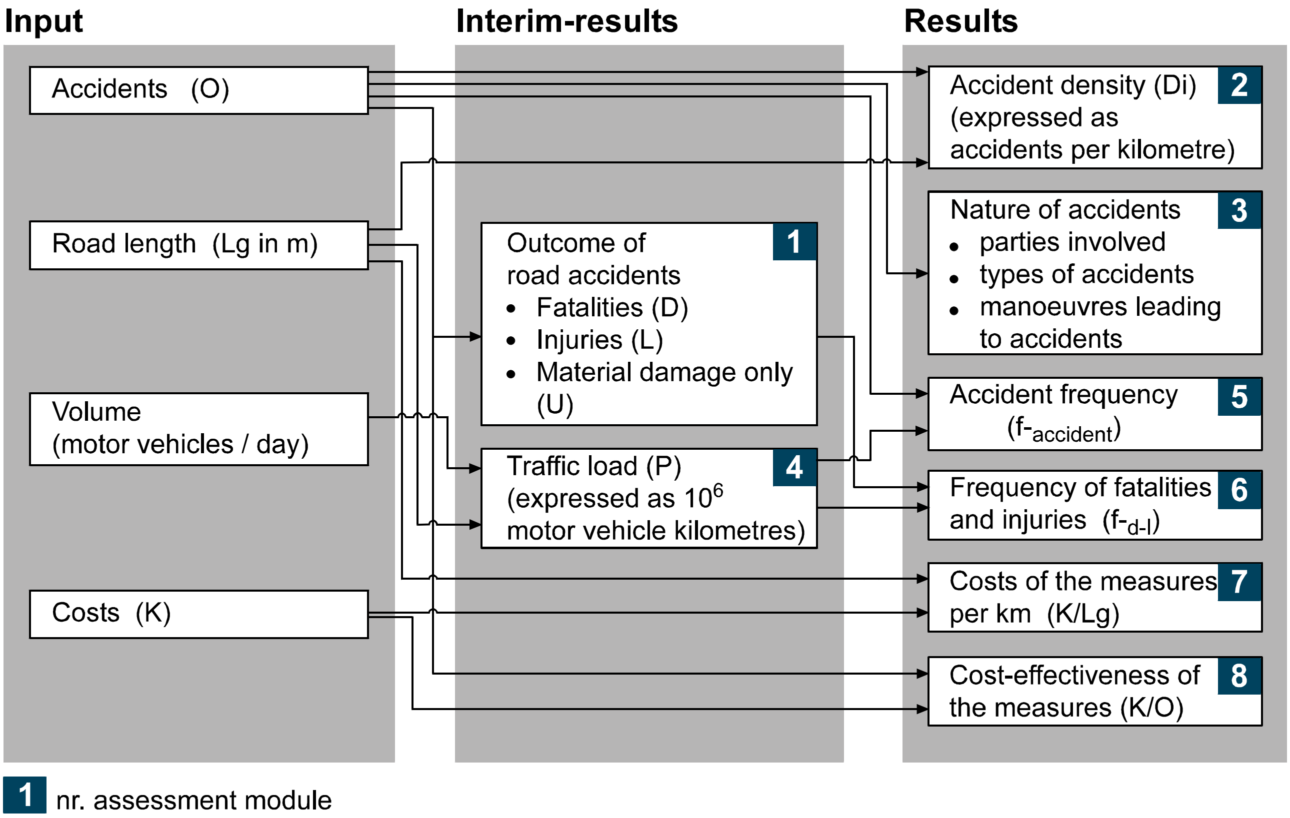
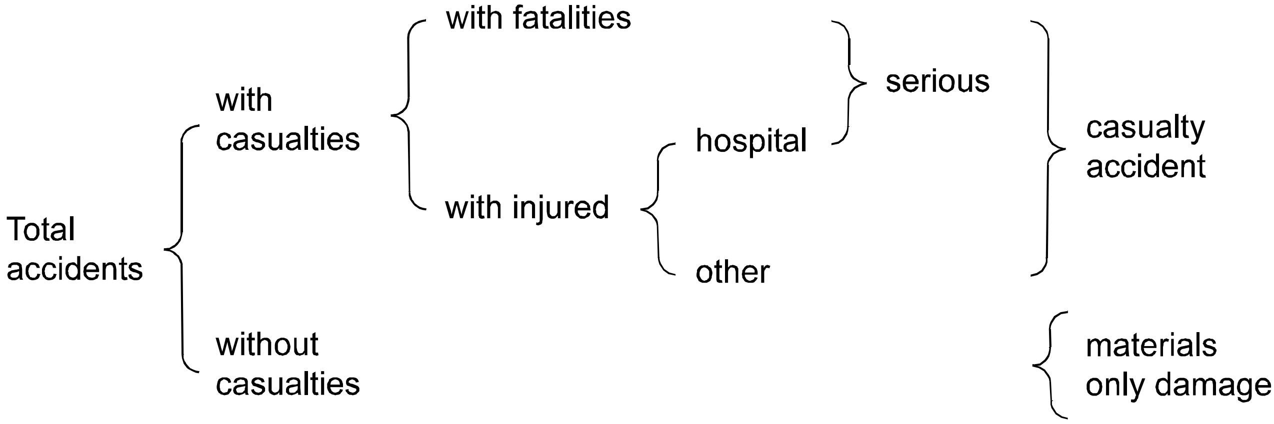


Figure 2 - Relationships between input data and the modules of the assessment tool. The results of the modules 1-8 jointly provide the answer to the central research question. Elaborated from [14].

From this figure, it can be seen that the 60 km/h areas are evaluated on the basis of the following 8 indicators:

1 the number of (casualty) accidents;
2 the accident density (number of casualty accidents/kilometre);
3 the nature of the (casualty) accidents;
4 the traffic load (number of ridden motorised vehicle kilometres);
5 the accident frequency (number of accidents per ridden motorised vehicle kilometres);
6 the casualty frequency (number of casualty accidents per ridden motorised vehicle/kilometre);
7 the costs of the measures;
8 the cost effectiveness of the measures (investment in euros to prevent one serious accident).

The accident data are based on the actual registered numbers. No correction has been made for the fact that the registration degree (the share of accidents that are registered by the police) is higher the more serious an accident is. According to the SWOV, in the Netherlands, the registration degree varies from 93% for fatal accidents to 61% for victims who have to be hospitalized and 15% for the remaining injured. As such, the accidents are classified according to their seriousness as follows:



Using the 8 indicators, the central research question can be answered. This answer is solely based on the changes brought about by the creation of a 60 km/h-zone. To gain insight into the development of traffic safety, a control study was done on comparable roads with a speed limit of 80 km/h. With the help of the control study, the question can be answered if the traffic safety effects after establishing the 60 km/h-zones deviate in a positive way from the traffic safety effects on 80 km/h roads. The comparison between the research areas and the control area occurred for modules 1 to 3. For the comparison, the T-test was used in a design that has been developed by the SWOV [15]. For modules 4 to 6, traffic intensities are needed. However, these are available only for the research areas and not for the control area. Therefore, for these modules, a T-test is used, which is only aimed at changes in the research areas themselves. For modules 7 and 8, no mathematical check takes place.

4.2. The application

The research was carried out in 9 water management board districts that maintain roads, with 20 sub-areas in total and a road length of 850 km. In this road network, stretches of road and intersections are differentiated. Stretches of road are restricted by an intersection or an area boarder. Intersections have been included in the research when all arms are managed by the water management board. To be able to representatively carry out the research, a year of "getting used to" the new situation was included between the measurements taken before and after the change. The pre-change period covers 5 years in all 20 sub-areas, in which the research years varied from 1992-1996 and 1996-2000. The post-change period varies in length from 2 to 5 years. On average, the post-change period covers a period of almost 3½ years. In the control study, about 2100 km of road were covered on the recommendation of SWOV [15]. The control study encompasses a pre-change period of 8 years and a post-change period of 4 years. This is considered sufficient to draw significant conclusions [16].

5. IMPACT ANALYSIS

In this section the results are described per module. However, we limit our discussion to the casualty accidents. The results of the T-test for modules 1 to 3 are described in table form in which a comparison with the control area is shown. In each table two questions are answered per section: (1) Is there, based on the T-test, an effect, and (2) how large is the effect minimally. The first question is answered in the table column 'chance of coincidence'. This column shows the chance that the found differences are based on coincidence. When this chance is smaller than 0.05, it is assumed that the differences are not coincidence, but the design of the 60 km/h-zone may be given as the cause of the difference. The values for which this is the case are printed in cursive in the tables. The second question is answered by mentioning the 'minimal effect': that is the effect of the measure (expressed in percentages) which, on basis of comparison, shall be reached or exceeded in 95% of the cases. A negative percentage represents a decline in the number of accidents and as such, it represents an improvement in the situation of the concerned accident characteristic.

For modules 4 to 6, the T-test has only been applied to the research areas. The results of these modules are only described in the sections 5.4/5.6 of this paper.

5.1. Module 1: Change in casualty accidents

In Table 4, the results of the accidents and casualties are summarised.

Table 4 - Cross comparison of the measurements taken pre- and post-change in the research and control area for casualty accidents (parts 1.1/1.5) and the number of casualties (part 1.6).

Part	Chance of coincidence *)	Minimal effect **)
1.1 at intersections	*0.005*	-31%
1.2 on stretches of road	*0.008*	-4%
1.3 on stretches of road and at intersections	*0.001*	-17%
1.4 ratio intersections versus stretches of road	*0.023*	-5%
1.5 ratio casualty accidents versus total accidents	> 0.50	+18%
1.6 number of casualties	*0.001*	-19%

*) *cursive:* a chance < 0.05 is considered significant
**) this effect is achieved or exceeded in 95% of the cases

Table 4 shows that the number of casualty accidents has significantly declined. The largest decline occurs at intersections, but stretches of road also show a significant decline. The previously expected decline of 10% to 20% in the number of traffic casualties through the establishment of 60 km/h zones has been achieved: the decline amounts to at least 19% with a chance of 95%. The ratio casualty accidents versus total accidents did not change significantly through the measures.

The larger decline in the number of casualty accidents at intersections can be the result of a concentration of measures at intersections. More measures on stretches of road can possibly contribute more to traffic safety. More detailed research on the relationship between the type and the number of measures and the development of the accident scenario can answer this [16].

5.2. Module 2: Change in accident density

In table 5, the results of the accident density (number of casualty accidents per kilometre) are summarised.

Table 5 - Cross comparison of the measurements taken pre- and post-change in the research and control area for the accident density of the casualty accidents, only on stretches of road and total stretches of road plus intersections.

Part	Chance of coincidence *)	Minimal effect **)
2.1 on stretches of road	*0.008*	-4%
2.2 on stretches of road and intersections	*0.001*	-17%

*) *cursive:* a chance < 0.05 is considered significant
**) this effect is achieved or exceeded in 95% of the cases

From table 5, it appears that the number of casualty accidents per kilometre of road length has significantly declined. On the basis of the results in table 4, it may be expected that the decline is somewhat larger (in 95% of the cases, minimally 17%) when the casualty accidents at intersections are also taken into consideration.

When only the casualty accidents with fatalities and injured who have to be hospitalized (the seriously wounded) and thus not all casualty accidents are considered, then the total decline by 14% in 95% of the cases is somewhat smaller than the total decline for all casualty accidents. This shows that the seriousness (this is the number of fatalities per 100 casualty accidents) of the accidents has not decreased with the establishment of the 60 km/h zones.

5.3. Module 3: Change in the nature of accidents

In table 6, the results of the accident characteristics of casualty accidents are summarised. Accidents with agricultural vehicles, buses and trucks are omitted in the table because of their very low numbers.

Table 6 - Cross comparison of the measurements taken pre- and post-change in the research and control area for diverse accident characteristics

Characteristic	Chance of coincidence *)	Minimal effect **)
3.1 1-sided (A)	0.274	-9%
3.2 with a fixed object (A)	0.136	+12%
3.3 frontal (B)	0.326	-5%
3.4 parked vehicle (B)	0.421	+14%
3.5 flank accidents (C)	*0.026*	-31%
3.6 with slow traffic (B)	0.309	+11%
3.7 with slow traffic (C)	0.242	-2%

*) *cursive:* a chance < 0.05 is considered significant
**) this effect is achieved or exceeded in 95% of the cases
(A) on stretches of road and at intersections (B) on stretches of road
(C) at intersections

Although, as is evident from table 4, a decline shows for the average of all researched accident characteristics, a significant difference for the individual accident characteristics is shown only for the flank casualties at intersections. It is assumed that this is connected with the presence of speed inhibitors at intersections. As such, the driver is sooner made aware of the presence of an intersection and is therefore better able to reduce his speed. It is also striking that for some accident characteristics, positive changes (i.e., a worsening of the safety) are part of the area where 95% of the results are found.

5.4. Module 4: Change in traffic load (performance, kilometres travelled)

Traffic load is understood to mean the total number of ridden motor vehicle kilometres on all stretches of road. For this purpose, the length per stretch of road is multiplied by the intensity. The weighted intensity of an area is achieved by dividing the traffic load by an area's total length of road. This gives an indication of the average number of motor vehicles that use a stretch of road per day.

The traffic load in all 20 research areas has cumulatively risen by 3.9% from 234 to 243 million motor vehicles per year. Previously, it was assumed that traffic load would decline. However, that this has not happened is possibly because the results of the measures taken are not severe enough to influence route choice or because there are no alternative routes available.

5.5. Module 5: Change in accident frequency

Accident frequency is understood to mean the number of accidents per ridden motor vehicle kilometre. The accident frequency is calculated by dividing the total number of accidents (average per year) by the traffic load.

The accident frequency in the research areas has decreased from 1.36 to 1.00 accidents per million motor vehicle kilometres, which is a decrease of 26%. The decrease occurs in 18 of the 20 research areas. Despite this decline, there are still no significant differences between the pre- and post-change periods. This means that the chance of being involved in an accident has not significantly declined with the establishment of 60 km/h zones.

5.6. Module 6: Change in casualty frequency

Casualty frequency is understood to mean the number of casualty accidents per ridden motor vehicle kilometre. This is calculated by dividing the total number of accidents with casualties (average per year) by the traffic load.

In the research areas, the casualty frequency has decreased from 0.14 to 0.11 casualty accidents per million motor vehicle kilometres. This is a decrease of 27%. The decrease occurs in 14 research areas. However, there are no significant differences: the probability value is 0.115. This means that the chance of being a victim of a casualty accident has not decreased with the establishment of a 60 km/h zone.

5.7. Module 7: Costs of the measures

Taking stock of all costs in all areas, an amount of €10,106 per kilometre is arrived at. This amount is strongly influenced by 4 areas where more drastic activities have taken place such as paving. When only the areas in which simple design measures were taken are considered, the costs amount to € 6,430 per kilometre. Still, this amount exceeds the recommended cost of €5,672 per kilometre for a simple design.

5.8. Module 8: The Cost-effectiveness

The cost-effectiveness of a measure is calculated by dividing the amount of euros divided by the number of accidents prevented. This quantity gives insight into the costs that are made in order to prevent one serious traffic casualty (injured that need to be taken to hospital or fatality). The cost-effectiveness is determined by the amount of the yearly costs, by the effects and by the number of years over which they occur. The cost-effectiveness is expressed in the yearly investment and the thereby realised total number of serious casualties prevented, which is expressed in "cash value"

The yearly costs are determined by dividing the costs from module 7 by the number of years in which the 60 km/h has been in effect. The yearly effects are calculated by comparing the serious casualties per year in the pre-change period with those in the post-change period. For investments in the infrastructure, it is assumed that the investments have a life span of 30 years and that effects occur during the whole period.

In cost-benefit analysis, converting something into cash value is an accepted working method to calculate the current cash value of a flow of future benefits (in this case: the number of prevented casualties). For each year that the benefit (prevented casualties) occurs later, the interest loss is deducted. As such, a specific yield is smaller the further it falls in the future. With cost benefit-analysis, the same principle is usually employed with future effects that, in that case, are expressed in other units than money [16]. By converting something into cash value a discount rate of 4% is used [12].

Previously, it was assumed that the cost-effectiveness would amount to €18,000 in cash value per prevented casualty. If the cost-effectiveness is calculated over all 20 areas together, then the cost-effectiveness comes out to a fraction lower at €17,600. If the calculation is only done for the areas with a simple design, then the cost-effectiveness amounts to €11,000. This amount is considerably lower than the previously expected value.

5.9. Conclusions

The research of the water management boards that maintain the roads has shown that establishing (simple) 60km/h-zones is an effective traffic safety measure. This is important in connection with the almost 2000 injured that have to be transported to hospital and the average 225 traffic fatalities that regretfully occur annually on the 47,500 kilometres of minor rural roads outside the built-up area.

The cost effectiveness with a simple design amounts to €11,000. This is much lower than the originally assumed amount of €18,000.

Finally, it is concluded that the reported favourable effects on traffic safety of the 60 km/h zones are completely attributable to the technical measures on the road itself, especially at the intersections. It is then to be expected that the effects can be strengthened by a maintenance and flanking policy: direct national communication and education and the like.

6. DISCUSSION

The assessment of 60-km/h zones is essential for a number of reasons [14]: "It enables determining the degree to which additional measures are required or whether there is a need for maintenance efforts [17]. In addition, assessment facilitates communication with the public. As the lack of safety on rural roads is not always evident due in part to the limited accident frequency, support among road users is sometimes limited or prone to wane quickly. Implementing the research method described above can underscore the usefulness and necessity of 60-km/h projects and thus help generate support."

The water boards play a unique role in Dutch minor rural road management [13]. An important difference with the other manager of the minor rural roads, the municipalities, is the area size. To effectively establish 60 km/h zones in connection with a network of 'major roads' for controlling through traffic, a large enough scale is needed. Water management boards are, with respect to area size, large enough to realise this, but most municipalities shall have to collaborate in order to come to a large enough area. In practice, this can be hindering. Additionally, it is clearly noticeable in practice that municipalities, in the adjusting their road networks in the framework of Sustainable Safety, emphasize measures within the built up area, for example, with the 30 km/h zones. It turns out that here a considerable accident reduction is also to be gained, but the costs per kilometre and also the costs per prevented casualty are much higher according to the numbers from the Ministry of Transport, Public Works and Water Management [17]. For this reason, the municipalities could be advised to first adapt minor rural roads that are under their management.

"Road safety targets, such as the European Union's goal of reducing fatalities by 50% by 2010, require long-term, sustainable solutions, with long-term impact" [18: p9]. In this framework, the IRF proposes that "major changes must be made to the road network itself: construction of motorways, bypasses, separated highways, where necessary; an improved level of road maintenance" [18: p9]. Because minor rural roads with respect to length form a large part of the network outside the built-up area and are, moreover, a part of the road network where many accidents happen per ridden kilometre, this category of roads emphatically deserves attention when improving traffic safety.

The research described in this paper shows that traffic outside the built-up area on the network of minor rural roads, a category of roads with a high risk of accidents, can get a specific interpretation through the innovative concept of the Sustainable Road Safety Programme. In simply designed 60 km/h zones, large and cost-effective improvements can be achieved with relatively modest investments in mostly small-scale technical traffic measures.

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