TRAFFIC SAFETY IN RECONSTRUCTED STREETS

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Introduction

On 24 March 1977 the Dutch Minister of Transport at that time decided to grant governmental contributions to municipalities for conducting experiments within built-up areas, aimed at improving the traffic safety of pedestrians and cyclists.
According to this ministrial decree 85% of the total costs involved in the implementation of experimental countermeasures will be provided by the government.
A condition of this governmental grant was that a before and an after investigation should be carried out in order to reveal the effects of the countermeasures.

What was the motivation of this keen governmental interest?
On studying the traffic situation within built-up areas, the following characteristic features of traffic could be observed. The number of persons killed decreased from 1319 to 664 between 1970 and 1982 (see Table 1). The share of slow traffic in these figures was slightly reduced in the same period, mainly as a result of the considerably lowered number of moped riders killed in accidents: from 282 (about 21%) in 1970 to 48 (about 7%) in 1982. The share of killed cyclists significantly increased from 20.5 to about 33% although the number decreased from 270 to 219. The share of pedestrian fatalities remained more or less unchanged (between 25 and 30%) during the entire period, whereas the number decreased from 397 to 184. The sharp decrease in moped fatalities was most probably the result of the reduced use of mopeds and the compulsory wearing of the crash-helmet. No direct relationship can be established between the other results and the countermeasures taken.

It is not possible to distribute the accidents over residential areas on the basis of statistical data on a national level. For this reason we have to confine ourselves to indications based on the results of some local accident studies.
In an experimental project in the Netherlands a very precise distinction was made between traffic and residential areas in Eindhoven and Rijswijk. The traffic areas form the main road networks of the aforementioned towns, while the residential areas are enclosed between the traffic areas.

In Eindhoven 80% and in Rijswijk nearly 90% of the injury-related accidents occurred in traffic areas. On correlating these figures with traffic performance a picture emerges which is not easy to interpret. The number of accidents involving injuries as related to traffic performance is not always higher in the traffic areas than in the residential areas, (see Table 2). The percentages established also depend upon the criteria used to define and divide the traffic and residential areas.

An extended investigation carried out in four English towns proved that most of the accidents occur on roads in suburban shopping areas. The number of accidents per vehicle kilometre was found to be three times higher there than in exclusively residential areas (see Table 3). The traffic accident pattern in residential areas does not show many "black spots". Accidents occur at random over all the streets. However, it is possible to point out some types of street with a higher accident concentration.
The aforementioned English investigation established that district collector roads and roads destined for the through-traffic are the most unsafe: 75% of the accidents took place on such roads in residential districts. These results are in accordance with the findings of another accident investigation, covering 20 towns in Great Britain. According to the conclusion of this investigation, pedestrian accidents occur mostly on roads with an access function (roads with bus traffic or shops). Access roads and collector roads (two names for the same road type) have a "habitat" function and also a traffic function.

Based on investigations into the unsafe character of certain streets, the following criteria could be established:
- slow traffic and motorised traffic cannot function in harmony with one another because of their opposite destinations: habitat versus traffic;
- the motorised traffic drives at relatively high speeds, in tortuous, short residential streets in old districts and in long, straight streets in new ones as well;
- in some districts there are typical residential streets with a considerable amount of sneaking traffic or through-traffic;
- there are streets of mixed functions, which are incompatible with one another, such as streets with through traffic, shops and dwellings;

- routes for motorised traffic leading through the centre of small villages are, as a rule, characterised by traffic with relatively high speeds.

All the indicated situations have common problems: confused lay-out and mixed functions of the street, causing difficulties both for the slow traffic and motorised traffic by impeding to carry out appropriate manoeuvres (braking, stopping, overtaking, crossing).

Over many years endeavours have been made to mitigate the conflict situations arising between the motorised traffic and the slow traffic. Both policy making and investigation-technical countermeasures are at present aimed in the Netherlands to create a more distinct segregation of traffic areas from residential areas. However, we have to be wary of oversimplifications because:
- there are, of course, various types of residential and traffic areas;
- by a much too drastic segregation, the traffic areas may act as a barrier for the residential areas at either side of the traffic area;
- the residents of a district have, as a rule, more liberal ideas about the border of their neighbourhood than policy makers and investigators.

For these reasons it seems a better approach to segregate all roads in urban areas according to their functions: traffic, habitat or access function, for example in traffic circulation plans. Such segregation is the first essential step towards taking other countermeasures. Countermeasures effected in residential areas in order to improve the quality of life (an important feature of which is traffic safety), have to be focused on the habitat function without loosing sight of the accessibility of destinations. Too many cars driving at high speed and many cars parked head-to-tail along the streets should not be allowed in residential areas. The quality of life is best promoted by infrastructural or physical countermeasures, if necessary supported by law, education and information. Legal measures alone are not effective enough, because their observance cannot be sufficiently controlled. The advantage of infrastructural countermeasures is that the spatial lay-out of a district has a direct effect on traffic behaviour.
However, these countermeasures are not without drawbacks: as a rule, high

costs, lack of space, or the structural impossibility of carrying out some plans. Moreover, the accessibility of some places is affected by creating various networks. The search for cheaper options is progressing slowly.

Traffic safety in residential areas can be promoted by:
- banning through-traffic and sneaking traffic;
- channeling traffic of a certain destination through some streets, appointed for example as "collector streets";
- controlling the movements of motorised traffic in residential streets;
- providing facilities, for pedestrians and cyclists and stimulating the proper use of such facilities by giving them a suitable recognisable shape.

Our knowledge about these matter can be complemented by a thorough analysis of the volume and type of traffic and the safety situation it creates in residential areas. In addition, methods and techniques will have to be developed for setting up priorities as regards the problems which have to be tackled, in order to choose the appropriate countermeasures. In the first place methods for short-term investigations have to be established.

The countermeasures

The aforementioned ministerial decree contains some limitations regarding the means and indicating the trend of countermeasures the Minister intends to take. The countermeasures have to modify in the first place the infrastructure of an area (thus: no education, no amendment of bills, etc.). These countermeasures have to be effected within the residential areas. An exeption is made for the school children's routes and the school surrounding, outside the residential areas.
Finally, these countermeasures must be "relatively simple" as regards the volume, the cost and the area the countermeasure is to be implemented in. In order to realise the goals of the countermeasures (i.e. improving the safety of pedestrians and cyclists), countermeasures are being envisaged, which restrict the choise of route and the speed of driving by the car drivers.

Of course, provisions are planned for the slow traffic as well, such as special protected routes for school children, cyclists and properly adapted traffic situations around schools, shopping centres and homes for old aged people.

Experimental policy

In the period 1977/1982 the Road Safety Directorate DVV of the Ministry of Transport subsidised altogether 35 experiments, of which 18 covered woonerfs, shopping erf's and village erf's, 5 access roads, 5 school routes/school surroundings, 6 speed-reducing provisions and 1 protected bicycle lane.
SWOV was asked to carry out an accident analysis of the chosen and subsidised areas at a period when the experiments were already going for some time.

In policy experiments of governmental authorities the investigator has hardly any influence (if any) on the countermeasures to be envisaged. The same goes for these experiments. Since it is not possible to manipulate freely the independent variables in such experiments, they cannot be regarded as scientific experiments, but only as quasi-experiments. With regard to democratic and ethical considerations this seems to be acceptable. However, the restrictions imposed upon the free manipulation of the independent variables reduce the possibilities of the correct interpretation of investigation results. This means that such an investigation will permitt no conclusions as regards the effect of special countermeasures on traffic safety. Conclusions, statements are only possible, if one assumes that all countermeasures are essentially "identical", i.e. all countermeasures are aimed at the same goal: the improvement of traffic safety based on identical theoretical considerations (reduction of sneaking traffic and/or reduction of the speed of motorised traffic in order to improve traffic safety).
It seems possible to make distinctions between certain situations, where countermeasures wil be effected (shopping-erf, woonerf, etc.). The consequence of such approach is that all cases are investigated and evaluated as a whole or as a category.

Municipal scopes

Studies proved that in some municipalities there are no goals for the experiments and in case there are some, they are formulated in a much too abstract manner. In practice the following situations can be encountered.

A. Municipalities set out policy goals for their region or a part of it. The countermeasures can be regarded as realisations of these goals. In several cases the goals and countermeasures are realised in close consultation with the persons concerned.
This model mainly applies to larger municipalities and more particularly to those where traffic situations particularly cause problems in the town centres. Thus, the experiments planned for the town centres are essentially aimed at:
- banning the traffic of no local destination from the town centre;
- ensuring the accessibility of the town centre for autorised traffic categories.

In a shopping area with great traffic congestion and which quite often forms a part of the town centre, the aim is to improve the "shopping climate" and to emphasise the attraction of shopping. These conditions can be translated into the following traffic-technical goals:
- to ban motorised traffic from such areas;
- to ban through-traffic from the streets in such areas or to adapt the speed of the driving traffic to the pedestrians' pace;
- to guarantee sufficient parking places around the shopping centre.

B. In a next model the municipalities did not formulate goals and plans. The residents in a area (district or neighbourhood) present their problems and wishes to the municipal authorities, who, on having recognised these wishes and problems as justifiable, will set up countermeasures in consultation with the concerned groups.
This model applies both to smaller and larger municipalities. The residents' initiatives mainly refer to traffic safety problems within the residential areas, along the children's routes to their school and the school's surrounding.

The goals of countermeasures which have to be taken in this case relate to:
- making streets safer and more sociable;
- banning sneaking traffic;
- ensuring safe routes for school-children of reach their school.
This model includes both aspects of "quality of life" and traffic safety.

From the studies of subsidised experiments the following conclusions can be drawn.
It is remarkable that the goals set up in the ministrial decree, in view of the slow traffic, are not so explicitly emphasised in the goals set up by municipal authorities.
To be sure, attention is given to the problems of pedestrians and cyclists without however precisely formulating the goals as regards their traffic safety.
It is also remarkable that no reference is made to the moped riders, neither in the Governmental Decree nor in the Explanatory Note to the Decree. Municipal plans provide no special countermeasures for moped riders either. The position of the moped rider is stil in discussion.

The experimental measures taken are on a small scale, both as regards their volume and their costs.
By way of examples, two locations will be presented in more detail: the Dorpsstraat in Zevenhuizen and the Wilgenlaan in Berkel-Roodenrijs.

The Dorpsstraat in Zevenhuizen

The Dorpsstraat is 300 m long and comprises buildings with shops, dwellings and some small-scale enterprises. In the Netherlands this street is indicated as a "village-erf", without having the official status of a "woonerf".

The Wilgenlaan in Berkel-Roodenrijs

The Wilgenlaan has a lenght of 550 m. It is a typical residential street with family houses, schools and a playground. Due to the presence of

schools and playground, the street has there important functions: it is the route for children going to their school and also their playing and leisure area. According to the municipal authorities, the average car speed was 45 km/hr, but 25% of the cars were driven faster than 50 km/hr. Consequently, the residents of this street asked for appropriate countermeasures.

Woonerfs

May be it is superfluous but I shall still show you some dias about the typical Dutch treat: the woonerf. Governmental authorities are very interested in the effects this measure had on the people living in such areas or coming there as visitors. For this purpose in the framework of governmental-sponsored experiments opinion polls were taken about the experiences people had with the woonerf. The polls were carried out in form of house-to-house surveys, questioning passers-by at random on the street and group discussions.

Since SWOV was and is more interested in the actual traffic safety, it was still possible to cary out a simple accident study. Complementary data on traffic intensities and speeds could not be collected because there was no money available for this purpose.

The already mentioned small-scale character of the countermeasures leads to problems for traffic safety investigations, in case the "experiments" had to be evaluated separately. This is not only the result of the small number of accidents, insufficient for statistical analyses, but also of the possibility of recognising some effects, which are related to specific situations. The application of the conflict method also involved complications on account of the small number of conflicts which can be analysed. Of course, other types of traffic behaviour could be used in the interpretation of the results obtained in accident investigation. Since the given investigation was strictly limited to accidents, various aspects, like traffic intensities, speed behaviour, conflict behaviour, sneaking traffic, were not studied.

In addition to collecting accident data, such an investigation also required a comprehensive description of the factors of random surveys concerning relevant criteria of the part areas in question; such criteria are chiefly important for the generalisation of the results and the choise of a control group.
The heterogeneity as regards criteria (village centres, woonerfs, school neighbourhoods, etc.) or the countermeasures taken could make it necessary to expand the random survey in order to get a more detailed analysis.

At the start of the investigation SWOV did not take part in the procedure of selection and subsidising of various types of "experiments" followed by the Road Safety Directorate DVV.
The only thing we were certain about was that the realisation of the governmental decree will require several years.
The aforementioned circumstances also indicated that the number of re quired experiments, the number of accidents to be analysed and the actual decrease of the number of accidents, necessary for the investigation could not be determined beforehand. For this reason it was decided to start with the collection of all injury-related accidents, whereafter it could be decided, which statistical procedures and analyses should be applied.

The investigation started at the end of 1979 and it lasted with some interruptions (for personal reasons) till July 1983.

Extension of the experiments

During the investigation it soon became evident that the number of experiments and their volume were insufficient to draw reasonable conclusions about the trend of traffic safety in the experimental areas. Thus, it has been decided to increase the number of woonerfs included in the subsidised experiments by non-subsidised woonerfs. Their effects on traffic safety were not known and for this reason problems connected with such areas were unsolved for years. Thus, this investigation provided a good opportunity to get answers to the hitherto undisclosed problems. In total 69 experiments have been carried out in 29 municipalities; 56 experiments related to woonerfs and 13 to other experimental measures.

Results of the accident study (Kraay & Bakker, 1984)

Table 5 provides a survey over the absolute and relative figures of accidents involving victims in the before and after period. The figures of woonerfs are listed separately because of its special importance. The table indicates in the after-period a decrease of the average figure of injury-related accidents in all investigation areas.
All experiments together show in the after-period for the experimental areas a total decrease of 48%, while the reduction of injury-related accidents in the rest of municipalities (control areas) was not more than 14% during the same period. Thus, a net effect of 34% was achieved.
As mentioned earlier, a difference was made between woonerfs and the rest of experimental measures. In the woonerfs even a net decrease of 49% (63-14%) could be observed in the after-period. The other experimental measures showed a net effect of 9%.

In the "influence" areas the net decreases of injury-related accidents in all experiments together, as for the other experimental measures and woonerfs separately, amount to 15, 13 and 10%.

In order to establish the extent to which these differences are significant from the statistical viewpoint, a statistical analysis technique has been applied (the so-called WPM-technique), based on log-lineair models of weighted numbers.
According to the statistical analysis (see Table 6), there seems to be a remarkable effect as regards the weighted number of accidents before and after the implementation of the countermeasures in the experimental area and the influence area together, with regard to the control area (X^2 = 15.77, df = 2). Thus, safety increased in both areas more considerably than in the control area. The effect seems to be stronger for the experimental area than for the influence area, but the difference is negligible.
Moreover, the total effect manifests itselfs more prominently in the woonerf's than in other experimental measures, but the effect is also in this case of indicative character only and just not enough significant (X^2 = 5.52, df = 2 as compared to $X^2.95$ = 5.99, df = 2).

The Tables 7, 8, 9 and 10 contain more data broken down according to location of the accidents, traffic participants and age groups.

Table 7 shows absolute and average figures of injury accidents, which occurred on intersections at the border of the experimental area, and on road stretches and on intersections within the experimental area.
This table proves that the average figures for injury accidents, both for all experiments together and for woonerfs and other experimental measures separately, display a distinctly declining trend in the after-period.
The average figures of accidents, involving injuries, occurring at the boundaries of experimental areas decreased in the after-period for all experimental measures together by 46%, for the experimental measures by 38 and for the woonerfs by 51%.
The average figures of accidents involving injuries occurring on road stretches within the experimental areas decreased in the after-period for all experiments together by 49%, for experimental measures by 25% and for woonerfs even by 78%, whilst the national decrease for such type of accidents was not more than about 5%.
The average figures for accidents involving injuries on intersections within the experimental area in the after-period for all experiments together decreased by 65%, for experimental measures by 41 and for woonerfs by 53%. The national decrease for accidents on intersections amounted to about 7%.

The aforementioned statistical data prove that the reduction of the number of accidents after the implementation of the countermeasures is in relationship with the location ($X^2 = 4.88$, df = 2), but not in a significant manner ($X^2.90 = 4.61$, df = 2). Between the countermeasures concerning woonerfs and other experimental measures no statistically important difference was found.

Table 8 contains absolute and average figures of injury-related accidents broken down according to the implicated traffic participants in the experimental area, in the before and after-period as well.
This table shows that excepting cyclists in situations with other experimental areas than woonerfs, a general decrease of the average figure of injury-involving accidents can be observed in the after-period.

The average figures of injury-involving accidents with cyclists decrease in all experiments together by 22% and in the woonerfs alone by 61%. In other experimental measures than woonerfs the cyclist-accidents increased by 25% in the after-period. On the national level an increase of about 2% can be noted between the before and the after-period.
The average figures of injury-involving accidents with pedestrians indicate in the after-period for all experiments together a reduction of 69%, while for experimental measures and woonerfs separately 66% and 74% respectively. On a national level, traffic accidents implicating pedestrians decreased by about 7%.
The average figures for injury-involving accidents with moped riders in the after-period decreased for all experiments together by 59%, while for experimental measures and woonerfs separately by 43% and 65% respectively. The national decrease of moped accidents amounts to about 15%.

The statistical analysis proves that there is a considerable difference as regards the decrease of type of accidents ($X^2 = 8.91$, df = 2). The reduction is the most striking in view of pedestrians and moped riders, while there is no statistically remarkable difference between the woonerfs and other experimental measures.

Table 9 represents the absolute and average figures for injury-related accidents, broken down according to the type of collision in the experimental area, in the before and after-period.
Injury-involving accidents caused by collisions with an immobile obstacle and unilateral accidents, decreased in all experiments together in the experimental areas by 12% in the after period. An outstanding decrease of 69% was found in woonerfs, whereas other experimental measures resulted in an accident increase of about 50%! In the after-period the national figures for such accidents decreased by about 8%.
As regards injury-related accidents caused by collisions between cars, the decrease in the number of accidents is about the same for all experiments together 64% and for experimental measures and woonerfs separately 62% and 70% respectively. On a national level a reduction of 2.5% can be observed in the after-period.

Injury-related accidents caused by collisions between motorised traffic and slow traffic decreased in the after-period in all experimental measures by 50, 35 and 60% respectively and on a national level by 7.5%. Injury-related accidents occurring between slow traffic participants were reduced in all experimental measures by 44% and in experimental measures and woonerfs separately by 11 and 78% respectively. On a national level the corresponding average figure indicating a decrease amounts to about 7%.

Statistical calculations indicate a difference in the effects with regard to the type of accident of: $X^2 = 6.51$ (a significant figure would be: $X^2.95$, df = 3 = 7.81).
Unilateral accidents do not seem to be much affected by the countermeasures. The effect is relatively the most remarkable in case of accidents between motorcars. But neither in this respect could there be observed a significant difference between woonerfs and other experimental measures.

Table 10 gives a survey over absolute and average figures concerning traffic victims, broken down according to age in the experimental areas in the before and after period.
The average figures indicating traffic victims younger than 15 years decreased in the experimental areas, in the after-period, for all experiments taken together by 51%, and for experimental measures and woonerfs taken separately by 42 and 63%. The national average figure indicating decrease for the same period is not higher than about 7%.
The same picture emerges for the age categories 15-60 years, with 53, 35 and 66% and a national average figure of decrease of about 6%.
There are hardly any differences in the 60+ age category of the after-period. The small differences are negligible in view of a decrease of about 5% on the national level.

Statistical tests provide here no significant differences or indications as regards age categories in the after period.

In spite of the lack of statistically differences in the after period, the countermeasures seem to have a positive effect on traffic safety.

Based on decreases, expressed as percentages, the countermeasures were the most effective in woonerfs.

An important fact, which has to be mentioned in this connection, is the considerable increase of the number of woonerfs created in the last decade. According to a survey of the Central Bureau of Statistics (CBS, 1983), there existed already 1691 woonerfs with 2792 streets at the beginning of 1980.

Analyses have also been carried out for establishing the relationship between the reduction of the accident number and the changes in road criteria.
As the most important results, these analyses found the following:
- The number of accidents can be reduced more considerably in case countermeasures are taken in areas, situated between the town centre and the border zones of the municipalities. These areas (mostly of residential character) surround shell-like the town-centre. This phenomenon can easily be explained. Due to their lay-out (straight lined streets with cars parked at either side and much through-traffic) the countermeasures realised in them seem to be rather effective.
New districts are as a rule so created that through-traffic can be banned from them. Reconstruction measures are therefore intended to remove slight "blemishes" from design and lay-out. Consequently, changes in traffic intensity will occur less frequntly in such areas, thereby lowering the effectiveness of countermeasures.
- The analyses proved that the number of accidents decreases in proportion to the number of erfs, mainly woonerfs and village-erfs, and to a lesser extent to the number of areas with shops therein (shopping-erfs). The reduction of the number of accidents is less significant with countermeasures taken on distributor roads and with speed-reducing provisions created in the neighbourhood of schools.
- The number of accidents dimishes in proportion to the number of physical countermeasures. This again implies hidden relationship with woonerfs, since more phsysical measures are realised on such streets than on distributor roads.
- The number of accidents can be reduced quite considerably in case the pavement area provided for the pedestrians is extended. According to a

rather remarkable basic principle of the woonerf all traffic categories are allowed to make use of the same traffic space on the same level (thus, without raised pavement).
- The number of parking may also influence the reduction of the accident number. Parking in special facilities is more likely to reduce accidents than parking along the street. However, the creation of various modes of parking has a negative effect on the reduction of accidents, most probably caused by the unclear character of mixed parking.
- The number of accidents increases in proportion to the number of junctions with the surrounding road network and the number of road intersections within the district.

The total number of injury-related accidents in the before and the after-period was quite low: 93 and 73 respectively. This means an annual accident figure of 0.6 per experiment for the before-period and 0.3 for the after-period.

It has to be pointed out that the declining trend of accidents manifested in the after-period is also a consequence of banning through-traffic and sneaking traffic from the experimental areas and of reducing the speed of motorised traffic.

Both the volume of the traffic safety phenomenon and data of national and international literature seem to confirm that residential areas included in the investigation are not the most unsafe ones.
According to literature data, streets of mixed functions are the most in need of countermeasures and investigations. This applies to access and collector roads (with shops and/or bus routes) and arterial roads (mainly for high-speed traffic) as well. It seems justified to study these roads more thoroughly in the future.

Experience investigation

As mentioned earlier, governmental authorities attach a great value to assessments and feelings of residents about the countermeasures taken in their district.
Experience investigations revealed that residents, as a rule, are satis-

fied with the sphere of their neighbourhood. However, the attitude of the residents depends quite considerably on the manner in which they were allowed to voice their feelings, opinions, recommendations. Studies proved that in situations, where the residents' opinions were not taken into consideration, their assessment of the traffic safety countermeasures in their neighbourhood was far from being flattering.

On asking, in addition to general assessments, also questions about specific criteria, on some points rather negative views were expressed. For example, the speed of cars and mopeds was found much too high; people in general are not content with the integration of traffic categories; there are complaints about parking and maintenance and the accessibility of shops (enterprises) is found downright worsened. As regards countermeasures other than those referring to woonerfs, the situation is more complicated. This will be illustrated by the examples of Zevenhuizen and Berkel-Roodenrijs.

Dorpsstraat in Zevenhuizen

A poll taken in Zevenhuizen proved that 14% of the residents in the Dorpsstraat preferred the situation as it was before the reconstruction measures, while the majority (67%) was satisfied with the present reconstructed layout (see Table 11).
The respondents preferring the "old" situation, gave the following explanation:
- before the reconstruction the sphere was more pleasant;
- the cyclists now ride much too close to the houses;
- there are too many obstacles, flower boxes, piles, and the like.

The respondents of the content majority found that:
- it is now easier and more comfortable to walk in the street;
- the paving of the street and the pavement, which were in a very bad shape, are nicely renovated;
- the entire sphere in the street is more attractive, cosy.

As regards the experience with traffic safety, the following can be observed.
With the exception of children's safety, the respondents found that the

safety of cyclists, moped riders, car drivers and pedestrians was improved by the reconstruction countermeasures (see Table 12a).
The residents of Dorpsstraat give a lower average mark for the traffic safety of all four road user categories than frequent or less frequent visitors in this street. The traffic safety of the Dorpsstraat as regards pedestrians is given a clearly higher average score by the less frequent visitors than by the permanent residents (see Table 12b).
The respondents gave the following opinions about the reconstruction with regard to traffic maintenance and quality of life of the Dorpsstraat, (see Table 13).
According to 67% the goals of the reconstruction were achieved, while 8% of the respondents denied this for the following reasons:
- there is no clear separation between the pavement and the car lane, thereby making the street unsafe for pedestrians;
- the layout became more dangerous for cyclists;
- the traffic intensity is still much too high, inevitably causing jammings;
- the loading and unloading of lorries is very cumbersome, overtaking manoeuvres are impossible;
- the one-way traffic system is highly inconvenient and time-wasting (see Table 14).

Wilgenlaan in Berkel-Roodenrijs

In the before-period residents in the Wilgenlaan were asked wether they find changes in their street necessary. About 75% of the respondents gave an affirmative answer (see Table 15).
The modifications recommended by the respondents were mostly of traffic-technical character. The most frequently advised countermeasures are given in Table 16.
As regards the questions, whether the countermeasures achieved the envisaged goals, the answers obtained from the respondents were not very convincing (see Table 17).
Respondents, denying the effectiveness of the implemented countermeasures, gave as reasons for their negative opinion: there is no improvement as regards the situation before the countermeasures, because car driving speeds are still much too high and complicated traffic situations could not be eliminated (see Table 18).

The residents, parents, passers-by had in general negative opinions about traffic safety after the implementation of reconstruction measures. Not more than 10% of the respondents gave a positive assessment, while 64-69% doubted the effectiveness of safety measures.

The experience investigation revealed great differences between the effects one expected from the countermeasures and those that were actually obtained by the reconstruction. These differences are represented in Table 19.

Summary

In general, it can be stated that there is a discrepancy between the results of the accident investigation and those obtained in the experience polls.
Thus, we are inevitably confronted with the problem, to what extent the validity of the obtained answers can be accepted. In other words: do the answers represent a realistic picture of the traffic situation? At the same time also the question arises, whether the measuring procedures of the poll were adequately appropriate to accurately assess traffic experiences.
As long as there is no satisfactory answer to these questions, I would like to give the following advices:
(a) base your opinion about the discussed subjects and the countermeasures to be taken as far as possible on objective data concerning traffic situations instead of using subjective information;
(b) in case you accept and honnour the wishes of the residents and you have sufficient financial means at disposal to realise them, you may improve the quality of life, but the question to what extent you also improved traffic safety, will still remain unanswered.

Literature

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- Kraay, J.H. & Bakker, M.G. (1984). Experimenten in verblijfsruimten; Verslag van onderzoek naar de effecten van infrastructurele maatregelen op verkeersongevallen. R-84-50. SWOV, 1984.

TABLES 1-19

Table 1. Distribution of traffic deaths according to various traffic participant categories within built-up areas in 1970-1982.

Table 2. Number of injury-related accidents (deaths, injured persons), number of vehicle-km (x 10^6) and accident quotients for the municipalities Eindhoven and Rijswijk in the period 1972/1977 (Source: Janssen, 1980).

Table 3. Accident quotients for various types of land use (Source TRRL, 1977).

Table 4. Accidents with and without pedestrians in traditional residential districts, broken down according to the type of road (streets) (Source: Bennett & Marland, 1978).

Table 5. Absolute and average figures of accidents with victims, broken down according to the investigation areas in the before and after period.

Table 6. Before period - after period; Experimental measures - residential precincts; Experimental, influence and control areas.

Table 7. Absolute and average figures for accidents with victims, broken down according to the location of the experimental area in the before and after period.

Table 8. Absolute and average figures for accidents with victims, broken down according to the involved participants of slow traffic in the experimental area in the before and after period.

Table 9. Absolute and average figures for accidents with victims, broken down according to the type of collision in the experimental area in the before and after period.

Table 10. Absolute and average figures for traffic victims, broken down according to age in the experimental area in the before and after period.

Table 11. Evaluation of the before and after reconstruction situation by the Dorpsstraat residents in Zevenhuizen (Source: Synthese, 1978).

Table 12a. Average scores given by respondents as regards traffic safety for various types of traffic categories in the before and after period (Source: Synthese, 1978).

Table 12b. Average scores given by respondents as regards the traffic safety for various types of traffic categories in the before and after period (Source: Synthese, 1978).

Table 13. Opinions why the Dorpsstraat (Zevenhuizen) had to be reconstructed (Source: Synthese, 1978).

year	total within built-up areas	passenger car		lorries		motor/ scooter		moped		bicycle		pedestrian		the rest	
		abs.	perc.	abs.	perc.	abs.	perc.	abs.	perc.	abs.	perc.	abc.	perc.	abs.	perc.
1970	1319	307	23.3	25	1.9	26	2.0	282	21.4	270	20.5	397	30.1	12	0.9
1971	1286	283	22.0	15	1.2	32	2.5	300	23.3	304	23.6	348	27.1	4	0.3
1972	1322	287	21.7	18	1.4	37	2.8	291	22.0	305	23.1	375	28.4	9	0.7
1973	1277	307	24.0	15	1.2	38	3.0	274	21.5	286	22.4	348	27.3	9	0.7
1974	1065	224	21.0	15	1.4	39	3.7	222	20.8	270	25.4	289	27.1	6	0.6
1975	897	199	22.2	6	0.7	38	4.2	158	17.6	225	25.1	264	29.4	7	0.8
1976	956	244	25.5	8	0.8	40	4.2	127	13.3	263	27.5	269	28.2	5	0.5
1977	933	232	24.9	10	1.1	42	4.5	137	14.7	262	28.1	240	25.7	10	1.1
1978	845	204	24.1	5	0.6	42	5.0	116	13.7	245	29.0	223	26.4	10	1.2
1979	738	207	28.0	7	0.9	50	6.8	72	9.8	208	28.2	185	25.1	9	1.2
1980	813	209	25.7	7	0.9	52	6.4	90	11.1	237	29.1	211	25.9	7	0.9
1981	715	170	23.8	5	0.7	49	6.8	78	10.9	213	29.8	195	27.3	5	0.7
1982	664	166	25.0	0	0	39	5.9	48	7.2	219	33.0	184	27.7	8	1.2

Table 1. Distribution of traffic deaths according to various traffic participant categories within built-up areas in 1970-1982.

	Demonstration area		Influence area		Control area	
	traffic area	habitat area	traffic area	habitat area	traffic area	habitat area
Eindhoven:						
Number of injury-related accidents	528	54	187	40	2901	787
Traffic performance	233	25	168	52	1756	1200
Accident quotient	2.27	2.26	1.11	0.77	1.65	0.66
Rijswijk:						
Number of injury-related accidents	286	55	124	33	675	90
Traffic performance	219	26	74	5	420	37
Accident quotient	1.31	2.12	1.68	6.60	1.61	2.43

Table 2. Number of injury-related accidents (deaths, injured persons), number of vehicle-km (x 10^6) and accident quotients for the municipalities Eindhoven and Rijswijk in the period 1972/1977 (Source: Janssen, 1980).

Use of land	Number of road stretches	Total length (km)	Vehicle-km (x 10^6)	Number of accidents*	Accident quotient
Shops/dwellings	8	4.20	22.94	67	2.92
Shops	25	13.20	89.21	259	2.90
Open	9	6.30	54.68	88	1.61
Industrial enterprise/ dwelling	11	4.95	46.93	57	1.21
Dwelling	60	44.70	275.50	327	1.19
Open/dwelling	21	15.35	113.91	123	1.08
Industrial enterprise	14	7.35	74.96	63	0.84
Others	6	3.05	18.22	19	1.04
Total	154	99.10	696.35	1003	1.44

* 12 accidents occurred on roads, where the traffic flow was not assessed; these accidents were not included in the table.

Table 3. Accident quotients for various types of land use (Source TRRL, 1977).

Type of street	Random survey of 9003 streets			Random survey of 5474 streets		
	number of streets	number of residents (x 1000)	number of pedestrian accidents per 10,000 residents	number of streets	number of residents (x 1000)	number of non-pedestrian accidents approx. per 10,000 residents
Straight lined	5007	559	5.30	2805	279	3.31
Bend r > 750 m	959	189	12.95	638	114	10.27
Bend r < 750 m	3036	646	9.14	2031	419	9.63
Fences, hedges, etc.	1227	184	7.21	967	143	7.15
No fences, hedges, etc.	7776	1210	8.25	4507	669	7.63
Bus route	700	243	25.66	495	166	26.64
No bus route	8303	1150	4.41	4979	645	3.14
School entrance	636	181	20.08	352	99	18.72
No school entrance	8367	1213	6.33	5122	712	5.99
Shops	490	158	25.65	253	89	24.51
No shops	8513	1236	5.87	5221	722	5.47
Playground	280	79	19.88	138	40	18.55
No playground	8723	1314	7.41	5336	771	6.98
No open end of the street	69	11	4.06	49	4	2.60
One open end	3229	294	2.50	1980	185	2.51
Two open ends	5696	1088	9.67	3439	618	9.12
Total	9003	1393	8.13	5474	811	7.55

Table 4. Accidents with and without pedestrians in traditional residential districts, broken down according to the type of roads (streets) (Source: Bennett & Marland, 1978).

	Absolute figures of accidents with victims			Average figures of accidents with victims		
	experimental area	influence area	control area	experimental area	influence area	control area
Experimental measures						
Before period	49	274	2,678	20.8	109.5	1,344.3
After period	41	248	2,713	14.6	72.2	1,061.6
				-30%	-34%	-21%
Residential precincts						
Before period	44	313	37,436	25.8	166.3	21,130.9
After period	32	460	68,505	9.6	126.4	18,249.1
				- 63%	- 24%	- 14%
Total						
Before period	93	587	40,114	46.6	275.8	22,475.2
After period	73	708	71,218	24.2	198.6	19,310.7
				- 48%	- 28%	- 14%

Table 5. Absolute and average figures of accidents with victims, broken down according to the investigation areas in the before and after period.

Data	49	274	2678	44	313	37436
	41	248	2713	32	460	68505
Weighting factors	2.358	2.506	1.992	1.706	1.883	1.773
	2.809	3.436	2.557	3.333	3.650	3.759
Design matrix	variable 1:		1	- 1		
	variable 2:		1	- 1		
	variable 3:		1	1	- 2	
			1	- 1	0	

Effects	Raw scores	St. scores	Chi-quadrats	Dfr.
0 0 0	18,5170	192,2273	36951,3359	1
1 0 0	0,6962	7,2272	52,2320	1
0 1 0	- 1,8400	- 19,1014	364,8652	1
1 1 0	- 0,1170	- 1,2149	1,4759	1
0 0 1	- 7,6899	-111,7242	21152,0781	2
0 0 2	- 2,7062	- 23,0189		
1 0 1	0,2572	3,7364	15,7663	2
1 0 2	0,2273	1,9331		
0 1 1	2,1265	30,8949	1858,3413	2
0 1 2	0,4149	3,5290		
1 1 1	- 0,1376	- 1,9985	5,5159	2
1 1 2	- 0,2724	- 2,3171		

Table 6. Before period - after period; Experimental measures - residential precincts; Experimental, influence and control areas.

	Absolute figures of accidents with victims			Average figures of accidents with victims		
	border zone experimental area	road sector within the area	intersection within the area	border zone experimental area	road sector within the area	intersection within the area
Experimental measures						
Before period	18	22	9	7.25	10.0	4.58
After period	12	22	7	4.45	7.5	2.7
				-38%	-25%	-41%
Residential precincts						
Before period	16	21	7	10.94	11.83	4.00
After period	18	13	1	5.31	2.50	1.88
				-51%	-78%	-53%
Total						
Before period	34	43	16	18.19	21.83	8.58
After period	30	35	8	9.76	11.10	3.03
				-46%	-49%	-65%

Table 7. Absolute and average figures for accidents with victims, broken down according to the location of the experimental area in the before and after period.

	Absolute figures of accidents with victims			Average figures of accidents with victims		
	bicycle	pedestrian	moped	bicycle	pedestrian	moped
Experimental measures						
Before period	15	11	16	5.75	5.17	6.50
After period	21	5	13	7.20	1.75	3.70
				+25%	-66%	-43%
Residential precincts						
Before period	13	7	22	7.03	3.66	14.99
After period	11	4	16	2.73	0.95	5.19
				-61%	-74%	-65%
Total						
Before period	28	18	38	12.78	8.83	21.49
After period	32	9	29	9.93	2.70	8.89
				-22%	-69%	-59%

Table 8. Absolute and average figures for accidents with victims, broken down according to the involved participants of slow traffic in the experimental area in the before and after period.

	Absolute figures of accidents with victims				Average figures of accidents with victims			
	obstacle + unilateral collision	fast/ fast traffic	fast/ slow traffic	slow/ slow traffic	obstacle + unilateral collision	fast/ fast traffic	fast/ slow traffic	slow/ slow traffic
Experimental measures								
Before period	1	12	30	6	0.33	5.22	11.92	3.33
After period	6	4	20	11	2.00	2.00	7.70	2.95
					+50%	-62%	-35%	-11%
Residential precincts								
Before period	4	5	30	5	3.00	2.75	16.86	3.16
After period	3	3	23	3	0.92	0.83	6.80	0.70
					-69%	-70%	-60%	-78%
Total								
Before period	5	17	60	11	3.33	8.00	28.78	6.49
After period	9	7	43	14	2.92	2.83	14.50	3.65
					-12%	-64%	-50%	-44%

Table 9. Absolute and average figures for accidents with victims, broken down according to the type of collision in the experimental area in the before and after period.

	Absolute figures of victims			Average figures of victims		
	< 15 years old	15-60 years old	> 60 years old	< 15 years old	15-60 years old	> 60 years old
Experimental measures						
Before period	16	32	4	6.08	15.25	1.83
After period	10	29	4	3.50	9.90	1.75
				-42%	-35%	-4%
Residential precincts						
Before period	9	30	3	4.66	20.11	1.00
After period	7	22	4	1.73	6.77	1.00
				-63%	-66%	0%
Total						
Before period	25	63	7	10.74	35.36	1.00
After period	17	50	8	5.23	16.67	2.75
				-51%	-53%	-3%

Table 10. Absolute and average figures for traffic victims, broken down according to age in the experimental area in the before and after period.

Percentage of residents in Dorpsstraat:	
preferring the situation as before the reconstruction	14%
preferring the situation as after the reconstruction	67%
with no opinion	19%

Table 11. Evaluation of the before and after reconstruction situation by the Dorpsstraat residents in Zevenhuizen (Source: Synthese, 1978).

	Present situation	Previous situation
Children can play more safely in Dorpsstraat	26%	30%
Dorpsstraat is safe for cyclists, moped riders	56%	45%
Dorpsstraat is safe for car drivers	65%	53%
Dorpsstraat is safe for pedestrians	64%	53%
Total number	23%	72%

Table 12a. Average scores given by respondents as regards traffic safety for various types of traffic categories in the before and after-period (Source: Synthese, 1978).

The street is safe	According to Residents of Dorpsstraat	Frequent visitors	Less frequent visitors
for children	26%	22%	33%
for cyclists, moped riders	51%	53%	55%
for car drivers	57%	59%	65%
for pedestrians	52%	62%	66%
Total number	38	136	130

Table 12b. Average scores given by respondents as regards the traffic safety for various types of traffic categories in the before and after-period (Source: Synthese, 1978).

Opinions with regard to traffic		48%
traffic safety, traffic intensity, high speeds	31%	
safety of pedestrians, dangerous pavements	14%	
insufficient parking place	2%	
creation of one-way systems	2%	
Opinions with regard to maintenance		26%
construction of sewage systems	18%	
bad state of road surface	5%	
Other opinions		38%
improving the aspect of the street	15%	
making it more plesant	13%	
permitting comfortable shopping	5%	
the municipality had surplus money at disposal which had to be spent	2%	

Table 13. Opinions why the Dorpsstraat (Zevenhuizen) had to be reconstructed (Source: Synthese, 1978).

There is no distinct separation of pavement and carriage lanes (carriageway): this is unsafe for pedestrians	18%
The situation is now less safe for cyclists	14%
There are still too many cars, the traffic is too busy; the streets are often jammed:	11%
Loading and unloading of lorries, cars, is complicated; lorries cannot be easily passed during loading/unloading (double parking);	3%
One-way traffic systems cause complications and are time wasting	1%
Earlier the area was safer	1%

Table 14. Reasons why respondents (Dorpsstraat, Zevenhuizen) found that the envisaged results were not achieved (Source: Synthese, 1978).

Modifications were requested	
by occupants of the houses	85%
by parents of school-going children	86%
by random passers-by on the road	75%

Table 15. The demand for modifications (provisons) in the Wilgenlaan (Berkel-Roodenrijs) (Source: Synthese, 1979).

Measures requested by	Residents	Parents	Passers-by
Construction of traffic humps	41%	34%	34%
Construction of safe pedestrian crossing (zebras) and installation of traffic lights	20%	31%	29%
Speed reducing measures	27%	15%	15%

Table 16. The measures requested for Wilgenlaan (Berkel-Roodenrijs) (Source: Synthese, 1979).

Effectiveness of measures according to	Residents	Parents	Passers-by
Effect has been achieved	13%	16%	18%
Effect has not been achieved	59%	68%	63%
Effect not quite achieved	20%	9%	7%

Table 17. Effectiveness of measures implemented in Wilgenlaan (Berkel-Roodenrijs) (Source: Synthese, 1979).

Reasons of ineffectiveness of measures according to	Residents	Parents	Passers-by
The roads became a race track; cars are driving too fast	50%	41%	17%
Unsatisfactory or no effect	37%	32%	39%
The traffic situations are disordered, not clearly visible	-	37%	13%

Table 18. Reasons why the respondents did not find the measures fully effective in Wilgenlaan (Berkel-Roodenrijs) (Source: Synthese, 1979).

		Residents	Parents	Passers-by
The Wilgenlaan is safer for car drivers	before	56%	57%	53%
	after	36%	32%	37%
Moped riders drive slower	before	48%	47%	45%
	after	28%	38%	36%
Pedestrians cross the street more safely	before	70%	55%	65%
	after	40%	50%	46%
Car drivers avoid Wilgenlaan	before	55%	39%	42%
	after	35%	40%	35%
Children cross the street more safely	before	64%	50%	64%
	after	35%	42%	36%
Wilgenlaan is race track for moped riders	before	55%	43%	49%
	after	56%	50%	47%
Wilgenlaan safer for cyclists	before	56%	52%	51%
	after	45%	47%	37%
Car drivers drive more slowly	before	73%	76%	69%
	after	40%	51%	45%
Children can play more safely in the Wilgenlaan	before	38%	34%	45%
	after	18%	28%	27%
Car drivers accelerate between the obstacles	before	42%	41%	45%
	after	59%	57%	57%
The street is safer for moped riders	before	37%	38%	43%
	after	38%	39%	33%

Table 19. Average scores of respondents over the effect of measures in the after-period as compared to the before-period (Source: Synthese, 1979).