SETTING UP AN ISA TRIAL FROM A TRAFFIC SAFETY PERSPECTIVE METHODOLOGY RESEARCH IN THE NETHERLANDS

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BACKGROUND

The Ministry of Transport, Public Works and Water Management (V&W) has set ambitious goals in relation to road safety: a reduction in the number of fatal accidents to 750 in 2010 and a maximum of 14,000 seriously injured (requiring hospital treatment). In the year 2000 there were 1,082 road deaths and an estimated 19,000 or more seriously injured (Kerncijfers Verkeersonveiligheid 2000, Ministerie van Verkeer en Waterstaat, 2001 [Traffic Safety Key Data 2000, published by the Ministry of Transport, 2001]). This means that in just over 10 years time a reduction of more than 30% in road deaths has to be achieved (compared with 1999). In terms of serious injuries (requiring hospitalisation) the goal is to achieve a reduction of around 25% (source: NVVP [National Traffic and Transport Plan 2000]).

To achieve these goals numerous measures are required in which technology will have an important part to play. In this respect ISA (Intelligent Speed Adaptation) represents an example of transport technology which through external speed regulation is intended to have a positive influence on the risk of injury and the seriousness of injury.

ISA has previously been studied in the Netherlands. In 1999 and 2000 a practical trial was held in which 20 vehicles were fitted with a mandatory speed-limiting version of ISA. The primary goal of this practical study was to examine whether ISA is a realistic option as an instrument for speed control, both from a technical-operational and from a social point of view. A major evaluation objective was to measure public acceptance of this type of ISA, both with test drivers and with the general public.
The conclusions of the experiment were:

**Technical feasibility**
- The trial has proven that ISA is technically possible, and relatively minor problems were encountered keeping the system operational.

**User acceptance**
- Up to 65% of test drivers support the idea of ISA. People from the test area Campenhoef are the most positive, 65% is (much) in favour. From the other reference groups outside the test area 30% declares to be opposed to the idea. For all groups the percentage of neutral is around 20%. Support for ISA is mainly based on the realisation that speeding in traffic is a problem in everyday life. Partly, support for ISA is also an opportunist attitude.

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**Acceptance of/support for ISA**

- There are strong indications that information and communication about ISA have a relatively large effect on attitudes, acceptance and even though the initial acceptance level was already at a high level (55%), a short but intensive information and communication effort lifted the level of positive attitudes to 80%. Only intensive communication efforts appear to have this result.
- Support for ISA is highest, by far, in the case of implementing it in 30 and 50 km/hr speed limited streets. Almost 66% of car drivers (in general) support implementation on streets of that kind. Support for implementation on 80 km and other rural roads is very much lower. Most people do not consider speeding there a problem (incorrectly so).
Driving behaviour.

- The main conclusion is that ISA has indeed a considerable effect on driving behaviour. Average speeds are lower, both in an absolute sense and in the variation of speeds. This effect is due to the fact that high speeds are cut off. Therefore there is a clear indication that ISA has a positive effect on road safety.
- (Enforced) speed reduction is not always consistent with the road conditions. Effects of ISA are largest when the road condition invites higher speeds than the limit allows.
- Indications are therefore, that ISA has a traffic calming effect, and therefore a positive effect on traffic safety. This effect is confirmed by the test drivers whom reported on less overtaking, and larger following distances.

*Figure 2: Driving behaviour: example of data-logging from Tilburg trial.*

![Graph of driving behaviour](image)

AVERAGE SPEED WITHOUT ISA = 28.9 KM/H
AVERAGE SPEED WITH ISA = 23.9 KM/H

Purpose of the methodology study

In the first trial the emphasis was on technical aspects and public acceptance. Good results were obtained in both areas. The question now is whether and how developments in the area of ISA should continue.

The main reasons for introducing ISA is the safety benefit which can be achieved. To be able to test this, a large scale trial is being considered.

The research problem in such a demonstration project is as follows:

*What is the safety benefit in terms of a reduction in the number of deaths and injuries further to full implementation of ISA in the Netherlands? And how will it affect quality of life and accessibility?*

The idea of a second, larger scale trial was conceived. However, before setting up such a project, it has to be clear whether it can answer the questions underlying the research. It is also
necessary to find out at an early stage whether or not a larger trial can actually be conducted. This latter aspect was the subject of the present study.

Whether ISA proceeds to the second phase or not, and what form this might take, is still entirely open. To be able to make a decision about this, a feasibility project was set up. The project will be tackled in three stages.

Stage A  Methodology *(is it theoretically possible?)*
Further consideration of the research problem and determining the criteria necessary to set up a second trial in order to be able to answer the research question.

Stage B  Practical considerations *(is it feasible?)*
Determining the practical considerations involved in a second trial.

Stage C  Trial set up *(how shall we do it?)*
Development of the trial set up.

This paper relates to stage A: the methodology.

**The structure of a large-scale demonstration project**

It was assumed that in a trial with ISA there would be an experimental group and a control group. The experimental group will be equipped with ISA and recruited in a certain area. The control group would be recruited in another area. Both groups should ideally be the same size.

For the time being we shall assume a trial period of 1 year.

The experimental group will experience the effects of ISA, but these effects will be limited to their own vehicles. Other vehicles in and around the experimental area will not be fitted with ISA. For this reason the full effects of ISA cannot be seen: since the overall effect of ISA is made up of the effect of one's own ISA system as well as its interactive effect with the rest of the traffic. To be able to approximate this it was proposed that enforcement be stepped up to create as near an ISA environment as possible in the experimental area. In this way the overall ISA effect would be achieved as closely as possible among the experimental group. It should be noted, however, that measurements of the experimental (and control) groups would always be the main consideration (i.e. not measurements in the area). Prior to taking measurements with ISA, it is proposed that baseline measurements for both groups be taken (accident history, driving speed and attitude towards ISA, etcetera)

Based on this approach a number of calculations were carried out in order to determine the size of the random sample required.

The size of the random sample required (for a trial period of 1 year) depends on the following variables:

- the risk per vehicle of being involved in an accident;
- the scale of the effect to be expect on road safety;
- the error \(\alpha\) that we accept that there is no actual effect while based on the data we may conclude that there is an effect (false positive);
- the error \(\beta\) that we accept that we conclude that there is no effect while in reality this is the case (false negative). The power (equal to \(1 - \beta\)) is used as an indicator. Hence, the greater the power the smaller the error \(\beta\).

Based on the calculations it was concluded that it is not possible to draw conclusions about certain types of roads (e.g. 120 km/h; 100 km/h, etc.) because this would require extremely
large random samples (e.g. at 120 km/h with less fatal accidents you need 67 million ISA cars!!). Therefore, from now on only that which affects the total (i.e. all road types) will be considered. Furthermore, given the extremely large random sample numbers required, it is not recommended that the trial is set up with non-mandatory ISA systems.

An overview of the main random sample variables is given in table 1.

Table 1: Summary of random sample variables

<table>
<thead>
<tr>
<th>Random sample variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration</td>
<td>1 year</td>
</tr>
<tr>
<td>Significance level ($\alpha$)</td>
<td>10%</td>
</tr>
<tr>
<td>Power</td>
<td>75%</td>
</tr>
<tr>
<td>Risk per 1000 vehicles</td>
<td>100</td>
</tr>
<tr>
<td>Expected effect on self-reporting</td>
<td>15%</td>
</tr>
<tr>
<td>Net random sample</td>
<td>3,127</td>
</tr>
<tr>
<td>Expected dropout</td>
<td>40%</td>
</tr>
<tr>
<td>Gross random sample</td>
<td>5,211</td>
</tr>
<tr>
<td>Expected response</td>
<td>10%</td>
</tr>
<tr>
<td>Minimum population required in area</td>
<td>52,110</td>
</tr>
<tr>
<td>Required radius of area</td>
<td>20 km – 1256 km²</td>
</tr>
</tbody>
</table>

Other recommendations concerning the set up of a large scale trial

The following recommendations are also made with regard to the area to be selected.

- The area should include roads with a representative variety of speed limits for the road context: 30 km/h, 50 km/h, 80 km/h, 100 km/h and 120 km/h;
- the number of speeding offences should preferably be average or above average;
- the road safety aspects should preferably be average or worse than average.

The following considerations apply with regard to the characteristics of the drivers in the experimental group and in the control group.

- The drivers should be representative in terms of their main use of the car: for business, commuting and for private use.
- There must be a sufficient number of fast cars included in the random sample (closely reflecting the population).
- The sample must be representative in terms of age and gender.
- During the screening as much attention as possible should be devoted to the damage/accident history and the number of speeding offences. These aspects must also not be underrepresented.

In general, it may be said that under-representation of fast drivers, combined with a safe area and a low average speed will hinder or even prevent detection of the effects of ISA. In this context, therefore, prior to the trial, it would be useful to make an estimate of the effects to be expected, based on random sample data particularly driving speeds and speeding fines, and link any decision whether to proceed or not with this information.

When setting up this trial, it has to be understood that the effect will be determined by the difference in the effect which occurs between the experimental group and the control group.
Possible alternatives

The following alternatives could also be considered.

Accident analysis

Instead of a large scale trial, accident records (VOR: Netherlands Traffic Accident Register) could be analysed in relation to speed-related aspects. Certain types of accidents can no longer occur with ISA.

This would include accidents which are caused by overtaking on 80 km/h roads in which the vehicle being overtaken is driving at or around the speed limit and the overtaking vehicle therefore has to drive faster than the speed limit. Accidents caused by two competitive drivers racing one another also fall into the category of accidents which can be prevented with ISA.

The first step in such a study would be to define the various accidents categories which can be identified as unlikely to occur with ISA. At the same time a clear set of criteria has to be drawn up which these accidents must meet in order to be allocated to certain categories.

A major obstacle to this approach is that all the available information about speed is not (or not always) included in accident records. Furthermore, ISA-induced accidents would fall outside the scope of such an approach.

If we consider the validity of such an approach it may be said that we can only measure a part of what we want to know, since only highly specific types of accidents can be used in this way.

Part of the effect of ISA is not so much the prevention of accidents as its influence on their seriousness. This aspect would not be illuminated if this approach were to be taken. For the same reasons (specific nature of accidents) an analysis of this type would not give a representative view of the effects of ISA. However, in terms of its feasibility this approach would be highly appropriate.

Analysis of adverse effects

When considering the total effect of ISA, apart from its positive effects, possible adverse effects may also occur due to the speed reduction. The total effect will then be equal to the sum of these positive and negative effects.

To obtain more insight into these effects it would be useful to investigate the possible adverse effects of ISA in a number of related smaller scale projects. For example, the following related projects could be considered, including:

- headways or Time-To-Collision (TTC)
- braking and delayed braking
- frustration
- speed compensation

In an ideal situation there would be a concrete relationship between the parameters derived from the experiments (e.g. Time-to-Collision) and road safety, expressed in deaths, injuries and accidents.

If these relationships exist then a completely different trial set up could be conceivable, entirely devoted to determining the adverse effects. Under this approach the speed effects can be calculated using models. These speed effects can then be corrected for road safety and any negative influences arising due to the adverse effects can be deducted.
Before starting the trials it must be clearly defined which hypotheses need to be tested in the various related projects.

However, as far as we know, with the exception of headways concrete (i.e. quantifiable) relationships between possible adverse effects and road safety have not been established.

This means that a large scale trial, with or without supporting research, would appear to be the most suitable method of demonstrating the overall road safety effects of ISA.

The future of ISA.

Full deployment of a mandatory, automatic ISA would be one of the most effective single measures imaginable for the improvement of traffic safety. Calculations based on the theoretical relationship between speed and traffic safety have come with predictions of 34% reduction in fatal accidents and 27% reduction of injuries. See table 2 for the expected effect of a mandatory ISA system on average speed and traffic safety.

Table 2: Average speed and standard deviation on different roads and expected reduction in injuries.

<table>
<thead>
<tr>
<th>Categorie</th>
<th>120 km/h</th>
<th>100 km/h</th>
<th>80 km/h</th>
<th>50 km/h</th>
<th>30 km/h</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without ISA (measured)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Speed</td>
<td>114</td>
<td>91</td>
<td>82</td>
<td>52</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Stand. dev. Speed</td>
<td>16*</td>
<td>13</td>
<td>15</td>
<td>12</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>With ISA (calculated)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- aver. speed km/h</td>
<td>110,2</td>
<td>89,1</td>
<td>75,0</td>
<td>46,1</td>
<td>27,3</td>
<td></td>
</tr>
<tr>
<td>- % speed reduction</td>
<td>3%</td>
<td>2%</td>
<td>9%</td>
<td>12%</td>
<td>17%</td>
<td></td>
</tr>
<tr>
<td>- % reduction of death</td>
<td>13%</td>
<td>8%</td>
<td>30%</td>
<td>38%</td>
<td>53%</td>
<td>34%</td>
</tr>
<tr>
<td>- % reduction of injuries</td>
<td>10%</td>
<td>6%</td>
<td>24%</td>
<td>30%</td>
<td>43%</td>
<td>27%</td>
</tr>
</tbody>
</table>

* calculated

However the most promising from a traffic safety point of view, implementation of mandatory ISA will not be reality in the near future. Acceptance for such a measure is still too low, standards have to be developed and issues like liability and maintenance of the data base with maximum speeds have to be resolved. But more and more car manufacturers already offer voluntary, advisory ISA in some of their models. In the coming years manufacturers and governments should work together to increase market penetration and functionality of such (voluntary) systems. The Ministry of Transport is now working on an action programme to contribute to this goal.
References.


