THE EFFECTS OF LARGE SCALE USE OF ACTIVE ACCELERATOR PEDAL IN URBAN AREAS

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Abstract

The long term- and large scale effects of the active accelerator pedal in 284 vehicles in Lund were evaluated with regard to speed, traffic safety, driver behaviour, travel time, emissions and acceptance. The results showed that compliance with the speed limits improved among test drivers both according to their own statements and the objective measurements. The reductions in average speeds, and in speed distribution, better car following behaviour, increased attention and better behaviour towards pedestrians indicate a great traffic-safety potential. Fuel consumption and emissions decreased significantly. Travel times were unaffected. The majority of the interviewed test drivers think that there is a need for speed control measures and society must undertake such measures. The test drivers think that the active accelerator pedal is an efficient means to improve traffic safety and experience it as a support in car driving. However, those who need it most are the most negatively inclined to the idea.

1. INTRODUCTION

Based on the promising results from earlier studies with vehicle based speed adaptation, large-scale trials with ISA-systems (Intelligent Speed Adaptation) in four Swedish cities were carried out. One of the sites was the city of Lund. The ISA system, tested in Lund is also known as “the active accelerator pedal”. When the driver attempts to exceed the speed limit, a resistance in the accelerator pedal is activated. If necessary, the driver can override the system by pressing the accelerator pedal harder (kick-down function). A GPS receiver, which identifies the position of the vehicle, was fitted in the test vehicles. The vehicle did not transmit a signal of its own and could therefore not be localised. The vehicles were also equipped with a digital map containing all the current speed limits within the test area.

The test area included the entire city of Lund, which contains all legislated speed-limits in Sweden, 30, 50, 70, 90 and 110 km/h. However, the system was only active within the 30, 50 and 70 km/h speed limit zones. The system was turned on every time the vehicle entered or started in Lund and it could not be turned off inside the test area. Outside Lund, the system could be used voluntarily.

The recruiting of the test drivers was based on letters to a randomised sample of vehicle owners in Lund and a request to companies to allow their company cars to be included in the trial. There were a total of 284 vehicles equipped with active accelerator pedal. The drivers
were assigned to groups with regard to gender, age and initial attitude towards the active accelerator pedal (positive/neutral/negative).

2. METHOD

The evaluation of the effects was designed as a before/after study with control. In order to be able to separate the effects on the test drivers from possible changes in traffic in general, besides observations of the system’s effect on the test drivers’ behaviour and attitudes, comparable observations of the public in Lund were made. In order to be able to trace if the test vehicles influenced other road users in the test city, comparative observations for control were carried out in the city of Helsingborg (see table 1 for the study design).

Table 1. The design of the observational studies on the effects of active accelerator pedal on test drivers and on the public.

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<th>Effects</th>
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<td>Lund</td>
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<td>Logbook</td>
<td>Interviews with passengers</td>
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<tr>
<td>Behaviour</td>
<td>Data logging in test cars</td>
<td>Speed measurements</td>
</tr>
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<td></td>
<td>In car observations</td>
<td>Red light violation</td>
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<td>Interactions</td>
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<td>Accidents</td>
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2.1 Interviews

2.1.1 Baseline questionnaire to the public

The aim with the baseline survey was to reveal the attitudes of different road users (not only drivers’) to speeds and road safety. Questionnaires were sent to 750 randomly selected inhabitants in Lund with age between 18 and 74 years. 469 persons answered which gives a response rate of 62.5 %.

2.1.2 Recruiting interviews

During the recruitment procedure drivers were asked about their opinion of the different systems used in the Swedish ISA-trial (also at other trial-sites) as well as a few questions from the base-line questionnaire. Further, the drivers were asked about themselves and their vehicle. Then, the private drivers were asked if they were willing to participate in the trial, and if they didn’t want to participate they were asked to give a short explanation why not. On company car drivers’ participation their employer decided.

2.1.3 Questionnaires to the test drivers

All test-drivers were interviewed three times: before their vehicle was equipped with ISA, after driving with the system for one month and finally at the end of the test-period. Most of the questions from the base-line questionnaire were repeated, but there were also more
specific questions about the active accelerator pedal. The objective of the questionnaire was to study the drivers’ attitudes and experiences of the active accelerator pedal, and possible changes after using the equipment for a long period.

2.1.4 Logbook
A number of test drivers (32 persons) were asked to fill in a logbook regarding their experience with the system. The aim of this study was to analyse and to show how the use of active accelerator pedal over a longer period is experienced by the test persons. The diary gives the possibility to tell about events that could not be predicted, about emotions that come up in unforeseeable situations and that only with great difficulties can be dealt with in another way than allowing and enhancing the individuals to answer at those moments when something comes to their mind or happens to them.

2.1.5 In depth interviews with test drivers
These interviews were carried out on a smaller sample, 26 of the test drivers after de-installation of the active accelerator pedal in their vehicles.

2.1.6 Interviews with passengers on ISA buses and taxi
The aim of the interview study with passengers of buses and a taxi equipped with the system was to study how passengers experience the system. Whether they realise that the driver drives in a different way with the system than previously without it, and what kind of difference do they realise. The hypothesis that has been tested was that passengers of equipped cars do not experience the system as disturbing. 60 bus passengers were interviewed when they travelled by an equipped bus, while taxi passengers got an interview form from the driver of the equipped taxi, and they were asked to fill in and send it to us, 15 answered.

2.1.7 Interviews with pedestrians
The aim of the study was to detect system-effects of the implementation of the active accelerator pedal that affect pedestrians. In Lund, 100 pedestrians were interviewed at two intersections in the before period, and approximately 160 at the same intersections in the after period. Parallely, 110 pedestrians were interviewed at two control-sites in Helsingborg during the before period, and at one of them during the after period.

2.1.8 Follow-up questionnaire to the public
The aim with the follow-up questionnaire was to control if possible changes in attitudes among test drivers were not due to general changes in attitudes in society. Questionnaires were sent to 840 randomly selected inhabitants in Lund after the ISA trial.

2.2 Behavioural observations

2.2.1 Data logging
All 284 vehicles were equipped with data-logging facilities and a flash-memory. This makes it possible to register and save data among others on speed, speed limit, position, time and date, and voluntary use of the system outside the test area. Data was saved 5 times per second when the vehicle was within the test area and once a second outside the test area. The driving data was logged for one month before the active accelerator pedal was activated.
and then during the entire trial. The logged data was used to analyse changes in speeds fuel-consumption and travel-time.

2.2.2 In-car observations

A selection of 28 drivers, distributed by age group and gender, was observed using the “Wiener Fahrprobe” method (Risser, 1997). Two observers studied the driver on a standardised test-route in an instrumented vehicle where data such as speed, acceleration and distance to the vehicle in front were registered. One of the observers looked at standardised variables such as speed, yielding behaviour and lane keeping, etc., the other observer made “free” observations looking at driver behaviour and interaction with other road-users. The in-car observations were carried out twice, once before the installation of the system in the test drivers’ own cars and once at the end of the trial.

2.3 Studies of system-effects

Field studies were carried out in Lund as well as in a control city, Helsingborg. The objective of the control studies was mainly to keep possible general changes in the traffic-situation under control.

2.3.1 Speed measurements

The aim of speed measurements in field was to reveal if the presence of equipped vehicles in Lund influenced the speed level or time headways in the city. The speed at critical spots, i.e. intersections and zebra crossings was measured with radar gun and on stretches with pneumatic tubes. In connection with tub-measurements of speeds also time headways between vehicles were measured. Control measurements were carried out in the city of Helsingborg.

2.3.2 Interaction studies

The aim of the interaction study was to analyse indirect effects of the active accelerator pedal system in situations where the prevailing speed is lower than the speed limit, and where test drivers have to negotiate on priority with other road users. The situation selected for study by analysing video-recordings was the priority of pedestrians when meeting equipped respective other cars at a pedestrian crossing.

2.3.3 Accidents

The aim of the accident study was to find out whether test drivers’ accident history differed from the “average” Swedish drivers’, and to follow up on any accident that would occur involving a test car, and to find out whether that accident might have any kind of relation to the use of the equipment.

3. RESULTS

Compliance with the speed limits improved among test drivers. Speed reductions were largest on stretches where the speed level without the active accelerator pedal was the highest, often above the speed limit, but the active accelerator pedal also had a clear effect on stretches with a calmer rhythm. Speed reduction was largest in mid-block sections where traffic was undisturbed from side streets, traffic lights or other hindrances. The mean speed of test vehicles in mid-block sections, where the speed level was highest in the before-situation, decreased statistically significantly ($p<0.05$) on arterial streets with double carriage way and speed limit of 70 km/h by 4.9 km/h (from 76.0 to 71.1 km/h); on arterial streets
with double carriage way and speed limit of 50 km/h by 5.0 km/h (from 55.3 to 50.3 km/h); on arterial streets with single carriage way and speed limit of 50 km/h by 3.7 km/h (from 52.8 to 49.1 km/h); on main streets with speed limit of 50 km/h by 2.2 km/h (from 45.5 to 43.3 km/h). On streets with mixed traffic and speed limits of 50 km/h and 30 km/h (where the speed level was already below the speed limit without the active accelerator pedal) the reductions were on average 1.0 km/h and 1.7 km/h respectively, which were not statistically significant (p<0.05). The proportion of vehicle-kilometers above the speed limit decreased significantly: from 36 % to 22 % on "70"-streets, from 28 % till 15 % on "50"-streets and from 34 % to 27 % on "30"-streets.

For approach speeds before intersections and for turning speeds at intersections no statistically significant (p<0.05) differences could be shown.

No signs of spill-over effects in the form of lower speeds or compensatory effects in the form of higher speeds outside the test area could be found. The speeds of test vehicles outside the test area were not influenced on through roads in small villages with a speed limit of 50 km/h and 30 km/h, rural roads with a speed limit of 70 km/h or 90 km/h and motorways with a speed limit of 110 km/h.

The voluntary use of the active accelerator pedal varied among the test drivers from 0 % to 88 % with a mean of 11 %. Women and old drivers used the active accelerator pedal voluntarily to a larger extent than men and young drivers. Test drivers, initially positive to the system, used it voluntarily to a larger extent than the initially negative test drivers. Test drivers, with high yearly mileage, used the system voluntarily to a lesser extent than those with lower yearly mileage.

Travel times changed marginally (decreased by 0.6 %), decreased mostly on streets with a speed limit of 30 km/h (by 5.4 %) while they increased by 0.9 % on streets with a speed limit of 50 km/h and by 1.2 % on streets with a speed limit of 70 km/h.

The reductions in mean speeds indicate a large traffic safety potential according to Nilsson's (1982) power model. On arterial streets the estimated effect on police-reported injury accidents is a decrease by 12 – 17 %, on main streets by 5 - 9 % and on central streets 11 % if all vehicles are driven like our test vehicles. The reductions in the number of fatal accidents are expected to be the double. We also could show reductions in speed variance. Given the relationship between speed variance and accidents, established in earlier studies (Salusjärvi, 1981; Finch, et al. 1994), this means an additional traffic-safety potential. These expected effects on traffic safety, from speed reductions and less speed variance can further be reinforced by better distance keeping to the car ahead, better attention to the traffic environment and better behaviour towards pedestrians.

However, it should be noted that some compensatory behavioural effects could be traced outside the test area. On roads where the system was not active it occurred that the test drivers forgot to slow down when they entered a zone with a lower speed limit or forgot to accelerate when the speed limit was increased. This effect can occur when the system is not active everywhere. It could also be observed that the use of a turning indicator deteriorated when driving with the system in a built-up area.

Fuel consumption per car decreased statistically significantly (p<0.1) by one percent. Emission volumes per car decreased statistically significantly (p<0.05) by 11 % for CO, 7 % for NOx and 8 % for HC.

The majority of the interviewed test drivers think that there is a need for speed control measures and society must undertake such measures. ISA measures are thought to be a
good possibility in this respect. The test drivers think that the active accelerator pedal is an efficient means to improve road safety and experience it as a support in car driving. However, those who need it most are the most negatively inclined to the idea.

Own behaviour was influenced positively with the active accelerator pedal according to some of the test drivers. Some of them noted no behavioural changes but no one said that his/her behaviour changed negatively. However, it was clear that problems with technology disturbed the acceptance level. One conclusion for further research is therefore, that in trials like this the prerequisites for faultless functioning of the test system must be assured.

No system effects on speeds, time headways, traffic volumes or accidents of the fact that 284 vehicles equipped with active accelerator pedals circulated in Lund could be found. The number of equipped vehicles was so small that the possibility of any “contagion” effect was low. ISA vehicles constituted at most only about 1 % of the vehicle fleet in Lund. The results show that this implementation rate and the way the vehicles were driven had little influence on the traffic system.

4. CONCLUSIONS

The results from the evaluation studies revealed that drivers’ speed behaviour improved and only small negative compensatory effects could be found. Compliance with the speed limits increased both according to the test drivers’ own statements and objective measurements.

The test drivers generally think that the active accelerator pedal is efficient for increasing traffic safety and experience it as a support in car driving. However those who would need it mostly are most negative to the idea.

It became clear that technical problems have the potential to disturb practical acceptance, so that the principle of ISA is considered positive but it is added that in practice the equipment will have to function better technically speaking in order to deploy its positive effects.
5. REFERENCES


