

SPAR PAA FARTEN

AN INTELLIGENT SPEED ADAPTATION PROJECT IN DENMARK BASED ON PAY AS YOU DRIVE PRINCIPLES

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ABSTRACT

The paper describes an Intelligent Speed Adaptation (ISA) project in Denmark based on Pay As You Drive principles, which means that the ISA equipment both gives a warning when the driver is speeding but also gives penalty points which reduce a promised bonus at 30 % on the insurance rate. In the project we have developed an On Board Unit (OBU) for ISA with mobile phone (GPRS) connection to a web server, and with an advanced map matching program, and air based map update function. We have developed a speed map for 22,000 km roads, including a web based maintaining tool. The project will proceed in a three year test period involving 300 car drivers as participants in the project, and we have some very primary results from the first 3 months driving. We have problems recruiting participants in the project, until now only 90 have signed a contract to have an OBU installed.

KEYWORDS

Intelligent Speed Adaptation, ISA, Speed Alert, Traffic Safety, Accident, Pay As You Go, Speed Map, Map Matching, On Board Unit, GPS,

BACKGROUND

Most European countries have experienced an almost constant decline in the number of fatalities and injuries in road accidents during the last 25 years. However, in recent years the decline has become smaller, and in some countries it has even changed to an increase. There are strong reasons to believe that if the reduction in the number of accidents is to continue, it will be necessary to use new measures. Intelligent Speed Adaptation (ISA) and other ITS-systems will certainly be a key factor in the road safety effort in the future [1].

ISA is a general term for systems that establish the geospatial position of a car, compare its current position and speed with a digital road map which includes the local speed limits, and it responds if the speed limit is exceeded. The response can take various forms; it can be as a visual and/or audio response; it can register the speed limit violation in an on-board car computer; there can be a built in resistance in the accelerator when the speed limit is exceeded; and eventually it can be made impossible to exceed the speed limit. The different ISA-systems can be classified as informative, advisory, recording, or intervening systems [2].

The INFATI project was the first ISA project in Denmark concerning informative and advi-

sory ISA and carried out at Aalborg University from 1 July 1998 to 31 June 2001. The advisory system was a friendly female voice telling the speed limit and the sentence *You are driving too fast* every 6 seconds when speeding. The project was small consisting of only 24 drivers tested for 6 weeks, but the results from INFATI were promising. The INFATI pilot project resulted in speed reductions of about 5 to 6 km per hour corresponding to approximately a 25 % reduction in the risk of road accidents [3]. Compared to other ISA projects the INFATI project took place in both urban areas and rural areas and it showed that the decrease of speed was largest in rural areas, an interesting result due to the fact that most severe accidents and fatalities happens in rural areas.[4]. The INFATI project also showed that the female voice was very effective as a speed reduction tool [5]. The *Spar paa Farten* project is based on the experience from INFATI.

INTRODUCTION

The target group for this project is primarily young drivers aged 18 - 28 years. This group is known to be overrepresented in road accidents. The statistic tells us that young drivers risk is much times higher than their parent's generation. Taken as a whole this age group is less likely to adhere to speed limits, they are less experienced and they also pay a high insurance rate on their car. The overall purpose of the project is to examine whether equipment for Intelligent Speed Adaptation installed in young drivers' cars, in combination with discounts on insurance rate, can motivate young road users to reduce speed and thus possibly save lives.

Getting insurance cover for a new, young car driver is very expensive in Denmark - about 2000 €/year. The level of insurance rate added to the price of a midrange second hand car, makes it very expensive for youngsters to buy and own a new car.

Based on the insurance companies' experience with the total amount of indemnifications for this group of young people, insurance rate appears to be even more expensive than today's rate. For every 100 € paid as insurance fee 130 € are paid back to the young drivers as indemnification. This fact gives the reason for the design of the project; you can meet the young car drivers need for cheaper insurance rate by rewarding them for respecting the speed limits.

The new project is a collaborative project carried out by Aalborg University, the County of North Jutland, the large Danish insurance company Topdanmark, the computing services company M-tec, Copenhagen University and the Danish Road Safety and Transport Agency. Each partner is responsible for a part of the project: Aalborg University for project development, management and research, The County of North Jutland for developing the digital speed map in cooperation with researchers in geo-informatics at Aalborg University, Topdanmark for administrating the test drivers among their customers and aiding the discounts on the insurance rate, M-tec for developing the ISA equipment and finally the Road Safety and Transport Agency for giving generous financial support and attention to the project. Department of Psychology at Copenhagen University has delivered research assistance including the design and analysis of the attitude questionnaire [10].

As in the previous INFATI study the ISA equipment, the so-called "On Board Unit", OBU, gets the cars position from the GPS receiver. This position is matched onto a digital speed map stored in the OBU. By matching the position and the speed map you get the current speed limit which will be compared to the actual speed of the car. If the car exceeds the speed limit by more than 5 km/h, the OBU gives the driver a verbal warning "you are driving too fast". The warning will be repeated every 6 seconds until the speed is below the speed limit + 5 km/h, and after the second warning the system will ad the speed limit to the



Figure 2 — The On Board Unit

Figures 1 and 2 shows respectively a system diagram and the OBU placed in the car.

The OBU is made up of three components. 1. GPS/GPRS unit with a memory card where the digital map with the speed limits are stored, this unit is placed under the dashboard. 2. Display and loudspeaker placed in the air nozzle, the display shows the speed limit, penalty points for the actual trip and the total number of penalty points. 3. GPS antenna. Here placed in the windscreen, but normally placed behind the rear-view mirror

The system works in the following way:

Every second the OBU receive a position from the GPS. The OBU calculate a position on the digital map, the so called map matching, and shows the actual speed limit in the display, it also compare the speed limit with the actual speed of the car, and as mentioned before, if the car exceeds the speed limit by more than 5 km/h; the OBU gives the driver a verbal warning e. g. “50 – you are driving too fast”. The warning will be repeated every 6 second until the speed is below the speed limit + 5 km/h, and after the second warning the system will give penalty points every 6. second. The penalty point numbers are related to the size of the speeding. The penalty points for the actual trip are shown in the display in the lower right corner, and the total number for the actual period is shown in the lover left corner of the display. For every map matched position, the system also calculate a map matching quality and if the map matching quality is too low (set point controls). The best guess on the speed limit is shown on the display, but in brackets, and the system did not react on speeding. In the project there have been developed a new and advanced map matching algorithm with very high performance. [6]

After a trip the OBU uploads a log file to the web server if there have been speeding on the trip. Every night OBU uploads an error log where, amongst other thing, attempt on cheating is logged. The OBU also upload a one second log, this log is for research purpose only and holds all information logged every one second. When there is these night connection between the OBU and the server, the server also can upload software updates, modifications to the digital speed map and corrections to the penalty points to the OBU. Finally the OBU has a tracking function. If the car is stolen, then the owner calls our hot line, and the hot line will send a SMS to the OBU, and the OBU will return the position of the car.

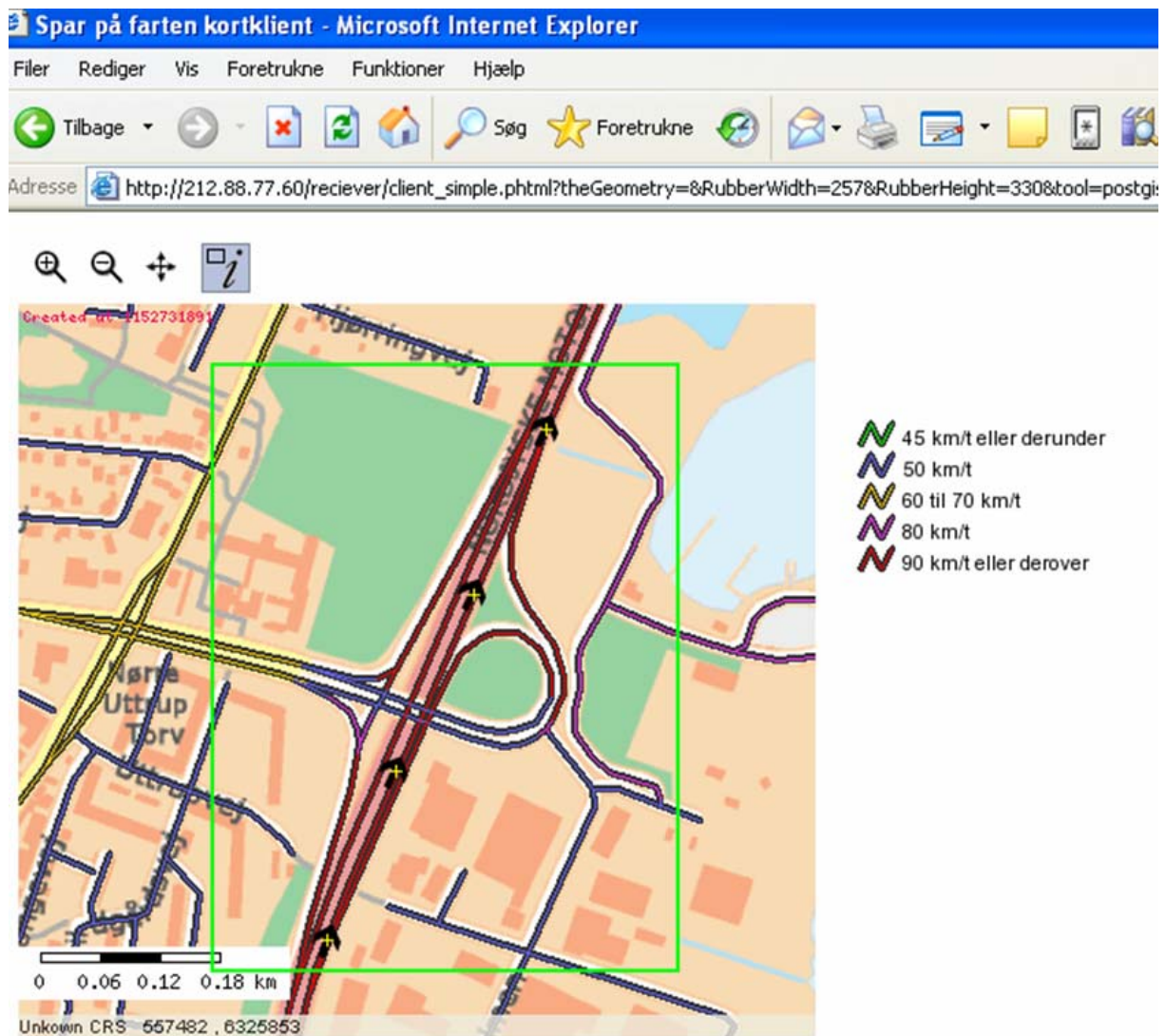


Figure 3 — Screen dump from the web server showing details about penalty points from a trip

After a trip the car driver can log in on the drivers' personal web page and see where and why he had got the penalty points.

Figure 3 shows a driver, who has driven in the northern direction on the motorway the 7th June 2006 at 19:44 when he got penalty points. The speed limit on this place is 90 according to the system. He had got points four times with 6 second between. The first time he got one point because his speed was 107, the second and the third time he got two points because his speed was respectively 112 and 111(the number of points depends on the size of the speeding) the fourth time he had slowed down to 102 and he got only one point.

The purpose with this web page is to give the car driver an opportunity to control the system. If the driver think, that the penalty points is wrong maybe because the digital map has a wrong speed limit or the system has map matched to a wrong road, he can control the system on the web and call the projects hot line to complaint. If he is right the hotline can remove his penalty points and the next night the correction will be send from the web server to the OBU.

THE DEVELOPMENT OF A DIGITAL SPEED MAP AND A WEB APPLICATION FOR LOCAL AUTHORITIES TO UPDATE THE POSITION OF SIGNS

The digital speed map is based on the registration of road signs regarding speed restrictions on the roads for the whole county of North Jutland, about 22,000 km of roads.

The local road authorities are updating the speed map via a new web application (figure 5) when they put up new speed signs, delete existing ones, make changes of speed limits or change the positions of the signs. In this way in theory we always have an updated digital speed map. Practice has shown that maintaining the speed map gives many administrative problems. [7]



Figure 4 — Special designed keyboard for registration speed sign

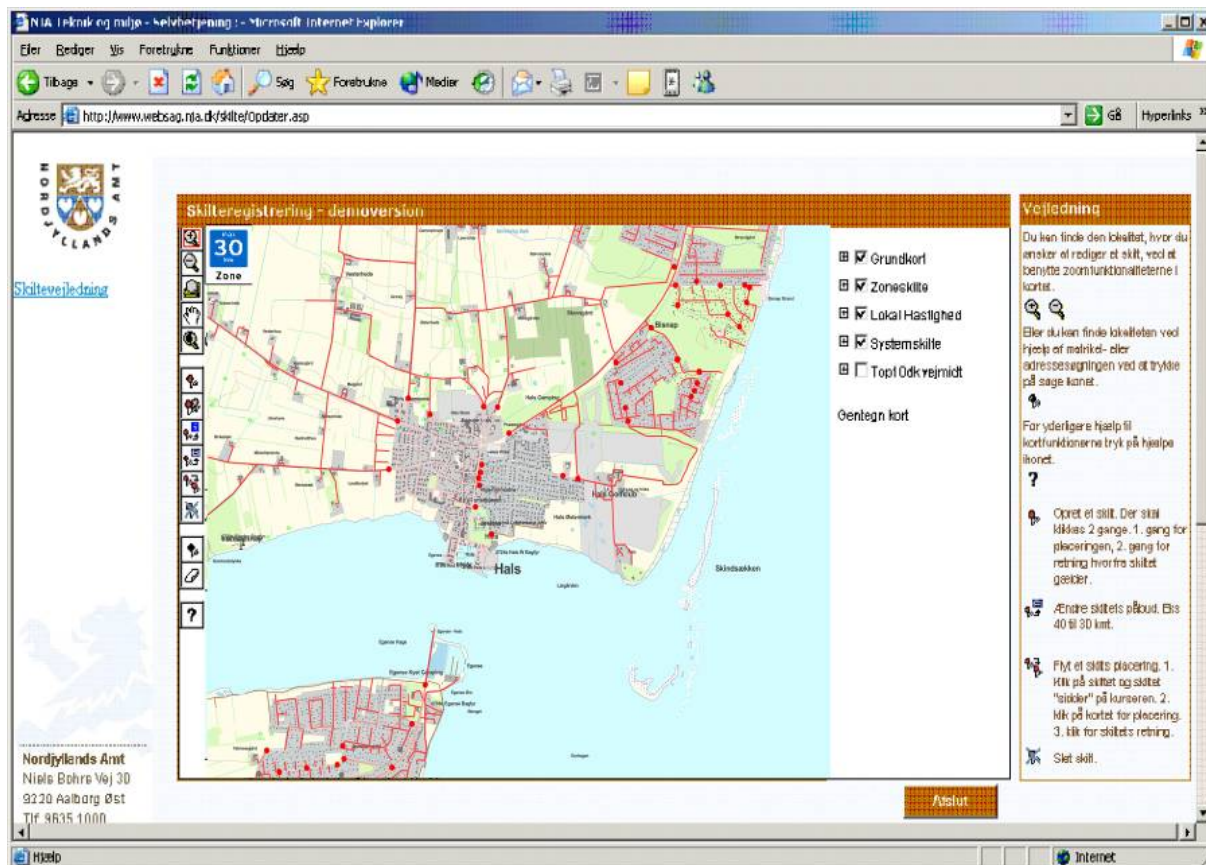


Figure 5 — Web application for maintaining speed map

The detailed digital speed map, including every minor road, only covers the county of North-Jutland. For the rest of Denmark we have incorporated a speed map including all roads with a speed limit on 90 km/h or more. It is only on these roads that the participants are allowed to drive faster than 80 km/h. On all other roads in the rest of Denmark the OBU will react if they exceed 80 km/h. In this way we can prevent the participants from driving wildly when they are outside the borders of North Jutland, but we cannot prevent them from driving too fast in cities for example, where the normal speed limit is 50 km/h. If the car is outside Denmark we have no speed limit data, and the system will have a blank display and will not react on speeding. [8]

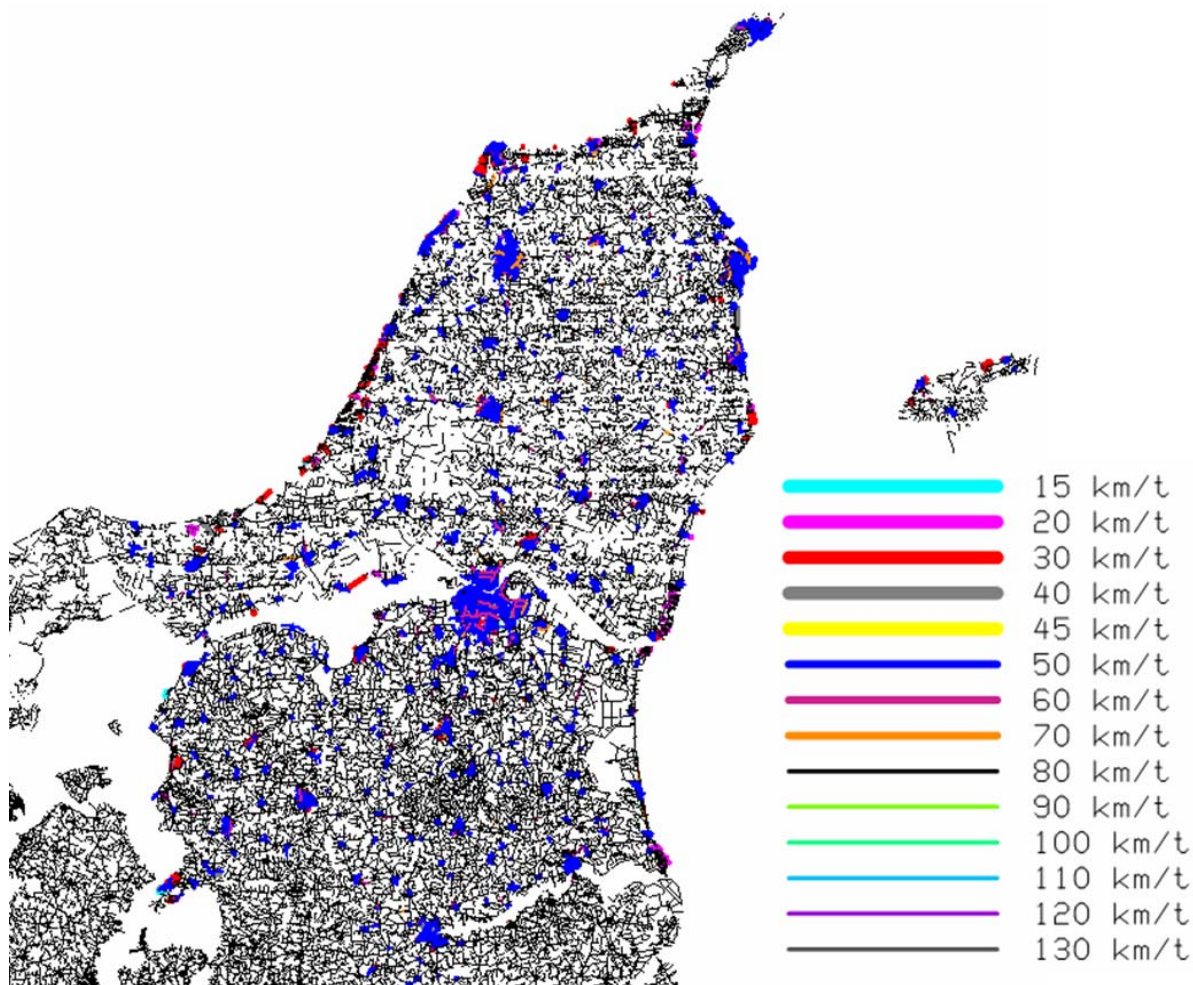


Figure 6 — Digital speed map (22,000 km) in the county of North Jutland

A THREE-YEAR FIELD TEST INVOLVING 300 YOUNG CAR DRIVERS AS PARTICIPANTS

From the starting point the goal was to have 300 young car drivers between 18 and 24 to drive three years in the project. The criteria for participating is that they are car owners and also that they are insured with the participating insurance company, Topdanmark, or are shifting to Topdanmark.

The basis for this goal was that all implemented ISA projects have until now only been running for a relatively short period, e.g. the Lund trial with the Active Acceleration Pedal had a

total test period up to 11 months [9], and many others have been running for an even shorter period. In this project we therefore wished to investigate the development in effect over time. A long test period will also ensure that a large amount of empirical data is collected, and give experience with maintaining speed map. Finally, it will give much operational experience with the ISA equipment.

The three years are divided in 6 periods of 6 months. After every period the drivers get their 30 % bonus on their insurance rate subtracted 7 cent for each penalty point in the period.

Different groups

In the first 6 month period, however, the drivers are distributed randomly in four groups with different modes. The idea is to test the impact of the two incentives in the project: the display with the speed limit and the female voice when speeding and the penalty points. The first 1½ month is for all drivers a before period, where the OBU logs their driving but with the display turned off, and no penalty point is given. After the six week period the drivers are driving in the following groups for the rest of the six month period (4½ month):

Combination group: The display is turned on and the driver receives visual and auditory information about the speed limits and speeding. The lower line on the display is also turned on and the drivers will get penalty points depending on their speeding. The lower line on the display shows the number of penalty points earned on the current trip in the right corner and the total number of penalty points in the current 6 month period in the left corner, see figure 2. After the six months the drivers get 30 % bonus on their insurance rate subtracted 7 cent for each penalty point in the last 4½ month period.

Information group: The display is turned on and the driver receives visual and auditory information about the speed limits and speeding, but no penalty points are given and the lower line in the display are turned off. After six months the group will get the full 30 % bonus.

Incentives group: The display is turned off, but even so the speeding is logged, and the driver gets penalty points. The driver can not see the penalty points when he is driving, but after the trip he can see the points on the web. After the six months the drivers get 30 % bonus on their insurance rate subtracted 7 cent for each penalty point in the last 4½ month period.

Control group: As for the first six weeks, the OBU logs their driving but the display is turned off, and no penalty point are given. This group will after six months get the 30 % bonus without any subtraction for penalty points independent of their speeding.

After the first six months of driving in different groups all drivers are transferred into the

Table 1 Different condition for the four groups in the last 4 ½ month of the first 6 month

| Group | Display on, Female voice on | Full bonus 30 % | Bonus depending the number of penalty points | Access to speeding information on the web server |
|-------|-----------------------------|-----------------|--|--|
| 1 | | x | | |
| 2 | x | x | | |
| 3 | | | x | x |
| 4 | x | | x | x |

combination group, and they stay in that group for the remainder of the 3 years. In this way it becomes possible to compare the relative effect of ISA information and ISA incentives.

Evaluation methodologies and primary results

In the evaluation of the experiment we will use both qualitative and quantitative methods. We will examine the young drivers' attitudes towards respecting the speed limits, and we will compare their attitudes with a control group. A first evaluation is already done, and it shows only small differences between the two groups. Participants and control group members were actually very similar with respect to background, their reporting of accidents and traffic offences and also in their basic attitudes to safe driving. Although participants did not differ from the controls on any single issue, the participants are generally a little more safety oriented or cautious than control group. The participants are, not surprisingly, more positive than the control group in their judgement of ISA. [10].

We will analyse the log data from the participants to examine whether they change their speeding when driving with the OBU. Also here a first evaluation has already been made on the first 38 participants driving in 2x1½ month with and without ISA, and the results are very promising. Participants who both receive information and warnings and get penalty points have on urban 50 km/h roads reduced their speeding from 16 % to 3% of the mileages with "free flow speed" and on rural 80 km/h roads the speeding is reduced from 29% to 2% of the mileages with "free flow speed". [11]

RECRUITING DRIVERS TO THE PROJECT

1. We started the recruiting in September 2005. We sent a letter to 6,000 car owners who were between 18 and 24 years old, and who lived in the County of North Jutland (495,000 inhabitants – Area: 6,173.4 km²), and we advertised for the project through the press, and got good press coverage. At that time the project, because of lack of financing, had a participation fee of 700 € and only 40 signed up as interested. Under these circumstances, the project owner allocated more funding to the project, and the fee could be removed.

2. The second recruitment was carried out in February 2006. Now it was free to participate in the project, but of course the participants must still change their car insurance to the insurance company Topdanmark who is our partner in the project. Topdanmark's market share is 20 % in the County of North Jutland. We also expanded the target group to all car owners who are between 18 and 27 years old, and we sent a personal letter to 11,400 persons in this group. Also this time we got good press coverage. After the promotion we got 180 new persons who was interested and the total number of interested was now 220.

3. In May 2006 the insurance company called about 1,000 of their own customers. There was a positive interest among the young customers, but in the end only very few signed up. The status in September 2006 was 50 signed contracts with young drivers.

4. The third recruitment campaign took place in October 2006. We removed the age limit and invited politicians in the municipalities in North Jutland to participate in the project as ambassadors. We also got fine press coverage this time, and the politicians were very positive and most of them have signed up for the project. The third recruiting round gave 30 more interested persons.

5. In a fourth recruiting round in the spring 2007 students have called 1500 car owners who have a car insurance at the participating insurance company and who pay a high insurance rate. This round has given some more participants, and the status the 1st of May 2007 is that we have 90 signed contracts.

We will continue recruiting participants in the next months, but we can already now conclude that the barriers against ISA are big amongst ordinary car drivers in Denmark, even if there are financial incentives from 300 € and up to 1000 € a year.

CONCLUSIONS AND FUTURE WORK

We are well under way in the project. We have developed a both reliable and advanced ISA system. The participants have web access to their speeding and the system has GPRS based update of the speed map data. We have developed a speed map for 22,000 km roads with a web based maintenance tool. The primary results show promising effects, the speeding on e.g. rural 80 km/h roads is reduced from 29% to 2% of the mileages. But we have not reached our goal of 300 participants; we have learned that the barriers against speeding surveillance in Denmark are big.

In the future months we will try to fulfil the goal of 300 participants and will work with the administrative routines in maintaining the speed map. And then the most interesting work will continue to evaluate the participants' speeding without and with ISA.

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