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PRELIMINARY RESULTS FROM THE DANISH ISA PROJECT SPAR PAA FARTEN - BEHAVIOR

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ABSTRACT

The driving behavior among participants in the Danish Intelligent Speed Adaptation (ISA) project *Spar paa Farten* is described in this paper. The project is the first ISA project based on Pay As You Drive principles. It means that the ISA equipment both gives a warning if the driver is speeding but also gives penalty points which reduce a potential 30% discount on the car insurance. The results are based on the first 38 of planned 300 participants. The key result is that the combination of information and incentive almost eliminates speeding.

KEYWORDS

Intelligent Transport Systems, Intelligent Speed Adaptation, behavior, Traffic Safety, Insurance

INTRODUCTION

In 2001 Europe's grim road accident statistics showed more than 40,000 fatalities and it forced the European Commission to set a target of reducing the number of road fatalities in Europe by 50% in 2010 [1]. However, still in 2005 41,000 people were killed and 1.7 million were severely injured on Europe's roads. To achieve goal set, more has to be done to prevent accidents from occurring in the first place. Intelligent Speed Adaptation (ISA) and other Intelligent Transport Systems (ITS) will certainly be a central tool for reaching this target. [2].

ISA is a general term for systems which compare the speed of a car with the speed limit on the location. In most new ISA projects the geospatial position of a car compares 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. There are various forms of response: it can be as a visual and/or audible response in real time; it can register the speed limit violation on an on-board car computer; resistance to speeding can be built into the accelerator; and speeding can even be made impossible. The different ISA systems can be categorized as informative, advisory, recording, or intervening systems [3].

In the last decade many ISA projects in several European countries and in Australia have shown the potential of ISA. The large-scale Swedish trials in Borlänge, Lidköping, Lund and Umeå during the period 1999-2002 involved almost 5,000 cars. One of the main results was an average speed reduction of 3-5 km/h. [4].

The first ISA project in Denmark was with informative and advisory ISA and was called *INFATI*. It was conducted at Aalborg University from 1998 to June 2001. The actual speed limit was shown on a display while the advisory system using a female voice telling the speed limit and the sentence "*You are driving too fast"* every 6 seconds if speeding. The project was consisting of only 24 drivers tested for 6 weeks, but the results from INFATI were promising. A speed reduction of up to 5 - 6 km/h was found. Compared to other ISA projects the *INFATI* project took place in both urban and rural areas and it indicated that the speed reduction was the largest in rural areas, and hence the acceptance of speed limit was smaller here [5]. It is a remarkable result when keeping in mind that most severe accidents and fatalities happen in rural areas. The *Spar paa Farten* project is based on the experience from the INFATI.

In the Australian TAC Safecar project, which was carried out from 2002 to 2004 in the Melbourne area, a reduction by up to 2.7 km/h was found for the 85 percentile. Moreover, speeding with more than 5 km/h was reduced by up to 65% [6].

Also a recent Swedish ISA project carried out from 2003 to 2005 in Stockholm, Sweden found some promising results. For a speed limit of 30 km/h no changes were registered when the participants were speeding. On roads with speed limits of 50 to 110 km/h a reduction of 1.1 to 2.0 km/h was found. In general the speed was distributed closer to the speed limit when driving with ISA [7]. Furthermore, field trials in Belgium, UK, France and the Netherlands have shown promising results [8], [9].

As shown above the ISA projects in general have shown promising results - especially on roads with high speed limits. None of the ISA projects have tested the impact from Pay As You Drive systems, which will be the main study area in *Spar paa Farten*. The main results in this paper are the impact from ISA using incentive, information and the combination of these actions.

METHODS

Project specification

In *Spar paa Farten* the target group is primarily young drivers aged 18 - 28 years. Statistical studies have shown that this group has a much higher traffic accident risk than their parent's generation. In general this group is more likely to violate the speed limits, they are less experienced and therefore they also pay a high insurance rate on their car. The overall research area of the project is to examine whether equipment for ISA installed in young drivers' cars, in combination with discounts on insurance rate, can motivate young road users to reduce speed and thus improve traffic safety.

The ISA equipment in the project, the so-called "On Board Unit" (OBU) gets the car's position from a GPS receiver. In the OBU the position is matched onto a digital speed map and the actual vehicle speed will be compared with the speed limit on the location. If the car exceeds the speed limit by more than 5 km/h, the driver receives a verbal warning. The

warning will be repeated every 6 seconds until the speed is below the speed limit + 5 km/h again. The third and the subsequent warnings give penalty points. The number of penalty points increases gradually so a small violation gives less penalty points than a serious and dangerous violation. Each second the OBU generates a GPS based position including i.e. the speed limit, actual speed, position and quality of the map matching. These data are transferred via GPRS to a database for research and the penalty points are available for the participants on a webpage. For more information about *Spar paa Farten* see Lahrmann et al. 2006 [10].

Initially, the participant will get 30% discount on the insurance rate. Every six months the discount will be sent to the driver deducted the penalty points, which is valued at 7 Euro cents each. The discount can not be negative.

Experimental set-up and data material

In *Spar paa Farten* the participants will have the equipment in their cars for 3 years in total. However, to determine the impact of the equipment, a 1½ month baseline period in the initial project period is practised. In this period the participants are driving with the display and the voice message switched off so their "normal" driving is recorded. In the next 4½ months the participants are randomly distributed in four different groups as shown in figure 1.

		Incentive	
		-	**+**
Information	**-**	**Control group** The participant receives neither information nor warnings or penalty points and continues like in the first 1½ month.	**Incentive group** The display and the voice message are switched off and no information or warnings are given. The participant gets penalty points if speeding.
	+	**Information group** The display and the voice message are connected and information and warnings are given. Speeding gives no penalty points.	**Combination group** The participant receives information and warnings and gets penalty points if speeding.

Figure 1 - The four groups.

By comparing the driving behavior in these four groups with the baseline period the impact of incentive, information and the combination of these will be measured. In the remaining 2½ years all the participants will drive in the combination mode.

In this paper the impact from ISA in the baseline period will be compared with the next 1½ months, subsequent named the effect period. In all, 38 participants are researched in this study. There are 9 in the information group, 10 in the incentive group, 10 in the combination group and 9 in the control group.

In these first three months the 38 participants have driven app. 156,000 km. The distribution on roads with different speed limits is mostly concentrated on the following:

- Roads with a 50 km/h speed limit, which is the normal speed limit in urban areas (subsequently named as 50 km roads etc.),

- Roads with a 80 km/h speed limit, which is the normal speed limit in rural areas and

- Roads with a 110/130 km/h speed limit, which is the normal speed limit on motorways.

In all, 87% of the 156,000 km is driven on these roads, and hence the below-mentioned results are based on mileage on roads with these speed limits.

These 156,000 km are registered by 11.9 million GPS positions in all. This number of data corresponds to approximately one hour of driving per participant each day.

Research procedure

All results concerning speeding are based on mileage and not the time spend. Time used is primarily useful when average speed and travel time is studied. When studying speeding, the use of time can bias the results, since a large violation of the speed limit will be underestimated compared to a minor one. To document the impact of the ISA equipment results are studied as mentioned below.

Due to the fact that the ISA equipment in *Spar paa Farten* starts to give warnings and penalty points if the speed limit is exceeded by more than 5 km/h, the part of speeding above this speed will be compared.

When studying the impact on free flow speed, it is important to avoid bias from congestions and idling. To avoid this bias, free flow speed is defined as the average speed for all periods when the speed is above the speed limit minus 10 km/h.

Due to the fact that large variations of speed seem to increase the number of accidents the variation of speed is studied [11]. A reduced speed deviation therefore indicates that the ISA equipment can reduce the number of accidents more than just related to the reduction of speed.

RESULTS

Percentage of speeding

Figure 2 and 3 show the percentage of the driven kilometers which were driven with a speed exceeding the speed limit with more than 5 km/h in the four groups incentive, information, combination and control in the baseline and effect periods.

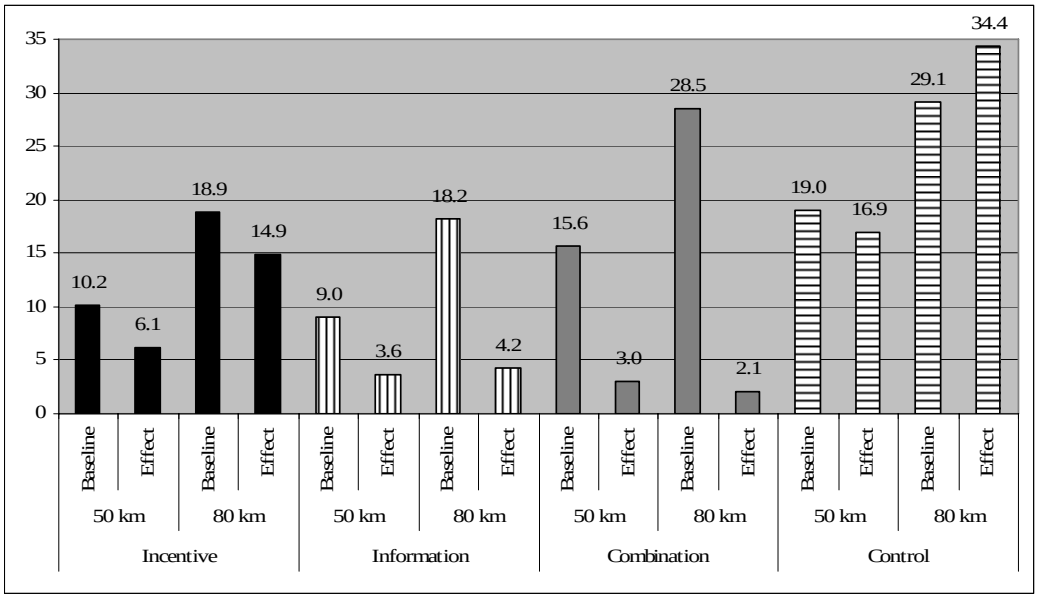

Figure 2. Percentage mileage exceeding the speed limit with more than 5 km/h on 50 and 80 km roads.

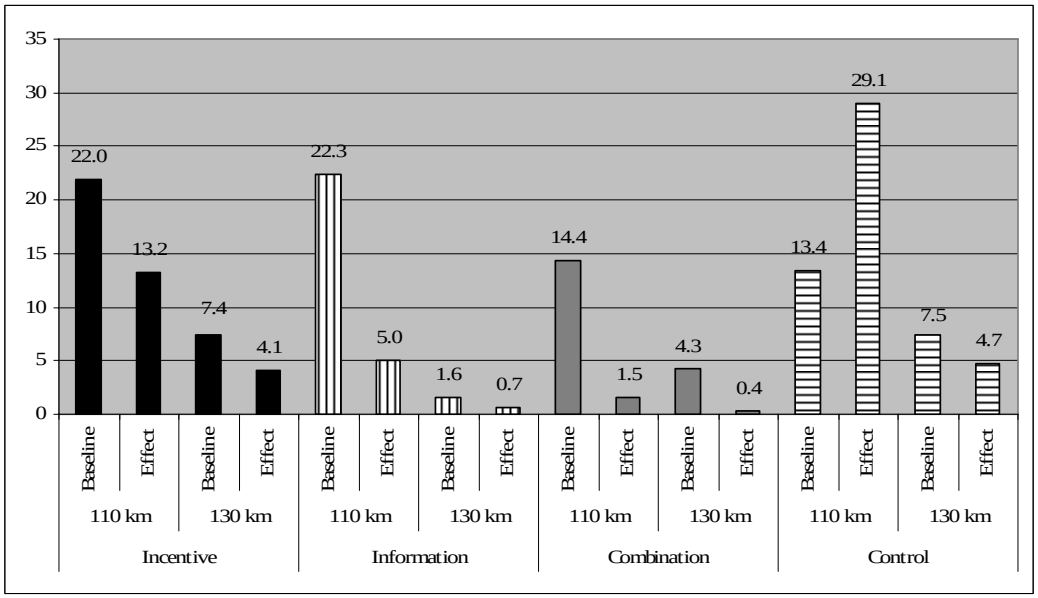

Figure 3. Percentage mileage exceeding the speed limit with more than 5 km/h on 110 and 130 km roads.

It is evident that the largest impact from ISA is found on rural roads with a speed limit at 80 km/h and to some extent on motorways with a speed limit at 110 km/h and on urban 50 km roads. As mentioned earlier, experiences from the INFATI project showed that people have a higher acceptance of urban speed limits than rural, so relating to this, a bigger impact on 80 km roads and 110 km roads can be explained. Also questionnaires to young Danish car owners have shown that they have the lowest acceptance of speed limit at 80 km/h and a higher one for the speed limits on both urban roads and slightly on motorways [12].

Furthermore, it is likely that a large part of the car users consider that 130 km/h is fast enough. Hence, the following analysis will mainly be focused on behavior on roads with speed limits of 50, 80 and in part 110 and 130 km/h. The apparently negative impact on the control group is discussed later.

When comparing the four modes, it seems clear that the impact of incentive in this first phase of the trial is limited, with a reduction by 4.1 percentage points on 50 km roads and 4.0 on 80 km roads. On 110 km/h roads the reduction is 8.8 percentage points and 3.3 on 130 km/h roads. For participants receiving information without incentive the reduction is 5.4, 14.0, 17.3 and 0.9 percentage points for the four road types and hence a far better result. When receiving both incentive and information the results are even better on 50 and 80 km roads, 12.6, 26.4, 12.9 and 3.9 percentage points for 50 km roads 80 km roads, 110 km roads and 130 km roads, respectively. For participants in the control group the reduction has been 2.1 and 2.8 for the 50 and 130 km roads, respectively, while an increase has been observed by 5.3 and 15.7 percentage points on 80 and 110 km roads. The increasing speeding in the control group will be discussed later.

An analysis of variance is made on the proportion of driven kilometres above the speed limit + 5 km/h divided for each participant in the baseline and effect period. On 80 km roads the impact from both incentive and information are statistical significant with p=0.03 and p=0.01, respectively. The impact from the combination is significant better than the two previously mentioned ($p<0.001$). Also on 50 km roads impact from information is statistical significant p=0.007 while the impact from incentive with p=0.059 tends to be statistical significant. The impact from the combination is again significant better than the two previously mentioned ($p<0.001$).

It appears as expected that a combination of incentive and information has a better impact than each of the two. It is especially clear on 80 km roads, where speeding with more than 5 km/h has essentially disappeared.

Free flow speed

The free flow speed shows the impact on speeds close to or above speed limit. Hence, the average speed when it is above the speed limit minus 10 km/h is compared. See table 4.

Table 4 - Impact on free flow speed. km/h.

	Speed limit											
	50 km/h			80 km/h			110 km/h			130 km/h		
	Baseline	Effect	Impact	Baseline	Effect	Impact	Baseline	Effect	Impact	Baseline	Effect	Impact
Incentive	47.8	47.2	-0.6	80.6	79.7	-0.9	111.8	110.6	-1.2	128.2	126.9	-1.3
Information	47.9	47.2	-0.7	81.1	79.3	-1.7	111.2	108.6	-2.6	124.4	125.2	0.8
Combination	49.6	47.2	**-2.4**	83.5	78.7	**-4.8**	110.9	109.2	-1.7	127.1	126.9	-0.2
Control	50.2	50.1	-0.1	83.7	85.6	1.9	111.1	113.2	2.1	129.1	127.2	-1.9

Unsurprisingly, the same trends as mentioned above can be found when studying free flow speed. On 50 km/h roads only minor change in the free flow speed is found for the incentive and information group. The impact on 80 km roads is slightly larger with 0.9 km/h for the incentive group and 1.8 km/h for the information group. For the combination group a reduction by 2.4 and 4.8 km/h respectively on 50 and 80 km roads is observed while the control group hardly changes on urban roads and increases the speed by 1.9 km/h on rural roads. On 110 km roads small reductions have been observed for all groups except for the control group, where a smaller increase is observed. On 130 km roads no clear impact is found and the changes are probably based on random behavior.

Speed variation

Speed variation indicates the range of speed on a road. If it is small it means that most of the traffic is driving at an almost similar speed. The impact on speed variation on 50 and 80 km roads from the ISA equipment is calculated on the free flow data and appears in figure 5 - 12.

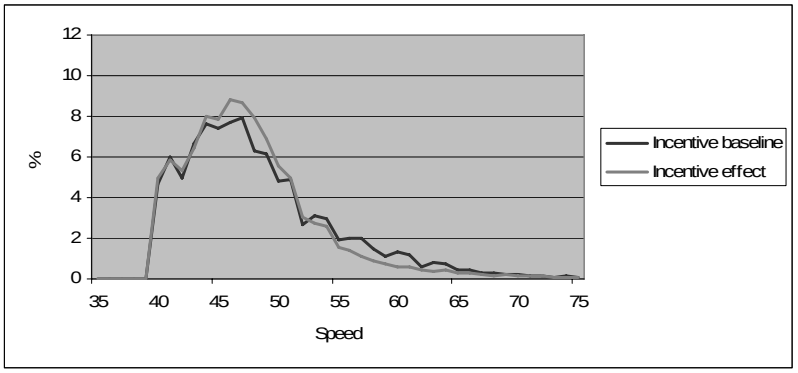

Figure 5 - Speed variation on 50 km roads for the incentive group.

In the incentive group only minor changes in the speed variation have been observed from baseline to effect period. The proportion above 55 km/h is reduced slightly and the standard deviation is reduced from 7.0 to 6.5 km.

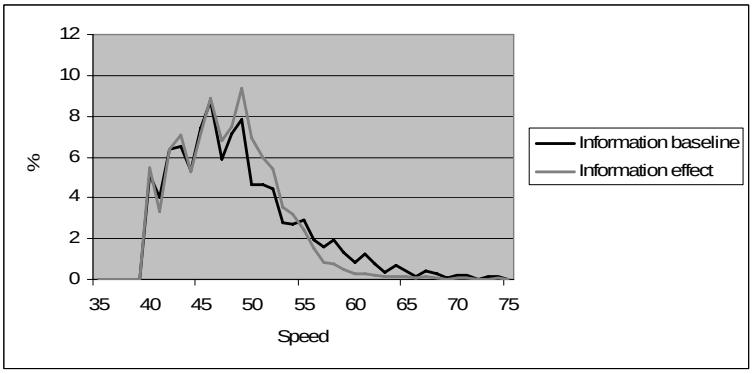

Figure 6 - Speed variation on 50 km roads for the information group.

Also the changes in speed variation for the information group have been observed from baseline to effect. The proportion near the speed limit is increased slightly and the proportion above 55 km/h is much reduced. The standard deviation has changed from 6.6 to 5.0 km.

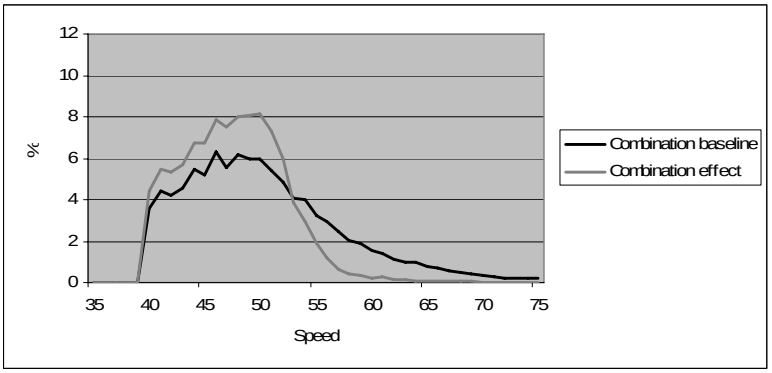

Figure 7 - Speed variation on 50 km roads for the combination group.

In the combination group the standard deviation has decreased the most from 8.5 to 5.4 km and the proportion above 55 km/h is minimal.

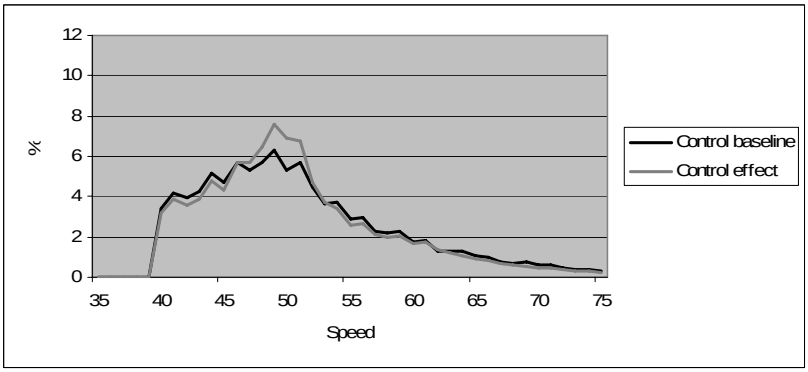

Figure 8 - Speed variation on 50 km roads for the control group.

Only minor changes in the control group are observed. However, a small increase of mileage near 50 km/h has been observed and the standard deviation has decreased slightly from 8.4 to 8.0 km.

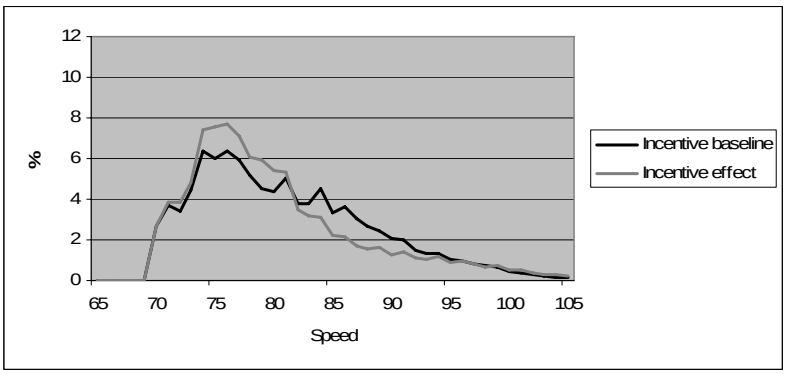

Figure 9 - Speed variation on 80 km roads for the incentive group.

In the incentive group only minor changes in the speed variation has been observed from baseline to effect on 80 km roads. The proportion above the limit is reduced slightly and the standard deviation is unchanged 7.9 km.

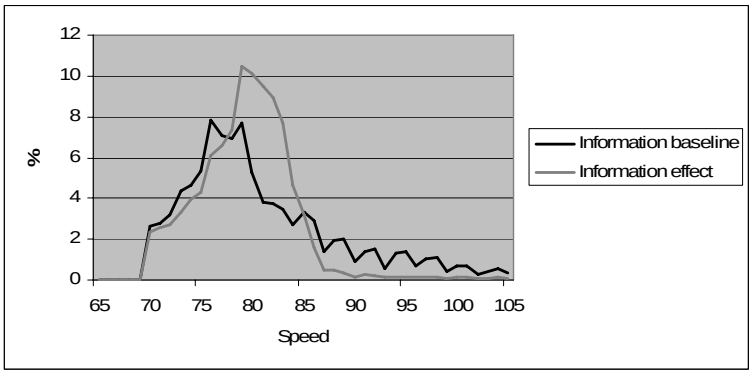

Figure 10 - Speed variation on 80 km roads for the information group.

In the information group the proportion near the speed limit is increased and the proportion above 85 km/h is much reduced. The standard deviation has changed from 9.8 to 6.0 km.

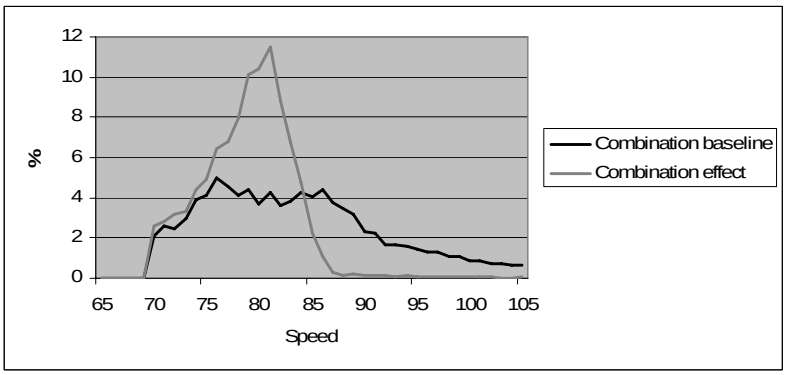

Figure 11 - Speed variation on 80 km roads for the combination group.

In the combination group the standard deviation has decreased the most from 10.1 to 4.5 km and the proportion above 85 km/h has almost disappeared.

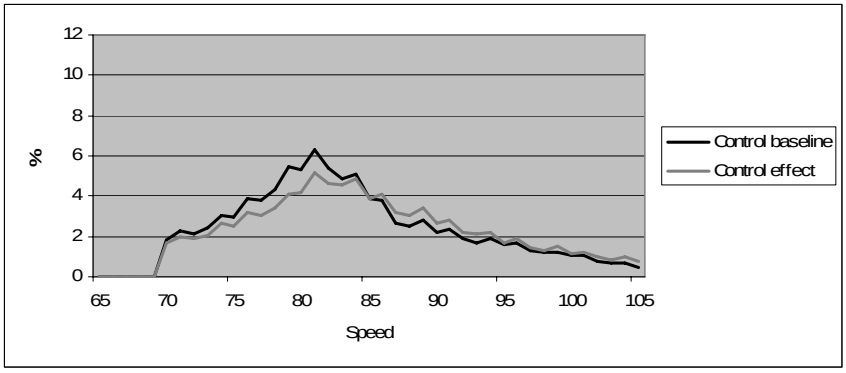

Figure 12 - Speed variation on 80 km roads for the control group.

Only minor changes in the control group are observed, but the standard deviation has increased from 9.8 to 11.8 km.

The study of the speed variation curves for the four groups and two speed limits shows that the ISA equipment gives a clear decrease in the speed variation, and it is most explicit for the combination group, less for the information group and least for the incentive group. A decrease which with reference to the literature will give improved traffic safety for the drivers [11]. The results are most clear on 80 km roads, but the same tendency can to some extents be observed on the 50 km roads.

DISCUSSION

The results seem quite clear and substantial for the combination group, The information group has minor but also promising results, while the incentive group in these first short “effect measurement” only had minor change in their speeding. The future will show if these tendencies will last, but a hypothesis could be, that the effect on the information group will decrease as times goes by and that the effect on incentive group will increase when the group realize the number of penalty points they have got. This hypothesis and many others will be tested when the first 6 month period is finished. These primary results are based on only a few participants and only a short time, and there are good reasons to believe, that there will be many results with high validity when all data are collected.

The participants in the control group have increased their general speed in the effect period. The most likely explanation for this result is that the control group in the beginning is aware of the equipment, and that this awareness is decreasing as time goes by. If this tendency will last in the remaining part of the 4.5 months it can be concluded that the impact from the ISA-equipment, and hence the recorded results are even more substantial than noted.

CONCLUSION

These preliminary results from the first ISA project based on Pay As You Drive principles are very promising. When data from all the expected participants are studied, it might give more reliable results, but the first results show that both information and to some extent economic incentive about speeding, reduce the test drivers speeding. The results also show that a combination of these gives the largest reduction in speeding and that speeding by more than 5 km/h is almost eliminated among drivers in this group. The control group has shown a minor unsubstantial increase in speed. These results indicate that even though the test period has been short and the number of participants has been limited the main results are in all likelihood reliable.

The results for participants who both receive information and warnings and get penalty points if speeding has reduced their free flow speed by 2.4 km/h on urban 50 km roads and 4.8 km/h on rural 80 km roads. On motorways the impact is infinitesimal. In addition on 50 km/h roads the percentage of mileage with speeding above 5 km/h has been reduced from 16% to 3% while the results on rural 80 km roads are as high as a reduction from 29% to 2%. These results are statistical significant.

So it seems that the *Spar paa Farten* concept has the best impact on 80 km roads, where speeding is almost eliminated. Moreover the speed variation on rural 80 km roads is reduced with 55%. No clear results were recorded concerning average travel speed.

In general the equipment from *Spar paa Farten* shows best impact on driving behavior on rural roads with a speed limit of 80 km/h.

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