

How does the use of ISA affect drivers' attitude towards the system?

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Several studies have shown that different systems for Intelligent Speed Adaptation (ISA) are effective ways to reduce the speeds on our roads. As it is well known that excessive speeds contribute to both the number and the outcome of road accidents with fatalities, reduced speeds would be a positive step towards a safer traffic environment. In order to make it possible to implement ISA on a large scale it is of great importance that the public accept these new support systems. To make this happen we need to find out what drivers think about these systems both before and after they've gained personal experience of them. We also need to know how the drivers' driving experience is affected by the systems. During the large-scale ISA field trials in Sweden an informative ISA speed-warning device was tested in the city of Borlänge. This device continuously informed the drivers of the current speed limit and warned them, with a flashing red light and sound signals, if they exceeded this limit. More than 150 test drivers were asked about their opinion towards the device both before and after they gained personal experience of it. They were also asked how their driving experience was affected by having the device installed in their vehicles. The results show that using the device actually affected the drivers' attitude towards the system in both positive and negative ways. They also show how the device is perceived by the drivers and what is seen as positive and negative with the device and its affect on the driving experience as a whole.

Keywords: ISA; Attitude; Acceptance; Personal Experience

Intelligent Speed Adaptation has during recent years received a lot of attention as a measure to keep the speeds on our streets and roads down (see Carsten, 2002, for an overview). As it is well known that excessive speeds contribute to both the number and the outcome of road accidents, reduced speeds would be a positive step towards a safer traffic environment. To enable this, different techniques have been used - ranging from advisory to intervening. Advisory systems just convey information about the current speed limit to the drivers and it is then up to them whether to use or neglect this information. Intervening systems, on the other hand, can be constructed to make it impossible for the drivers to exceed the speed limit. It has already been shown that different ISA-systems, when implemented, successfully affect the drivers' speed behaviour (Hjälmdahl, 2004; Vägverket, Swedish National Road Administration, 2002).

Whereas excellent system performance is a prerequisite for this new technique to be effective, it is equally important that the systems are accepted by the drivers – not the least when it comes to large scale implementation. One important factor affecting driver's acceptance is their personal experience of the system. The Swedish large-scale field trials with ISA presented an excellent opportunity to examine the test drivers' attitudes towards an informative ISA speed-warning device after the test drivers had gained personal experience of the system.

Between 1999 and 2002 the Swedish Road Administration funded large-scale field trials with approximately 4500 vehicles in four different cities. The cities differed with respect to the number of test vehicles as well as the ISA-devices used (Swedish National Road Administration, 1999, 2002). In the city of Borlänge, an informative ISA speed-warning device was installed in approximately 400 vehicles (250 private, 150 commercial). The device was, in principle, a navigation system based on a digital map covering approximately 700 km of roads within the city of Borlänge and four main roads leaving the city. Using GPS technology and map matching, the device continuously monitored where the vehicle was and with which speed it was travelling. It then compared this information with the digital map that included speed limits, and informed the test drivers of the current speed limit at their present position. If the speed limit was exceeded the test drivers were warned with a flashing red light and sound signals. In addition to this, the device continuously logged the test drivers' behaviour with regards to, for example, speeding. The test drivers also had to complete several questionnaires.

The aim of this study is to examine how the use of an informative ISA speed-warning device affects the drivers' attitude towards the system.

Method

Test drivers

In 1999 private test drivers were recruited among 1000 randomly selected car owners (with cars no older than from 1984) in the town of Borlänge. Approximately one year later a new recruitment was made among an additional 2000 randomly selected car owners in the area. A total of approximately 250 car owners and their co-drivers (other family members that regularly used the vehicle) chose to participate in the project and were sent the additional three questionnaires that this study is based on. Out of these 250 car owners and their co-drivers, a total of 161 test drivers drove their vehicle more than 45% of the time the vehicle was driven and completed the three questionnaires.

The test drivers' age ranged from 24 to 79 years old, with a mean of 55 years. Seventy percent of the test drivers were men while 30% were women. The skewed distribution can to some extent be explained by the fact that 68% of the total number of car owners, in the Borlänge municipal area, are men and the car owners average age is 50 years (H. Granlund, Swedish Road Administration, personal communication, December 11th 2003).

Procedure

Logged Speeding

After recruitment, an informative ISA speed-warning device was installed in the test drivers' vehicles. During the first two to four weeks the device logged the test drivers' behaviour but the warning system was not yet activated. This meant that the test drivers did not get any information about the current speed limit or any warning signals if this limit was exceeded. After this period the warning system was activated and the test drivers were warned with a flashing red light and sound signals if the speed limit was exceeded. In addition to this, the device continuously logged the test drivers' behaviour and by using GSM technique the logged data was collected from the vehicles. The data was then gathered and stored in a central Microsoft SQL-server database (version 7.0) where analyses of the logged data could be performed. For further technical description see Myhrberg, Holting and Brus (2002). To give the test drivers some margin the measure of speeding behaviour was taken as the total time exceeding the speed limits by at least 2 km/h, divided by the total time driven. The speeds measured by the device were all based on the vehicles actual speeds measured by

GPS. These speeds did not necessarily correspond to the speeds shown on the vehicles speedometers. This is due to the fact that most car manufacturers are using a margin so that the speed shown on the speedometers is somewhat higher than the vehicles actual speed.

The size of this margin differs between brands but on average the speedometers in most of the test drivers' vehicles showed a speeding rate of approximately 7 km/h when the device measured a 2 km/h excess in speed.

Questionnaires

The test drivers also received several questionnaires, of which three are used in this study. The first of these three was distributed in March 2000 after the test drivers had had the informative ISA speed-warning device installed in their vehicles, but before the warning system had been activated. The second questionnaire was distributed to the test drivers after they had driven with the device activated for approximately one month which meant that they received this questionnaire at somewhat different times depending on when they joined the project. Finally, the last questionnaire was distributed in December 2001 after they had driven with the device for up to 14 month. At this point the warning system had just been inactivated again. The questionnaires included questions about how the test drivers thought their driving experience would be affected by having the device installed in their vehicles, and later on how they actually were affected. In the end of the project the test drivers' acceptance of the informative ISA speed-warning device was measured using a Swedish acceptance-scale based on the Van der Laan *et al.* scale from 1997. In addition to this the test drivers had to evaluate when and for whom the informative ISA speed-warning device was desirable. Several sections dealing with other aspects of speed and road safety were also included but because this article is only concerned with the test drivers' perception of the device tested, these other issues will not be addressed here.

Analyses

To decide whether the test drivers' gained experience had affected their attitude towards the informative ISA speed-warning device a Paired-Samples T-test was used. The period just after activation and the period approximately 14 months after activation, were compared with the data collected during the period before activation. Missing values for items included in the T-test were replaced by series mean.

Results

Table 1 shows that during the period after the informative ISA speed-warning device was installed in the vehicles, but before it was activated, the test drivers drove above the speed limit for 13.9% to 22.7% of the total time driven. After activation the time spent above the speed limit decreased to between 4.9% and 9.3%. After the test drivers had been driving with the device for over a year the initial effect of the device had been reduced, and 10.7% to 16.8% of the total time driven was now spent above the speed limit. On roads with a 70 km/h speed limit the effect of the device was no longer significant during 2001.

Table 1. Mean and standard deviation for the quotient of time driven 2 km/h or more above the speed limit and total time driven. (n=161)

Compared to Before Activation the difference is: *** significant on 0.1% level; * significant on 5% level

Speed limit (km/h)	Before Activation		After Activation		2001	
	Time above limit		Time above limit		Time above limit	
	M (%)	SD	M (%)	SD	M (%)	SD
50	22.7	17.8	9.3***	9.8	16.8***	12.4
70	14.6	16.3	5.5***	7.0	12.3	11.7
90	13.9	17.6	4.9***	8.1	10.7*	12.1

Table 2 shows what expectations the test drivers had on the informative ISA speed-warning device to affect their driving experience. The test drivers' highest expectation, before activation of the device, concerned the feeling of being controlled where the test drivers thought that their feeling of being controlled would increase when the device was activated. During the periods just after activation and more than a year after activation, respectively, it was shown that the drivers' feeling of being controlled was significantly lower than expected.

More than a year after the device had been activated the test drivers also thought that their travel time in urban areas had increased less than what they had expected before activation of the device. On the other hand, they thought that their feeling of irritation in traffic had increased more than expected.

The test drivers' lowest expectation, before activation of the device, concerned the feeling of being stressed. The test drivers did not think that activation of the device would make them either less or more stressed in traffic. This was confirmed after activation where no significant differences concerning level of stress were recorded.

Table 2. The test drivers' opinion of how the informative ISA speed-warning device affects their driving experience. (n=161)

Compared to Before Activation the difference is: *** significant on 0.1% level, ** significant on 1% level

Driving experience	Before		After		2001	
	Activation		Activation			
	M	SD	M	SD	M	SD
<i>1=Decrease a lot</i>						
<i>5=Increase a lot</i>						
Feeling controlled	3.58	0.54	3.42**	0.61	3.29***	0.59
Safety in traffic	3.41	0.59	3.37	0.68	3.42	0.64
Attention of pedestrians	3.24	0.46	3.22	0.52	3.15	0.46
Travel time in urban areas	3.22	0.50	3.18	0.44	3.12*	0.47
Irritation in traffic	3.05	0.58	3.11	0.70	3.22**	0.66
Stress in traffic	3.04	0.54	3.00	0.68	3.08	0.67

Table 3 shows what affect the informative ISA speed-warning device had on the test drivers driving in general after extended use of the device. The largest effects were found for the feeling of being in the way for others and the amount of time spent looking at the speedometer, which the test drivers experienced had increased after activation of the device.

After the test drivers had driven with the device installed for more than a year there was a significant decrease in how much time the test drivers felt they needed to spend looking at the speedometer.

After having driven with the device for more than a year the test drivers also experienced a significant increase in how much better they were as drivers compared to what they had felt during the period just after activation.

Table 3. The test drivers' opinion of how the informative ISA speed-warning device affects their driving. (n=161)

*Compared to Before Activation the difference is: *** significant on 0.1% level, ** significant on 1% level*

Affect on driving	After Activation		2001	
	M	SD	M	SD
<i>1=Much less</i>				
<i>5=Much more</i>				
Feeling of being in the way	3.79	0.73	3.89	0.72
Looking at the speedometer	3.53	1.11	3.26 ^{***}	1.13
Need for paying attention	3.34	0.79	3.29	0.88
Feeling of frustration	3.25	0.76	3.32	0.80
Feeling of time pressure	3.20	0.62	3.16	0.64
Need for effort	3.17	0.64	3.08	0.72
Need for accelerating/braking	3.12	0.83	2.99	0.91
Being a better driver				
<i>1=Much worse, 5=Much better</i>	3.40	0.62	3.54 ^{**}	0.68

After the test drivers had been driving with the informative ISA speed-warning device for more than a year they were asked to evaluate the device on an acceptance-scale and to report when and for whom it was desirable to have a device installed.

A principal component factor analysis with varimax rotation was used and two factors were extracted using the Kaiser criterion of eigenvalues over 1.0 and the Catell scree plot test. The first factor explained 34.2% of the variance while the second explained another 32.7% of the remaining variance. In accordance with Van der Laan *et al.* (1997) the first factor was named *usefulness* and as table 4 shows it included items concerning clearness, informativeness, effectiveness and importance. The second factor was named *satisfying* and included items concerning agreeability, niceness, calmness and pleasantness. The item good/bad loaded more or less equal on the two factors. For clarity all factor loadings smaller than 0.30 have been excluded from the table.

In general the items included in the *usefulness* factor scored higher (were more positively received) than the items included in the *satisfying* factor.

Table 4. The test drivers' opinion of the informative ISA speed-warning device in 2001.

I think the informative ISA speed-warning device is: 1-7	M	SD	Factor 1	Factor 2	n
			Usefulness	Satisfying	
Unclear - Clear	6.11	1.19	.819		158
Confusing - Informative	5.98	1.46	.800		159
Ineffective - Effective	5.84	1.40	.778	.341	159
Unimportant - Important	5.80	1.41	.771	.359	158
Bad - Good	6.03	1.20	.574	.432	160
Disagreeable - Agreeable	4.51	1.47		.864	158
Ugly – Nice	4.61	1.45		.559	159
Irritating - Calming	4.27	1.61		.857	158
Unpleasant - Pleasant	4.61	1.45		.823	157

Table 5 shows when the test drivers thought it was desirable to have an informative ISA speed-warning device installed. In general the test drivers thought that it was more desirable to have a device installed when driving on roads with a low speed limit (30 km/h and 50 km/h) compared to when driving on roads with a high speed limit (90 km/h and 110 km/h). They also thought that it was more desirable to have a device installed while driving in busy traffic than while driving under calmer traffic conditions.

Table 5. The test drivers' opinion of how desirable an informative ISA speed-warning device is during different conditions.

How desirable is it to have an informative ISA speed-warning device:	2001		
	M	SD	n
<i>1=Not at all desirable</i>			
<i>5=Very desirable</i>			
at schools and day nurseries with 30 km/h speed limit?	4.50	0.80	159
at schools and day nurseries with 50 km/h speed limit?	4.33	0.90	160
in housing estates with 30 km/h speed limit?	4.21	1.01	160
in urban areas with 30 km/h speed limit?	4.16	1.02	160
in housing estates with 50 km/h speed limit?	4.04	0.95	158
in urban areas with 50 km/h speed limit?	3.95	1.00	159
in urban areas during daytime?	3.81	1.02	160
in urban areas during rush hour?	3.76	1.06	160
in urban areas with 70 km/h speed limit?	3.74	1.01	160
in urban areas during low traffic?	3.44	1.11	157
in rural areas with 70 km/h speed limit?	3.40	1.10	159
in urban areas during night time?	3.36	1.14	159
in rural areas with 90 km/h speed limit?	3.11	1.17	159
in rural areas with 110 km/h speed limit?	2.83	1.19	158
on motorways with 110 km/h speed limit?	2.66	1.21	158

Table 6 shows for whom the test drivers thought it was desirable to have an informative ISA speed-warning device installed. In general the test drivers thought that it was more desirable to have a device installed for drivers who repeatedly had been convicted for speeding and for drivers that were inexperienced. For elderly drivers and for commercial- or private drivers in general the test drivers thought it was less desirable to have a device installed.

Table 6. The test drivers' opinion of how desirable an informative ISA speed-warning device is for different types of drivers.

How desirable is an informative ISA speed-warning device for:

	2001		
	M	SD	n
<i>1=Not at all desirable</i>			
<i>5=Very desirable</i>			
drivers who have repeatedly been convicted for speeding?	4.66	0.71	160
drivers who recently received their driving licence?	4.52	0.72	159
young private drivers?	4.45	0.78	159
commercial drivers transporting children to school?	4.43	0.85	159
bus drivers?	4.38	0.87	159
taxi drivers?	4.14	1.01	159
truck drivers?	4.13	1.01	159
all commercial drivers?	4.07	1.03	159
elderly private drivers?	4.01	0.97	158
all private car drivers?	3.82	1.08	159

Table 7 shows what the test drivers thought of the informative ISA speed-warning device as a measure to make drivers keep to the speed limit. Before the device was activated the test drivers were asked what they thought of the device in general as a measure to make drivers keep the speed limit. On average the test drivers considered the device to be a good measure for both urban and rural areas. When they had driven with the device activated for approximately a month and more than a year, respectively, they were asked the same question again. They still thought that the device was a good measure to make drivers keep to the speed limit but after using the device for more than a year their evaluation of it had decreased for both urban and rural areas, even though this decrease was only significant for urban areas.

Table 7. What do you think about an informative ISA speed-warning device as a measure to make drivers keep to the speed limits?

(1=Very Bad, 3=Neither good or bad, 5=Very Good) (n=161)

*Compared to Before Activation the difference is: * significant on 5% level*

Area	Before Activation		After Activation		2001	
	M	SD	M	SD	M	SD
Urban	4.34	0.79	4.26	0.82	4.19*	0.88
Rural	4.03	0.99	3.98	0.96	3.90	1.06

Discussion

The results showed that the informative ISA speed-warning device had a large initial effect on the drivers' speeding behaviour. Even when the drivers had been driving with the device for up to 14 months this effect was significant for roads with a 50 km/h and 90 km/h speed limit. This conforms well with previous studies that have shown that different types of ISA-devices have a large initial effect but that this effect is then decreasing with time (Hjälmdahl, 2004).

But how did the use of the informative ISA speed-warning device affect the drivers' attitude towards the system? After having driven with the device activated the test drivers experienced less feeling of being controlled and less increase in travel time in urban areas compared to what they had expected before the device was activated. On the other hand, they experienced a larger feeling of irritation than they had expected. For the remaining items, feeling of safety and stress in traffic together with attention of pedestrians, the personal experience corresponded well with the test drivers' expectations.

Regarding the test drivers expectations on how the informative ISA speed-warning device would affect their actual driving, the test drivers' experience of the device did not cause any large changes due to prolonged use of the device. Six, out of eight, ways in which the test drivers experienced that the device affected their driving experience was not significantly affected due to prolonged exposure. In the remaining two cases prolonged use did however affect their driving experience. After the test drivers had driven with the device installed for more than a year there was a significant decrease in how much time the test drivers felt they needed to spend looking at the speedometer compared to just after activation. Also, the test drivers' experienced a significant increase in how much better they were as drivers, after having driven with the device installed for more than a year, compared to how they had felt during the period just after activation. This might be explained by the fact that it takes some time for a driver to get used to new technologies being integrated in their vehicle.

So, after the drivers had gained personal experience of the informative ISA speed-warning device, what was seen as positive and negative with the device? And when and for whom is

it desirable to have an informative ISA-device installed? Using the Swedish acceptance-scale two different factors was extracted. These factors were, in accordance with Van der Laan *et al.* (1997), named *usefulness* and *satisfying*. In general the items included in the *usefulness* factor scored higher (were more positively received) than the items included in the *satisfying* factor. This suggests that the test drivers are positive towards the idea of the informative ISA speed-warning device and can see its usefulness at the same time as they are not totally satisfied with the experience of the device. The item with good/bad as its end points, loaded high on both factors which suggests that this item covers both aspects of the test drivers' acceptance of the device.

As for when the test drivers thought it was desirable to have an informative ISA speed-warning device installed, roads with a low speed limit (30 km/h and 50 km/h) scored higher compared to roads with a high speed limit (90 km/h and 110 km/h). A reason for this might be that roads with low speed limits is also used by vulnerable road users which means that even rather limited speeding can have disastrous consequences. If a pedestrian is hit by a car driving in 30 km/h the chance of survival is 90% but if the speed is 50 km/h the chance of survival has decreased to 15%-60% (Englund *et al.*, 1998). The test drivers also thought that it was more desirable to have a device installed while driving in busy traffic than while driving under calmer traffic conditions, which can be explained by the fact that the risk for an accident to happen at all, is higher in busy traffic than on a calm road with little traffic.

Regarding for whom the test drivers thought it was desirable to have an informative ISA speed warning device installed, they thought it was more desirable to have a device installed for drivers who repeatedly had been convicted for speeding and for drivers that were inexperienced. For elderly drivers and for commercial- or private drivers in general the test drivers thought it was less desirable to have a device installed. This is in accordance with general knowledge that says that young inexperienced drivers are more likely to be involved in a traffic accident than older and more experienced drivers.

Finally, in general the personal experience the test drivers gained from having the informative ISA speed-warning device installed in their vehicles did not seem to have a large effect on their attitude towards the system in general. Before the device was activated the test drivers perceived it as a good measure to make drivers keep the speed limit in both urban and rural areas. This view did not change after the drivers had driven with the device activated for approximately a month but after they had driven with it for more than a year their evaluation of it had changed. Even though they still thought the device was a good measure their positive perception of it had decreased for both urban and rural areas, even though the decrease was only significant for urban areas.

Conclusions

On the whole the test drivers seemed to be able to predict the effect the informative ISA speed-warning device would have on their driving behaviour and therefore the use of the device did not largely affect their attitude towards the system. But even if the test drivers' attitudes in general were stable over time there were a few exceptions for which the use of the device affected the test drivers' view of the system. In some cases the personal experience of the device made the test drivers more positive towards the system, while in other cases the personal experience made them more negative towards the system. The results also showed that the test drivers liked the idea with the informative ISA speed-warning device and could see its usefulness, at the same time as they were not totally satisfied with the experience of the device. They also thought that the device was more desirable for certain groups of drivers and in certain situations, rather than for the whole driving population in general.

When the day comes and it is time to start implementing different ISA-systems on a large scale, we have to remember that a technical solution can never be successfully implemented without the public's acceptance of the systems. Also, we have to bear in mind that personal experience of a system might affect the drivers' attitude towards the system in both positive and negative ways.

References

- Carsten, O. (2002, May). European research on ISA: Where are we now and what remains to be done. Proceedings of the ICTCT-extra workshop in Nagoya, Japan.
- Englund, A., Gregersen, N. P., Hydén, C., Lövsund, P., & Åberg, L. (1998) *Trafiksäkerhet – en kunskapsöversikt* [Traffic Safety – an overview of the knowledge in the area]. Lund, Sweden: Studentlitteratur.
- Hjälmdahl, M. (2004). In-vehicle speed adaptation. On the effectiveness of a voluntary system. *Lund University Dissertations. Department of Technology and Society*. Lund, Sweden.
- Myhrberg, S., Holting, S., & Brus, N. (2002). *Rätt Fart: Teknik* [The Right Speed Project: Technology]. Borlänge, Sweden: Vägverket.
- Van der Laan, J. D., Heini, A., & De Ward, D. (1997). A simple procedure for the assessment of acceptance of advanced transport telematics. *Transportation Research Part C, 5*, 1-10.
- Vägverket, Swedish National Road Administration (1999) *ISA Intelligent Speed Adaptation*. [Brochure] Borlänge, Sweden: Vägverket.
- Vägverket, Swedish National Road Administration (2002) *Results of the world's largest ISA trial*. [Brochure] Borlänge, Sweden: Vägverket.