ISA implementation in Sweden - from research to reality

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Abstract
The relationship between speed and road safety has been well known among road safety experts for a long time. In the beginning of 1990's, interest for modern information technology solutions grew in Sweden. Several research and demonstration projects were carried out and as a result, approximately 3000 cars have been equipped with new ISA (Intelligent Speed Adaptation) technology from the open market. In this paper the experience from the implementation of ISA systems in Sweden will be presented. Both the hardware and strategic aspects will be discussed.

Keywords
ISA system, Road safety, Vision Zero, Sweden, Intelligent Transport Systems (ITS)

Introduction
The relationship between speed and road safety has been well known among road safety experts for a long time. There is a clear relationship between the speed and the severity of accidents. Even small changes in the speed level result in significant changes in the total number and severity of accidents as shown by Elvik R, Christensen P, Amundsen A, (1). In order to reduce the speed several different measures such as speed limits, enforcement, traffic engineering have been deployed. However, these countermeasures are quite rigid and don't take into account the dynamic characteristics of the road transport system. In the beginning of 1990's, interest for modern information technology solutions grew in Sweden. One focus area was Intelligent Speed Adaptation (ISA). Several research and demonstration projects were carried out and as a result, approximately 3 000 cars have been equipped with new ISA technology from the open market.

An innovative technology has usually two components: a hardware aspect, consisting of the tool that embodies the technology and a usage aspect, consisting of user interfaces, acceptance and incentives. In this paper experiences from the ISA system implementation in Sweden will be presented with particular focus on the technical and strategic aspects..

Small scale trials with different technologies
In the mid 1990's different limited ISA projects were carried out. The technique used in these trials can be described according by how they interfaced with the driver and by the way that the system receive speed limit data.

Ways to interface with the driver:
- Informative systems gives audio or visual information about the prevailing speed limit.
- Supportive systems in addition to information, it also warns the driver when the speed limit is exceeded. This can be done through audio, visual or tactile channels.
- Intervening systems interacts with the vehicle in some way. This type has mainly been represented by the 'active accelerator'. This system gives the driver a slight resistance in the accelerator when the driver attempts to exceed the maximum speed.

In order to receive information about position and prevailing speed limits the systems were mainly tested with two different technologies: GPS with digital maps and roadside transmitters.

The experiments provided important knowledge but did not result in products that could enter a market.

Vision Zero – a new road safety policy in the 1990's
As shown in the figure 1 below, there has been a steadily declining trend in number of fatalities per 100 000 cars in Sweden over the last three decades, possibly as a result of implementing road safety interventions.

Figure 1 *(Source: Swedish Road Administration)*

It has, however, become more and more difficult to push the fatality number down. Sweden has become more and more aware that working with "business as usual" may only be sufficient to maintain existing safety levels. Therefore, parallel with the development of new technology, this insight has pushed for a comprehensive review of existing road safety policy which was commenced in mid 1990s. The final outcome of this review was a new strategy "Vision Zero" which was formally adopted by the Swedish Parliament in October 1997.

Vision Zero differ in many aspects from a more traditional road safety policy but two important strategic aspects are the focus on kinetic energy and the human tolerance to physical forces and the shared responsibility focus which also emphasis people's right and demand for a safe road transport system.

Human tolerance to physical force
The human body's tolerance to physical force could be illustrated according to following figure. For example, a pedestrian hit by a vehicle travelling at 60 km/h is almost certain to be killed, as is a motor vehicle involved in a side-impact crash at 80 km/h, and a motor vehicle occupant involved in a head-on or fixed object crash at 100 km/h. With this perspective speed and human tolerance becomes the most crucial design parameters in order to achieve a safe road transport system. These kinds of thresholds should, for example, compel road designers not to design intersections which allow crashes between motor vehicles higher than approximately 70 km/h.

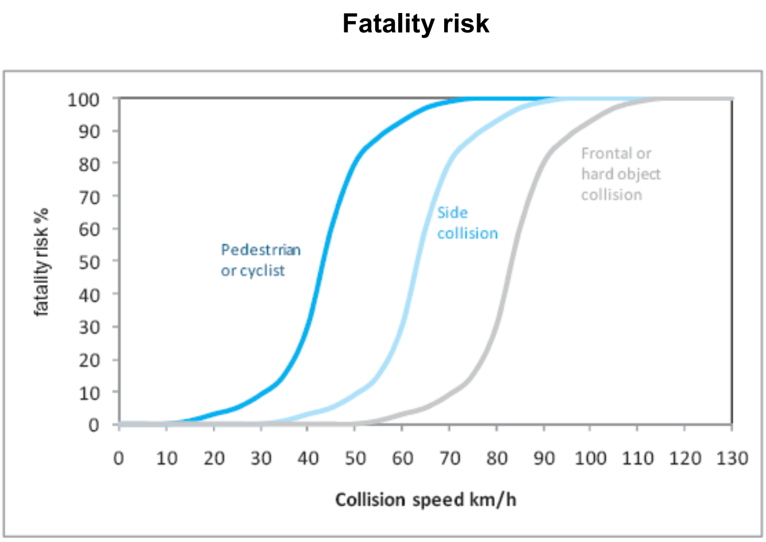

Figure 2 (*Source: Wramborg, P. (2005). A New Approach to a Safe and Sustainable Road Structure and Street Design for Urban Areas. Paper presented at Road Safety on Four Continents Conference, Warsaw Poland)*

People want safety

Traditional traffic safety work primarily aims at reinforcing the capabilities and intentions of road users to act correctly in traffic. Training, information, regulations, and monitoring aimed at road users are important actions in traditional traffic safety work. The starting point is often that there is no demand for safety and that the government must therefore make use of its arsenal of sticks and carrots to influence the road-users. Legal and moral responsibility also falls on road-users, and in the event of a traffic accident, the party most likely to be found guilty.

Vision Zero on the other hand takes a different approach and is based on the idea that people do not accept life threatening risks or long term health losses and they are genuinely interested in safety and have a right to use roads and streets without threats to life or health (Tylösand Declaration 2007). Humans want to have a safe road transport system. This is an important starting point in Vision Zero. The design and function of road transport systems must therefore be adapted to this requirement. Those who deliver roads, traffic environments, trucks, transport services, etc, have a great responsibility to achieve a safe road transport system. System designers therefore always have the greatest responsibility for the safety level of road transport systems. In Vision Zero, road users, as before, are responsible for exercising attention and judgment in traffic, but at the same time it is required that if road users do not take their share of responsibility; system designers must take further actions.

The implementation of a Vision Zero strategy requires, therefore, a process to move people and organizations from need to demand of a safe transport system. A market for example ISA will probably not arise automatically. You need a long term commitment and below are some of the steps taken in Sweden.

Sweden's large scale ISA-trial

Vision Zero and the following public debate around road safety made it possible to move from prototype to a large scale social experiment. In 1999-2002 a large scale trial was commenced in four different municipalities in Sweden. In total some 10 000 drivers tested different hardware systems. Although this trial was first of all a research project in order to evaluate different systems, it was also a step before a broader implementation of ISA systems within the society. Full scale trials of this size made ISA known and put speed on the map as an important factor for road traffic safety and showed all stakeholders that they have a part in road traffic safety.

When the trial ended all stakeholders were positive, the acceptance among the drivers was even higher than it was for safety belts and the car industry was cautiously positive. Since the use of the ISA and other ITS systems had potential to increase safety and reduce climate influence it was, and still is, well in line with the political agenda of the day, there was no question about moving to an implementation phase.

There were (and still are) of course a lot of unanswered questions, but all stakeholders agreed on changing focus from R&D to implementation. Spinoff projects from the large scale trial ran for a couple of more years, but thereafter the SRA tried to be clear on that the national R&D phase was over and implementation should start. From 2004, the Swedish Road Administration (SRA) mainly granted projects aiming at market matters and to promote ISA development within existing systems.

Target group in the implementation stage

As mention previously, Vision Zero added another perspective on responsibility; from individual to also including professional users of the road transport system, and those who influence fleet transport purchaser and other tendered transport services. Therefore, in response to an increasing awareness of organizations responsibility for road safety, many municipalities, private and government organisations have developed programs and policies to improve their own fleet safety and to ensure that their purchased transport services are carried out in a safe manner. One key stakeholder to develop this interest has been the Swedish Road Administration through its so called ‘sectoral activities’. These policy changes have a promising direct effect on the demand for different road safety technology. One good example is the Alcohol starter inter-lock devices which have gone from an almost unknown technology in the mid 1990’s, to over 100.000 units in use today.

The conditions mentioned above suited commercial companies better because they are less price sensitive than private drivers and with tendered fleet transport services, were well suited as a focus group.

Choice of technique

The main incentive and ‘selling argument’ for ISA was that the user wanted an aid to keep to legal speed limits and also as a tool for quality assurance. Consequently the system did not need to initially achieve more than inform the driver. In a later stage, speed data logging for quality assurance would be necessary. The large scale test showed that intervening systems potentially are more effective but was not suitable as an aftermarket device for many reasons. It would to start with be politically delicate to introduce. It is more expensive and complicated than a supportive system. Furthermore, the technology for these kinds of aftermarket devices was not compliant with all types of vehicles. A difficult question is also a matter of legal responsibility in cases of malfunction since this is not an OEM feature (Original Equipment Manufacturer). Another argument is that intervening systems requires a more accurate database than a “softer” system.

Moreover, the large scale trial also showed that using roadside transmitters would have required a larger investment and maintenance cost. Using transmitter technology instead of GPS would also have made the system more difficult to later integrate with other vehicle systems, e.g. navigators and fleet management systems.

Speed limit data

Choosing GPS for vehicle position made access to a speed limit database necessary. Fortunately Sweden had during the first half of 1990’s built the Swedish national road database (NVDB). Not only did its presence make a national ISA implementation technically possible, it also made it easier for management to give an approval for the ISA implementation. A commercial use of the NVDB was expected but has still not been realized. This way the data delivery processes would be put on the spot and feedback would be given on the quality of the database (at least for the speed limit part)

Municipalities

Sweden’s 290 municipalities is one of the four owners of NVDB. The municipalities have showed a great interest in the ISA trials and were a natural and important part in the ISA implementation stage. By installing ISA in their own vehicles and demanding safe speed in their transport purchases they speed up the implementation process. When the municipalities use ISA in their own vehicles it also helps improves the NVDB since they are delivering most of its data. Today, the two largest municipalities, city of Stockholm and Gothenburg both have taken the decision to install ISA in all of their own vehicles as well as demanding ‘safe speed’ in their transport purchases.

Getting ISA on the market

In order to make it possible for the market to offer ISA systems, the SRA decided to buy systems for their own vehicles. A call for tender was published in The Official Journal of the European Union’s supplement S for public procurement. Later these requirements were reformulated with Norway and Finland in our common effort to achieve a Nordic market. (Appendix 1)

The contract was for 300 systems and in 2004 the first vehicles were equipped. The system included a GPS antenna, a display and a hidden box where a memory card was installed. This card was to be replaced when speed limit updates were needed. Since it was crucial to get an acceptance for the system and the quality of the speed limit database in the beginning, a button was included that could silence the speed warning beep for 10 minutes.

Market today

The SRA has a national ambition to be a trendsetter when it comes to transport and vehicle demands. The SRA put pressure on the vehicle industry in late 1990’s when cars consuming more than 0.78 litre per 10 km were excluded from the SRA’s tendered transport services. These kinds of ‘controversial’ demands are a way of showing industry what transport buyers demand. Today demands for Alcohol Starter Interlock and ISA are also included these tendered services. These demands are widely copied in other parts of the Swedish society and contribute to a demand for ISA systems.

From the year 2005 and onwards several ISA-suppliers have appeared on the Swedish market. The first systems were standalone systems with only supporting ISA functionality. Today most suppliers offers ISA together with other services such as fleet management. Approximately 3 000 vehicles are equipped with ISA in Sweden today and some 50 organizations have committed themselves to install ISA. Furthermore, transport contracts are often signed for 3-5 year cycles. This implies that we should see a major increase in equipped vehicles in the coming years. Recent activities from new suppliers and new customers to the NVDB can also indicate that this will be the case.

Acceptance

The use of ISA is a way of increasing acceptance for keeping to speed limits. Using ISA can also bolster an otherwise negative attitude towards installing the system, i.e., users are usually pleasantly surprised by the benefits of using the ISA system. Attitudes towards driving under the influence of alcohol when compared to speeding vary greatly. There is very little acceptance for drunk drivers whereas drivers frequently exceed the speed limits appear to be more accepted.

The SRA estimates that approximately 98-99% of the time ISA is operating in a correct way in relation to signposted speed limit. In a majority of the cases when the information is given late or incorrectly, the driver knows what the correct speed is. The system does in other words function very well as a support to follow prevailing speed limits. In the same way as a navigation system is supporting the driver, it too can sometimes give incorrect information. In relation to the system’s performance, a lot of time and energy is spent on questioning the accuracy and general performance of the system.

It is of course important for the users to trust the system and that the system works correctly, especially to avoid unintentional speeding. But if it is seen and marketed as a supportive system and not as a digital roadside information system today’s quality is comparable to almost any other information source.

ISA in the future

Many activities in Swedish (and international) society are contributing to an improved road safety situation for the future. The increased numbers of speed cameras will not only affect road users wish to avoid a speeding tickets, it will also increase awareness of speed as an important factor. So will the increased use of variable speed limits.

Another important step in this direction is the introduction of a new rating scheme in Euro NCAP which includes speed limitation devices. Even if Euro NCAP only is supporting very trivial speed limitations systems today, the organization has stated the will to promote more intelligent systems when they are available.

Another interesting process is the development of a new ISO standard for road safety: 390001 and according to an early draft, the assurances of and support for safe usage of the road transport system, which including speed, will be an important criteria.
There are signs indicating that the car industry has seen this demand coming. Ford announced in October 2008 the introduction of MyKey; a parental control key that can program the car's top speed. Opel has during 2009 marketed a car with sign recognition and speed limit display. Blaupunkt had earlier introduced the same function in an off-board navigation system.
The possibility for the European car industry to introduce ISA has technically been prevented by the loss of speed limit data. Introduction of ADAS (Advanced Driving Assistance Systems) with cameras for lane-keeping, crash avoidance etc. will hopefully serve as an easy solution for retrieving roadside speed limit information.

References

1. Elvik R, Christensen P, Amundsen A, (2004) Speed and road accidents – an evaluation of the power model, TOI report 740/240

Appendix 1

Nordic ISA/Speed Alert requirements

The purpose of the system is to provide voluntary support to drivers to help them keep to the prevailing speed limit

The system shall comply with the following basic requirements:

- automatically inform the driver about the prevailing speed limit, inside the vehicle and/or
- automatically give the driver a clear warning when the speed limit is exceeded
- the system must be capable of receiving updated speed limit data
- coverage will be classified as:
  A. cross-border functionality in Europe
  B. Swedish roads (state, local authority and other roads)
  C. restricted area (according to customer needs e.g. route, city, county etc.)
  E. Swedish TERN-roads*

SRA specific requirements:

- the system should be permanently fitted to the vehicle.
- the system should start when the vehicle starts
- the system must function in accordance with the requirements for vehicle mounting and design specified in SRA regulation (VVFS 2003:22) and design of HMI conforming to EU's principle 2000/53/EC, document nr C (1999) 4681
- it must be possible for the owner/user to perform system updates without outside assistance
- the system must be able to operate in temperature ranges from -30° to +50° Celsius (and heat from direct sunlight)

Possible development issues and other comments:

- configuration of warning e.g. warning strength, repetition and disabling
- combination with other services, e.g. navigation, speed recording
- possibility to choose other types of warning, e.g. audio, visual, tactile
- ability to give correct position in complex traffic environments
- ability to handle dynamic speed limits e.g. variable, temporary speed limits
- automatic update of speed limit data

* TERN Trans European Road Network