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Anders Lie
Johan Strandroth
Maria Krafft
Swedish Transport Administration
Sweden

SWEDISH ROAD SAFETY ORGANISATION

The Ministry of Enterprise and Innovation is responsible for road traffic safety in Sweden. But due to the decentralised structure in Sweden, the Ministry works with budget, goals, and policy related issues while the operations are managed by the **Swedish Transport Administration** based on the directions from the ministry. The administration is responsible for the planning of the entire transport system with all modes of transport. It is also responsible for the building and maintenance of roads and railroads. The Swedish Transport Administration, also has an overarching role in the development of long term strategies and plans for all modes of transport in the transport system, contributing to the goals set up by the government for the transport sector. The Transport Administration holds responsibility for research within the fields of mobility, environment and traffic safety. It is also performing in-depth studies of fatal crashes within the road traffic system. If co-operation with other actors in society is necessary to effectively achieve its goals the Administration may work together with these actors.

The other authority in the sector is the **Swedish Transport Agency** which has overall responsibility for regulations within air, sea, rail road and road traffic. Within the Swedish Transport Agency the Road and Railway Department formulates regulations, examines and grants permits, as well as exercise supervision within the field of road transport over e.g. road traffic, vehicles, driving licences and commercial transport. The agency also conducts analyses of road traffic and supply information about injuries and accidents within the road transport system. Swedish Transport Agency is also maintains vehicle and driver licence registers.

The Swedish Transport Administration and the Swedish Transport Agency are both responsible to work towards the transport policy goals.

In Sweden the main other bodies active in road traffic safety efforts are the police, the local authorities and the vehicle importers association. Other important parties are the NGOs for example the National Society for Road Safety (NTF), with its member organisations, and transport industry organisations. The Group for National Road Safety Co-operation (GNS) is a central body that co-ordinates the co-operation between the Swedish Transport Administration and Agency, the local authorities the authority for occupational health and safety and the police. The NTF is an additional member of this group, as well as some other key partners from the traffic safety sector.

ROAD TRAFFIC FATALITIES

The Swedish overarching long-term safety objective within the road transport system was settled in 1997 (now twenty years ago), when the Swedish parliament voted for the “Vision Zero”. This vision states that ultimately no one should be killed or seriously injured in the road transport system (Johansson, 2009). The design and function of the system should be adapted to the conditions required to meet this goal.

Since Sweden introduced a visionary goal in the middle of the 1990s several jurisdictions have taken the same approach. In some jurisdictions the name has been changed to Safe Systems Approach to avoid the strong focus on the number zero (OECD, 2008, ITF 2016).

In 2016 the Ministry of Enterprise and Innovation have made a renewed commitment to Vision Zero (Swedish Government, 2016a). In conjunction with this the Swedish Transport Administration got a strengthened responsibility for co-ordination of the traffic safety activities in Sweden.

The Commission of the European Communities has in its White Paper on transports set out the goal “By 2050, move close to zero fatalities in road transport. In line with this goal, the EU aims at halving road casualties by between 2010 and 2020. Make sure

that the EU is a world leader in safety and security of transport in all modes of transport" (EC, 2011. Page 10).

Sweden as member of the European Union was part of the union's target of a 50% reduction of fatalities between 2001 and 2010. For Sweden that target meant a maximum 271 fatalities year 2010.

In the year 2010 the number of fatalities in Sweden was 266. The road toll in Sweden thus did reach the 50% EU target for 2010. Great progress was also made in other countries in the EU.

With significantly less than 300 fatalities per year Sweden is one of the safest countries when it comes to road traffic, with a level of 2.6 fatalities per 100.000 inhabitants in 2015. This is about half of the European Union risk average (5.2 fatalities per 100 000 inhabitants year 2015). In Sweden fatalities related to distance travelled is 3.4 fatalities per billon vehicles-kilometres (2014) which can be compared with the 6.7 fatalities per billion –vehicle kilometres (2014) in USA (IRTAD 2016).

Since 2010 the reduction of fatalities is not on the same level as for the years 2000-2010. The stagnation is most apparent for passenger car fatalities on rural roads. One explanation could be the economic upturn which is supported by the fact that the stagnation is a reality also in the rest of EU and in the US. However, there is reason to believe that what we see may be the beginning of a long-term trend due to fewer infrastructural improvements than before.

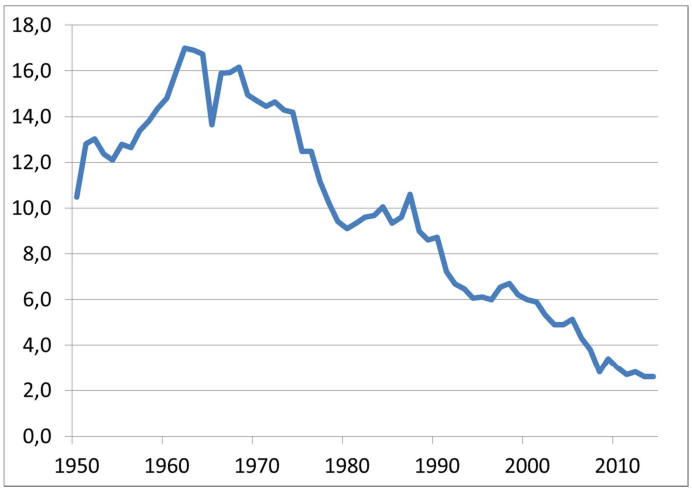

Figure 1. Road fatalities per 100 000 inhabitants in Sweden 1950-2016

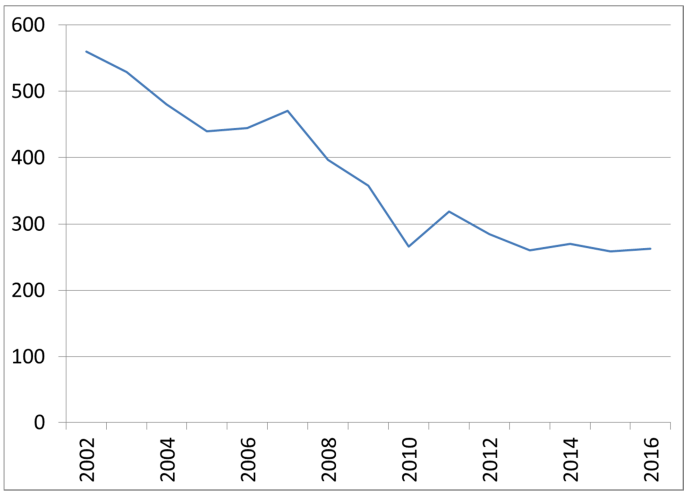

Figure 2. Road fatalities in Sweden 2002 to 2016

INTERIM TRAFFIC SAFETY TARGET FOR 2020

Sweden has a long tradition in setting quantitative road traffic safety targets. In 2009 the Swedish government stated a target of 50% reduction of fatalities and 25 % reduction of severe injuries from 2007 to 2020. This target would demand Sweden to be at a maximum of 220 fatalities in the year 2020. This interim target towards the Vision Zero is a part of an updated continuing road safety operation in collaboration with other stakeholders (The Group for National Road Safety Co-operation, GNS).

After Sweden decided on a target for 2020 the European Union has decided on a 50% fatality reduction between 2010 and 2020.

The current Swedish road safety operation is based on a system of management by objectives. This system is based on cooperation between stakeholders, targets on Safety Performance Indicators (SPI:s), and annual result conferences where road safety developments and targets are followed up. The aim is to create long-term and systematic road safety operation together with the other stakeholders.

In 2016 the interim road safety target for 2020 together with the road SPI:s was revised and proposed to the Swedish Government by the Swedish Transport Administration (STA, 2016). The revised road SPI:s that are monitored is speed compliance, sober driving, seat belt use, helmet use, safe vehicles, correct motorcycles use, safe national roads, safe crossings for vulnerable road users, maintenance standard on bicycle path streets and ISO 39001 - Road traffic safety (RTS) management systems. Most of these indicators each have a target for 2020 which makes it possible to prioritize between measures easier for stakeholders.

One important element in the revision was to predict the benefits of planned interventions for road safety in order to estimate the number of fatalities in 2020. But also to facilitate the prioritisation of future road safety measures to reach midterm and long term road safety targets. It was estimated that the number of road fatalities would be reduced with approximately 16 percent from 2014 to 2020 with the current planned interventions for this period. The main part of the reduction originated from the gradual replacement of the vehicle fleet.

DEVELOPMENT TOWARDS THE GOAL 2020 AND 2030

The role of the vehicles to contribute to the target is further discussed later in this paper. However, it is worth noticing that the replacement of the car fleet gave the biggest contribution to the results 2010 and in the near future. But even though the replacement of vehicles will continue to improve road safety significantly it has been estimated to not be enough to reach the 2020 target.

In 2016 the Swedish Government expressed a new focus on the Vision Zero and an intensified effort for road safety in Sweden. The government commissioned the Swedish Transport Administration to be the lead agency for road safety and the Swedish Government Agency for transport policy analysis to present a new proposal for interim road safety targets beyond 2020 as a response to the UN Global Goals for Sustainable Development (Swedish Government, 2016b).

ISO-MANAGEMENT SYSTEM FOR ROAD TRAFFIC SAFETY

In the spirit of the Tylösand Declaration, Sweden has been an initiator to get a new work within International Organization for Standardization (ISO). The management system standard ISO 39001 was released in 2012.

The vision of the International Management Systems Standard is:

• Elimination of death and serious injury in the road transport system is the overarching goal.

• A voluntary and complimentary tool to legislation, addressing all organizations interacting with road traffic and driven by the needs of interested parties, including market forces.

• An approach to utilize and disseminate ”best practice”.

• Knowledge transfer from Traffic safety experts to the intended user community of the standard.

All requirements of the International Standard are generic and are intended to be applicable to all organizations regardless of type, size, products and services provided.

In Sweden today more than 100 transport companies are certified to ISO 39001.

PENETRATION OF SOME SAFETY SYSTEMS IN SWEDEN

Electronic Stability Control (ESC) has been proven to be very effective in reducing crashes related to loss of control (Erke, 2008, Ferguson, 2007, Lie et al. 2006).

A study of fatal crashes in Sweden has shown that ESC is reducing fatal loss-of-control crashes with 74% (Lie. 2012).

Sweden has been world leading in getting a high degree of ESC penetration in new car sales. Now all new passenger cars were equipped with ESC. Even with this rapid introduction of ESC predictions show that in 2017 only 90% of the traffic will be performed in cars with ESC.

Sweden has actively been part of Euro NCAP since the start of the organisation. Over the years since Euro NCAP started, vehicles safety performance has improve radically. Swedish Transport Administration has done an evaluation of the relation between Euro NCAP results and the risk of injury and fatality in real life crashes. The study shows a 70% fatality risk reduction between a Euro NCAP 2 star car and a 5 star car (Kullgren et al. 2010). Another Swedish study shows the relation between Euro NCAP pedestrian score and real life impairment risks for pedestrians and bicyclists (Strandroth et al. 2014). Results show that the injury severity for pedestrians and bicyclists hit by cars with three and four star pedestrian protection compared to cars with just one star was significantly reduced (24-56%) for all body regions. Regarding injuries of higher severity the reduction was most evident for head injuries. The injury reduction grows with higher levels of medical impairment and in lower impact speeds.

Nowadays all new cars in Europe have seat belt reminders. Seat belt reminders are reducing the number of unbelted driver in city traffic with 80% in Europe (Lie et al. 2008). A Swedish study has shown that seat belt reminders living up to Euro NCAP's specification is increasing seat belt use in fatal crashes with 80%. (Lie, 2012).

Several studies has verified the effectiveness of low and high speed Autonomous Emergency Braking (Rizzi et al., 2014; Fildes et al., 2015; Cicchino, 2016). In the end of 2015 low speed AEB was offered as standard on 55% of the vehicles models sold in Sweden. On 15% it was offered as optional. Regarding high speed AEB it was offered as standard on 19% and optional on 31% of the models respectively. Numbers for 2016 are not yet available.

In 2016 a Swedish study was publishing as one of the first in the world to show the real life effectiveness of Lane Departure Warning (Sternlund el al., 2016). The LDW-system was concluded to contribute to a reduction of head-on and single-vehicle passenger car injury crashes with 30% (with a lower limit of 6% with CI 95%). These findings strongly supports the introduction of LDW/LKA-systems in NCAP test protocols.

THE CONTRIBUTION OF NEW VEHICLES

With a rapid development of vehicles safety there has been of interest to calculate the yearly benefit of the exchange of the vehicle fleet. With about 140 fatalities in cars every year, the exchange of slightly fewer than 7% of the vehicle fleet results in around 8 "saved" lives in 2016. Out of these about two thirds comes from the better crash protection and one third from the ESC systems. As more advanced safety systems are getting to the market bigger effects can be foreseen in the future.

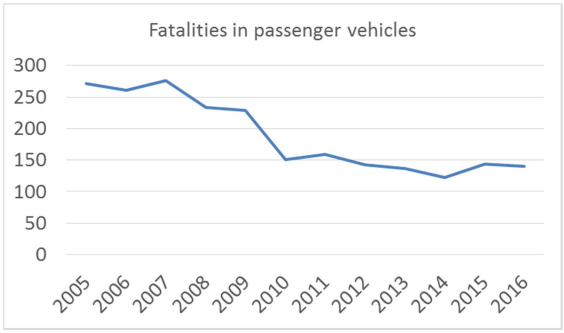

Figure 3. Road fatalities in passenger vehicles Sweden 2005 to 2016

ABS ON MOTORCYCLES

Anti-lock Brakes (ABS) has been proved by several studies to significantly reduce motorcycle crashes by some 20-50% depending on injury severity (Teoh, 2011; HLDI, 2009; Rizzi et al., 2009). A study on US insurance data (HLDI, 2014) also shows that the benefit with ABS was even higher in combination with Combined Brake System (CBS). As technology evolves more advanced ABS-system is expected and in 2013 Bosch introduced Motorcycle Stability Control (MSC) with enables full braking in a cornering manoeuvre.

Earlier studies have focused primarily on heavier motorcycle models. In 2014 a new study was therefore performed in order to confirm if the results applies to lighter motorcycles, i.e. scooters, as well (Rizzi et al., 2015). Results show that the effectiveness of motorcycle ABS in reducing injury crashes ranged from 24% in Italy to 29% in Spain, and 34% in Sweden. The reductions in severe and fatal crashes were even greater, at 34% in Spain and 42% in Sweden. The overall reductions of crashes involving ABS-equipped scooters (at least 250 cc) were 27% in Italy and 22% in Spain.

It was concluded that at this stage, there is more than sufficient scientific-based evidence to support the implementation of ABS on all motorcycles, even light ones.

Many stakeholders have been encouraging the fitment of ABS on new motorcycles (STA, 2012). In Sweden the fitment rate has increased from approximately 15% in 2008 to 85 % in 2014. According to Bosch Corporation (2012) the installation rate in Europe for ABS in production on motorcycles with engine size larger than 250 cc has increased from 27% in 2007 to 36% in 2010. Since the European Parliament also has voted for a legislation which makes ABS mandatory for all new motorcycles over 125cc from 2016, the fitment rate is likely to increase even more in the years to come.

The continuous implementation of ABS will contribute to a motorcycle fleet with increased stability, making crashes that do occur more predictable. This can have important implications for the designers of road transport systems, i.e. future safety countermeasures should be designed with greater focus on upright crashes. Therefore, improving motorcycle stability with ABS can create the conditions for making other safety systems more effective, motorcycle crashworthiness, for instance.

A concept in that direction was developed by Rizzi (2016) as a first step towards a safe system for motorcyclists.

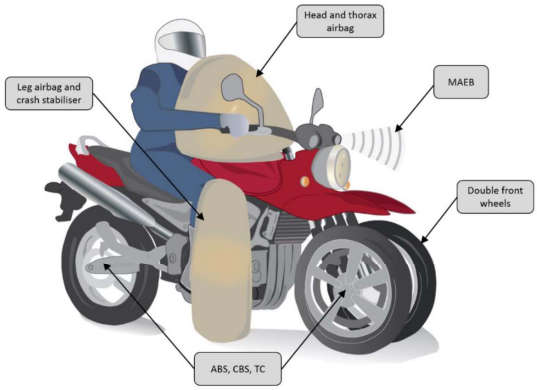

Figure 4. A concept motorcycle with improved crashworthiness (Rizzi, 2016)

FFI – STRATEGIC VEHICLE RESEARCH AND INNOVATION

Transport, mobility and accessibility are of major importance for quality of life and growth. If society is to continue its positive development, transport solutions must be safe and environmentally sustainable. Safe electric cars, smarter logistics and resource-efficient production technology are examples of the innovation and renewal which can help the Swedish automotive industry meet this challenge. To drive the development forwards, Sweden's government together with the industry have initiated a long-term partnership within FFI – Strategic Vehicle Research and Innovation (R&D). Sweden has a long and positive experience of such co-operation between authorities, the industry and academia. FFI funds R&D that focuses on climate, environment and safety. The effort is ongoing and includes some €100 million per year, half of which comes from public funds through VINNOVA, the Swedish Transport Administration and the Swedish Energy Agency. An equivalent amount is invested by the industry partners including Volvo, FKG (Scandinavian Automotive Suppliers), Scania and Volvo Cars who are also parts of the FFI program. This collaboration between public bodies, industry, educational establishments and research institutes is intended to provide high-quality results and contribute to positive social development. In order to keep the focus and to strive for the goals, the members in collaboration have developed a road map defining safety concepts and mile posts for the years 2020, 2025 and 2030. The road maps will be updated as progress is achieved.

FFI funds for projects are divided so that two thirds of the money is allocated to climate and environment while one third to safety. An FFI board is responsible for setting a balance between

targeted projects and more long-term efforts which can deliver ground breaking results. The board's duties also include promoting constructive cooperation between the various actors in the road traffic system.

The investments in FFI take place through various collaborative programmes. One is "traffic safety and automated vehicles". Sweden is a world leader in traffic safety. The programme will contribute to the continued development of vehicles with active systems to prevent accidents as well as passive ones to mitigate the consequences of those accidents where a vehicle is involved. Initiatives have a systemic approach so as to get roads, vehicles and road- users to interact well.

IMPORTANT FIELDS FOR FURTHER RESEARCH

Many fatalities in Sweden as well as globally are related to impaired driving. As many other countries Sweden has an Alco lock programme for offenders. There is also some 100 000 Alco locks used in Sweden in trucks, buses and taxis on a voluntary basis. There are even some installations made in trams, ferries and locomotives. These Alco locks are used on an emerging market for safe transports. Both buyers of transports and suppliers have found these Alco locks attractive to ensure sober drivers. There is an ongoing technology development both in terms of new basic technologies for Alco locks and forms for a reliable and non-intrusive sobriety support systems. Alco locks are well suited to be used for quality assurance with ISO 39001.

Alcohol consumption is not the only reason for impaired driving. Often fatigue, distraction, legal and illegal drugs are also lumped into the term impaired driving. Vehicle systems that detect distraction and fatigue are out on the market. These systems are using signals from the vehicle to analyse the state and driving pattern for the driver. Already today the cars have an idea about when driving isn't up to standards. The systems as of today have weak feed back to the driver and uses signal lamps of haptic feedback. Not far away in time the vehicle will have a good estimate of the potential impairment of the driver. The question is how a vehicle, on its own, can restrict and guide the driver into a safe driving envelope. The most evident way is to limit the speed of the vehicle and putting safety systems into a more nervous mode. This makes a potential crash avoided and less harmful. There is an evident need in society to research this field and to develop guide lines for a safe shut down sequence. Euro NCAP is looking at the possibility to include extended driver monitoring in the future rating system.

The layout of infrastructure and the properties of it are becoming important for modern safety technologies. Already today lane departure warning systems are using lane markings as a critical component. In the near future crash avoidance by steering will need even better environmental awareness from lines and other road furniture. More and more cars are reading traffic signs and speed restriction signs are used to help drivers from speeding. As identified by the European Council, there is an urgent need for better co-operation between vehicle manufacturers and suppliers, and road authorities. Rules, standards and strategies for line painting and road signs could be aligned with the properties of modern vehicle systems to better achieve good functionality and safety.

In the light of the rapid development within the field of automated cars the implication for infrastructure design must be better investigated. An efficient automated system can only be achieved through a tight co-operation between vehicle manufacturers and infrastructure providers. In Sweden the Drive Me project is a foundation for such a co-operation.

Speed management is a key element to achieve good safety. More and more countries are using speed cameras and section control to diminish illegal speeding. In Sweden more than 1000 speed cameras or as it is called in Sweden, "road safety cameras" have been put up the last years. The aim of the camera system in Sweden is to support drivers in making a safe speed choice and, through a change in speed behaviour among a large proportion of the traffic create a new social norm with respect to what is an appropriate speed (Belin et al 2010). This has generated an emerging market demand for support systems helping users not to over speed. Already many years ago nomadic Satnavs indicated the speed limit. The same approach is now entering integrated navigations systems. Some vehicle manufacturers are also using cameras to read speed signs. As an effect of the marker development the consumer crash test program Euro NCAP is today assessing Speed Assistance Systems (SAS) and is using the protocol since January 2013. A better compliance with speed limits will give significant environmental benefits through lower fuels consumption.

Although the road traffic injuries is a very complex problem a comprehensive knowledge have been developed over the years about the magnitude of the road safety problem, knowledge about important risk factors and both theoretical knowledge and practice experience about effective road safety strategies and measures . However, we are still lacking systematic knowledge about the way different public authorities, private organizations in different time periods try to tackle this major public health problem. We do not seem to have an adequate understanding and interpretation of the dynamics of the process aimed at formulating and implementing road safety polices and how sound road safety interventions are diffused in the society. Improving road safety requires knowledge about implementation processes, measures known to be effective and how and where in other sectors of society road safety aspects can be mainstreamed and partnerships built. It also requires the ability to choose the strategies and approaches that best fit the specific conditions of different countries Racioppi 2004, Belin 2012).

The safety development for car users is impressive over the last decade. We have in Sweden seen a drop of in car fatalities with more than 50 %. But there is still a need to further improve.

For other road users the same positive development isn't seen. The fatalities in the group of vulnerable road users is proportionally growing. When looking at impairing injuries, pedestrians together with bicyclists have as many injuries as car users. Significant efforts are needed to reduce the number of killed and severely injured pedestrians, cyclist and motorcyclists. This will impact traffic safety work in the future, both from the road design and the vehicle perspective.

CONCLUSIONS

When it comes to traffic Sweden is one of the safest countries in the world. The Vision Zero approach has further boosted a good safety culture.

The exchange of vehicles in combination with improved vehicle technology is a major contributor to achieve ambitious traffic safety targets. As more than 50% of new sales cars are sold to companies and other non-private buyers, active strategies to convince large fleet buyers to choose best safety standard is of outmost importance.

Road users have a responsibility to operate within the safety limits of the road transport system where vehicle industry in its role as system designer partner can support the road user. Intelligent seat belt reminders, systems alerting drivers when speeding and alcohol starter interlocks are important systems to further develop and put on the market in large scale.

The ISO 39001 management system standard for traffic safety will give organisations a possibility to work focused with traffic safety.

Vehicle manufacturers and organisations responsible for infrastructure must develop better co-operations to ensure that the modern road offers a useful interface to modern vehicle technology such as lane departure warning and traffic sign recognition.

A safe system is achieved when user capabilities, vehicle safety, road design and speed limits all are in harmony. A holistic perspective on road safety is under development and is important when prioritizing research efforts.

More general information is available at the following pages
http://www.trafikverket.se/eng
http://www.transportstyrelsen.se/en
http://www.vinnova.se/en/ffi/

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